Southern African Large Telescope
High-Resolution Spectrograph

SALT HRS

3210AD0006 Optical Specifications

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Issue History

Number and file name	Person	Issue	Created	Status
3210AD0006 SALT HRS optical spec	SIB	2.0	24 Feb 2005	Extracted from existing docs
		2.1	8 Mar 2005	Calibration optics
		2.2	9 Mar 2005	Fibre feed optics
	MDA/ SIB	2.3	18 Mar 2005	Image slicers and cameras

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Summary of optical components

List of optical components:

Fibre injection:

Input:

- Entrance windows
- Fibres

Output:

a) Direct injection
- Micro-lenses
- Reference lamp:
  - Lamp
  - Fibre
  - Input optics

b) Intermediate injection
- Exit windows
- Ball lenses
- Image slicers
- Focal conversion optics/vacuum window
- Telecentric corrector
- Fold mirror

Collimator

Echelle grating

Exposure meter:
- Collector
- Concentrator
- Fibres
- Output?

Dichroic

Pupil mirrors:
- Blue
- Red

Fold mirrors
- Blue
- Red

VPH gratings:
- Lenses

Blue
Red
Gratings
Blue
Red

Flat-fielding lamps:
Lamps
Fibres

Cameras:
Blue
Red

CCDs:
Blue
Red

1 Fibre injection optics

The fibre injection optics described in this section include:

- Fibres
- Fibre entrance and exit windows
- Direct injection optics
  - Pupil imaging micro-lens
  - Reference fibre micro-lens
- Image slicer optics

1.1

  - Ball lenses
  - Lenslet IS1.1
  - Lenslet IS1.2
  - Image slicers
  - Image slicer mounting plates
- Slit transfer optics
  - Element FC1.1
  - Element FC1.2
  - Element FC2.1
  - Element FC2.2
  - Element TC1.1
  - Vacuum window
- Slit viewing optics

1.2 Fibres

Fibres are required to service the fibre feed modes listed in Table 1.

Table 1: Summary of the SALT HRS fibre feed formats. In each mode a single object plus sky can be observed.

Spectrograph fibre feed mode	*Description*	*Fibre core diameter (µm)*	*Number of fibres (number of spare)*	*Length*
High IS	High resolving power image slicer	350	2 (2)	35m [**TBC**]
Med IS	Medium resolving power image slicer	500	2 (2)	35m [**TBC**]
Low	Low resolving power fibre	500	2 (2)	35m [**TBC**]
Ref. fibre	Direct injection reference fibre	100	1 (1)	20m [**TBC**]

Fibres selection will be made on the basis of high transmission and low focal ratio degradation tests to be performed by either the fibre supplier and/or UC. Various combinations of the following fibre types will be sourced and tested:

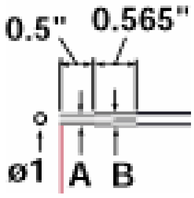
- Polymicro FPB and/or STU (http://www.polymicro.com/)
- Ceramoptec Optran UV (http://www.ceramoptec.com/)

To limit the number of fibres requiring insertion into the telescope the fibres should be loomed as follows [**TBC**]:

- Loom 1: High IS fibres (x2) plus Med. IS fibres (x2). The individual fibres should remain free with 1m [**TBC**] of their terminating faces. Fibre ends should be capable of being inserted into the input ferrules described in FIF document 3400AE0024. The output ferrules are described in SALT HRS document 3230AE0030.
  Note: Fibre entrance and exit windows (Sec 1.2) will be supplied.

- Loom 2: Low resolving power fibres (x2). The individual fibres should remain free with 1m [**TBC**] of their terminating faces. The loom is required to have vacuum feed-through as described in 3220AE0004 Mechanical. Fibre ends should be capable of being inserted into the input ferrules described in FIF document 3400AE0030 Input Mechanics. The output ferrules are described in SALT HRS document 3220AE0004 Mechanical.
  Note: Fibre entrance windows (Sec. 1.3) and fibre output micro-lenses (Sec. 1.4.2) will be supplied.

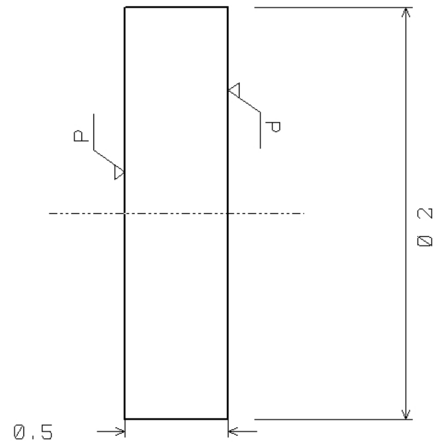
- Loom 3: Reference fibre (x1). This fibre requires a vacuum feed-through as described in 3220AE0004 Mechanical. The fibre input end will be prepared according to the following dimensions:

  The output end will be compatible with insertion along-side Loom 2.
  Note: Fibre output micro-lenses (Sec. 1.3.1) will be supplied.

One spare of each loom is also to be provided.

1.3 Fibre entrance and exit windows



Surface 1 is plane
Surface 2 is plane

Name: Fibre entrance/exit window

Material: Silica

Coating: AR coated for 370nm to 890nm surface 1 only.

Finish: 60-40

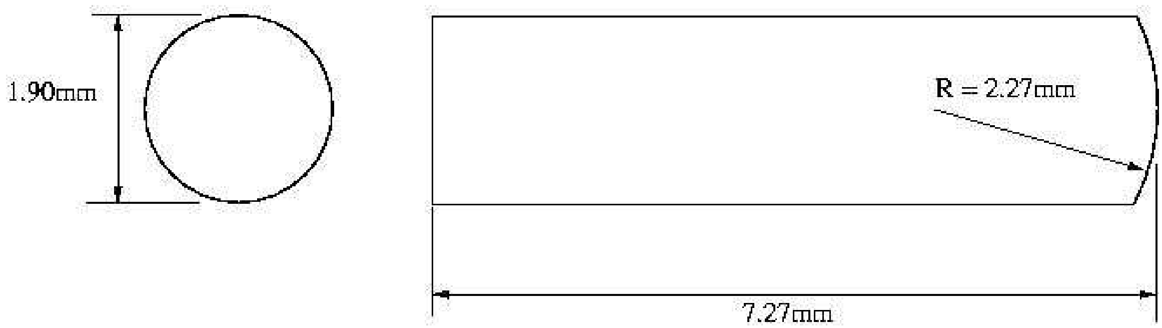
Tolerances

- **Homogeniety:**
- **Diameter:**
- **Wedge:**
- **Centration:**
- **CT:**
- **Irr. surface 1:**
- **Irr. surface 2:**

Notes: Each element to be cemented to fibre entrance/exit on surface 2.

1.4 Direct injection optics

1.4.1 Pupil imaging micro-lens



Surface 1 is plane
Surface 2 is convex

Name: Pupil imaging micro-lens

Material: Fused silica

Coating: AR coated for 370nm to 890nm surface 2 only.

Finish: 60-40

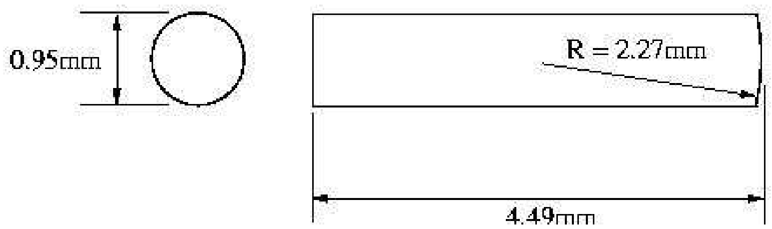
Tolerances

- **Homogeniety:**
- **Diameter:** ±0.1mm
- **Wedge:**
- **Centration:**
- **CT:** ±0.05mm
- **R2:** ±0.05mm
- **Irr. surface 1:**
- **Irr. surface 2:**

Number required: 8 [**TBC**]

Notes: Each element to be cemented to fibre exit on surface 1.

1.4.2 Reference fibre micro-lens



Surface 1 is plane
Surface 2 is convex

Name: Reference fibre micro-lens

Material: Fused silica

Coating: None

Finish: 60-40

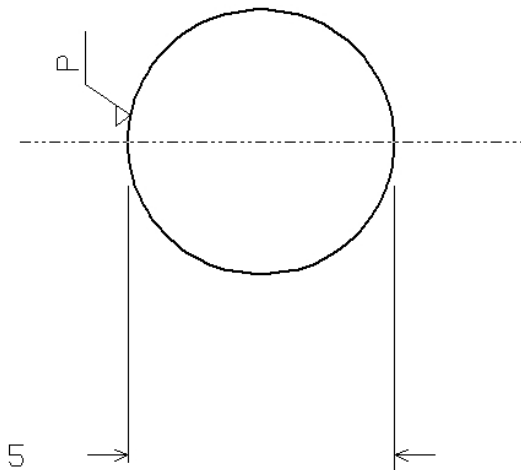
Tolerances
- **Homogeniety:**
- **Diameter:** ±0.1mm
- **Wedge:**
- **Centration:**
- **CT:** ±0.05mm
- **R2:** ±0.05mm
- **Irr. surface 1:**
- **Irr. surface 2:**

Number required: 2 [**TBC**]

Notes: Each element to be cemented to fibre exit on surface 1.

1.5 Image slicer optics

1.5.1 Ball lenses



Ball lens

Name: Image slicer ball lens

Material: BK7

Radii: R = 2.5mm

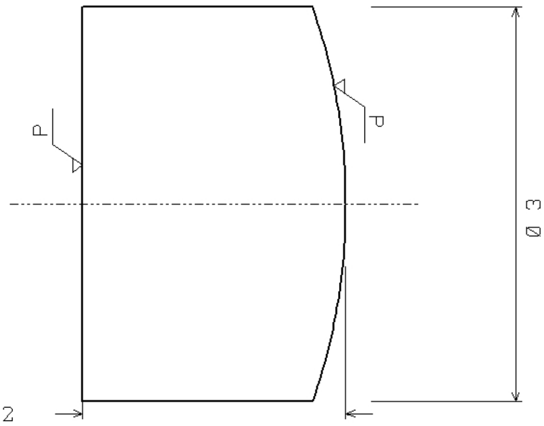
Coating: Uniform AR coated for 370nm to 890nm

Finish: 60-40

Tolerances

- **Homogeniety:**
- **Diameter:**
- **Centration:**
- **CT:**
- **R:**
- **Irr. surface:**

1.5.2 Lenslet IS1.1



Surface 1 is plane
Surface 2 is concave

Name: Image slicer lenslet IS1.1

Material: S-LAL7

Radii: $R_2 = -4.59$

Coating: AR coated for 370nm to 890nm surface 1 only.

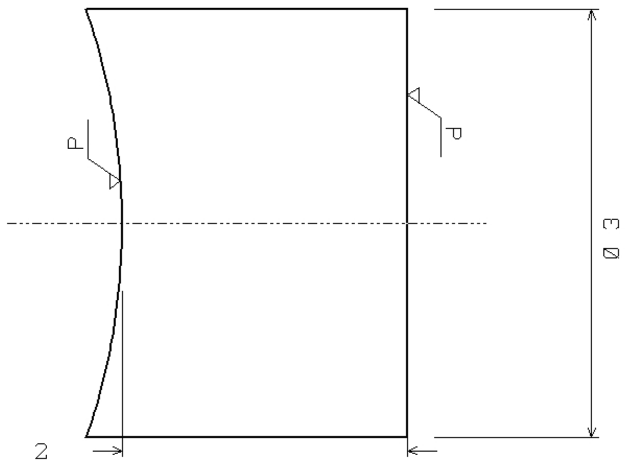
Finish: 60-40

Tolerances

- **Homogeniety:**
- **Diameter:**
- **Wedge:**
- **Centration:**
- **CT:**
- **R1:**
- **R2:**
- **Irr. surface 1:**
- **Irr. surface 2:**

Notes: Element cemented to IS1.2 on surface 2.

1.5.3 Lenslet IS1.2



Surface 1 is concave
Surface 2 is plane

Name: Image slicer lenslet IS1.2

Material: Silica

Radii: $R_1 = -4.59$

Coating: None.

Finish: 60-40

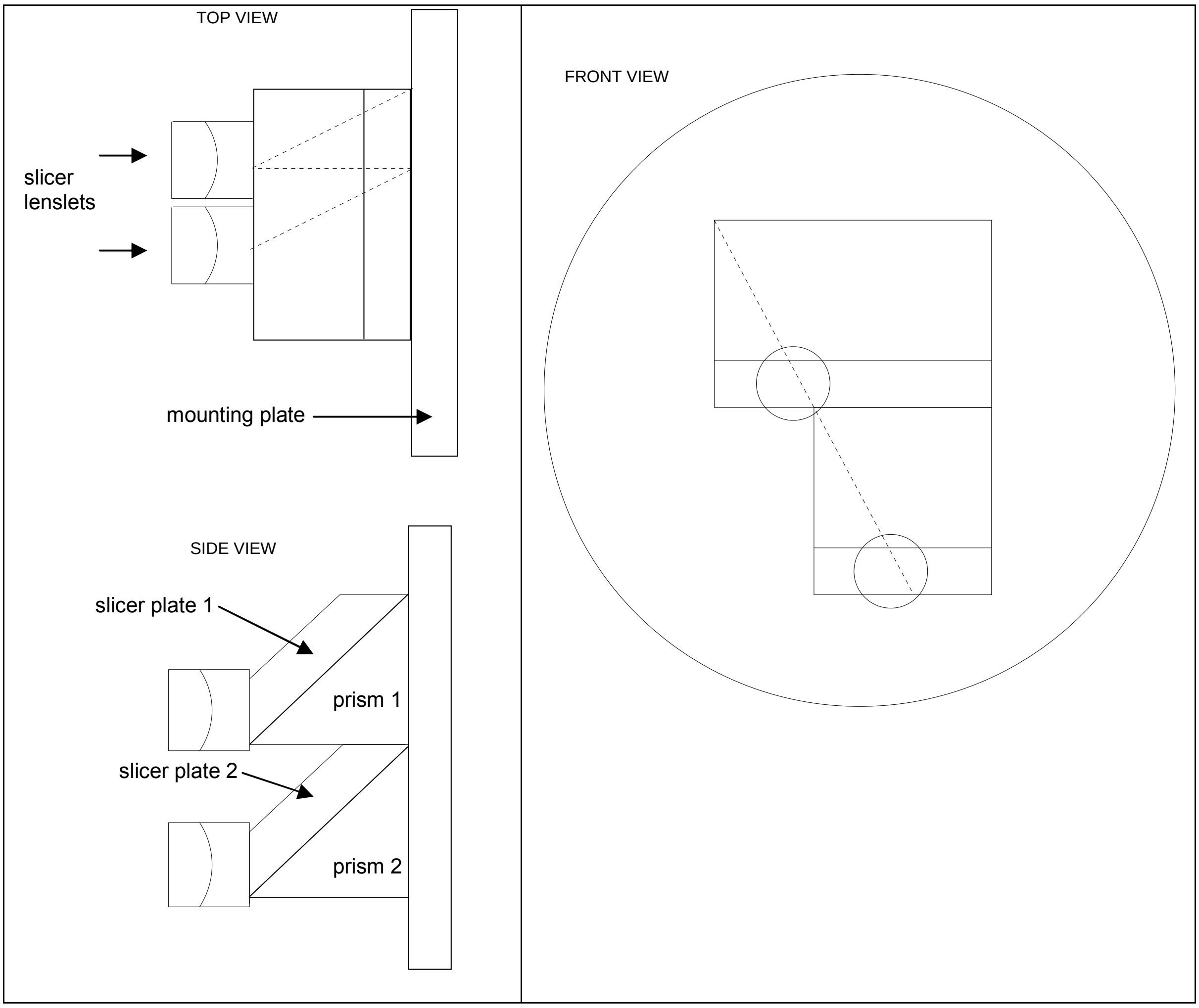
Tolerances
- **Homogeniety:**
- **Diameter:**
- **Wedge:**
- **Centration:**
- **CT:**
- **R1:**
- **R2:**
- **Irr. surface 1:**
- **Irr. surface 2:**

Notes: Element cemented to IS1.1 on surface 1.

