Digital Imaging and Communications in Medicine (DICOM)

Supplement 144

Ophthalmic Axial Measurements Storage SOP Classes

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Scope and Field of Application

This Supplement to the DICOM Standard introduces one Measurement IOD for ophthalmic axial measurements devices and one for intraocular lens calculations. This is part of an ongoing program by DICOM WG9 to create a comprehensive set of DICOM information objects for the full range of ophthalmic instruments.

Ophthalmic axial measurements devices currently do not have a specific data representation in the DICOM standard. Similarly to the ophthalmic refractive devices defined in supplement 130 these modalities produce a set of numeric measurement values. Most instruments incorporate an imaging function, or the measurement function may be an adjunct to an imaging modality, and most instruments provide at least a graphical display associated with one or more measurements. For this reason, the present IOD provides for referencing captured graphical displays as well as numeric measurements.

Both ophthalmic axial measurements devices and standalone software produce results of calculations that are based on axial measurements values as well as on data from other sources (for example manual data entry, data transfer, or reference to other SOP instances).

Changes to NEMA Standards Publication PS 3.2-2009

Digital Imaging and Communications in Medicine (DICOM)

Part 2: Conformance

Item: Add to table A.1-2 categorizing SOP Classes:

The SOP Classes are categorized as follows:

Table A.1-2
UID VALUES

UID Value	UID NAME	Category
…	…	…
1.2.840.10008.5.1.4.1.1.78.7	**Ophthalmic Axial Measurements Storage**	**Transfer**
1.2.840.10008.5.1.4.1.1.78.8	**Intraocular Lens Calculations Storage**	**Transfer**
…	…	…

Changes to NEMA Standards Publication PS 3.3-2009

Digital Imaging and Communications in Medicine (DICOM)

Part 3: Information Object Definitions

Update PS3.3 Annex A to include the Ophthalmic Axial Measurements and Intraocular Lens Calculations

A.1.4 Overview of the Composite IOD Module Content

Table A.1-2
COMPOSITE INFORMATION OBJECT MODULE OVERVIEW - NON-IMAGES

IODs Modules	Ophthalmic Axial Measurements	Intraocular Lens Calculations
Patient	**M**	**M**
Clinical Trial Subject	**U**	**U**
General Study	**M**	**M**
Patient Study	**U**	**U**
Clinical Trial Study	**U**	**U**
General Equipment	**M**	**M**
Enhanced General Equipment	**M**	**M**
General Series	**M**	**M**
Clinical Trial Series	**U**	**U**
Ophthalmic Axial Measurements Series	**M**	
Intraocular Lens Calculations Series		**M**
General Ophthalmic Refractive Measurements	**M**	**M**
Ophthalmic Axial Measurements	**M**	
Intraocular Lens Calculations		**M**

SOP Common	**M**	**M**

Add the following to Ophthalmic Measurements IODs PS 3.3 Annex A

A.5A.6 Ophthalmic Axial Measurements Information Object Definition

A.5A.6.1 Ophthalmic Axial Measurements Information Object Description

The Ophthalmic Axial Measurements IOD is used to encode axial measurements of the eye made by an axial measurements device.

A.5A.6.2 Ophthalmic Axial Measurements IOD Entity-Relationship Model

The E-R Model in Section A.1.2 of this Part applies to the Ophthalmic Axial Measurements IOD.

A.5A.6.3 Ophthalmic Axial Measurements IOD Module Table

Table A.5A.6-1 specifies the Modules of the Ophthalmic Axial Measurements IOD.

Table A.5A.6-1
OPHTHALMIC AXIAL MEASUREMENTS IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Ophthalmic Axial Measurements Series	C.8.X.XXX 5	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Measurements	Ophthalmic Axial Measurements	C.8.X.XXX 6	M
	General Ophthalmic Refractive Measurements	C.8.25.7	M
	SOP Common	C.12.1	M

A.5A.8 Intraocular Lens Calculations Information Object Definition

A.5A.8.1 Intraocular Lens Calculations Information Object Description

The Intraocular Lens Calculations IOD is used to encode calculations performed by ophthalmic axial measurements devices or by standalone software. Data input to these calculations comes both from the devices and from other sources.

A.5A.8.2 Intraocular Lens Calculations IOD Entity-Relationship Model

The E-R Model in Section A.1.2 of this Part applies to the Intraocular Lens Calculations IOD.

A.5A.8.3 Intraocular Lens Calculations IOD Module Table

Table A.5A.8-1 specifies the Modules of the Intraocular Lens Calculations IOD.

Table A.5A.8-1
INTRAOCULAR LENS CALCULATIONS IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Intraocular Lens Calculations Series	C.8.X.XXX9	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Measurements	Intraocular Lens Calculations	C.8.X.XXX10	M
	General Ophthalmic Refractive Measurements	C.8.25.7	M
	SOP Common	C.12.1	M

Update PS3.3 to add Modality values for the axial length measurements object and the intraocular lens calculations object

C.7.3.1.1.1 Modality

Defined Term for the Modality (0008,0060) is:

… …

IOL = Intraocular Lens Data

Update PS3.3 to Include Axial Measurements Modules

C.8.X.XXX5 Ophthalmic Axial Measurements Series Module

Table C.8.X.XXX5-1 specifies the Attributes that identify and describe general information about the Ophthalmic Axial Measurements Series.

Table C.8.X.XXX5-1
OPHTHALMIC AXIAL MEASUREMENTS SERIES MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the measurements in this Series. Enumerated Values: OAM See section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related (e.g. a Modality or General-Purpose Performed Procedure Step SOP Instance). Only a single Item shall be permitted in this sequence. Required if the Modality Performed Procedure Step SOP Class, or General Purpose Performed Procedure Step SOP Class is supported.
>Include 'SOP Instance Reference Macro' Table 10-11			

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C.8.X.XXX6 Ophthalmic Axial Measurements Module

Table C.8.X.XXX6-1 defines the Attributes used to encode axial measurements of the eye made by an axial measurements device. This is typically done for both eyes, but may be for just one.

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Table C.8.X.XXX6-1
OPHTHALMIC AXIAL MEASUREMENTS MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Axial Measurements Device Type	(0022,1009)	1	Describes the type of ophthalmic axial measurement acquisition device. Defined Terms: ULTRASOUND OPTICAL
Ophthalmic Ultrasound Method Code Sequence	(0022,1044)	1C	The method used for obtaining axial measurements of the eye. Required if Ophthalmic Axial Measurements Device Type (0022,1009) is ULTRASOUND. Only a single Item shall be permitted in this sequence.
>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4230			

Anterior Chamber Depth Definition Code Sequence	(0022,1125)	3	The definition of anterior chamber depth for this instrument. Only a single Item shall be permitted in this sequence.
>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4239			
Ophthalmic Axial Measurements Right Eye Sequence	(0022,1007)	1C	Axial measurements of a patient's right eye. Required if the right eye is measured. Only a single Item shall be permitted in this sequence.
>Include ' Ophthalmic Axial Measurements Macro' Table C.8.X.XXX6-2			
>Include ' Ophthalmic Axial Measurements Selected Macro' Table C.8.X.XXX6-5			
Ophthalmic Axial Measurements Left Eye Sequence	(0022,1008)	1C	Axial measurements of a patient's left eye. Required if the left eye is measured. Only a single Item shall be permitted in this sequence.
>Include ' Ophthalmic Axial Measurements Macro' Table C.8.X.XXX6-2			
>Include ' Ophthalmic Axial Measurements Selected Macro' Table C.8.X.XXX6-5			

C.8.X.XXX6.1 Ophthalmic Axial Measurements Macro

90 Table C.8.X.XXX6-2 describes the attributes for the Ophthalmic Axial Measurements Macro.

Table C.8.X.XXX6-2
OPHTHALMIC AXIAL MEASUREMENTS MACRO

Attribute Name	Tag	Type	Attribute Description
Lens Status Code Sequence	(0022,1024)	1	Lens status of the eye. See section C.8.X.XXX6.1.1.1 for further explanation. Only a single Item shall be permitted in this sequence.
>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4231			
Lens Status Description	(0022,1065)	3	A free form text description of the Lens Status (0022,1024).
Vitreous Status Code Sequence	(0022,1025)	1	Status of the vitreous cavity. See section C.8.X.XXX6.1.1.2 for further explanation. Only a single Item shall be permitted in this sequence.
>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4232			

Vitreous Status Description	(0022,1066)	3	A free form text description of Vitreous Status (0022,1025).
Pupil Dilated	(0022,000D)	2	Whether or not the patient's pupils were pharmacologically dilated for this acquisition Enumerated Values: YES NO If this tag is empty, no information is available.
Degree of Dilation	(0022,000E)	2C	The degree of the dilation in mm. Required if the value of Pupil Dilated (0022,000D) is YES.
Mydriatic Agent Sequence	(0022,0058)	2C	Information about the agent administered. Required if the value of Pupil Dilated (0022,000D) is YES. Zero or more Items may be included in this sequence. Note: An empty sequence indicates that an agent was used for dilation, but the name was not entered.
>Mydriatic Agent Code Sequence	(0022,001C)	1	The actual agent administered to dilate the pupil. Only a single Item shall be permitted in this sequence.
>>Include 'Code Sequence Macro' Table 8.8-1 Baseline Context ID is 4208.			
>Mydriatic Agent Concentration	(0022,004E)	3	The concentration of the agent.
>Mydriatic Agent Concentration Units Sequence	(0022,0042)	1C	Units of measure for the Mydriatic Agent Concentration. Required if Mydriatic Agent Concentration (0022,004E) is present. Only a single Item shall be permitted in this sequence.
>>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4244			
Ophthalmic Axial Length Measurements Sequence	(0022,1050)	1	Measurements of the axial length of a patient's eye. One or more items shall be present in this sequence.