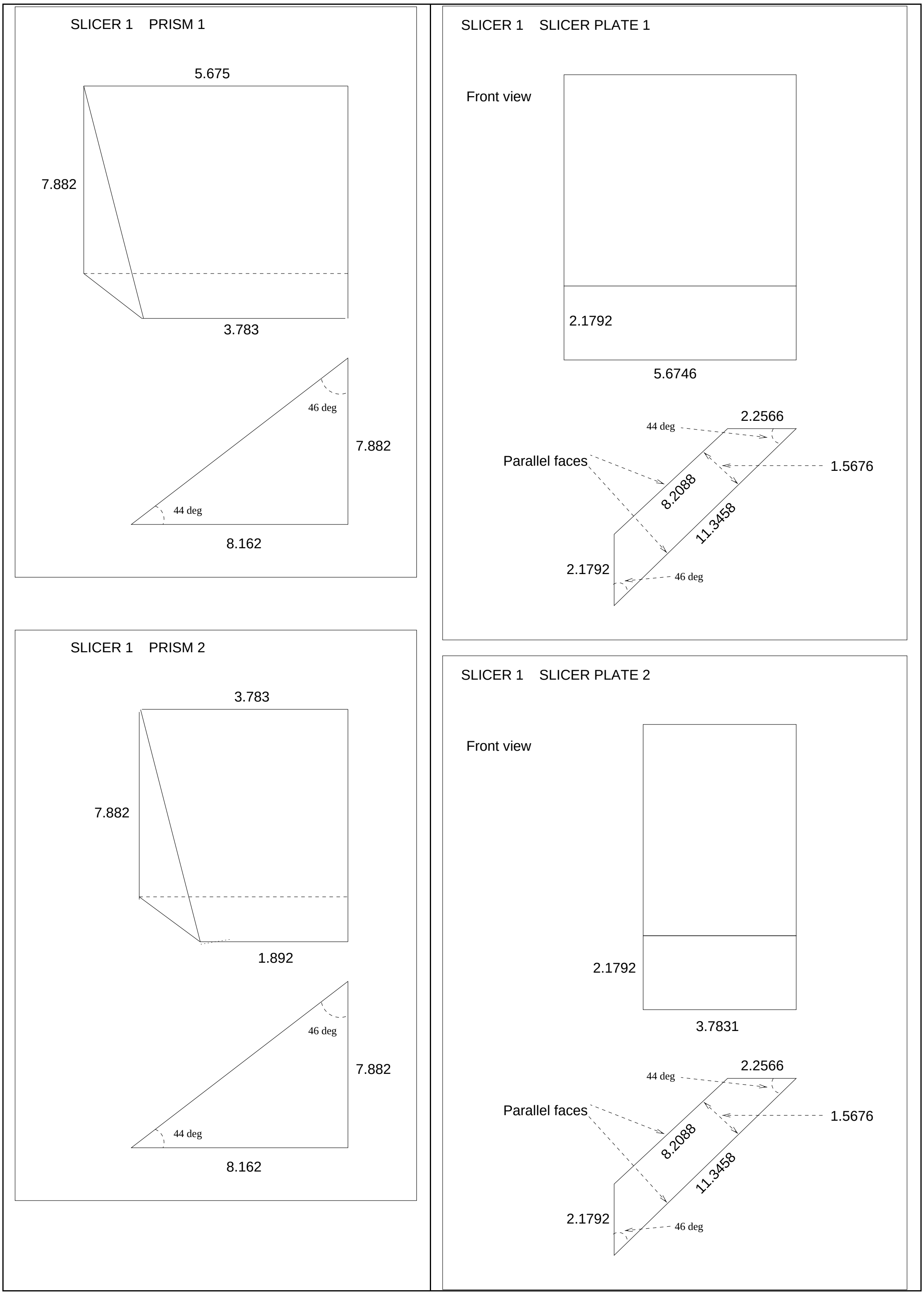
1.5.4 Image slicers

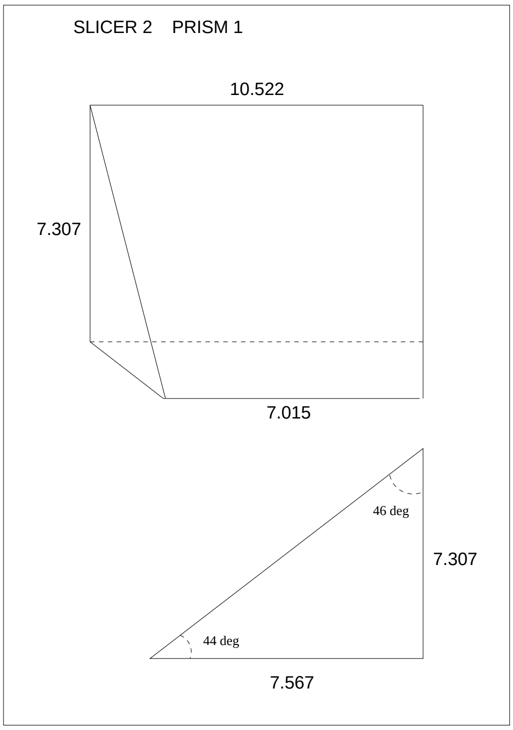
A schematic of the SALT HRS images slices is shown on this page. On subsequent pages details of the slicer optics are presented.

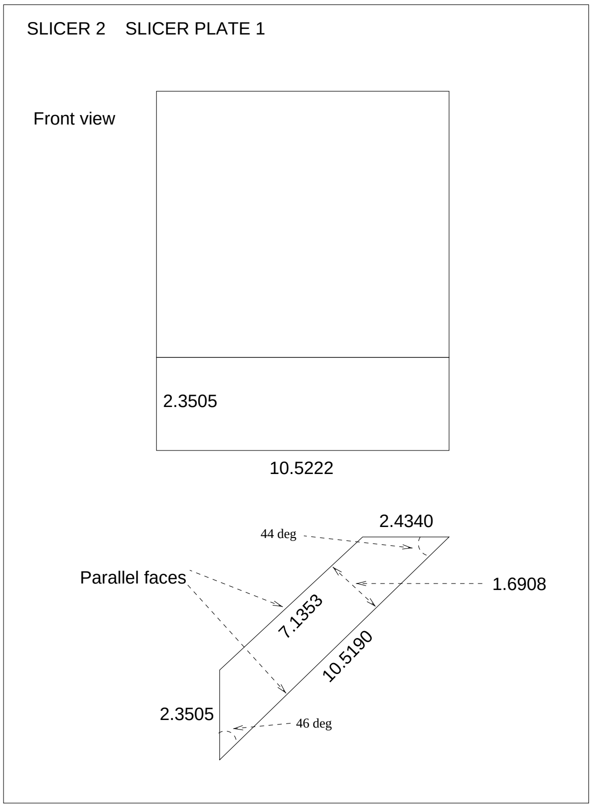
Schematic:

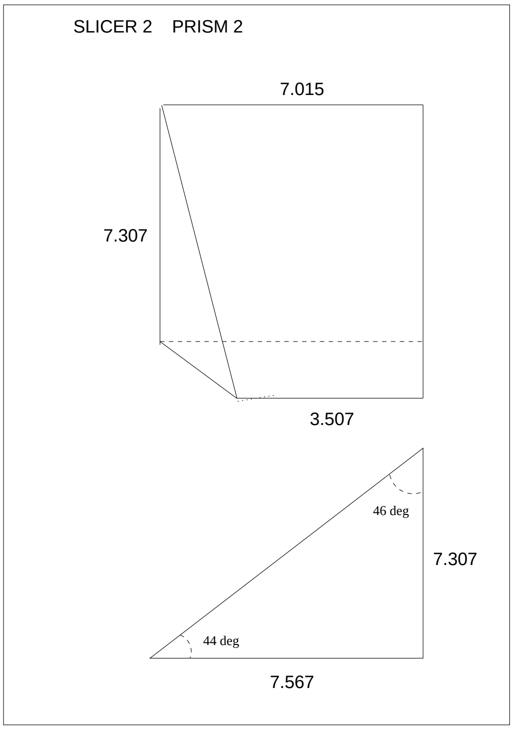


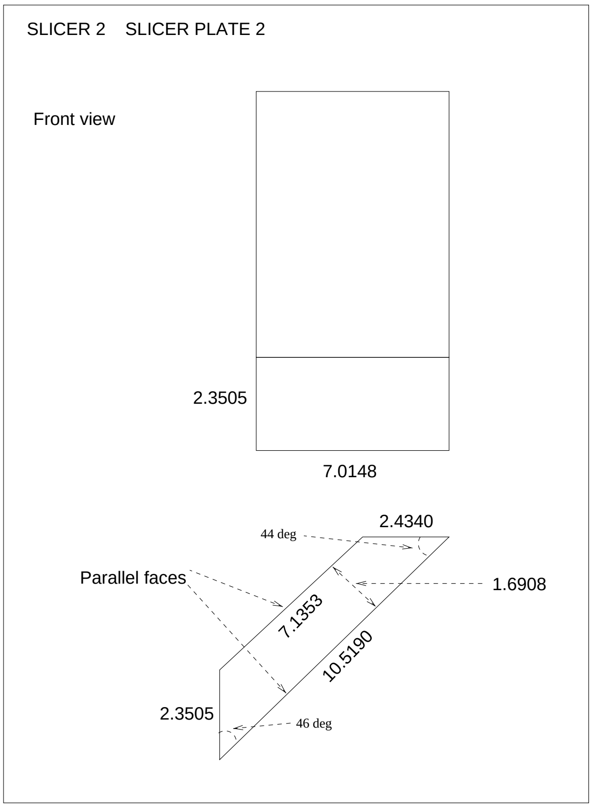
Detail:


SLICER 1 PRISM 1
5.675
7.882
3.783
46 deg
7.882
44 deg
8.162
SLICER 1 SLICER PLATE 1
Front view
2.1792
5.6746
44 deg
2.2566
Parallel faces
1.5676
8.2088
11.3458
2.1792
46 deg
SLICER 1 PRISM 2
3.783
7.882
1.892
46 deg
7.882
44 deg
8.162
SLICER 1 SLICER PLATE 2
Front view
2.1792
3.7831
44 deg
2.2566
Parallel faces
1.5676
8.2088
11.3458
2.1792
46 deg


SLICER 2 PRISM 1
10.522
7.307
7.015
46 deg
7.307
44 deg
7.567


SLICER 2 SLICER PLATE 1
Front view
2.3505
10.5222
44 deg
2.4340
Parallel faces
1.6908
7.1353
10.5190
2.3505
46 deg


SLICER 2 PRISM 2
7.015
7.307
3.507
46 deg
7.307
44 deg
7.567


SLICER 2 SLICER PLATE 2
Front view
2.3505
7.0148
44 deg
2.4340
Parallel faces
1.6908
7.1353
10.5190
2.3505
46 deg

All dimensions are in mm

Slicer 1 is high resolution slicer.
Slicer 2 is medium resoluion slicer.

Material: Fused silica

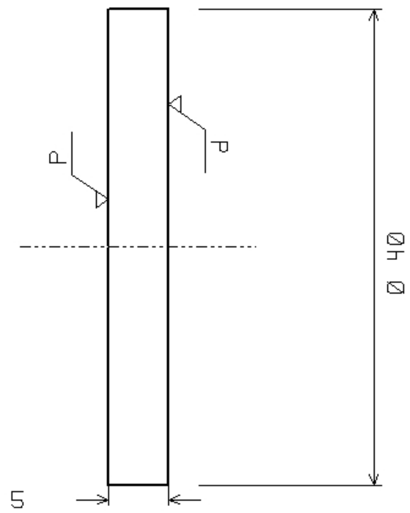
Coating: None

Tolerances

- **Homogeniety:**
- **Slicer plate thickness:** ±0.02 mm
- **Prism angles:** 1°
- Lenslet position: **:** ±0.2 mm

Note: 1. Lenslets to be cemented to slicer plate front surfaces.
2. Prisms to be cemented to mounting plates
3. Slicer plates to be optically contacted to prisms.

1.5.5 Image slicer mounting plates



Surface 1 is plane
Surface 2 is plane

Name: Image slicer mounting plate

Material: Fused silica

Coating: AR coated for 370nm to 890nm surface 2 only.