>Ophthalmic Axial Length Measurements Type	(0022,1010)	1	Identifies whether measuring the total axial length of the patient's eye or a segment of the eye for which a discrete measurement was obtained. Enumerated Values: TOTAL LENGTH = the total axial length was taken with one measurement LENGTH SUMMATION = a summation of segmental lengths that determine the total axial length SEGMENTAL LENGTH = a segmental axial length
>Ophthalmic Axial Length Measurements Total Length Sequence	(0022,1210)	1C	The axial length of a patient's eye, in mm. Required if Ophthalmic Axial Length Measurements Type (0022,1010) is TOTAL LENGTH. One or more items shall be present in this sequence. See section C.8.X.XXX6.1.1.4 for further explanation.
>>Ophthalmic Axial Length	(0022,1019)	1	The axial length measurement acquired, in mm. The type of measurement is specified in the Ophthalmic Axial Length Measurements Type (0022,1010). See sections C.8.X.XXX6.1.1.3 and C.8.X.XXX6.1.1.4 for further explanation.
>>Ophthalmic Axial Length Measurement Modified	(0022,1140)	1	Whether or not the clinician intervened to modify the output of the device. For example by forcing it to select a different peak in the display. Enumerated Values: YES NO
>>Referenced Ophthalmic Axial Length Measurement QC Image Sequence	(0022,1330)	1	Reference to the quality control image associated with this measurement. Only a single Item shall be permitted in this sequence. See section C.8.X.XXX6.1.1.6 for further explanation.
>>>Include 'Ophthalmic Axial Measurements Quality Image SOP Instance Reference Macro' Table C.8.X.XXX10-6			
>>Include 'Ophthalmic Axial Measurements Related Information Macro' Table C.8.X.XXX6-4			

>Ophthalmic Axial Length Measurements Length Summation Sequence	(0022,1212)	1C	Axial length of a patient's eye, in mm, when it is calculated by summation of multiple segmental axial length measurements. Required if Ophthalmic Axial Length Measurements Type (0022,1010) is LENGTH SUMMATION. One or more items shall be present in this sequence. See section C.8.X.XXX6.1.1.4 for further explanation.
>>Ophthalmic Axial Length	(0022,1019)	1	The axial length measurement acquired, in mm. The type of measurement is specified in the Ophthalmic Axial Length Measurements Type (0022,1010). See sections C.8.X.XXX6.1.1.3 and C.8.X.XXX6.1.1.4 for further explanation.
>>Ophthalmic Axial Length Measurement Modified	(0022,1140)	1	Whether or not the clinician intervened to modify the output of the device. For example by forcing it to select a different peak in the display. Enumerated Values: YES NO
>>Referenced Ophthalmic Axial Length Measurement QC Image Sequence	(0022,1330)	1	Reference to the quality control image associated with this measurement. Only a single Item shall be permitted in this sequence. See section C.8.X.XXX6.1.1.6 for further explanation.
>>>Include 'Ophthalmic Axial Measurements Quality Image SOP Instance Reference Macro' Table C.8.X.XXX10-6			
>>Ophthalmic Axial Length Measurements Segmental Length Sequence	(0022,1211)	1	Segmental axial length measurements of a patient's eye that contribute to an aggregate axial length measurement. One or more items shall be present in this sequence. See section C.8.X.XXX6.1.1.4 for further explanation.
>>>Include 'Ophthalmic Axial Length Segmental Measurements Macro' Table C.8.X.XXX6-3			

>Ophthalmic Axial Length Measurements Segmental Length Sequence	(0022,1211)	1C	Segmental axial length measurement of a patient's eye. Required if Ophthalmic Axial Length Measurements Type (0022,1010) is SEGMENTAL LENGTH. Only a single Item shall be permitted in this sequence. See section C.8.X.XXX6.1.1.4 for further explanation.
>>Include 'Ophthalmic Axial Length Segmental Measurements Macro' Table C.8.X.XXX6-3			

C.8.X.XXX6.1.1 Ophthalmic Axial Measurements Macro Attribute Descriptions

C.8.X.XXX6.1.1.1 Lens Status Code Sequence

Lens Status Code Sequence (0022,1024) refers to either the natural lens of the eye (phakic), or various types of lens implants inserted in cataract surgery, or lack of a lens in the eye (aphakic).

C.8.X.XXX6.1.1.2 Vitreous Status Code Sequence

Vitreous Status Code Sequence (0022,1025) refers to either the natural status of the vitreous cavity (vitreous only) or to various possible states after vitreous surgery.

C.8.X.XXX6.1.1.3 Ophthalmic Axial Length

If Ophthalmic Axial Measurements Device Type (0022,1009) is ULTRASOUND, the Ophthalmic Axial Length (0022,1019) measurement is taken from the anterior vertex of the cornea to the anterior surface of the retina (internal limiting membrane).

If Ophthalmic Axial Measurements Device Type (0022,1009) is OPTICAL, the Ophthalmic Axial Length (0022,1019) measurement is taken from the anterior vertex of the cornea to the level of the photoreceptors in the retina and compensated to adjust for the thickness of the retina to mimic the ultrasound technique.

This difference is an inherent property of the measurement method. Since optical devices measure to retinal pigment epithelium and ultrasound devices measure to internal limiting membrane, the difference must be subtracted to obtain comparable results for use in intraocular lens calculation formulas. The difference is the thickness of the retina, which has been determined empirically and varies with the axial length of the eye.

The intent is to measure along the patient's visual axis.

C.8.X.XXX6.1.1.4 Ophthalmic Axial Length Measurements Segment Name Code Sequence

When the acquisition device type is ultrasound, the Ophthalmic Axial Length (0022,1019) may represent distance calculated using a single time value and an average presumed velocity for the entire eye. Alternatively it may represent the sum of multiple segmental axial length measurements with each distance value calculated using a different time value and a presumed velocity specific to that segment of the eye.

When the acquisition device type is optical, the whole length can be measured instead of measuring and summing up different segments of the eye. Nevertheless, optical axial measurement devices can also measure segments of the eye independently (e.g. the Anterior Chamber depth).

Each segment of the eye that is measured shall be identified by the Ophthalmic Axial Length Measurements Segment Name Code Sequence (0022,1101).

C.8.X.XXX6.1.1.5 Observer Type

For attribute Observer Type (0040,A084), Ultrasound axial length measurement devices take many measurements in rapid sequence. The machine can be set to select a good quality measurement automatically, or it can be set so that the user presses a footswitch when he/she sees a quality measurement based on the graphical display.

C.8.X.XXX6.1.1.6 Referenced Ophthalmic Axial Length Measurement QC Image Sequence

The attribute Referenced Ophthalmic Axial Length Measurement QC Image Sequence (0022,1330) references a quality control image that is a secondary capture of the presentation of a one dimensional waveform produced when performing ophthalmic axial measurements. It is acquired by the modality creating the ophthalmic axial measurements. The purpose of these images is to judge the quality of an axial length measurement for use in calculating the power of intraocular lens to place in a patient's eye in cataract surgery. The image is used for quality control and not for diagnostic purposes. See PS3.17.

The SOP Instance for the quality control image will meet the following requirements:

- Frame Increment Pointer (0028,0009) is set to 00182002 = sequencing by Frame Label Vector (0018,2002).

  Note: The frame number is the recommended value for the label.

- The attribute Reference Instance Sequence (0008,114A) is conveyed and only a single item is used. The item in Reference Instance Sequence (0008,114A) contains the value "1.2.840.10008.5.1.4.1.1.78.7" = (this SOP Class) for attribute Referenced SOP Class UID (0008,0050) and attribute Reference SOP Instance UID (0008,1155) will reference this measurement SOP Instance.

- Burned In Annotation (0028,0301) is set to NO.

  The attribute Burned In Annotation (0028,0301) defines whether patient demographics have been burned into the image. This attribute does not prohibit non-demographic burned in annotation, such as position of gates, for image or waveform annotations that are very important to a user. Such annotations are expected to be conveyed and displayed.

- Quality Control Image (0028,0300) is set to YES.

C.8.X.XXX6.2 Ophthalmic Axial Length Segmental Measurements Macro

Table C.8.X.XXX6-3 describes the attributes for the Ophthalmic Axial Length Segmental Measurements Macro.

Table C.8.X.XXX6-3
OPHTHALMIC AXIAL LENGTH SEGMENTAL MEASUREMENTS MACRO

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Axial Length	(0022,1019)	1	The axial length measurement, in mm. The type of measurement is specified in the Ophthalmic Axial Length Measurements Type (0022,1010). See sections C.8.X.XXX6.1.1.3 and C.8.X.XXX6.1.1.4 for further explanation.

Ophthalmic Axial Length Measurement Modified	(0022,1140)	1	Whether or not the clinician intervened to modify the output of the device. For example by forcing it to select a different peak in the display. Enumerated Values: YES NO
Ophthalmic Axial Length Measurements Segment Name Code Sequence	(0022,1101)	1	The name of the segment measured. See section C.8.X.XXX6.1.1.4 for further explanation. Only a single Item shall be permitted in this sequence.
>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4233			
Include 'Ophthalmic Axial Measurements Related Information Macro' Table C.8.X.XXX6-4			

165 **C.8.X.XXX6.3 Ophthalmic Axial Measurements Related Information Macro**

Table C.8.X.XXX6-4 describes the attributes for the Ophthalmic Axial Measurements Related Information Macro.

Table C.8.X.XXX6-4
OPHTHALMIC AXIAL MEASUREMENTS RELATED INFORMATION MACRO

Attribute Name	Tag	Type	Attribute Description
Ultrasound Ophthalmic Axial Length Measurements Sequence	(0022,1220)	1C	Related information about an axial length measurement being performed on an ultrasound device. Required if Ophthalmic Axial Measurements Device Type (0022,1009) is ULTRASOUND. Only a single Item shall be permitted in this sequence.
>Ophthalmic Axial Length Velocity	(0022,1059)	1	The sound velocity used in calculating the Ophthalmic Axial Length Measurement Value (0022,1019), in m/sec.
>Observer Type	(0040,A084)	1	Method used to select which acquired axial length measurement values are kept. Enumerated Values: PSN = Person; manually selected DEV = Device; automatically selected See section C.8.X.XXX6.1.1.5 for further explanation.
>Ophthalmic Axial Length Data Source Code Sequence	(0022,1150)	1	Source of the value recorded in Ophthalmic Axial Length (0022,1019). Only a single Item shall be permitted in this sequence.

>>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4240			
>Ophthalmic Axial Length Data Source Description	(0022,1159)	3	A free text description of the axial length measurement data source.
Optical Ophthalmic Axial Length Measurements Sequence	(0022,1225)	1C	Related information about an axial length measurement being performed on an optical device. Required if Ophthalmic Axial Measurements Device Type (0022,1009) is OPTICAL. Only a single Item shall be permitted in this sequence.
>Signal to Noise Ratio	(0022,1155)	1C	The ratio of signal power to the background noise power (P_{signal}/P_{noise}). Required if Ophthalmic Axial Length Measurements Type (0022,1010) is TOTAL LENGTH. May be present otherwise.
>Ophthalmic Axial Length Data Source Code Sequence	(0022,1150)	1	The source of the value in Ophthalmic Axial Length (0022,1019). Only a single Item shall be permitted in this sequence.
>>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4240			
>Ophthalmic Axial Length Data Source Description	(0022,1159)	3	A free text description of the axial length measurement data source.

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C.8.X.XXX6.4 Ophthalmic Axial Measurements Selected Macro

Table C.8.X.XXX6-5 describes the attributes for the Ophthalmic Axial Measurements Selected Macro. These are the attributes of the Ophthalmic Axial Length (0022,1019) selected for use in IOL calculations.

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OPHTHALMIC AXIAL MEASUREMENTS SELECTED MACRO

Attribute Name	Tag	Type	Attribute Description
Ultrasound Selected Ophthalmic Axial Length Sequence	(0022,1230)	1C	Information related to the selected axial length measurement of the patient's eye when acquired on an ultrasound device. Required if Ophthalmic Axial Measurements Device Type (0022,1009) is ULTRASOUND. Only a single Item shall be permitted in this sequence.
>Ophthalmic Axial Length	(0022,1019)	1	The axial length measurement, in mm. The type of measurement is specified in the Ophthalmic Axial Length Measurements Type (0022,1010). See sections and C.8.X.XXX6.1.1.4 for further explanation.

>Ophthalmic Axial Length Selection Method Code Sequence	(0022,1250)	1	Method used to derive the value recorded in Ophthalmic Axial Length (0022,1019).
>>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4241			
>Referenced Ophthalmic Axial Length Measurement QC Image Sequence	(0022,1330)	1	References to the quality control image associated with this measurement. Only a single Item shall be permitted in this sequence. See section C.8.X.XXX6.1.1.6 for further explanation.
>> Include 'Ophthalmic Axial Measurements Quality Image SOP Instance Reference Macro' Table C.8.X.XXX10-6			
>Ophthalmic Axial Length Quality Metric Sequence	(0022,1262)	1	Information about the quality metric applied to Ophthalmic Axial Length (0022,1019). Only a single Item shall be permitted in this sequence.
>>Include 'Ophthalmic Axial Length Quality Metric Macro' Table C.8.X.XXX6-6			
>Selected Segmental Ophthalmic Axial Length Sequence	(0022,1257)	1C	Segmental axial length measurements of a patient's eye that are summed to derive a total axial length for the eye. Required if Ophthalmic Axial Length Measurements Type (0022,1010) is LENGTH SUMMATION. One or more items shall be present in this sequence.
>>Ophthalmic Axial Length	(0022,1019)	1	The axial length measurement, in mm. The type of measurement is specified in the Ophthalmic Axial Length Measurements Type (0022,1010). See sections C.8.X.XXX6.1.1.3 and C.8.X.XXX6.1.4 for further explanation.
>>Ophthalmic Axial Length Measurements Segment Name Code Sequence	(0022,1101)	1	Name of the segment measured. See section C.8.X.XXX6.1.1.4 for further explanation. Only a single Item shall be permitted in this sequence.
>>>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4233			

Optical Selected Ophthalmic Axial Length Sequence	(0022,1255)	1C	Information related to the selected axial length measurement(s) of the patient's eye when acquired on an optical device. Required if Ophthalmic Axial Measurements Device Type (0022,1009) is OPTICAL. One or more items shall be present in this sequence.
>Selected Total Ophthalmic Axial Length Sequence	(0022,1260)	1C	Total axial length measurement selected for the patient's eye. Required if Ophthalmic Axial Length Measurements Type (0022,1010) is TOTAL LENGTH. Only a single Item shall be permitted in this sequence.
>>Ophthalmic Axial Length	(0022,1019)	1	The axial length measurement, in mm. The type of measurement is specified in the Ophthalmic Axial Length Measurements Type (0022,1010). See sections C.8.X.XXX6.1.1.3 and C.8.X.XXX6.1.1.4 for further explanation.
>>Referenced Ophthalmic Axial Length Measurement QC Image Sequence	(0022,1330)	1	Reference to the quality control image associated with this measurement. Only a single Item shall be permitted in this sequence. See section C.8.X.XXX6.1.1.6 for further explanation.
>>> Include 'Ophthalmic Axial Measurements Quality Image SOP Instance Reference Macro' Table C.8.X.XXX10-6			
>>Ophthalmic Axial Length Quality Metric Sequence	(0022,1262)	1	Information about the quality metric applied to Ophthalmic Axial Length (0022,1019). Only a single Item shall be permitted in this sequence.
>>>Include 'Ophthalmic Axial Length Quality Metric Macro' Table C.8.X.XXX6-6			
>Selected Segmental Ophthalmic Axial Length Sequence	(0022,1257)	1C	Segmental axial length measurement(s) selected for the patient's eye. Required if Ophthalmic Axial Length Measurements Type (0022,1010) is SEGMENTAL LENGTH. May be present otherwise. One or more items shall be present in this sequence.
>>Ophthalmic Axial Length Measurements Segment Name Code Sequence	(0022,1101)	1	Name of the segment measured. See section C.8.X.XXX6.1.1.4 for further explanation. Only a single Item shall be permitted in this sequence.

>>>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4233			
>>Ophthalmic Axial Length	(0022,1019)	1	The axial length measurement, in mm. The type of measurement is specified in the Ophthalmic Axial Length Measurements Type (0022,1010). See sections C.8.X.XXX6.1.1.3 and C.8.X.XXX6.1.1.4 for further explanation.
>>Referenced Ophthalmic Axial Length Measurement QC Image Sequence	(0022,1330)	3	Reference to the quality control image associated with this measurement. Only a single Item shall be permitted in this sequence. See section C.8.X.XXX6.1.1.6 for further explanation.
>>>Include 'Ophthalmic Axial Measurements Quality Image SOP Instance Reference Macro' Table C.8.X.XXX10-6			
>>Ophthalmic Axial Length Quality Metric Sequence	(0022,1262)	3	Information about the quality metric applied to Ophthalmic Axial Length (0022,1019). Only a single Item shall be permitted in this sequence.
>>>Include 'Ophthalmic Axial Length Quality Metric Macro' Table C.8.X.XXX6-6			

C.8.X.XXX6.5 Ophthalmic Axial Measurements Quality Metric Macro

Table C.8.X.XXX6-6 describes the attributes for the Ophthalmic Axial Length Quality Metric
180 Macro.

Table C.8.X.XXX6-6
OPHTHALMIC AXIAL LENGTH QUALITY METRIC MACRO

Attribute Name	Tag	Type	Attribute Description
Concept Name Code Sequence	(0040,A043)	1	Type of metric used to evaluate the quality of the ophthalmic axial length. Only a single Item shall be permitted in this sequence.
>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4243			
Numeric Value	(0040,A30A)	1	Value for quality metric applied to axial length values.
Measurement Units Code Sequence	(0040,08EA)	1	Units of Numeric Value (0040,A30A). Only a single Item shall be permitted in this sequence.
>Include 'Code Sequence Macro' Table 8.8-1 Defined Context ID is 82			

Update PS3.3 to Include Intraocular Lens Calculations Modules

C.8.X.XXX9 Intraocular Lens Calculations Series Module

Table C.8.X.XXX9-1 specifies the Attributes that identify and describe general information about the Intraocular Lens Calculations Series.

Table C.8.X.XXX9-1
INTRAOCULAR LENS CALCULATIONS SERIES MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Specific equipment on which the software that performed the calculations in this Series resides. Enumerated Values: IOL See section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related (e.g. a Modality or General-Purpose Performed Procedure Step SOP Instance). Only a single Item shall be permitted in this sequence. Required if the Modality Performed Procedure Step SOP Class, or General Purpose Performed Procedure Step SOP Class is supported.
>Include 'SOP Instance Reference Macro' Table 10-11			

C.8.X.XXX10 Intraocular Lens Calculations Module

Table C.8.X.XXX10-1 defines the Attributes used to calculate the power of an intraocular lens to be placed in a patient's eye. This is typically done for both eyes for comparison, but may be for just one eye. Values used may be measurements acquired using the axial length measurements device, manually entered, or derived from a referenced SOP class or other data source.

Table C.8.X. XXX10-1
INTRAOCULAR LENS CALCULATIONS MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Intraocular Lens Calculations Right Eye Sequence	(0022,1300)	1C	Calculations of intraocular lens power for a patient's right eye. Required if the device calculated intraocular lens power for the right eye. One or more Items shall be included in this sequence.
>Include 'Intraocular Lens Calculations Macro' Table C.8.X.XXX10-2			

Intraocular Lens Calculations Left Eye Sequence	(0022,1310)	1C	Calculations of intraocular lens power for a patient's left eye. Required if the device calculated intraocular lens power for the left eye. One or more Items shall be included in this sequence.
>*Include '*Intraocular Lens Calculations *Macro' Table C.8.X.XXX10-2*			

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C.8.X.XXX10.1 Intraocular Lens Calculations Module Attributes

C.8.X.XXX10.1.1 Referenced SOP Sequence

Data in an IOL Calculations SOP Instance will frequently be gathered from other SOP instances, such as ophthalmic axial measurements SOP Instances or refractive measurements SOP
205 Instances. If this occurs, a reference to the SOP instances is desired in attribute Referenced SOP Sequence (0008,1199).

C.8.X.XXX10.2 Intraocular Lens Calculations Macro

Table C.8.X.XXX10-2 describes the attributes for the Intraocular Lens Calculations Macro.

210 **Table C.8.X.XXX10-2**
INTRAOCULAR LENS CALCULATIONS MACRO

Attribute Name	Tag	Type	Attribute Description
Target Refraction	(0022,1037)	1	The desired postoperative refractive error, in diopters.
Refractive Procedure Occurred	(0022,1039)	2	Whether or not a patient has had refractive surgery. Enumerated Values: YES NO
Refractive Surgery Type Code Sequence	(0022,1040)	2C	Type of refractive surgery a patient has had. Required if the value of Refractive Procedure Occurred (0022,1039) is YES. One or more Items may be included in this sequence.
>*Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4234*			

Refractive Error Before Refractive Surgery Code Sequence	(0022,1103)	2C	The patient's refractive error before any of the refractive surgeries listed in Refractive Surgery Type Code Sequence (0022,1040) were performed. Required if the value of Refractive Procedure Occurred (0022,1039) is YES. Only a single Item shall be permitted in this sequence.
>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4238			
Corneal Size	(0046,0046)	3	The horizontal diameter measurement of the cornea, in mm.
Lens Thickness Sequence	(0022,1127)	3	Lens thickness value and source. Only a single Item shall be permitted in this sequence.
>Lens Thickness	(0022,1130)	1	The value for axial length of the lens in a patient's eye, in mm.
>Source of Lens Thickness Data Code Sequence	(0022,1132)	1	Source of the value of Lens Thickness (0022,1130). Only a single Item shall be permitted in this sequence.
>>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4240			
>Referenced SOP Sequence	(0008,1199)	1C	SOP Instance that is relevant to the interpretation of this SOP Instance. Only a single Item shall be permitted in this sequence. See section C.8.X.XXX10.1.1 for further explanation. Required if Source of Lens Thickness Data Code Sequence (0022,1132) contains an item with the value (111782, DCM, "Axial Measurements SOP Instance").
>>Include 'SOP Instance Reference Macro' Table 10-11			
Anterior Chamber Depth Sequence	(0022,1128)	3	Anterior chamber depth value and source. Only a single Item shall be permitted in this sequence.
>Anterior Chamber Depth	(0022,1131)	1	The value for axial length of the anterior chamber, in mm.
>Source of Anterior Chamber Depth Data Code Sequence	(0022,1133)	1	Source of the value of Anterior Chamber Depth (0022,1131). Only a single Item shall be permitted in this sequence.
>>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4240			