Finish: 60-40

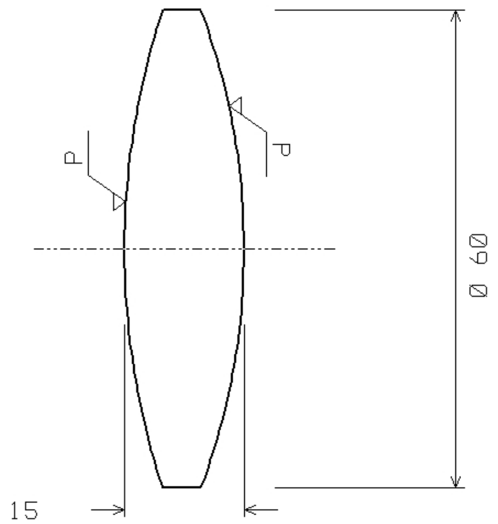
Tolerances

- **Homogeniety:**
- **Diameter:**
- **Wedge:**
- **Centration:**
- **CT:**
- **Irr. surface 1:**
- **Irr. surface 2:**

Notes: Image slicers 1.4.4 to be cemented to surface 1.

1.6 Slit transfer optics

1.6.1 Element FC1.1



<u>Surface 1 is convex</u>
<u>Surface 2 is convex</u>

Name: Focal conversion lens FC1.1

Material: N-FK51

Radii: R_1 = 96.82mm, R_2 = -85.49

Coating: AR coated for 370nm to 890nm surface 1 only.

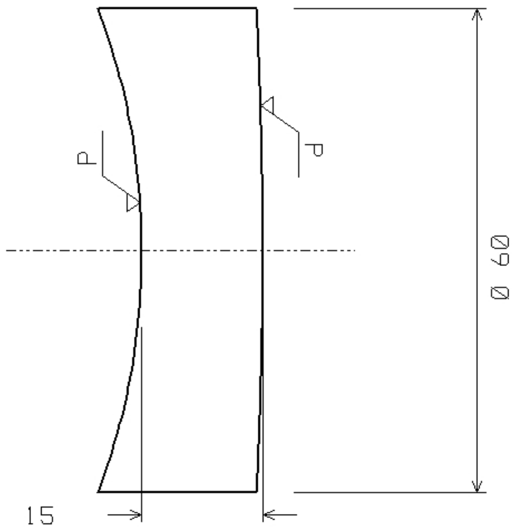
Finish: 60-40

Tolerances

- **Homogeniety:**
- **Diameter:**
- **Wedge:**
- **Centration:**
- **CT:**
- **R1:**
- **R2:**
- **Irr. surface 1:**
- **Irr. surface 2:**

Notes: Element cemented to FC1.2 on surface 2.

1.6.2 Element FC1.2



Surface 1 is concave
Surface 2 in convex

Name: Focal conversion lens FC1.2

Material: S-LAL7

Radii: R_1 = -85.49mm, R_2 = -563.00

Coating: AR coated for 370nm to 890nm surface 2 only.

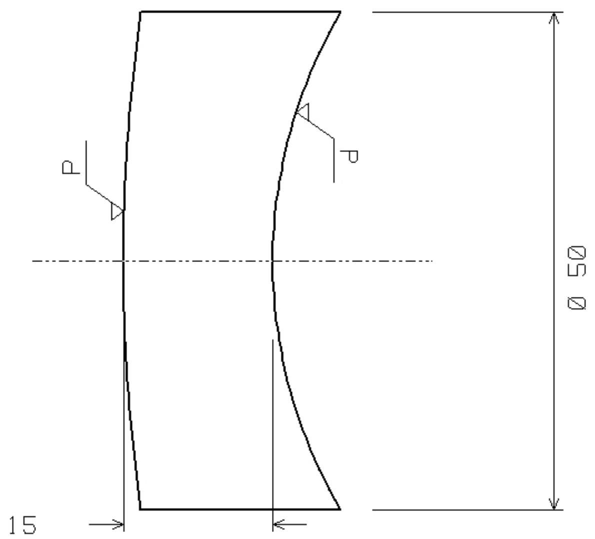
Finish: 60-40

Tolerances

- **Homogeniety:**
- **Diameter:**
- **Wedge:**
- **Centration:**
- **CT:**
- **R1:**
- **R2:**
- **Irr. surface 1:**
- **Irr. surface 2:**

Notes: Element cemented to FC1.1 on surface 1.

1.6.3 Element FC2.1



<u>Surface 1 is convex</u>
<u>Surface 2 in concave</u>

Name: Focal conversion lens FC2.1

Material: S-LAL7

Radii: R_1 = 180.67mm, R_2 = 49.29mm

Coating: AR coated for 370nm to 890nm surface 1 only.

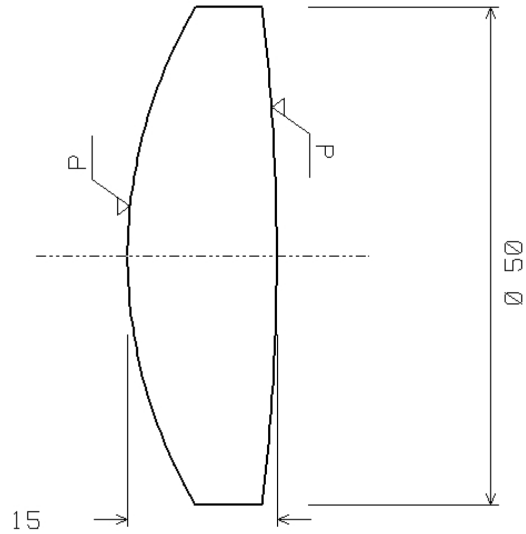
Finish: 60-40

Tolerances

- **Homogeniety:**
- **Diameter:**
- **Wedge:**
- **Centration:**
- **CT:**
- **R1:**
- **R2:**
- **Irr. surface 1:**
- **Irr. surface 2:**

Notes: Element cemented to FC2.2 on surface 2.

1.6.4 Element FC2.2



<u>Surface 1 is convex</u>
<u>Surface 2 in convex</u>

Name: Focal conversion lens FC2.2

Material: N-FK51

Radii: R_1 = 49.29mm, R_2 = -212.06mm

Coating: AR coated for 370nm to 890nm surface 2 only.

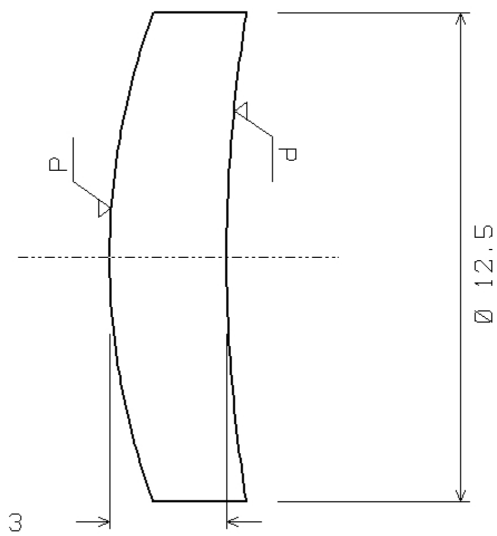
Finish: 60-40

Tolerances

- **Homogeniety:**
- **Diameter:**
- **Wedge:**
- **Centration:**
- **CT:**
- **R1:**
- **R2:**
- **Irr. surface 1:**
- **Irr. surface 2:**

Notes: Element cemented to FC2.1 on surface 1.

1.6.5 Element TC1.1



<u>Surface 1 is convex</u>
<u>Surface 2 in concave</u>

Name: Telecentric correction lens TC1.1

Material: BK7

Radii: R_1 = 18.09mm, R_2 = 39.20mm

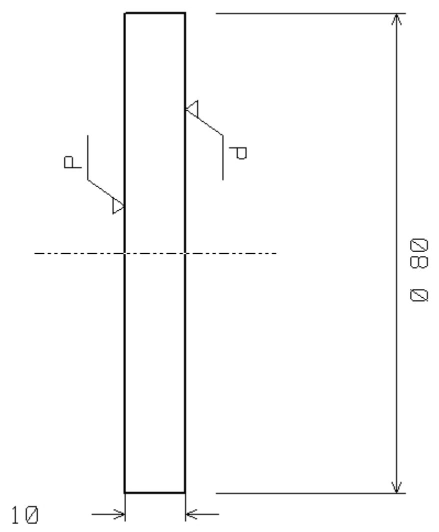
Coating: AR coated for 370nm to 890nm on both surfaces.

Finish: 60-40

Tolerances
- **Homogeniety:**
- **Diameter:**
- **Wedge:**
- **Centration:**
- **CT:**
- **R1:**
- **R2:**
- **Irr. surface 1:**
- **Irr. surface 2:**

Notes:

1.6.6 Vacuum window



<u>Surface 1 is plane</u>
<u>Surface 2 in plane</u>

Name: Vacuum window

Material: Silica

Coating: AR coated for 370nm to 890nm on both surfaces.

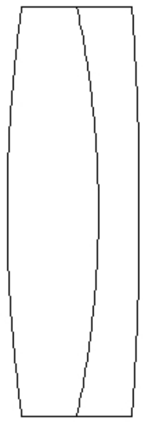
Finish: 60-40

Tolerances

- **Homogeniety:**
- **Diameter:**
- **Wedge:**
- **Centration:**
- **CT:**
- **R1:**
- **R2:**
- **Irr. surface 1:**
- **Irr. surface 2:**

Notes: Centre thickness **TBC**.

1.7 Slit viewing optics



Lens is achromatic doublet

Name: Slit viewing optic

Material: BK7/SF5 (or equivalent)

Focal length: 100mm

Diameter: 18mm

Coating: AR coated for 370nm to 890nm on both surfaces.

Notes: Item is lens #23-9509 from Coherent or equivalent.

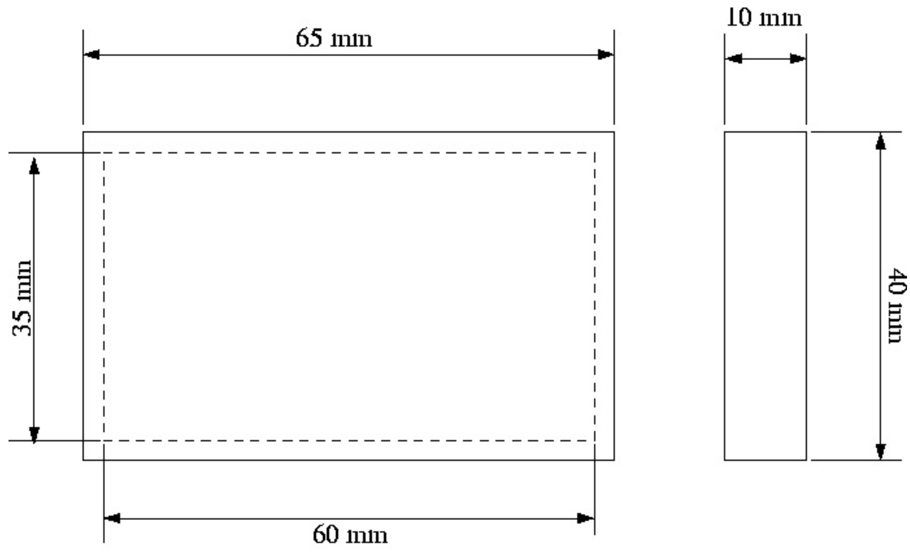
2 Mirrors

Several mirrors are required for SALT HRS. These are:

- Intermediate injection fold mirror
- Collimator
- Dichroic mirror
- Blue pupil mirror
- Red Pupil mirror
- Blue fold mirror
- Red fold mirror

Each mirror will be described in detail below.

2.1 Intermediate injection fold mirror



<u>Mirror is flat</u>

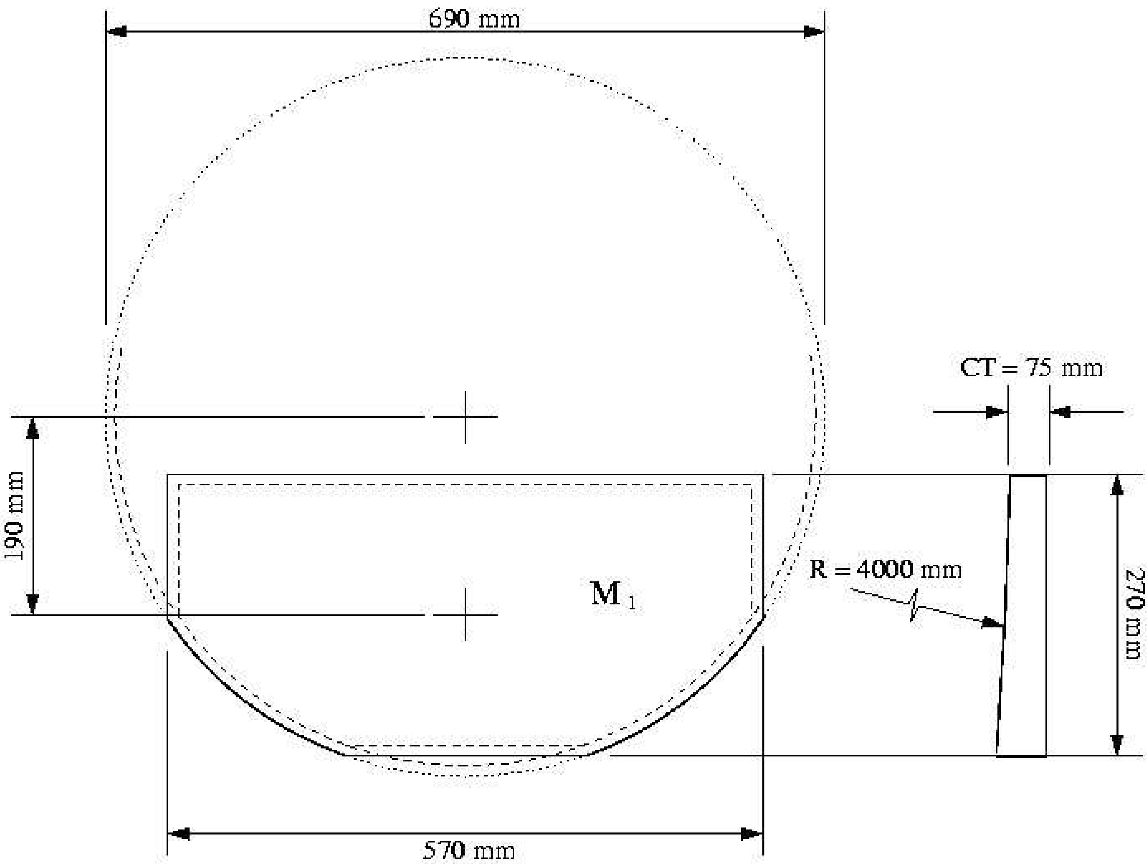
Material: Fused silica

Coating: Multi-layer overcoated silver (or equivalent).