>Referenced SOP Sequence	(0008,1199)	1C	SOP Instance that is relevant to the interpretation of this SOP Instance. Only a single Item shall be permitted in this sequence. See section C.8.X.XXX10.1.1 for further explanation. Required if Source of Anterior Chamber Depth Data Code Sequence (0022,1133) contains an item with the value (111782, DCM, “Axial Measurements SOP Instance”).
>>Include ‘SOP Instance Reference Macro’ Table 10-11			
Refractive State Sequence	(0022,001B)	2	Refractive state of the imaged eye at the time of acquisition. Zero or one Item may be included in this sequence.
>Spherical Lens Power	(0022,0007)	1	Sphere value in diopters.
>Cylinder Lens Power	(0022,0008)	1	Cylinder value in diopters.
>Cylinder Axis	(0022,0009)	1	Axis value in degrees.
>Source of Refractive Measurements Sequence	(0022,1134)	1	Refractive measurements source. Only a single Item shall be permitted in this sequence.
>>Source of Refractive Measurements Code Sequence	(0022,1135)	1	Source of values in Refractive State Sequence (0022,101B). Only a single Item shall be permitted in this sequence.
>>>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4240			
>>Referenced SOP Sequence	(0008,1199)	1C	SOP Instances that are relevant to the interpretation of this SOP Instance. One or more items may be included in this sequence. See section C.8.X.XXX10.1.1 for further explanation. Required if Source of Refractive Measurements Code Sequence (0022,1135) contains an item with the value (111783, DCM, “Refractive Measurements SOP Instance”).
>>>Include ‘SOP Instance Reference Macro’ Table 10-11			
Include ‘Keratometry Macro’ Table C.8.X.XXX10-3			
IOL Formula Code Sequence	(0022,1028)	1	Formula used to calculate IOL power. Only a single Item shall be permitted in this sequence.
>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4236			

IOL Formula Detail	(0022,1029)	3	A free form text description of the of the IOL Formula Code Sequence (0022,1028) (e.g. a reference to the mathematical equation).
Include 'IOL Ophthalmic Axial Length Macro' Table C.8.X.XXX10-4			
Include 'Calculated IOL Macro' Table C.8.X.XXX10-5			

C.8.X.XXX10.3 Keratometry Macro

Table C.8.X.XXX10-3 describes the attributes for the Keratometry Macro.

215 **Table C.8.X.XXX10-3**
KERATOMETRY MACRO

Attribute Name	Tag	Type	Attribute Description
Steep Keratometric Axis Sequence	(0046,0074)	1	Steepest meridian as defined by the greatest power of curvature and shortest radius of curvature. Only a single Item shall be permitted in this sequence.
>Radius of Curvature	(0046,0075)	1	The radius of curvature of the principal meridians of the cornea, measured in mm.
>Keratometric Power	(0046,0076)	2	The refractive power of the cornea at the principal meridians, measured in diopters.
>Keratometric Axis	(0046,0077)	2	The meridian where the keratometric radius of curvature or power is measured, in degrees.
Flat Keratometric Axis Sequence	(0046,0080)	1	Flattest meridian as defined by the least power of curvature and longest radius of curvature. Only a single Item shall be permitted in this sequence.
>Radius of Curvature	(0046,0075)	1	The radius of curvature of the principal meridians of the cornea, measured in mm.
>Keratometric Power	(0046,0076)	2	The refractive power of the cornea at the principal meridians, measured in diopters.
>Keratometric Axis	(0046,0077)	2	The meridian where the keratometric radius of curvature or power is measured, in degrees.
Keratometry Measurement Type Code Sequence	(0022,1096)	2	Descriptors relevant to keratometry data. Only a single Item shall be permitted in this sequence.
>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4235			

Keratometer Index	(0022,1033)	2	The translation factor specific to each keratometer that derives a number for power from the measured radius of curvature of the cornea.

C.8.X.XXX10.4 IOL Ophthalmic Axial Length Macro

Table C.8.X.XXX10-4 describes the attributes for the IOL Ophthalmic Axial Length Macro.

220 **Table C.8.X.XXX10-4**
IOL OPHTHALMIC AXIAL LENGTH MACRO

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Axial Length Sequence	(0022,1012)	1	Axial length value and source that was used in calculation of IOL power. Only a single Item shall be permitted in this sequence.
>Ophthalmic Axial Length	(0022,1019)	1	The axial length of a patient's eye, in mm, that was used in calculation of IOL power.
>Ophthalmic Axial Length Selection Method Code Sequence	(0022,1250)	1	Method used to select the value recorded in Ophthalmic Axial Length (0022,1019). Only a single Item shall be permitted in this sequence.
>>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4241			
>Source of Ophthalmic Axial Length Code Sequence	(0022,1035)	1	Source of the value of Ophthalmic Axial Length (0022,1019). Only a single Item shall be permitted in this sequence.
>>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4240			
>Referenced SOP Sequence	(0008,1199)	1C	SOP Instances that are relevant to the interpretation of this SOP Instance. One or more items may be included in this sequence. See section C.8.X.XXX10.1.1 for further explanation. Required if Source of Ophthalmic Axial Length Code Sequence (0022,1035) contains an item with the value (111782, DCM, "Axial Measurements SOP Instance").
>>Include 'SOP Instance Reference Macro' Table 10-11			

>Ophthalmic Ultrasound Method Code Sequence	(0022,1044)	1C	Method used for obtaining axial measurements of the eye. Required if Ophthalmic Axial Measurements Device Type (0022,1009) is ULTRASOUND. Only a single Item shall be permitted in this sequence.
>>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4230			

C.8.X.XXX10.5 Calculated IOL Macro

Table C.8.X.XXX10-5 describes the attributes for the Calculated IOL Macro.

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Table C.8.X.XXX10-5
CALCULATED IOL MACRO

Attribute Name	Tag	Type	Attribute Description
IOL Manufacturer	(0022,1093)	1	Name of the manufacturer that produced the lens.
Implant Name	(0022,1095)	1	The (product) name of the lens.
Lens Constant Sequence	(0022,1092)	1	Constants used in calculation of intraocular lens power. These constants are a characteristic of the model of intraocular lens being considered for use in cataract surgery. One or more Items shall be included in this sequence.
>Concept Name Code Sequence	(0040,A043)	1	Constant type used in calculation of intraocular lens power. Only a single Item shall be permitted in this sequence.
>>Include 'Code Sequence Macro' Table 8.8-1. Defined Context ID is 4237			
>Numeric Value	(0040,A30A)	1	The value of the constant used.
IOL Power Sequence	(0022,1090)	1	Information needed to select the intraocular lens power for cataract surgery. One or more Items shall be included in this sequence.
>IOL Power	(0022,1053)	1	The intraocular lens power, in diopters.
>Predicted Refractive Error	(0022,1054)	1	The predicted postoperative refractive error (i.e. amount of near or far sightedness), in diopters.
>Implant Part Number	(0022,1097)	2	The (product) identifier of the lens.
IOL Power for Exact Emmetropia	(0022,1121)	2	The IOL power that would be required to achieve exact emmetropia, or no need for glasses at distance after surgery, in diopters.

IOL Power for Exact Target Refraction	(0022,1122)	2	The IOL power that would be required to exactly achieve the Target Refraction (0022,1037), in diopters.

C.8.X.XXX10.6 Ophthalmic Axial Measurements Quality Image SOP Instance Reference Macro

Table C.8.X.XXX10-6 describes the attributes for the Ophthalmic Axial Measurements Quality Image SOP Instance Reference Macro

Table C.8.X.XXX10-6
OPHTHALMIC AXIAL MEASUREMENTS QUALITY IMAGE SOP INSTANCE REFERENCE MACRO

Attribute Name	Tag	Type	Attribute Description
Referenced SOP Class UID	(0008,1150)	1	Uniquely identifies the referenced SOP Class. Enumerated Values: “1.2.840.10008.5.1.4.1.1.7.2” = Multi-frame Grayscale Byte Secondary Capture Image Storage “1.2.840.10008.5.1.4.1.1.7.4” = Multi-frame True Color Secondary Capture Image Storage
Referenced SOP Instance UID	(0008,1155)	1	Uniquely identifies the referenced SOP Instance.
Referenced Frame Number	(0008,1160)	1	Identifies the frame number within the Referenced SOP Instance to which the reference applies. The first frame shall be denoted as frame number 1. Only a single value shall exist. Note: This Attribute is a multi-value field but for this Macro it can only contain one value.

Update Annex F to include Measurements for the Directory Record

Table F.3-3

DIRECTORY INFORMATION MODULE

Attribute Name	Tag	Type	Attribute Description
>Directory Record Type	(0004,1430)	1C	…

			Enumerated Values (see Section F.5): **MEASUREMENT**

Table F.4-1

RELATIONSHIP BETWEEN DIRECTORY RECORDS

Directory Record Type	Section	Directory Record Types which may be included in the next lower-level directory Entity
…	…	…
SERIES	F.5.3	IMAGE, RT DOSE, RT STRUCTURE SET, RT PLAN, RT TREAT RECORD, PRESENTATION, WAVEFORM, SR DOCUMENT, KEY OBJECT DOC, SPECTROSCOPY, RAW DATA, REGISTRATION, FIDUCIAL, ENCAP DOC, VALUE MAP, STEREOMETRIC, **MEASUREMENT,** PRIVATE
…		
MEASUREMENT	**F.5.X**	**PRIVATE**

Update Annex F- Figure F.4-1 Basic Directory IOD Information Model: add Measurement DR below the Series DR, as 0-n under "<references>"

F.5.X Measurement directory record definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "MEASUREMENT". Table F.5-X lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Measurement IE of the Measurement IODs. This Directory Record shall be used to reference a Measurement SOP Instance. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-X
MEASUREMENT KEYS

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Content Date	(0008,0023)	1	The date the content creation started.
Content Time	(0008,0033)	1	The time the content creation started.
Include Content Identification Macro Table 10-12			
Any other Attribute of the Measurement IE Modules		3	

Note: Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (See Table F.3-3), it is not duplicated in this list of keys.