Wavefront: λ/5

Notes: 2mm chamfer on all edges
2.5mm allowance for clear aperture (dashed line) on all edges
All dimensions +/- 0.5mm

2.2 Collimator



<u>Mirror is concave and parabolic</u>

Material: Zerodur or AstroSital

Coating: UV-enhanced silver

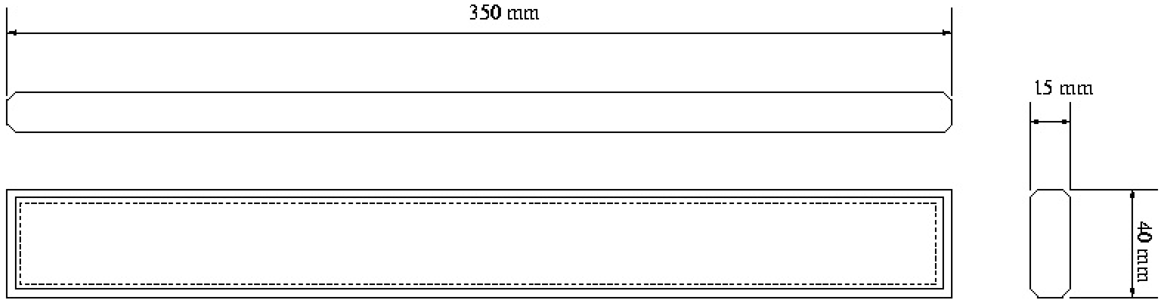
Wavefront: lam/5

Radius: R = 4000mm +/- 20mm

Conic: c = -1.0 +/- 0.05

Notes: 5mm chamfer on all edges
10mm allowance for clear aperture (dashed line) on all edges
All dimensions +/- 0.5mm

2.3 Dichroic mirror



<u>Mirror is flat</u>

Material: Fused silica

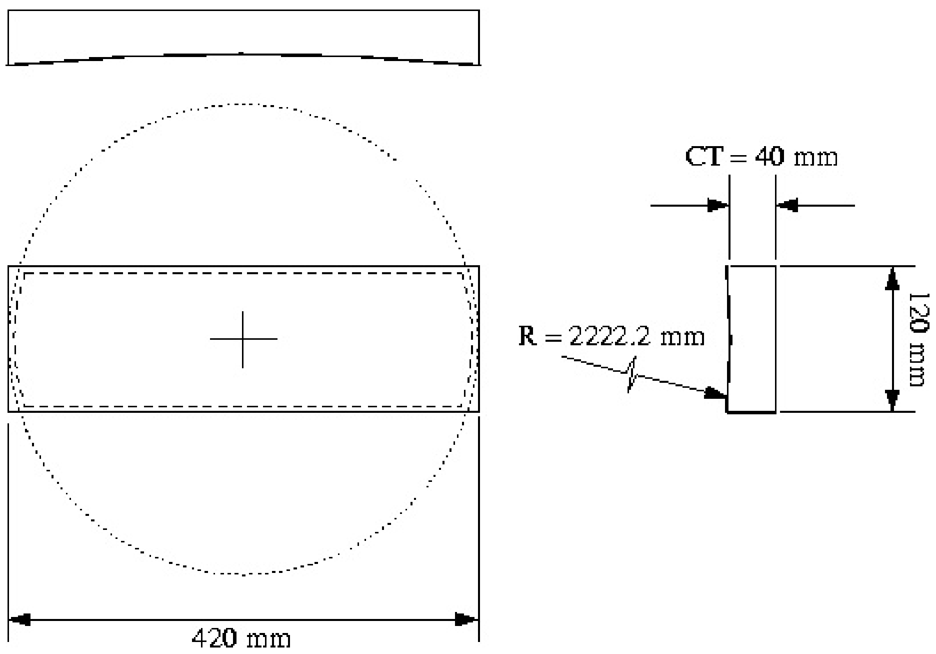
Coating: Dichroic: R > 95% 370-535nm, T > 90% 575-890nm

Wavefront: λ/5 reflected and transmitted

Wedge: Nil, parallelism < 30 arcsec.

Notes: 2-3mm chamfer on all edges
5mm allowance for clear aperture (dashed line) on all edges
All dimensions except thickness +/- 1mm
Thickness is 15mm +/- 0.25mm

2.4 Blue pupil mirror



<u>Mirror is concave and spherical</u>

Material: Zerodur or AstroSital

Coating: Enhanced aluminium

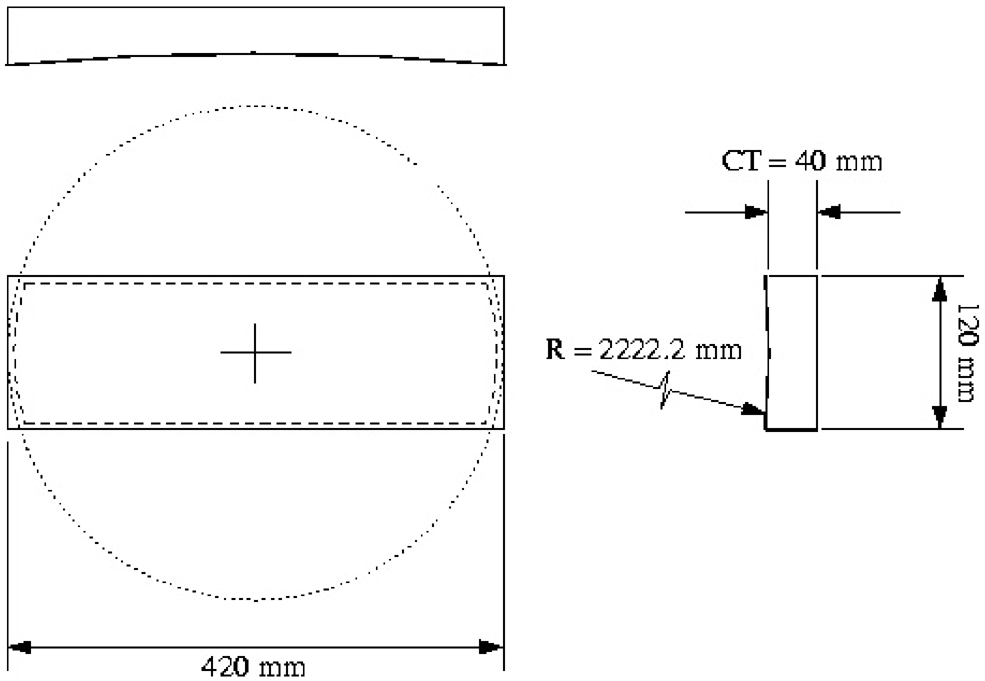
Wavefront: $\lambda/5$

Radius: R = 2222.2mm +/- 10mm

Conic: c = 0

Notes: Mirror may be formed from 420mm diameter parent (dashed line) (TBC)
5mm chamfer on all edges
5mm allowance for clear aperture (dashed line) on all edges
All dimensions +/- 0.5mm
Mirror is identical to red pupil mirror (except coating)

2.5 Red Pupil mirror



<u>Mirror is concave and spherical</u>

Material: Zerodur or AstroSital

Coating: Enhanced silver

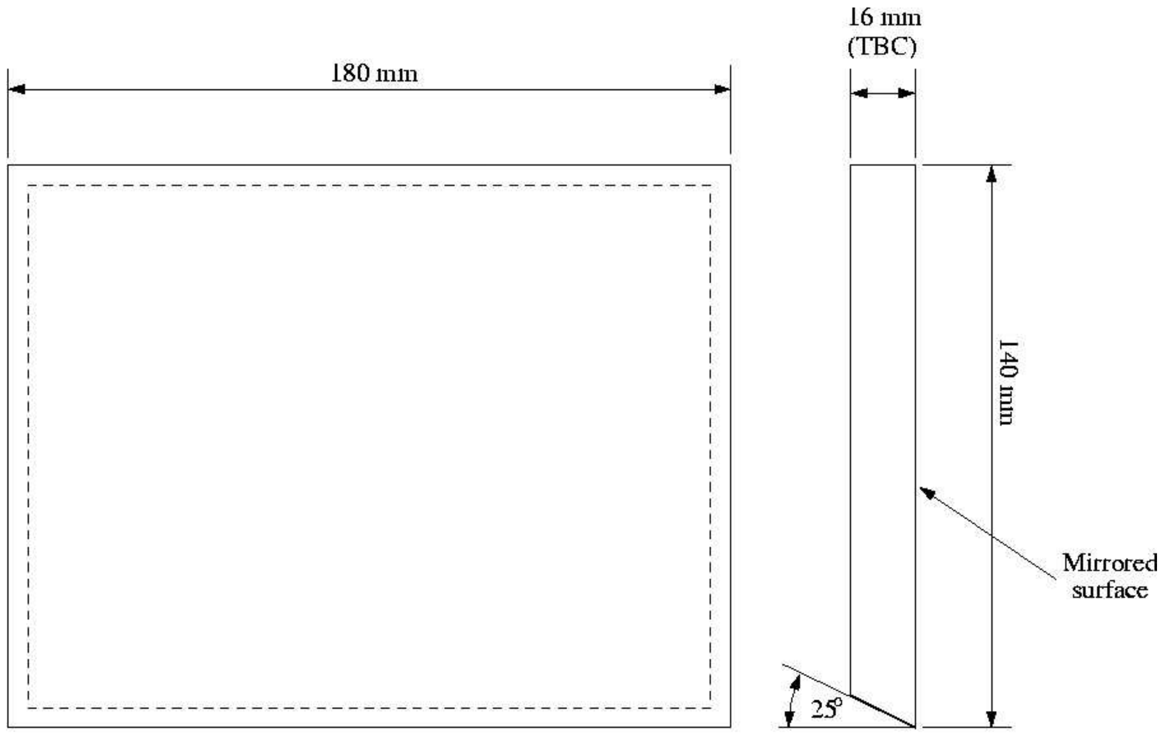
Wavefront: λ /5

Radius: R = 2222.2mm +/- 10mm

Conic: c = 0

Notes: Mirror may be formed from 420mm diameter parent (dashed line) (TBC)
5mm chamfer on all edges
5mm allowance for clear aperture (dashed line) on all edges
All dimensions +/- 0.5mm
Mirror is identical to blue pupil mirror (except coating)

2.6 Blue fold mirror



<u>Mirror is flat</u>

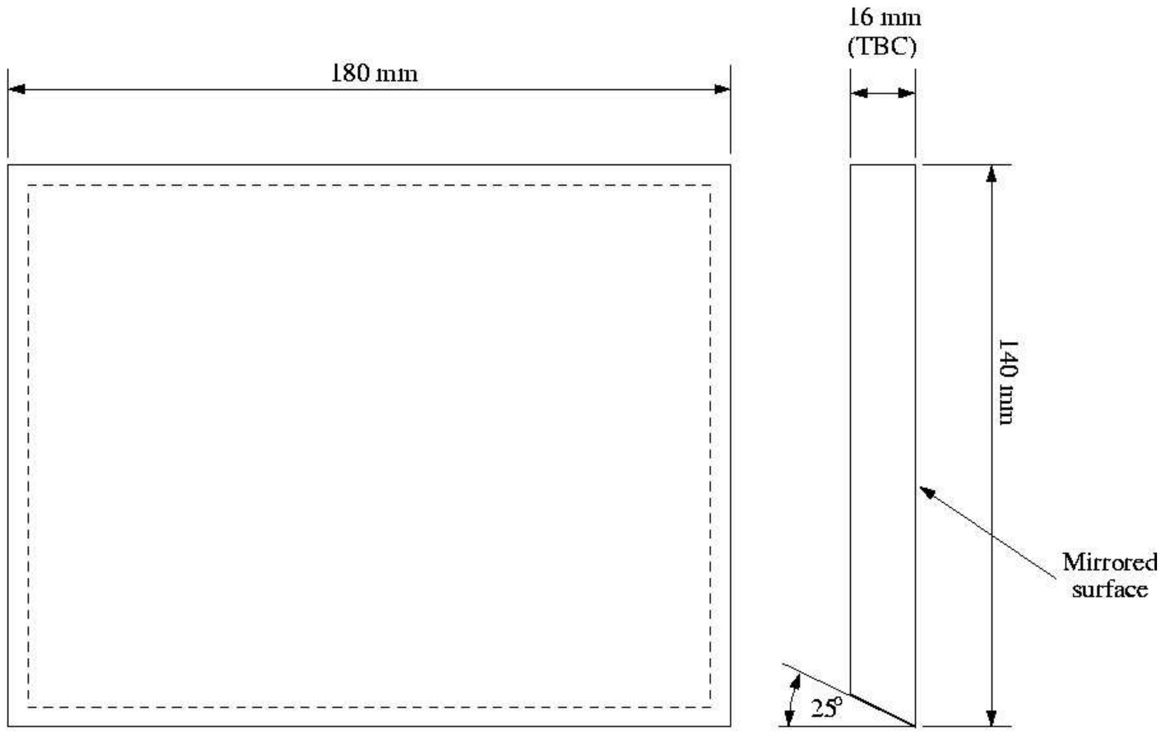
Material: Zerodur or AstroSital

Coating: Enhanced aluminium

Wavefront: $\lambda /5$

Notes: 5mm chamfer on all edges
5mm allowance for clear aperture (dashed line) on all edges
All dimensions +/- 0.5mm
Mirror is identical to red fold mirror (except coating)
25 degree chamfer is required on one edge as indicated

2.7 Red fold mirror



<u>Mirror is flat</u>

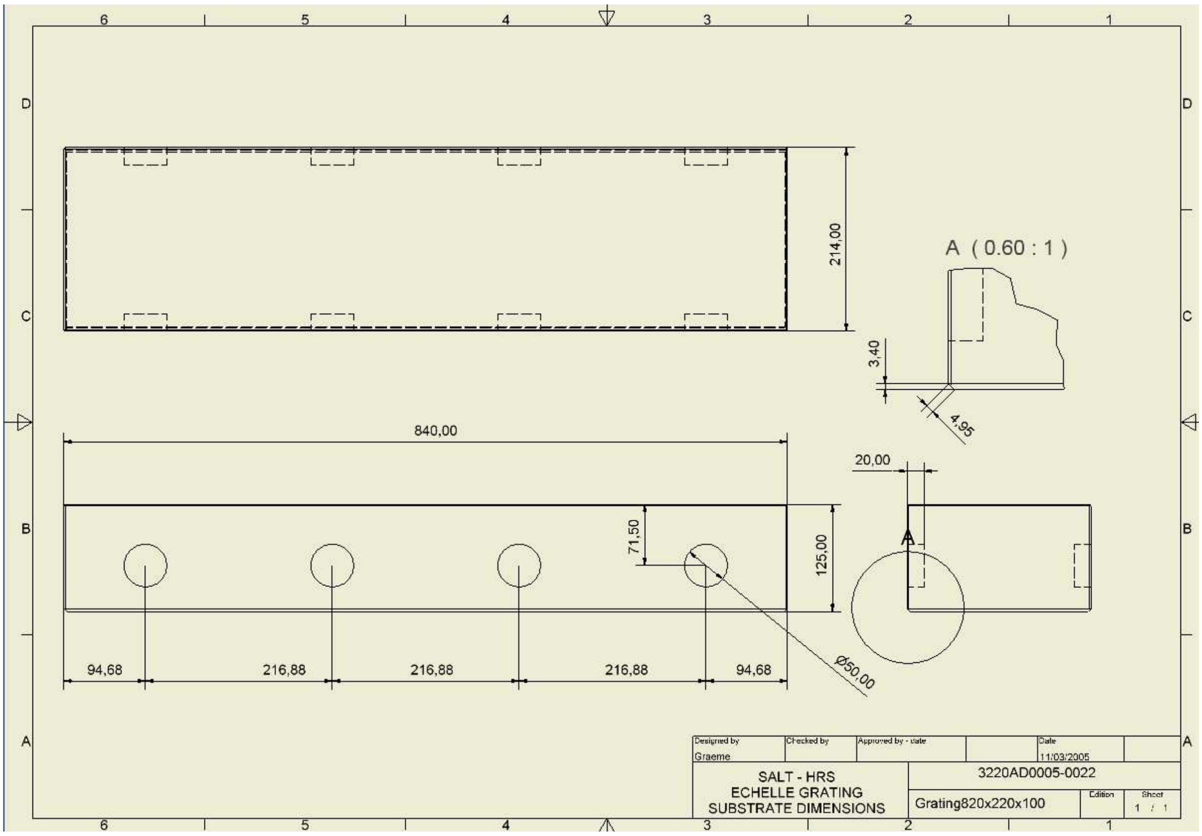
Material: Zerodur or AstroSital

Coating: Enhanced aluminium

Wavefront: $\lambda/5$

Notes: 5mm chamfer on all edges
5mm allowance for clear aperture (dashed line) on all edges
All dimensions +/- 0.5mm
Mirror is identical to blue fold mirror (except coating)
25 degree chamfer is required on one edge as indicated

3 Echelle grating



Catalog number: 53050ZD01-425E

Master: MR166

Description: 41.59 g/mm echelle mosaic with 76° blaze angle

Angle tolerance: ±0.4°

Substrate size: 214mm x 840mm x 125mm. Holes are to be machined as per SALT HRS drawing 3220AD00005-0022 shown above.

Dimension tolerance: ±0.4mm in length and width, ±0.5mm in thickness

Material: Schott Zerodur expansion class 1 or 0 (or equivalent)

Ruled area: To be ruled in two segments each approx 204 x 407mm.

Mosaic alignment tolerance: ±2 arcsec for groove alignment and tilt between mosaics, ±2μm lateral displacement between mosaics.

Centre gap: 18mm maximum, 15mm minimum

Spectral resolution: > 500 000 at 632.8nm

Spatial resolution: < 4 arc second

Ghost intensity: < 1.5 x 10-4 relative to parent

Wavefront: 0.5 waves P-V for 90% of points at 632.8nm (to be measured within 200mm x 814mm ellipse centred on grating mosaic)

Coating: Aluminium

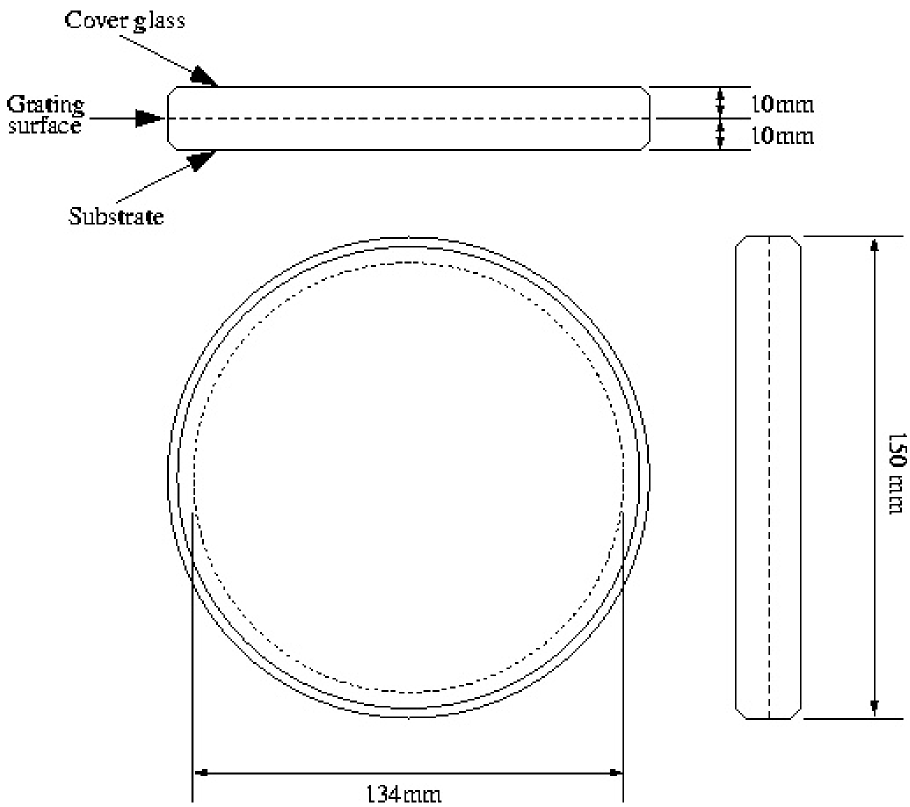
Efficiency: >55% at 360nm, >61% at 400nm, >62% at 550nm, >58% near 900nm. All measurements to be absolute at nearest blaze peak.

Notes: The following data is to be provided:
Full aperture wavefront photo with spatial calibration, reported as surface figure.
Ghost traces.
Polarized efficiency measurements.
Standard materials and epoxies are to be used to ensure vacuum compatibility.

4 VPH gratings

The two volume phase holographic gratings required for SALT HRS are described below:

4.1 Blue VPH grating



<u>Item: Blue volume phase holographic grating</u>

Description: 1850 l/mm volume phase holographic grating

AOI: 24.60° ±0.3°

CWL: 450.0nm ±20nm

Wavelength range: 370 < λ < 555nm. Polarized efficiencies to be matched as per "best effort".

Material: BK7 (10mm substrate plus 10mm cover glass)

Size: Physical diameter = 150mm. Clear diameter= 134mm

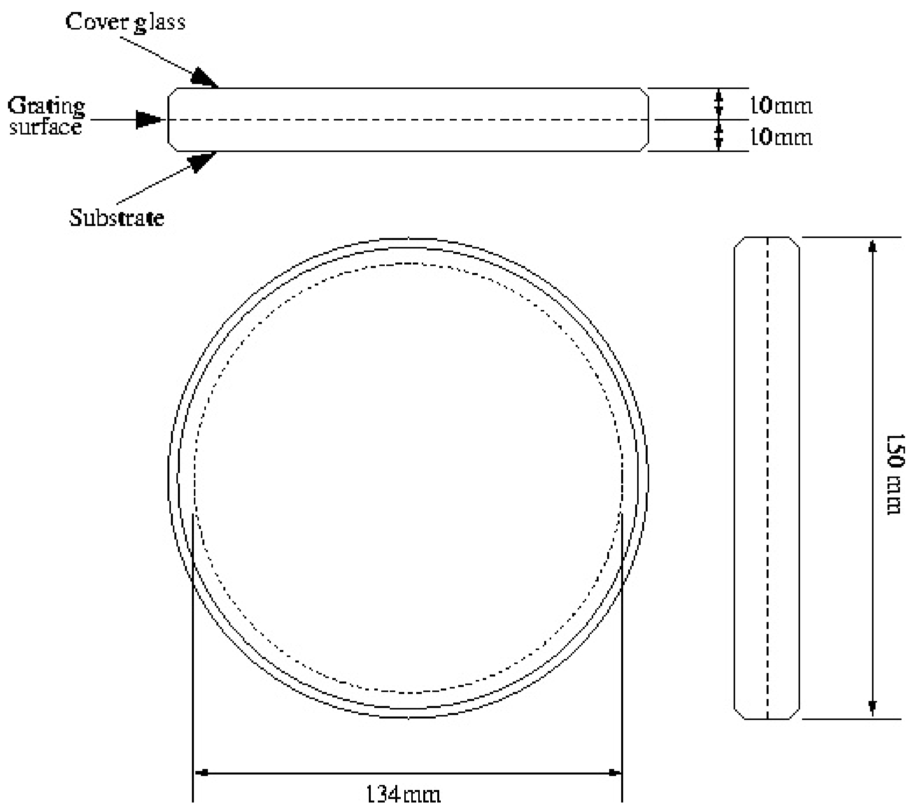
Surface figure: 4 fringes over clear diameter.

Wedge tolerance: 0.1mm total indicated runout (TIR)

Coating: None.

Notes:
A mark should be provided to indicate groove orientation.
Efficiency measurements are to be provided.
5mm chamfers to be placed on both faces.
Grating will be cemented between a pair of plano-concave and plano-convex lenses.

4.2 Red VPH grating



<u>Item: Red volume phase holographic grating</u>

Description: 855 l/mm volume phase holographic grating

AOI: 17.5° ±0.1°

CWL: 705.0nm ±20nm

Wavelength range: 555 < λ < 890nm. Polarized efficiencies to be matched as per "best effort".

Material: BK7 (10mm substrate plus 10mm cover glass)

Size: Physical diameter = 150mm. Clear diameter= 134mm

Surface figure: 4 fringes over clear diameter.

Wedge tolerance: 0.1mm total indicated runout (TIR)

Coating: None.

Notes:
A mark should be provided to indicate groove orientation.
Efficiency measurements are to be provided.
5mm chamfers to be placed on both faces.
Grating will be cemented between a pair of plano-concave and plano-convex lenses.

5 Cameras

Specifications for the blue and red cameras are provided by Damien Jones of Prime Optics. The following is from his reports dated 2005 Feb. 23 (v3.01).

5.1 Blue camera

5.1R1 and 5.1R2 are critical whilst other similar length radii are nearly so. It will be desirable to have these test plates made and measured first. A refit will be necessary if these plates are outside tolerance. Progressive refits will take place, as necessary, as other test plates are finished.

Curvature tolerances are set assuming that all inter-lens spacings will be readjusted to fit.

The optical designer is quite open to suggestions and comments as to ways of improving this design. He also reserves the right to make small alterations that improve performance or manufacturability.

Physical clear apertures are in general at least 16 mm greater than the optical clear apertures on the larger components. On the smaller components the aperture is set at 10 mm greater unless the surface is concave where just several mm are added.

Chamfers and non-optical flats should be fine-ground.

Please note that element 7.1 has a cylindrical rear surface. This element may be made in 2 pieces that can be subsequently cemented together. Marks must be scribed on the edge of this lens defining the direction of one of the cylindrical axes.

Blue Camera, v1.09
Date: 11 February 2005

Do not scale
UNITS: mm

NOTES

Chamfer no more than
2.0 x 45 deg on each surface.

A/R coat side 1, 370 - 550 nm

From outside:

Surface 1 is CONVEX
Surface 2 is PLANE

DATA/TOLERANCES

Glass: SCHOTT BK7

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: 0.1 mm TIR

Centration: 0.2 mm

CT: +/-1.0 mm

Radius 1: +/-50.0 mm

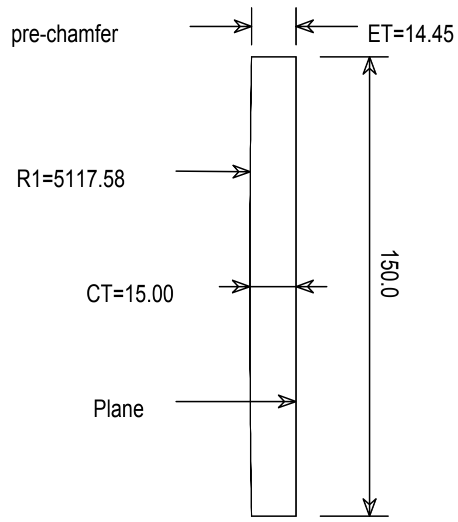
Irr. surface 1: 1Fr @ 600 nm

Irr. surface 2: 4Fr @ 600 nm

Prime Optics
17 Crescent Road
EUMUNDI Q 4562
AUSTRALIA

SALT HRS Blue Camera

Element VPH-Blue LENS 1



HRS-B-SY.109

Blue Camera, v1.09
Date: 11 February 2005

Do not scale
UNITS: mm

NOTES

Chamfer no more than
2.0 x 45 deg on each surface.