Changes to NEMA Standards Publication PS 3.4-2009

Digital Imaging and Communications in Medicine (DICOM)

Part 4: Service Class Specifications

Update PS3.4 to Include Ophthalmic Axial Measurements and Intraocular Lens Calculations SOP Classes to Annex B

B.5 Standard SOP Classes

Table B.5-1
STANDARD SOP CLASSES

SOP Class Name	SOP Class UID	IOD (See PS 3.3)
Ophthalmic Axial Measurements Storage	1.2.840.10008.5.1.4.1.1.78.7	Ophthalmic Axial Measurements
Intraocular Lens Calculations Storage	1.2.840.10008.5.1.4.1.1.78.8	Intraocular Lens Calculations

Add Ophthalmic Axial Measurements and Intraocular Lens Calculations Media Storage SOP Classes to PS3.4 Annex I

I.4 MEDIA STANDARD STORAGE SOP Classes

Table I.4-1
Media Storage Standard SOP Classes

SOP Class Name	SOP Class UID	IOD (See PS 3.3)
Ophthalmic Axial Measurements Storage	1.2.840.10008.5.1.4.1.1.78.7	Ophthalmic Axial Measurements
Intraocular Lens Calculations Storage	1.2.840.10008.5.1.4.1.1.78.8	Intraocular Lens Calculations

Add to Annex B.5.1 for Ophthalmic Axial Measurements and Intraocular Lens Calculations Storage SOP Classes

B.5.1.x Ophthalmic Axial Measurements Storage SOP Class

Ophthalmic axial measurements devices are used in the preoperative assessment of every cataract surgery patient. Ophthalmic axial measurements SOP Classes support ophthalmic axial measurements devices.

For a device that is both a SCU and a SCP of the Ophthalmic Axial Measurements Storage SOP Class, in addition to the behavior for the Storage Service Class specified in B.2.2, the following additional requirements are specified for Ophthalmic Axial Measurements Storage SOP Classes:

— A SCP of this SOP Class shall support Level 2 Conformance as defined in Section B.4.1.

Note: This requirement means that all Type 1, Type 2, and Type 3 Attributes defined in the Information Object Definition and Private Attributes associated with the SOP Class will be stored and may be accessed.

B.5.1.y IOL Calculation Storage SOP Class

IOL (intraocular lens) calculation is used in the preoperative assessment of every cataract surgery patient. IOL Calculation SOP Classes support IOL calculation software, which may be located either on ophthalmic axial measurement devices or on a separate computer.

For a device that is both a SCU and a SCP of the IOL Calculation Storage SOP Class, in addition to the behavior for the Storage Service Class specified in B.2.2, the following additional requirements are specified for IOL Calculation Storage SOP Classes:

— A SCP of this SOP Class shall support Level 2 Conformance as defined in Section B.4.1.

Note: This requirement means that all Type 1, Type 2, and Type 3 Attributes defined in the Information Object Definition and Private Attributes associated with the SOP Class will be stored and may be accessed.

315 **Changes to NEMA Standards Publication PS 3.6-2009**

Digital Imaging and Communications in Medicine (DICOM)

Part 6: Data Dictionary

320 **Modify PS3.6 Section 6 Registry of DICOM data elements – add new items.**

Tag	Name	Keyword	VR	VM
(0022,1007)	Ophthalmic Axial Measurements Right Eye Sequence	OphthalmicAxialMeasurementsRightEyeSequence	SQ	1
(0022,1008)	Ophthalmic Axial Measurements Left Eye Sequence	OphthalmicAxialMeasurementsLeftEyeSequence	SQ	1
(0022,1009)	Ophthalmic Axial Measurements Device Type	OphthalmicAxialMeasurementsDeviceType	CS	1
(0022,1010)	Ophthalmic Axial Length Measurements Type	OphthalmicAxialLengthMeasurementsType	CS	1
(0022,1012)	Ophthalmic Axial Length Sequence	OphthalmicAxialLengthSequence	SQ	1
(0022,1019)	Ophthalmic Axial Length	OphthalmicAxialLength	FL	1
(0022,1024)	Lens Status Code Sequence	LensStatusCodeSequence	SQ	1
(0022,1025)	Vitreous Status Code Sequence	VitreousStatusCodeSequence	SQ	1
(0022,1028)	IOL Formula Code Sequence	IOLFormulaCodeSequence	SQ	1
(0022,1029)	IOL Formula Detail	IOLFormulaDetail	LO	1
(0022,1033)	Keratometer Index	KeratometerIndex	FL	1
(0022,1035)	Source of Ophthalmic Axial Length Code Sequence	SourceofOphthalmicAxialLengthCodeSequence	SQ	1
(0022,1037)	Target Refraction	TargetRefraction	FL	1
(0022,1039)	Refractive Procedure Occurred	RefractiveProcedureOccurred	CS	1
(0022,1040)	Refractive Surgery Type Code Sequence	RefractiveSurgeryTypeCodeSequence	SQ	1
(0022,1044)	Ophthalmic Ultrasound Method Code Sequence	OphthalmicUltrasoundMethodCodeSequence	SQ	1
(0022,1050)	Ophthalmic Axial Length Measurements Sequence	OphthalmicAxialLengthMeasurementsSequence	SQ	1
(0022,1053)	IOL Power	IOLPower	FL	1
(0022,1054)	Predicted Refractive Error	PredictedRefractiveError	FL	1
(0022,1059)	Ophthalmic Axial Length Velocity	OphthalmicAxialLengthVelocity	FL	1
(0022,1065)	Lens Status Description	LensStatusDescription	LO	1
(0022,1066)	Vitreous Status Description	VitreousStatusDescription	LO	1
(0022,1090)	IOL Power Sequence	IOLPowerSequence	SQ	1
(0022,1092)	Lens Constant Sequence	LensConstantSequence	SQ	1

Tag	Name	Keyword	VR	VM
(0022,1093)	IOL Manufacturer	IOLManufacturer	LO	1
(0022,1095)	Implant Name	ImplantName	LO	1
(0022,1096)	Keratometry Measurement Type Code Sequence	KeratometryMeasurementTypeCodeSequence	SQ	1
(0022,1097)	Implant Part Number	ImplantPartNumber	LO	1
(0022,1100)	Referenced Ophthalmic Axial Measurements Sequence	ReferencedOphthalmicAxialMeasurementsSequence	SQ	1
(0022,1101)	Ophthalmic Axial Length Measurements Segment Name Code Sequence	OphthalmicAxialLengthMeasurementsSegmentName Code Sequence	SQ	1
(0022,1103)	Refractive Error Before Refractive Surgery Code Sequence	RefractiveErrorBeforeRefractiveSurgeryCodeSequence	SQ	1
(0022,1121)	IOL Power For Exact Emmetropia	IOLPowerForExactEmmetropia	FL	1
(0022,1122)	IOL Power For Exact Target Refraction	IOLPowerForExactTargetRefraction	FL	1
(0022,1125)	Anterior Chamber Depth Definition Code Sequence	AnteriorChamberDepthDefinitionCodeSequence	SQ	1
(0022,1127)	Lens Thickness Sequence	LensThicknessSequence	SQ	1
(0022,1128)	Anterior Chamber Depth Sequence	AnteriorChamberDepthSequence	SQ	1
(0022,1130)	Lens Thickness	LensThickness	FL	1
(0022,1131)	Anterior Chamber Depth	AnteriorChamberDepth	FL	1
(0022,1132)	Source of Lens Thickness Data Code Sequence	SourceofLensThicknessDataCodeSequence	SQ	1
(0022,1133)	Source of Anterior Chamber Depth Data Code Sequence	SourceofAnteriorChamberDepthDataCodeSequence	SQ	1
(0022,1134)	Source of Refractive Measurements Sequence	SourceofRefractiveMeasurementsSequence	SQ	1
(0022,1135)	Source of Refractive Measurements Code Sequence	SourceofRefractiveMeasurementsCodeSequence	SQ	1
(0022,1140)	Ophthalmic Axial Length Measurement Modified	OphthalmicAxialLengthMeasurementModified	CS	1
(0022,1150)	Ophthalmic Axial Length Data Source Code Sequence	OphthalmicAxialLengthDataSourceCodeSequence	SQ	1
(0022,1155)	Signal to Noise Ratio	SignaltoNoiseRatio	FL	1
(0022,1159)	Ophthalmic Axial Length Data Source Description	OphthalmicAxialLengthDataSourceDescription	LO	1

Tag	Name	Keyword	VR	VM
(0022,1210)	Ophthalmic Axial Length Measurements Total Length Sequence	OphthalmicAxialLengthMeasurementsTotalLengthSequence	SQ	1
(0022,1211)	Ophthalmic Axial Length Measurements Segmental Length Sequence	OphthalmicAxialLengthMeasurementsSegmentalLengthSequence	SQ	1
(0022,1212)	Ophthalmic Axial Length Measurements Length Summation Sequence	OphthalmicAxialLengthMeasurementsLength SummationSequence	SQ	1
(0022,1220)	Ultrasound Ophthalmic Axial Length Measurements Sequence	UltrasoundOphthalmicAxialLengthMeasurementsSequence	SQ	1
(0022,1225)	Optical Ophthalmic Axial Length Measurements Sequence	OpticalOphthalmicAxialLengthMeasurementsSequence	SQ	1
(0022,1230)	Ultrasound Selected Ophthalmic Axial Length Sequence	UltrasoundSelectedOphthalmicAxialLengthSequence	SQ	1
(0022,1250)	Ophthalmic Axial Length Selection Method Code Sequence	OphthalmicAxialLengthSelectionMethodCodeSequence	SQ	1
(0022,1255)	Optical Selected Ophthalmic Axial Length Sequence	OpticalSelectedOphthalmicAxialLengthSequence	SQ	1
(0022,1257)	Selected Segmental Ophthalmic Axial Length Sequence	SelectedSegmentalOphthalmicAxialLengthSequence	SQ	1
(0022,1260)	Selected Total Ophthalmic Axial Length Sequence	SelectedTotalOphthalmicAxialLengthSequence	SQ	1
(0022,1262)	Ophthalmic Axial Length Quality Metric Sequence	OphthalmicAxialLengthQualityMetricSequence	SQ	1
(0022,1265)	Ophthalmic Axial Length Quality Metric Type Code Sequence	OphthalmicAxialLengthQualityMetricTypeCodeSequence	SQ	1
(0022,1300)	Intraocular Lens Calculations Right Eye Sequence	IntraocularLensCalculationsRightEyeSequence	SQ	1
(0022,1310)	Intraocular Lens Calculations Left Eye Sequence	IntraocularLensCalculationsLeftEyeSequence	SQ	1
(0022,1330)	Referenced Ophthalmic Axial Length Measurement QC Image Sequence	ReferencedOphthalmicAxialLengthMeasurementQCImageSequence	SQ	1

Add the Ophthalmic Axial Measurements and IOL Calculations UIDs to PS3.6 Annex A:

Annex A (Normative): Registry of DICOM Unique Identifiers (UID)

UID Value	UID NAME	UID TYPE	Part
1.2.840.10008.5.1.4.1.1.78.7	Ophthalmic Axial Measurements Storage	SOP Class	3.4
1.2.840.10008.5.1.4.1.1.78.8	Intraocular Lens Calculations Storage	SOP Class	3.4