A/R coat side 2, 370 - 550 nm

From outside:

Surface 1 is PLANE
Surface 2 is CONCAVE

DATA/TOLERANCES

Glass: SCHOTT BK7

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: 0.1 mm TIR

Centration: 0.2 mm

CT: +/-1.0 mm

Radius 2: +/-50.0 mm

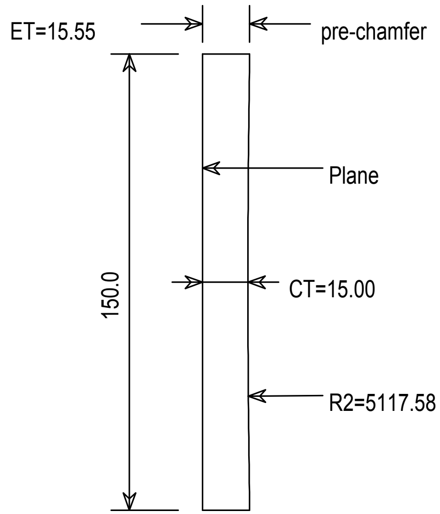
Irr. surface 1: 4Fr @ 600 nm

Irr. surface 2: 1Fr @ 600 nm

Prime Optics
17 Crescent Road
EUMUNDI Q 4562
AUSTRALIA

SALT HRS Blue Camera

Element VPH-Blue LENS 2



HRS-B-SY.109

Blue Camera, v1.09
Date: 11 February 2005

Do not scale
UNITS: mm

NOTES

Chamfer no more than
2.0 x 45 deg on each surface.

A/R coat side 1&2, 370 - 550 nm

From outside:

Surface 1 is CONVEX
Surface 2 is CONVEX

DATA/TOLERANCES

Glass: OHARA S-FPL51Y

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: 0.05 mm TIR

Centration: 0.05 mm

CT: +/-0.20 mm

Radius 1: +/-10 mm

Radius 2: +/-0.6 mm

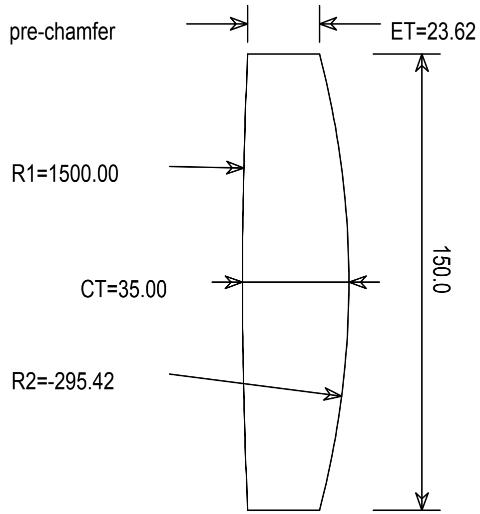
Irr. surface 1: Fr/2 @ 600 nm

Irr. surface 2: Fr/2 @ 600 nm

Prime Optics
17 Crescent Road
EUMUNDI Q 4562
AUSTRALIA

SALT HRS Blue Camera

Element BCM1.1



R1 is base radius of conic:
cc=-182 +/-5%

HRS-B-SY.109

Blue Camera, v1.09
Date: 11 February 2005

Do not scale
UNITS: mm

SALT HRS Blue Camera

Element BCM2.1

NOTES

Chamfer no more than
2.0 x 45 deg on each surface.

A/R coat side 1, 370 - 550 nm

From outside:

Surface 1 is CONCAVE
Surface 2 is CONCAVE

DATA/TOLERANCES

Glass: OHARA PBM2Y

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: 0.025 mm TIR

Centration: 0.05 mm

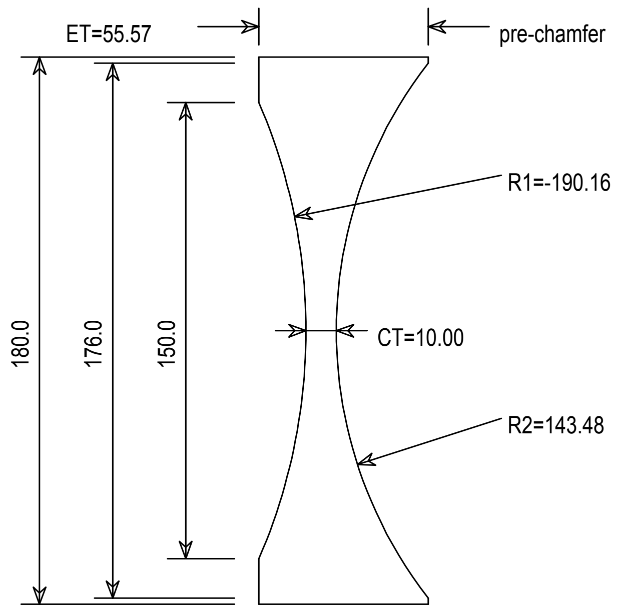
CT: +/-0.20 mm

Radius 1: +/-0.3 mm

Radius 2: +/-0.25 mm

Irr. surface 1: Fr/2 @ 600 nm

Irr. surface 2: 2Fr @ 600 nm



Prime Optics
17 Crescent Road
EUMUNDI Q 4562
AUSTRALIA

Element cemented to BCM2.2 on surface 2

HRS-B-SY.109

Blue Camera, v1.09
Date: 11 February 2005

Do not scale
UNITS: mm

NOTES

Chamfer no more than
2.0 x 45 deg on each surface.

A/R coat side 2, 370 - 550 nm

From outside:

Surface 1 is CONVEX
Surface 2 is CONCAVE

DATA/TOLERANCES

Glass: OHARA S-FSL5

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: 0.05 mm TIR

Centration: 0.1 mm

CT: +/-0.20 mm

Radius 1: +/-0.25 mm

Radius 2: +/-50 mm

Irr. surface 1: 2Fr @ 600 nm

Irr. surface 2: Fr/2 @ 600 nm

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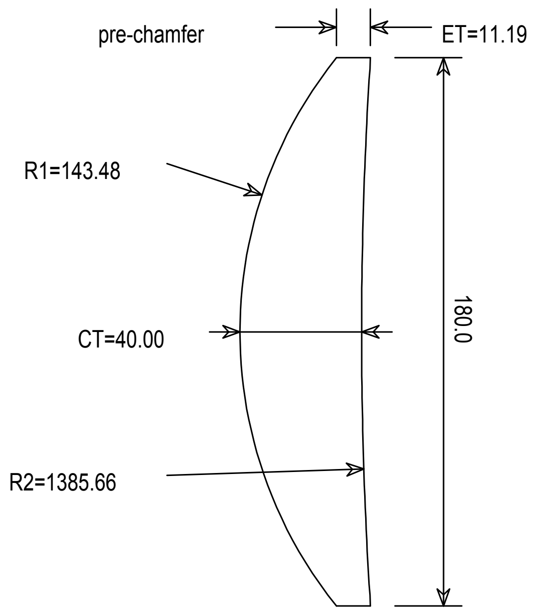
SALT HRS Blue Camera

Element BCM2.2



Element cemented to BCM2.1 on surface 1

HRS-B-SY.109

Blue Camera, v1.09
Date: 11 February 2005

Do not scale
UNITS: mm

NOTES

Chamfer no more than
2.0 x 45 deg on each surface.

A/R coat side 1&2, 370 - 550 nm

From outside:

Surface 1 is CONVEX
Surface 2 is CONVEX

DATA/TOLERANCES

Glass: OHARA S-FPL51Y

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: <0.02 mm TIR

Centration: <0.02 mm

CT: +/-0.20 mm

Radius 1: +/-0.4 mm

Radius 2: +/-0.4 mm

Irr. surface 1: Fr/2 @ 600 nm

Irr. surface 2: Fr/2 @ 600 nm

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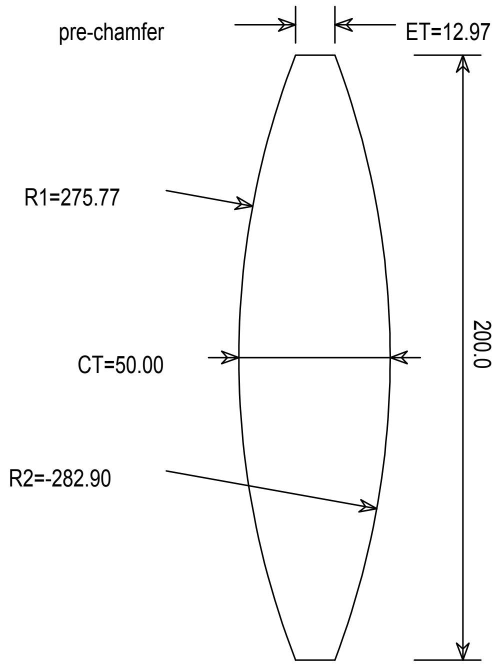
AUSTRALIA

SALT HRS Blue Camera

Element BCM3.1



HRS-B-SY.109

Blue Camera, v1.09
Date: 11 February 2005

Do not scale
UNITS: mm

NOTES

Chamfer no more than
2.0 x 45 deg on each surface.

A/R coat side 1&2, 370 - 550 nm

From outside:

Surface 1 is CONVEX
Surface 2 is CONVEX

DATA/TOLERANCES

Glass: OHARA PBM2Y

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: 0.05 mm TIR

Centration: 0.1 mm

CT: +/-0.20 mm

Radius 1: +/-1.0 mm

Radius 2: +/-5.0 mm

Irr. surface 1: Fr/2 @ 600 nm

Irr. surface 2: Fr/2 @ 600 nm

Prime Optics
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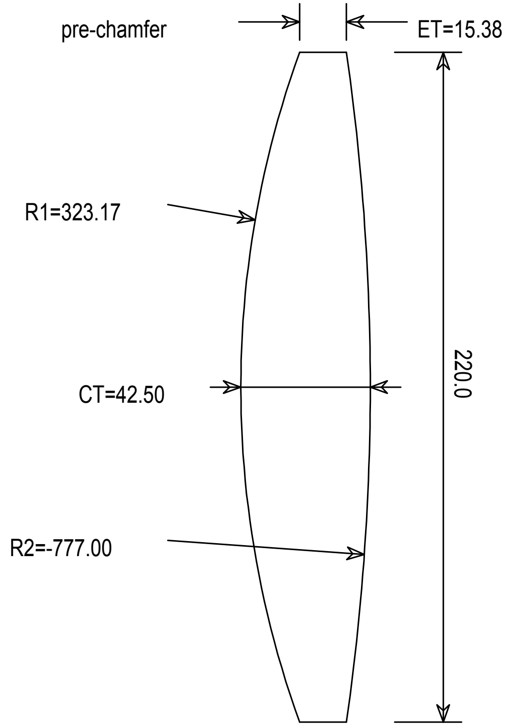
EUMUNDI Q 4562
AUSTRALIA

SALT HRS Blue Camera

Element BCM4.1



HRS-B-SY.109

Blue Camera, v1.09
Date: 11 February 2005

Do not scale
UNITS: mm

NOTES

Chamfer no more than
2.0 x 45 deg on each surface.

A/R coat side 1&2, 370 - 550 nm

From outside:

Surface 1 is CONVEX
Surface 2 is CONCAVE

DATA/TOLERANCES

Glass: OHARA PBM2Y

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: 0.025 mm TIR

Centration: 0.025 mm

CT: +/-0.20 mm

Radius 1: +/-0.1 mm

Radius 2: +/-0.1 mm

Irr. surface 1: 1Fr @ 600 nm

Irr. surface 2: 1Fr @ 600 nm

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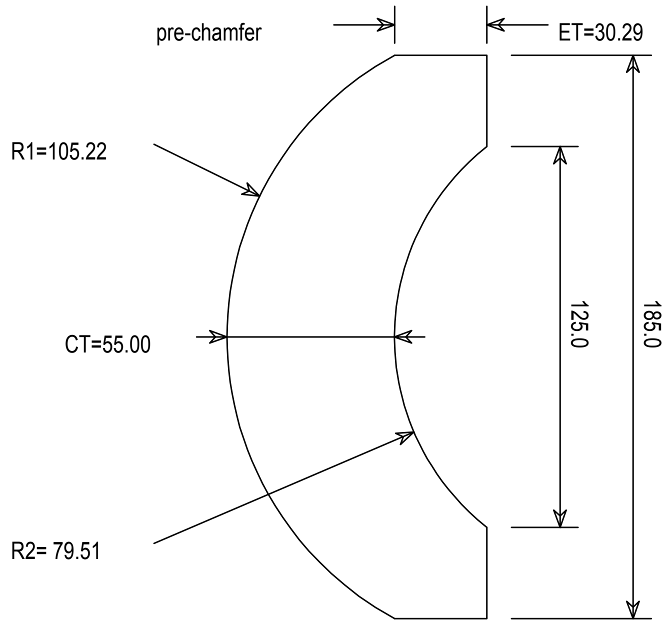
AUSTRALIA

SALT HRS Blue Camera

Element BCM5.1



HRS-B-SY.109

Blue Camera, v1.09
Date: 11 February 2005

Do not scale
UNITS: mm

SALT HRS Blue Camera

Element BCM6.1

NOTES

Chamfer no more than
2.0 x 45 deg on each surface.

A/R coat side 1&2 , 370 - 550 nm

From outside:

Surface 1 is CONVEX
Surface 2 is CONCAVE

DATA/TOLERANCES

Glass: OHARA PBM2Y

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: 0.025 mm TIR

Centration: 0.025 mm

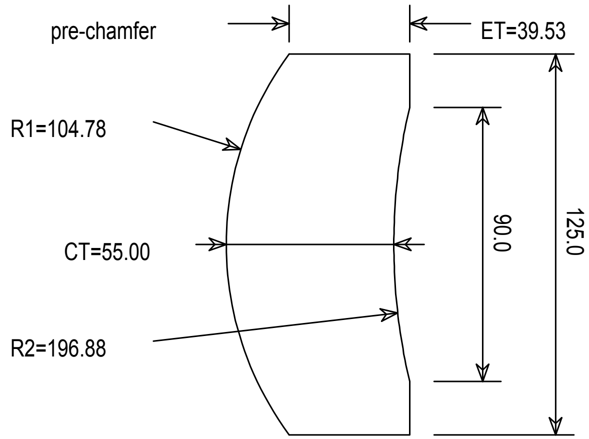
CT: +/-0.20 mm

Radius 1: +/-0.3 mm

Radius 2: +/-0.5 mm

Irr. surface 1: 1Fr @ 600 nm

Irr. surface 2: 1Fr @ 600 nm



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AUSTRALIA

HRS-B-SY.109

Blue Camera, v1.09
Date: 11 February 2005

Do not scale
UNITS: mm

NOTES

Chamfer no more than
1.0 x 45 deg on each surface

A/R coat sides 1&2, 370 - 550 nm

From outside:

Surface 1 is CONCAVE
Surface 2 is CONCAVE

DATA/TOLERANCES

Glass: fused SILICA

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: 0.025 mm TIR

Centration: <0.025 mm

CT: +/-0.20 mm

Radius 1: +/-1.0 mm

Radius 2: +/-5.0 mm
(CYLINDRICAL)

Irr. surface 1: 2Fr @ 600 nm

Irr. surface 2: 2Fr @ 600 nm

Prime Optics
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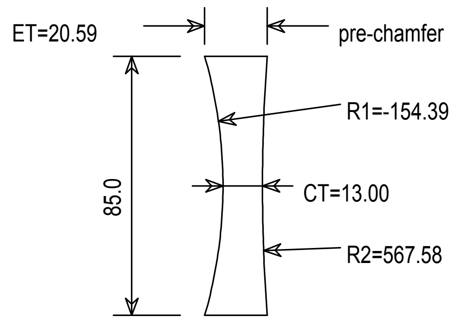
EUMUNDI Q 4562
AUSTRALIA

SALT HRS Blue Camera

Element BCM7.1



Surface 2 is cylindrical

HRS-B-SY.109

5.2 Red camera

There are no critical radii. However, a progressive refit to manufactured test-plates, starting with some of the shorter radii, would be highly desirable.

Curvature tolerances are set assuming that all inter-lens spacings will be readjusted to fit.

The optical designer is quite open to suggestions and comments as to ways of improving this design. He also reserves the right to make small alterations that improve performance or manufacturability.

Physical clear apertures are in general at least 16 mm greater than the optical clear apertures on the larger components. On the smaller components the aperture is set at 10 mm greater unless the surface is concave where just several mm are added.

Chamfers and non-optical flats should be fine-ground.

Please note that element 5.1 has a cylindrical rear surface. This element may be made in 2 pieces that can be subsequently cemented together. Marks must be scribed on the edge of this lens defining the direction of one of the cylindrical axes.

Red Camera, v1.09 Date: 11 February 2005	**SALT HRS Red Camera** Element VPH-Red LENS 1
Do not scale UNITS: mm	

NOTES

Chamfer no more than
2.0 x 45 deg on each surface.

A/R coat side 1, 550 - 900 nm

From outside:

Surface 1 is CONVEX
Surface 2 is PLANE

DATA/TOLERANCES

Glass: SCHOTT BK7

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: 0.1 mm TIR

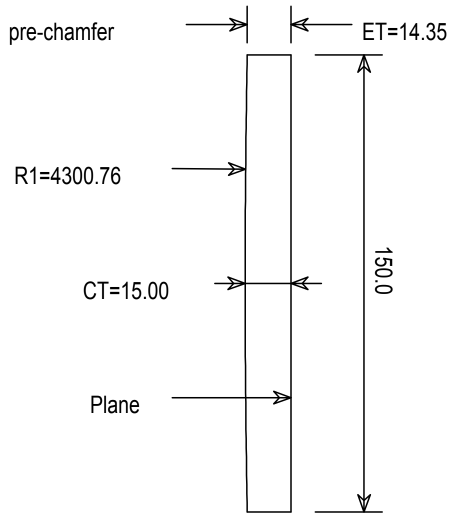
Centration: 0.2 mm

CT: +/-1.0 mm

Radius 1: +/-50 mm

Irr. surface 1: 1Fr @ 600 nm

Irr. surface 2: 4Fr @ 600 nm



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HRS-R-SY.109

Red Camera, v1.09
Date: 11 February 2005

Do not scale
UNITS: mm

NOTES

Chamfer no more than
2.0 x 45 deg on each surface.

A/R coat side 2, 550 - 900 nm

From outside:

Surface 1 is PLANE
Surface 2 is CONCAVE

DATA/TOLERANCES

Glass: SCHOTT BK7

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: 0.1 mm TIR

Centration: 0.2 mm

CT: +/-1.0 mm

Radius 2: +/-50 mm

Irr. surface 1: 4Fr @ 600 nm

Irr. surface 2: 1Fr @ 600 nm

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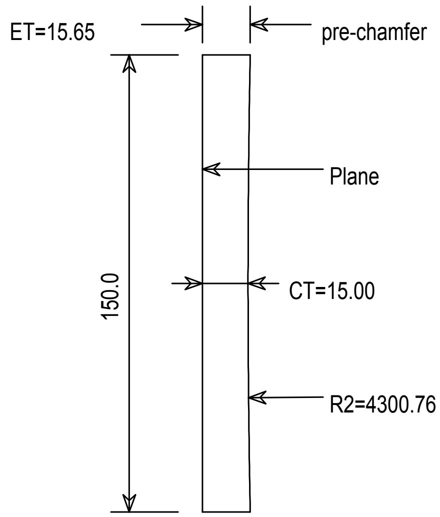
AUSTRALIA

SALT HRS Red Camera

Element VPH-Red LENS 2



HRS-R-SY.109

Red Camera, v1.09
Date: 11 February 2005

Do not scale
UNITS: mm

SALT HRS Red Camera

Element RCM1.1

NOTES

Chamfer no more than
2.0 x 45 deg on each surface.

A/R coat side 1, 550 - 900 nm

From outside:

Surface 1 is CONVEX
Surface 2 is CONVEX

DATA/TOLERANCES

Glass: OHARA S-FSL5

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: 0.05 mm TIR

Centration: 0.05 mm

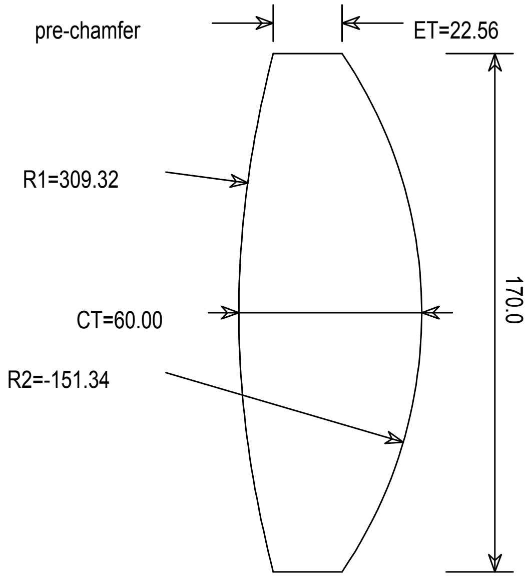
CT: +/-0.20 mm

Radius 1: +/-1.0 mm

Radius 2: +/-0.4 mm

Irr. surface 1: Fr/2 @ 600 nm

Irr. surface 2: 2Fr @ 600 nm



Prime Optics
17 Crescent Road
EUMUNDI Q 4562
AUSTRALIA

R1 is base radius of conic:
cc=-2.76 +/-5%
Element cemented to RCM1.2 on surface 2

HRS-R-SY.109

Red Camera, v1.09
Date: 11 February 2005

Do not scale
UNITS: mm

NOTES

Chamfer no more than
2.0 x 45 deg on each surface.

A/R coat side 2, 550 - 900 nm

From outside:

Surface 1 is CONCAVE
Surface 2 is CONCAVE

DATA/TOLERANCES

Glass: OHARA S-TIH1

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: 0.05 mm TIR

Centration: 0.05 mm

CT: +/-0.20 mm

Radius 1: +/-0.4 mm

Radius 2: +/-1.0 mm

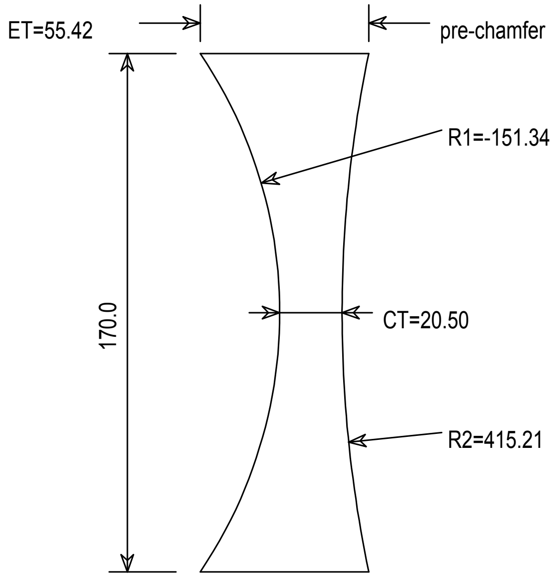
Irr. surface 1: 2Fr @ 600 nm

Irr. surface 2: Fr/2 @ 600 nm

Prime Optics
17 Crescent Road
EUMUNDI Q 4562
AUSTRALIA

SALT HRS Red Camera

Element RCM1.2



Element cemented to RCM1.1 on surface 1

HRS-R-SY.109

Red Camera, v1.09
Date: 11 February 2005

Do not scale
UNITS: mm

NOTES

Chamfer no more than
2.0 x 45 deg on each surface.

A/R coat sides 1&2, 550 - 900 nm

From outside:

Surface 1 is CONVEX
Surface 2 is CONVEX

DATA/TOLERANCES

Glass: OHARA S-BAH11

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: <0.025 mm TIR

Centration: <0.025 mm

CT: +/-0.20 mm

Radius 1: +/-30 mm

Radius 2: +/-0.6 mm

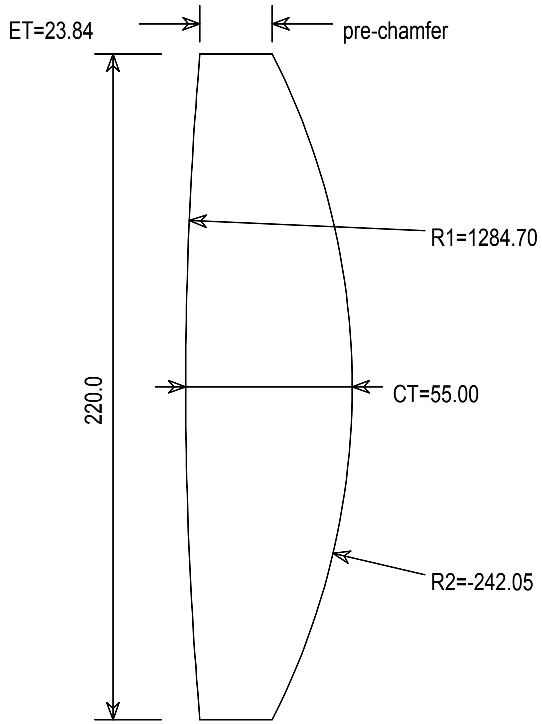
Irr. surface 1: Fr/2 @ 600 nm

Irr. surface 2: Fr/2 @ 600 nm

Prime Optics
17 Crescent Road
EUMUNDI Q 4562
AUSTRALIA

SALT HRS Red Camera

Element RCM2.1



HRS-R-SY.109

Red Camera, v1.09
Date: 11 February 2005

Do not scale
UNITS: mm

NOTES

Chamfer no more than
2.0 x 45 deg on each surface.

A/R coat sides 1&2, 550 - 900 nm

From outside:

Surface 1 is CONVEX
Surface 2 is CONCAVE

DATA/TOLERANCES

Glass: SCHOTT BK7

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: 0.025 mm TIR

Centration: 0.025 mm

CT: +/-0.20 mm

Radius 1: +/-0.3 mm

Radius 2: +/-2 mm

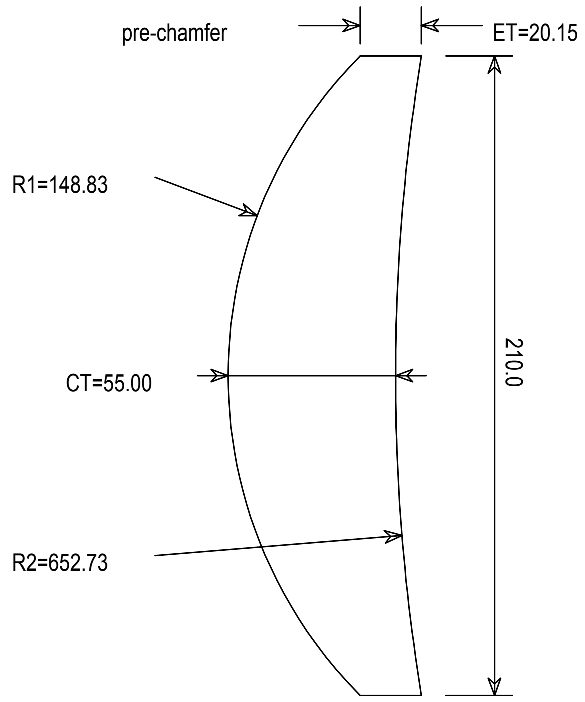
Irr. surface 1: Fr/2 @ 600 nm

Irr. surface 2: Fr/2 @ 600 nm

Prime Optics
17 Crescent Road
EUMUNDI Q 4562
AUSTRALIA

SALT HRS Red Camera

Element RCM3.1



HRS-R-SY.109

Red Camera, v1.09
Date: 11 February 2005

Do not scale
UNITS: mm

NOTES

Chamfer no more than
2.0 x 45 deg on each surface.