Add new rows to PS 3.6 Annex A Table A-3

Table A-3
CONTEXT GROUP UID VALUES

Context UID	Context Identifier	Context Group Name
...		
1.2.840.10008.6.1.876	4230	Ophthalmic Ultrasound Axial Measurements Type
1.2.840.10008.6.1.877	4231	Lens Status
1.2.840.10008.6.1.878	4232	Vitreous Status
1.2.840.10008.6.1.879	4233	Ophthalmic Axial Length Measurements Segment Names
1.2.840.10008.6.1.880	4234	Refractive Surgery Types
1.2.840.10008.6.1.881	4235	Keratometry Descriptors
1.2.840.10008.6.1.882	4236	IOL Calculation Formula
1.2.840.10008.6.1.883	4237	Lens Constant Type
1.2.840.10008.6.1.884	4238	Refractive Error Types
1.2.840.10008.6.1.885	4239	Anterior Chamber Depth Definition
1.2.840.10008.6.1.886	4240	Ophthalmic Measurement or Calculation Data Source
1.2.840.10008.6.1.887	4241	Ophthalmic Axial Length Selection Method
1.2.840.10008.6.1.889	4243	Ophthalmic Axial Length Quality Metric Type
1.2.840.10008.6.1.890	4244	Ophthalmic Agent Concentration Units

Changes to NEMA Standards Publication PS 3.16-2009

Digital Imaging and Communications in Medicine (DICOM)

Part 16: Content Mapping Resource

Add the following to PS3.16 Annex B

CID 4230 Ophthalmic Ultrasound Axial Measurements Type

Context ID 4230
Ophthalmic Ultrasound Axial Measurements Type
Type: Extensible Version: 20100623

Coding Scheme Designator	Code Value	Code Meaning
DCM	111750	Ultrasound Contact
DCM	111751	Ultrasound Immersion

CID 4231 Lens Status

Context ID 4231
Lens Status
Type: Extensible Version: 20100623

Coding Scheme Designator	Code Value	Code Meaning
SRT	DA-73410	Aphakic
SRT	R-2073F	Phakic
SRT	A-040F7	Phakic IOL
SRT	F-02087	Piggyback IOL
SRT	DA-73460	Pseudophakia

CID 4232 Vitreous Status

Context ID 4232
Vitreous Status
Type: Extensible Version: 20100623

Coding Scheme Designator	Code Value	Code Meaning
SRT	F-035F3	Gas in vitreous cavity
SRT	DA-7930D	Post-Vitrectomy

SRT	F-035FD	Silicone Oil
SRT	T-AA092	Vitreous Only

CID 4233 Ophthalmic Axial Length Measurements Segment Names

Context ID 4233
Ophthalmic Axial Length Measurements Segment Names
Type: Extensible Version: 20100623

Coding Scheme Designator	Code Value	Code Meaning
SRT	T-AA200	Cornea
SRT	T-AA050	Anterior Chamber
DCM	111778	Single or Anterior Lens
DCM	111779	Posterior Lens
SRT	T-AA079	Vitreous Cavity

CID 4234 Refractive Surgery Types

Context ID 4234
Refractive Surgery Types
Type: Extensible Version: 20100623

Coding Scheme Designator	Code Value	Code Meaning
SRT	P1-A3102	RK
SRT	P1-A3835	PRK
SRT	P0-0526F	LASIK
SRT	P1-A3846	LASEK

CID 4235 Keratometry Descriptors

Context ID 4235
Keratometry Descriptors
Type: Extensible Version: 20100623

Coding Scheme Designator	Code Value	Code Meaning
DCM	111753	Manual Keratometry
DCM	111754	Auto Keratometry
DCM	111755	Simulated Keratometry
DCM	111756	Equivalent K-reading

CID 4236 IOL Calculation Formula

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Context ID 4236
IOL Calculation Formula
Type: Extensible Version: 20100623

Coding Scheme Designator	Code Value	Code Meaning
DCM	111760	Haigis
DCM	111761	Haigis-L
DCM	111762	Holladay 1
DCM	111763	Holladay 2
DCM	111764	Hoffer Q
DCM	111765	Olsen
DCM	111766	SRKII
DCM	111767	SRK-T

375 **CID 4237 Lens Constant Type**

Context ID 4237
Lens Constant Type
Type: Extensible Version: 20100623

Coding Scheme Designator	Code Value	Code Meaning
SRT	F-048FA	A-Constant
DCM	111768	ACD Constant
DCM	111769	Haigis a0
DCM	111770	Haigis a1
DCM	111771	Haigis a2
DCM	111772	Hoffer pACD Constant
DCM	111773	Surgeon Factor

380 **CID 4238 Refractive Error Types**

Context ID 4238
Refractive Error Types
Type: Extensible Version: 20100623

Coding Scheme Designator	Code Value	Code Meaning
SRT	DA-74120	Myopia
SRT	DA-74110	Hyperopia

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CID 4239 Anterior Chamber Depth Definition

Context ID 4239
Anterior Chamber Depth Definition
Type: Extensible Version: 20100623

Coding Scheme Designator	Code Value	Code Meaning
DCM	111776	Front Of Cornea To Front Of Lens
DCM	111777	Back Of Cornea To Front Of Lens

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CID 4240 Ophthalmic Measurement or Calculation Data Source

Context ID 4240
Ophthalmic Measurement or Calculation Data Source
Type: Extensible Version: 20100623

Coding Scheme Designator	Code Value	Code Meaning
DCM	111780	Measurement From This Device
DCM	113857	Manual Entry
DCM	111781	External Data Source
DCM	111782	Axial Measurements SOP Instance
DCM	111783	Refractive Measurements SOP Instance

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CID 4241 Ophthalmic Axial Length Selection Method

Context ID 4241
Ophthalmic Axial Length Selection Method
Type: Extensible Version: 20100623

Coding Scheme Designator	Code Value	Code Meaning
DCM	121412	Mean value chosen
DCM	121410	User chosen value

400

CID 4243 Ophthalmic Axial Length Quality Metric Type

405 **Context ID 4243**
Ophthalmic Axial Length Quality Metric Type

Type: Extensible Version: 20100623

Coding Scheme Designator	Code Value	Code Meaning
DCM	111786	Standard Deviation of measurements used
DCM	111787	Signal to Noise Ratio

CID 4244 Ophthalmic Agent Concentration Units

410 **Context ID 4244**
Ophthalmic Agent Concentration Units
Type: Extensible Version: 20100623

Coding Scheme Designator	Code Value	Code Meaning
UCUM	%	Percent
UCUM	mg/ml	mg/ml

Add to PS3.16 – Add To Annex D DICOM Controlled Terminology Definitions (Normative)

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Code Value	Code Meaning	Definition	Notes
…			
111750	Ultrasound Contact	A method of obtaining ophthalmic axial measurements that uses ultrasound, and that requires applanation of the cornea.	
111751	Ultrasound Immersion	A method of obtaining ophthalmic axial measurements that uses ultrasound, and that requires immersion of the patient's eye in fluid as he lies in a supine position.	
111752	Optical	A method of obtaining ophthalmic axial measurements that uses light.	
111753	Manual Keratometry	Measurements taken of the corneal curvature using a manual keratometer.	
111754	Auto Keratometry	Measurements taken of the corneal curvature using an automated keratometer.	
111755	Simulated Keratometry	Simulated Keratometry measurements derived from corneal topography.	
111756	Equivalent K-reading	Corneal power measurements using Scheimpflug camera.	

111760	Haigis	The Haigis IOL calculation formula. Haigis W, Lege B, Miller N, Schneider B. Comparison of immersion ultrasound biometry and partial coherence interferometry for intraocular lens calculation according to Haigis. Graefes Arch Clin Exp Ophthalmol 2000;238:765–73.	
111761	Haigis-L	The Haigis-L IOL calculation formula. Haigis W. Intraocular lens calculation after refractive surgery for myopia: Haigis-L formula. J Cataract Refract Surg. 2008 Oct;34(10):1658-63.	
111762	Holladay 1	The Holladay 1 IOL calculation formula. Holladay JT, Prager TC, Chandler TY, Musgrove KH, Lewis JW, Ruiz RS. A three-part system for refining intraocular lens power calculations. J Cataract Refract Surg. 1988; 14:17-24.	
111763	Holladay 2	The Holladay 2 IOL calculation formula.	
111764	Hoffer Q	The Hoffer Q IOL calculation formula. Hoffer KJ. The Hoffer Q formula: a comparison of theoretic and regression formulas. J Cataract Refract Surg 1993;19:700-12. Errata. J Cataract Refract Surg 1994;20:677 and 2007;33:2-3.	
111765	Olsen	The Olsen IOL calculation formula. Olsen T. Calculation of intraocular lens power: a review. Acta Ophthalmol. Scand. 2007: 85: 472–485.	
111766	SRKII	The SRKII IOL calculation formula. Sanders DR, Retzlaff J, Kraff MC. Comparison of the SRK II formula and other second generation formulas. J Cataract Refract Surg. 1988 Mar;14(2):136-41.	

111767	SRK-T	The SRK-T IOL calculation formula. Retzlaff JA, Sanders DR, Kraff MC. Development of the SRK/T intraocular lens implant power calculation formula. J Cataract Refract Surg 1990;16:333-40. Erratum 1990;16:528.	
111768	ACD Constant	The “ACD Constant” used in IOL calculation.	
111769	Haigis a0	The “Haigis a0” constant used in IOL calculation.	
111770	Haigis a1	The “Haigis a1” constant used in IOL calculation.	
111771	Haigis a2	The “Haigis a2” constant used in IOL calculation.	
111772	Hoffer pACD Constant	The “Hoffer pACD Constant” used in IOL calculation.	
111773	Surgeon Factor	The “Surgeon Factor” constant used in IOL calculation.	
111776	Front Of Cornea To Front Of Lens	Anterior chamber depth defined as the front of the cornea to the front of the lens.	
111777	Back Of Cornea To Front Of Lens	Anterior chamber depth defined as the back of the cornea to the front of the lens.	
111778	Single or Anterior Lens	Refers to the anterior lens when there are two lenses in the eye. The distance, in mm, from the anterior surface of the lens to the posterior surface of the lens.	
111779	Posterior Lens	Refers to the posterior lens when there are two lenses in the eye. The distance, in mm, from the anterior surface of the lens to the posterior surface of the lens.	
111780	Measurement From This Device	Value obtained from measurements taken by the device creating this SOP Instance.	
111781	External Data Source	Value obtained by data transfer from an external source – not from measurements taken by the device providing the value.	
111782	Axial Measurements SOP Instance	Axial Measurements DICOM SOP Instance.	
111783	Refractive Measurements SOP Instance	Refractive Measurements DICOM SOP Instance.	

111786	Standard Deviation of measurements used	Standard Deviation is a simple measure of the variability of a data set.	
111787	Signal to Noise Ratio	Signal to Noise Ratio of the data samples taken to create a measurement.	