A/R coat sides 1&2, 550 - 900 nm

From outside:

Surface 1 is CONVEX
Surface 2 is CONCAVE

DATA/TOLERANCES

Glass: OHARA S-BAH11

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: 0.05 mm TIR

Centration: 0.05 mm

CT: +/-0.20 mm

Radius 1: +/-0.5 mm

Radius 2: +/-0.6 mm

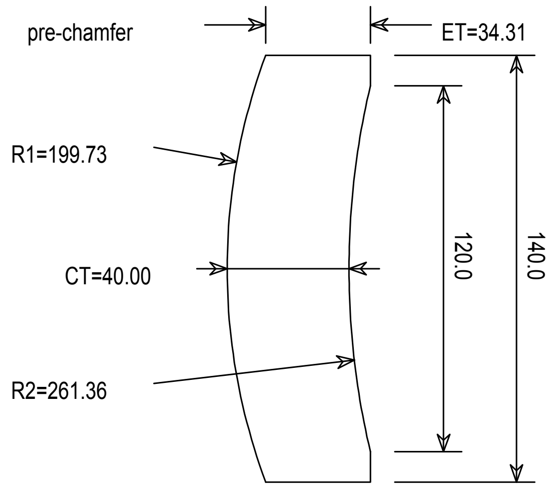
Irr. surface 1: Fr/2 @ 600 nm

Irr. surface 2: Fr/2 @ 600 nm

Prime Optics
17 Crescent Road
EUMUNDI Q 4562
AUSTRALIA

SALT HRS Red Camera

Element RCM4.1



HRS-R-SY.109

Red Camera, v1.09
Date: 11 February 2005

Do not scale
UNITS: mm

SALT HRS Red Camera

Element RCM5.1

NOTES

Chamfer no more than
2.0 x 45 deg on each surface.

A/R coat sides 1&2, 550 - 900 nm

From outside:

Surface 1 is CONCAVE
Surface 2 is CONCAVE

DATA/TOLERANCES

Glass: fused SILICA

Homogeneity: +/-2E-6

Finish: 60/40 S/D

Diameter: +0,-0.1 mm

Wedge: <0.025 mm TIR

Centration: 0.025 mm

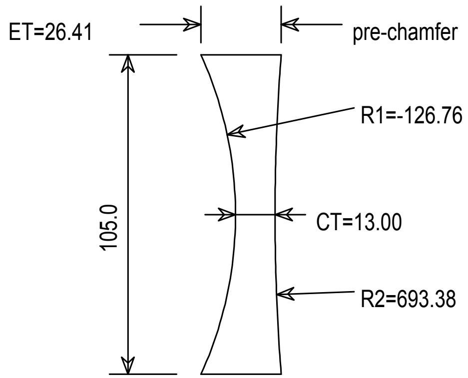
CT: +/-0.20 mm

Radius 1: +/-1.0 mm

Radius 2: +/-10 mm

Irr. surface 1: Fr @ 600 nm

Irr. surface 2: Fr @ 600 nm



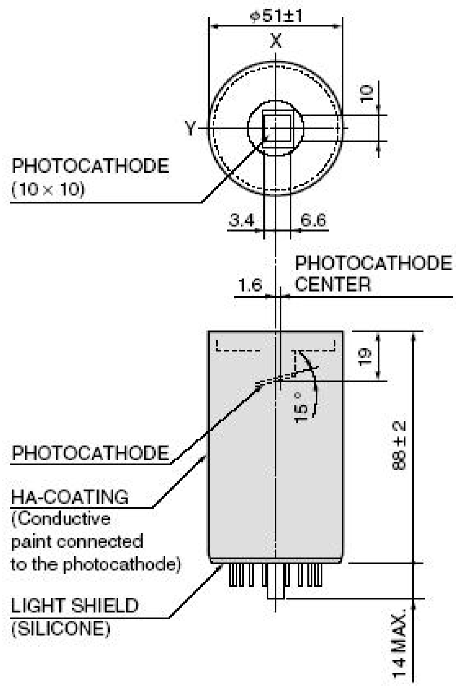
Surface 2 is cylindrical

HRS-R-SY.109

Prime Optics
17 Crescent Road
EUMUNDI Q 4562
AUSTRALIA

6 Exposure meter

6.1 Photomultiplier tube



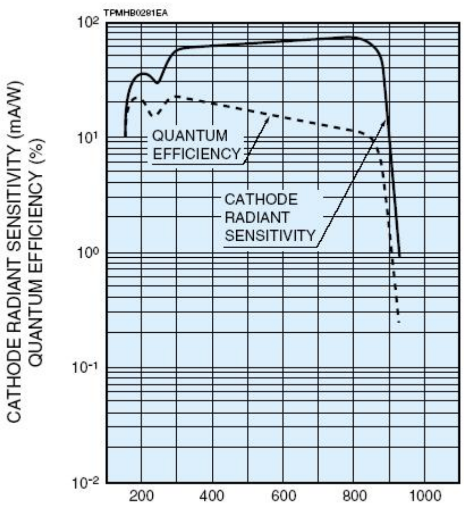
(all dimensions mm)

Name: R943-02

Type: GaAs (Cs) photocathode.

Supplier: Hamamatsu.
www.hpk.co.jp/Eng/products/ETD/pdf/R943-02_TPMH1115E06.pdf

Quantum efficiency:

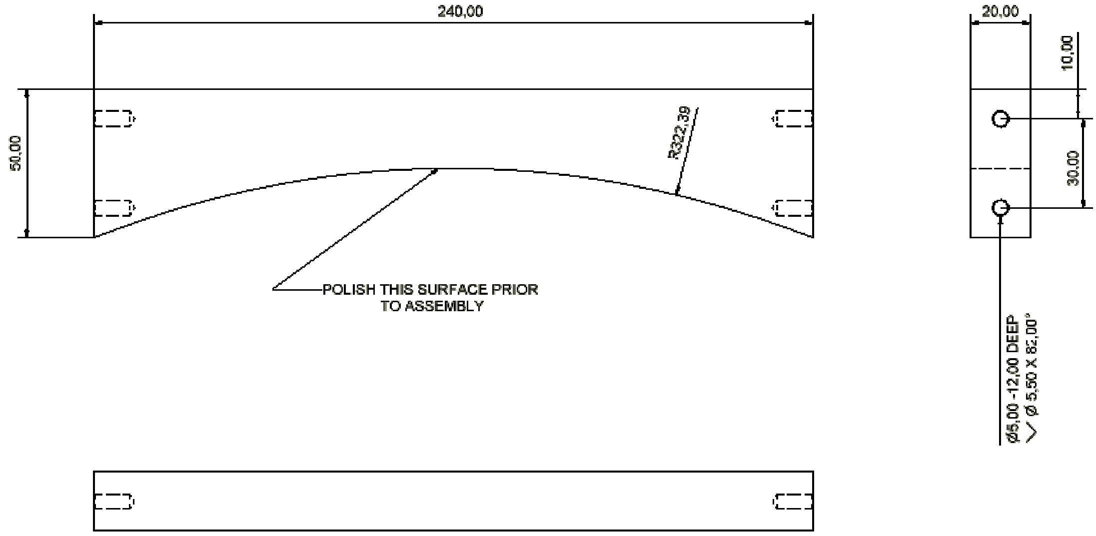


6.2 Collector optics

6.2.1 Echelle mirror

Require one piece 200 x 10mm aluminized mylar. 90-99% reflectivity. Local supplier **TBD**.

6.2.2 Collector mirror



<u>Mirror is concave, parabolic and toroidal</u>

Material: Aluminium

Coating: Best effort surface polish or aluminized mylar [**TBC**]

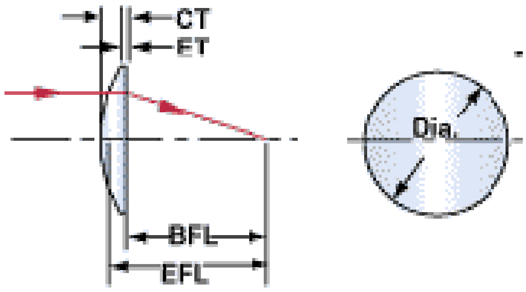
Wavefront: 50 - 100λ

Conic: c = -1.0 +/- 0.1

Radius: R = 310mm +/- 1mm

Notes: 2mm chamfer on all edges
All dimensions +/- 0.5mm

6.2.3 Fibre coupling optic



Material: BK7

Dimensions: Diameter = 12.5mm, Radius = 6.480, CT = 7.480mm, ET = 2.720
EFL = 12.500mm, BFL = 7.570mm.

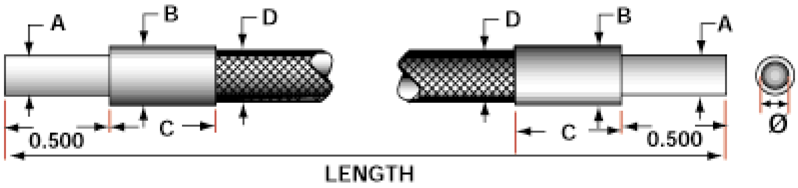
Supplier: Edmund Scientific
www.edmundoptics.com/onlinecatalog/DisplayProduct.cfm?productid=2110

Catalogue number: NT46-193

Number required: 1

Notes: To be glued to fibre light guide (item 6.2.4).

6.2.4 Fibre light guide



Type: [TBC] Flexible fibre light guide. Sheathed in PVC-covered metal hose.

Dimensions: Diameter = 6.32mm, A = 7.92mm, B = 12.32mm, C = 17.35mm, D = 10.92mm

Length: 1829mm

Supplier: Edmund Scientific
http://www.edmundoptics.com/onlinecatalog/displayproduct.cfm?productID=1439

Number required: 1

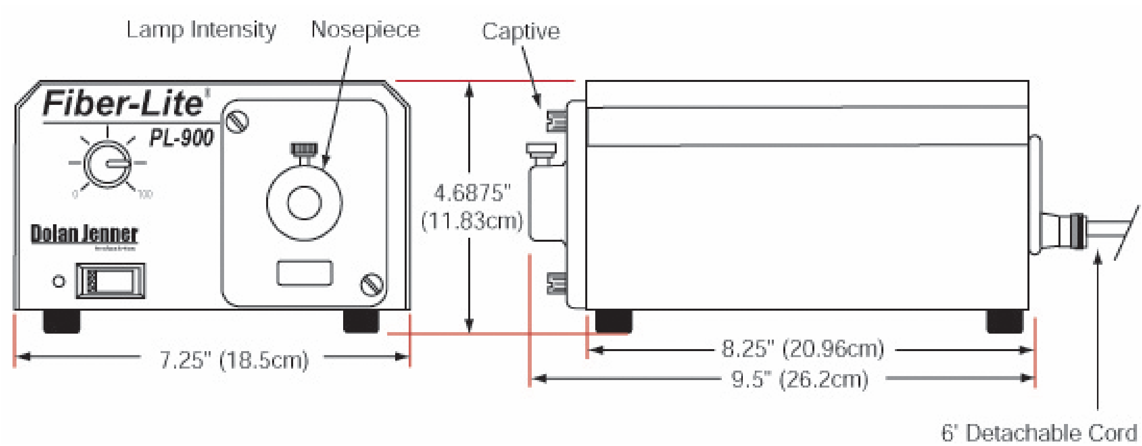
Notes: Input to be mated with fibre coupling optic (item 6.2.3). Vacuum feedthrough to be provided.

7 Calibration sources

Calibration sources and optics are required for the following:

- CCD flat-fielding
- Direct injection calibration

7.1 CCD flat-fielding source



Name: Dolan-Jenner DC-950 fibre optic illuminator

Lamp: 150W EKE Quartz Halogen

Lamp output: 21V, 400,000 footcandles at fibre insertion plate

Colour temperature: 3250K at maximum intensity

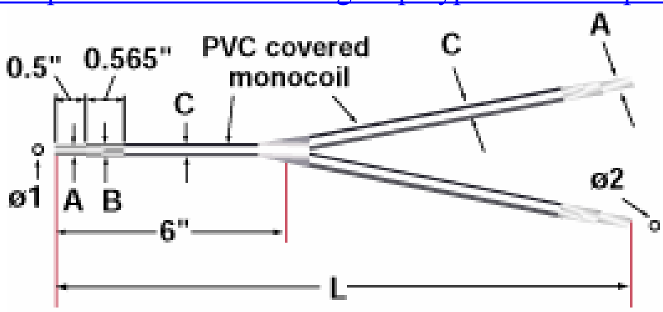
Supplier: Edmund Scientific
www.edmundoptics.com/onlinecatalog/DisplayProduct.cfm?productid=1614

Number required: 1

Auxiliary equipment:

- Filters [TBD]. Possible combination of neutral density and narrow band filters.

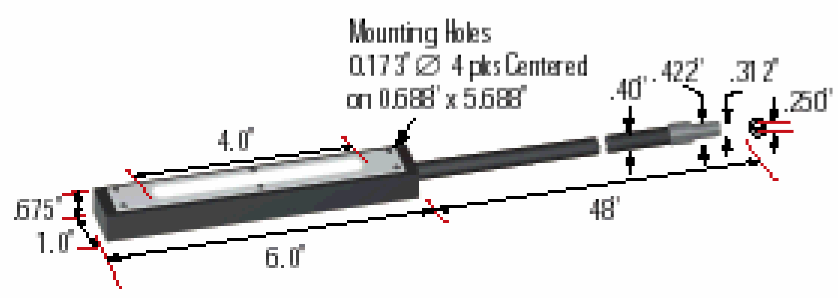
- Dual branch light pipe NT54-203 from Edmund Scientific
  www.edmundoptics.com/onlinecatalog/displayproduct.cfm?productID=1265



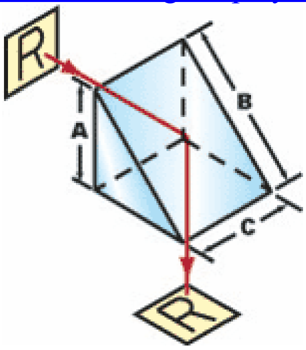
Dimensions are: $\phi 1$ = 6.35mm, $\phi 2$ = 4.50mm, A = 8.00mm, B = 12.07mm, C = 10.92mm, L = 1829mm. Requires standard input adapter for illuminator and custom adapter for fibre input mounting.

Auxiliary equipment cont.:

- Linear fibre optic backlight NT39-825 from Edmund Scientific.
  www.edmundoptics.com/onlinecatalog/DisplayProduct.cfm?productid=1443



- Right angle prism NT32-540 from Edmund Scientific.
  www.edmundoptics.com/onlineCatalog/DisplayProduct.cfm?productid=2038



Dimensions: A = 5mm, B = 7mm, C = 5mm.

7.2 Direct injection light source

Hollow cathode emission lamp(s). Details are **TBC**. Possible selection from S & J Juniper and Co. (www.sjjuniper.com/perkin_data.asp); e.g. #5160PEDC - thorium with argon gas.

Flexible benchtop arrangements and fibre coupling to be provided. Details are **TBC**.