Changes to NEMA Standards Publication PS 3.17-2009

Digital Imaging and Communications in Medicine (DICOM)

Part 17: Explanatory Information

Add to PS3.17 – Add to Use Cases for Ophthalmic Axial Measurements

Annex X Ophthalmic Axial Measurements and Intraocular Lens Calculations Use Cases (Informative)

X.1 Axial Measurements

An axial measurements device is used to take axial measurements of the eye, from the anterior surface of the cornea to either the surface of the retina (ultrasound) or the retinal photoreceptors (optical). The axial measurements are typically expressed in mm (Ophthalmic Axial Length (0022,1010). Currently these measurements are taken using ultrasound or laser light. The measurements are used in calculation of intraocular lens power for cataract surgery. Axial measurements devices and software on other systems perform intraocular lens power calculations using the axial measurements in addition to measurements from other sources (currently by manual data entry, although importation from other software systems is expected in the future).

When the natural lens of the eye turns opaque it is called a cataract. The cataract is surgically removed, and a synthetic intraocular lens is placed where the natural lens was before. The power of the lens that is placed determines what the patient's refractive error will be, meaning what power his glasses will need to be to maximize vision after surgery.

Axial measurements devices provide graphical displays that help clinicians to determine whether or not the probe used in taking the measurements is aligned properly. Annotations on the display provide information such as location of gates that assists the clinician in assessing measurement quality. High, fairly even waveform spikes suggest that the measurement producing a given graph is likely to be reliable. The quality of the graphical display is one of the factors that a clinician considers when choosing which axial length measurement to use in calculating the correct intraocular lens power for a given patient.

X.2 Intraocular Lens Calculations Introduction

Axial measurements devices and software on other systems perform intraocular lens power calculations for cataract surgery patients. The power selection of intraocular lens to place in a patient's eye determines the refractive correction (e.g. glasses, contact lenses, etc.) the patient will require after cataract surgery.

The data input for these calculations consists of ophthalmic axial length measurements (one dimensional ultrasound scans that are called "A-scans" in the eye care domain) and keratometry (corneal curvature) measurements in addition to constants and sometimes others kinds of measurements. The data may come from measurements performed by the device, on which the intraocular lens calculation software resides, or from manual data entry, or from an external source. There are a number of different formulas and constants available for doing these calculations. The selection of formula to use is based on clinician preference and on patient factors such as the axial length of the eye. The most commonly used constants, encoded by Concept Name Code Sequence (0040,A043) using CID 4237, are a function of the model of intraocular lens to be used.

The most commonly used formulas, encoded by IOL Formula Code Sequence (0022,1029) using CID 4236, for intraocular lens calculation are inaccurate in a patient who has had refractive surgery, and numerous other formulas are available for these patients. Since most of them have not been validated to date, they were not included in this document.

Intraocular lens calculation software typically provides tabular displays of intraocular lens power in association with each lens's predicted refractive error (e.g. glasses, contact lenses, etc).

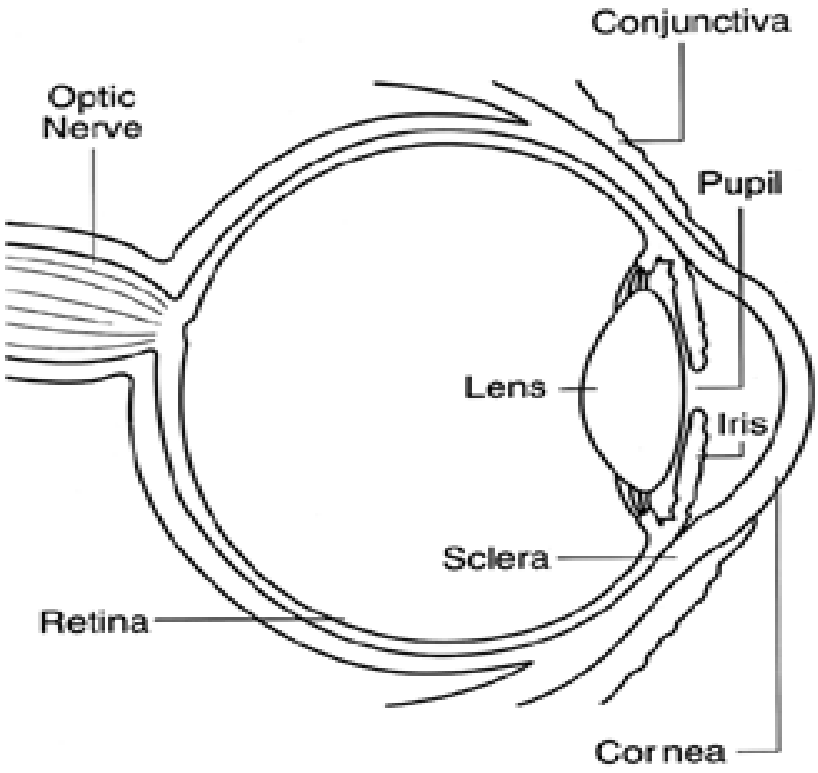

Figure X.2-1 Sagital Diagram of Eye Anatomy (when the lens turns opaque it is called a cataract)

Courtesy; National Eye Institute, National Institutes of Health; ftp://ftp.nei.nih.gov/eyean/eye_72.tif

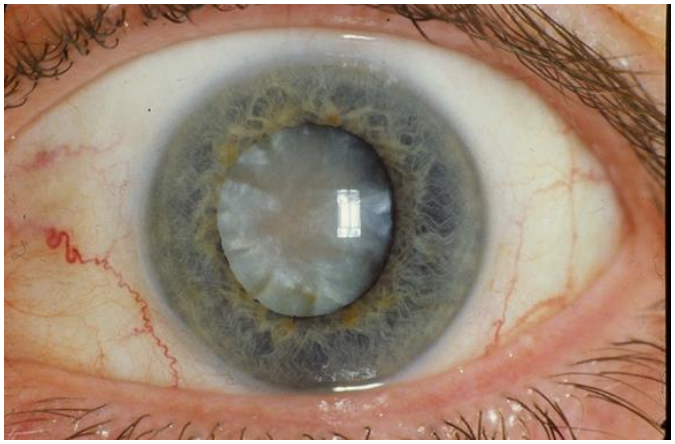

Figure X.2-2 Eye with a cataract

Courtesy; National Eye Institute, National Institutes of Health;
ftp://ftp.nei.nih.gov/eyedis/EDA13_72.tif

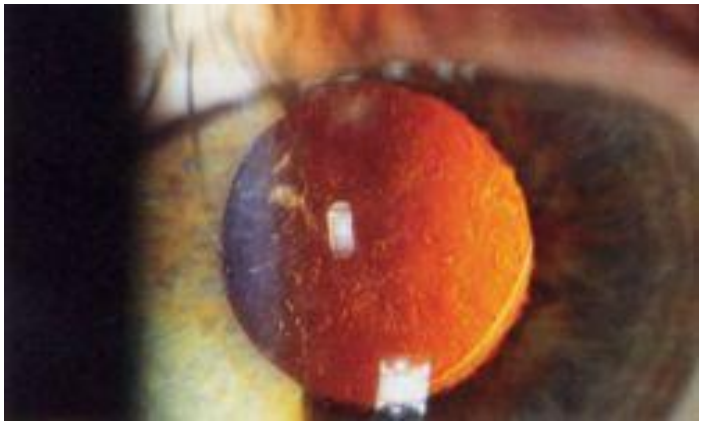

Figure X.2-3 Eye with Synthetic Intraocular Lens Placed After Removal of Cataract

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http://en.wikipedia.org/wiki/Image:Posterior_capsular_opacification_on_retroillumination.jpg

X.3 Output of an Ultrasound A-scan Device

Figure X.3-1 demonstrates an A-scan waveform – produced by an ultrasound device used for ophthalmic axial length measurement. This is referenced in the Ophthalmic Axial Measurements IOD in Attribute Referenced Ophthalmic Axial Length Measurement QC Image Sequence (0022,1033).

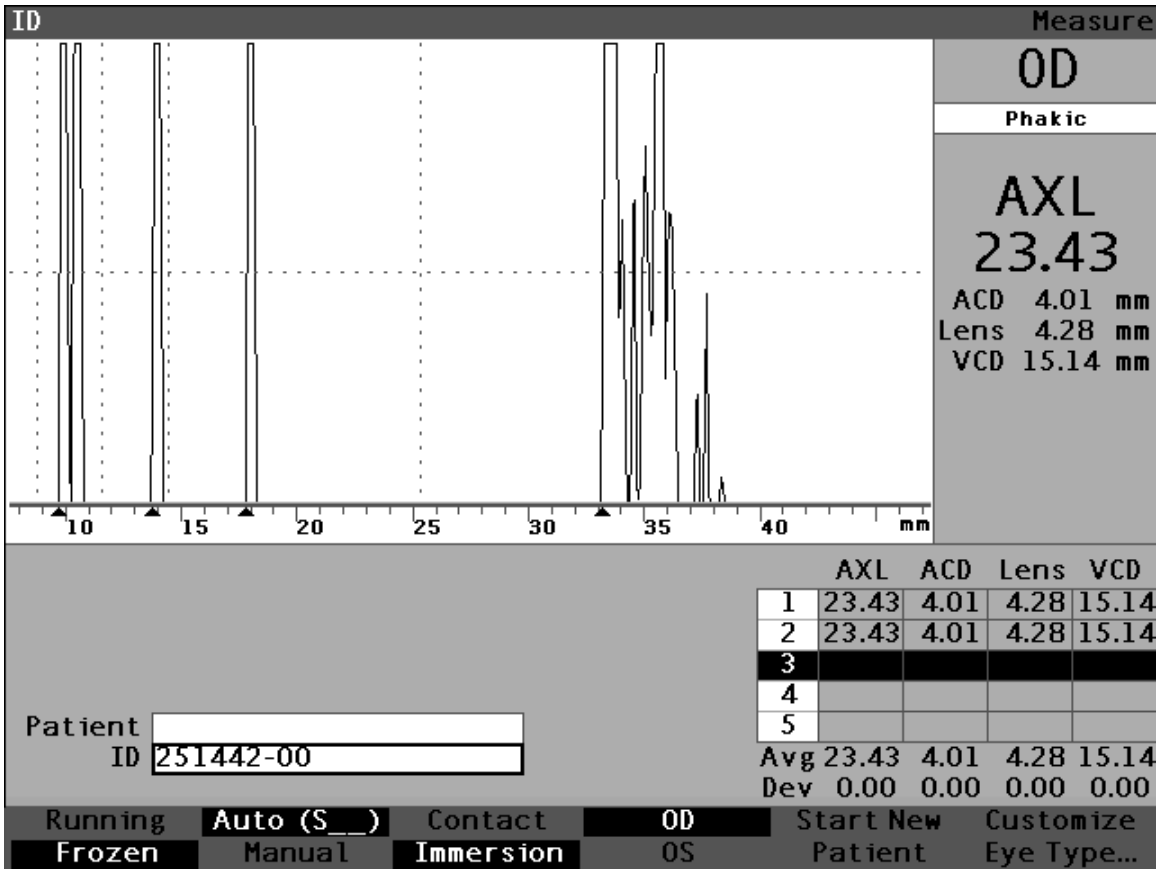

Figure X.3-1 Scan Waveform Example

Time (translated into distance using an assumed velocity) is on the x-axis, and signal strength is on the y-axis. This waveform allows clinicians to judge the quality of an axial length measurement for use in calculating the power of intraocular lens to place in a patient's eye in cataract surgery. Figure X.3-1 above demonstrates a high quality scan, with tall, even spikes representing the ocular structures of interest. This tells the clinician that the probe was properly aligned with the eye. The first, double spike on the left represents anterior cornea followed by posterior cornea. The second two, more widely spaced spikes represent anterior and posterior lens. The first tall spike on the right side of the display is the retinal spike, and the next tall spike to the right is the sclera. Smaller spikes to the far right are produced by orbital tissues. Arrows at the bottom of the waveform indicate the location of gates, which may be manually adjusted to limit the range of accepted values. Note that in the lower right corner of the display two measurements are recorded. In the column labeled AXL is an axial length measurement, which on this device is the sum of the measurements for ACD (anterior chamber depth), lens, and VCD (vitreous chamber depth). The measured time value for each of the segments and a presumed velocity of sound for that segment are used to calculate the axial length for that segment. An average value for each column is displayed below along with the standard deviation of measurements in that column. The average axial length is the axial length value selected by this machine, although often a clinician will make an alternative selection.

X.4 Output of an Optical A-scan Device

Figure X.4-1 demonstrates the waveform-output of a partial coherence interferometry (PCI) device used for optical ophthalmic axial length measurement. This is referenced in the Ophthalmic Axial Measurements IOD in Attribute Referenced Ophthalmic Axial Length Measurement QC Image Sequence (0022,1033).

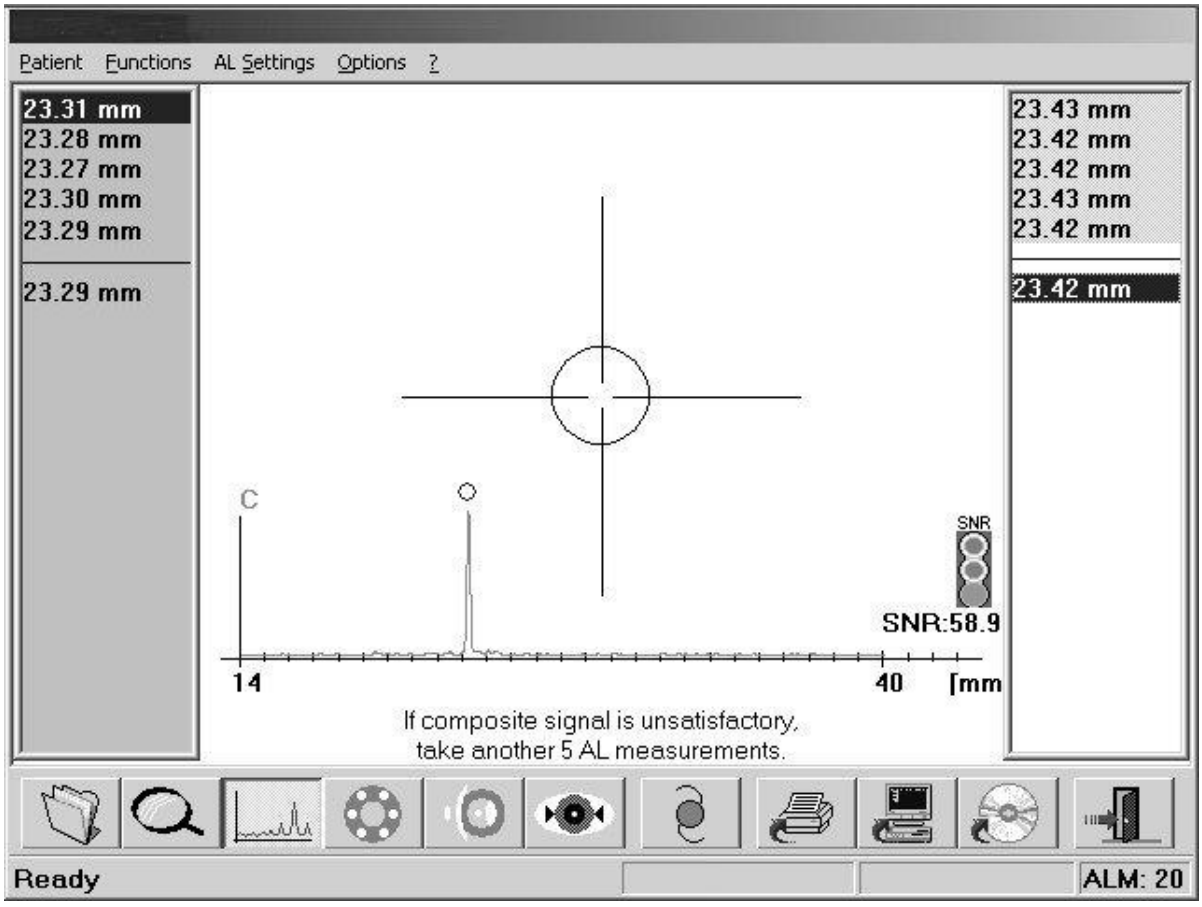

Figure X.4-1 Waveform Output of a Partial Coherence Interferometry (PCI) Device Example

Physical distance is on the x axis, and signal strength is on the y axis. What is actually measured is phase shift, determined by looking at interference patterns of coherent light. Physical distance is calculated by dividing “optical path length” by the “refractive group index” – using an assumed average refractive group index for the entire eye. The “optical path length” is derived from the phase shift which is actually observed. Similar to ultrasound, this waveform allows clinicians to judge the quality of an axial length measurement.

Figure x.4-1 above demonstrates a high quality scan, with tall, straight spikes representing the ocular axial length. The corneal spike is suppressed (outside the frame on the left hand side) and represents the reference 0 mm. The single spike on this display represents the signal from the retinal pigment epithelium (RPE) and provides the axial length measurement value (position of the circle marker). Sometimes smaller spikes can be observed on the left or right side of the RPE peak. Those spikes represent reflections from the internal limiting membrane (ILM, 150-350 µm before RPE) or from the choroid (150-250 µm behind RPE) respectively.

Because all classical IOL power calculation formulas expect axial lengths measured to the internal limiting membrane (as provided by ultrasound devices), axial length measurements obtained with an optical device to the retinal pigment epithelium are converted to this convention by subtracting the retinal thickness.

Figure x.4-1 above displays five axial length measurements obtained for each eye (one column for each eye) and the selected axial length value is shown below the line.

X.5 IOL Calculation Results Example

Figure X.5-1 demonstrates a typical display of IOL (intraocular lens) calculation results.

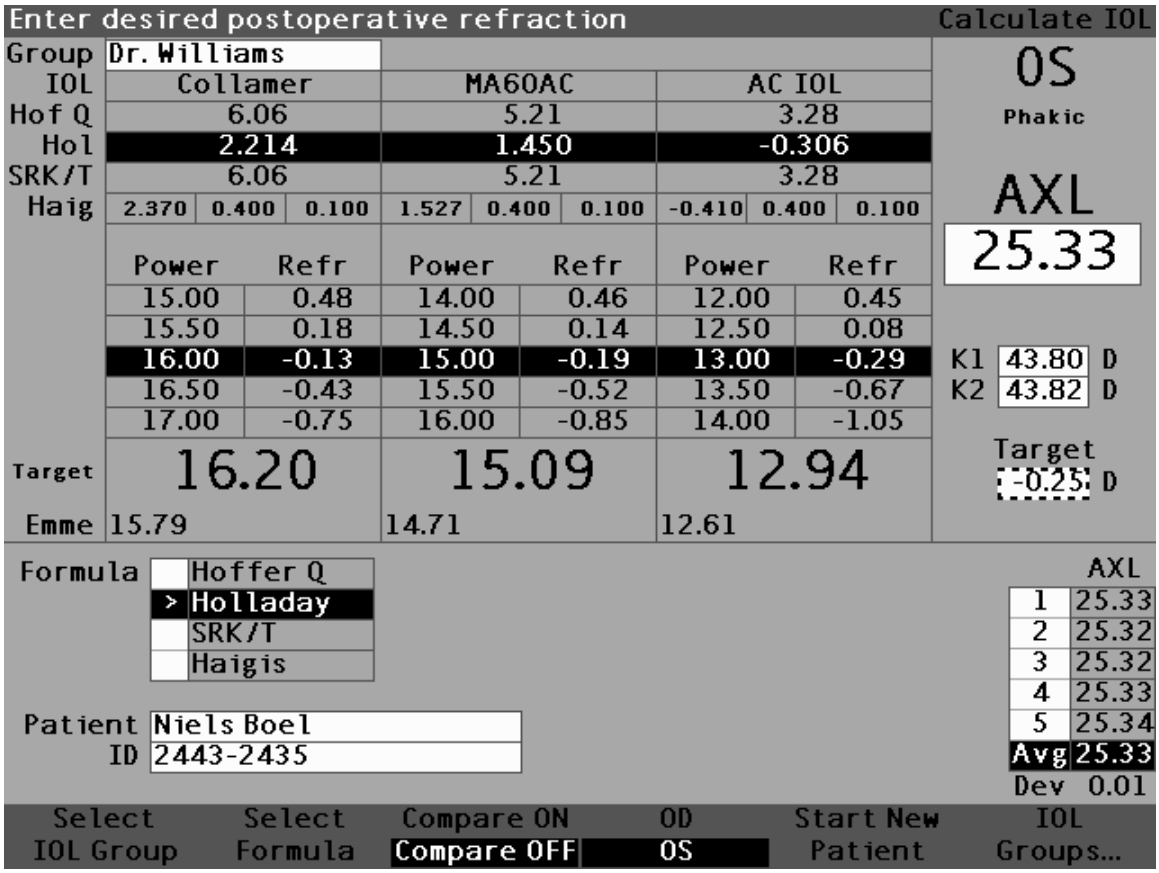

Figure X.2-6 IOL Calculation Results Example

On the right the selected target refractive correction (e.g. glasses, contact lenses, etc.) is -0.25 diopters. At the top of the table three possible intraocular lens models are displayed, along with the constants (CID 4237) specific to those lens models. Each row in that part of the table displays constants required for a particular formula. In this example the Holladay formula has been selected by the operator, and results are displayed in the body of the table below. Calculated intraocular lens powers are displayed with the predicted postoperative refractive error (e.g. glasses, contact lenses, etc.) for each lens. K1 and K2 on the right refer to the keratometry values (corneal curvature), in diopters, used for these calculations.