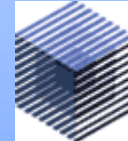


Solar Orbiter EUV Spectrometer (EUS) Proto-Consortium Meeting
Cosener's House, Abingdon, Oxfordshire, UK
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Optical characteristics of the EUV spectrometer for the grazing-incidence region

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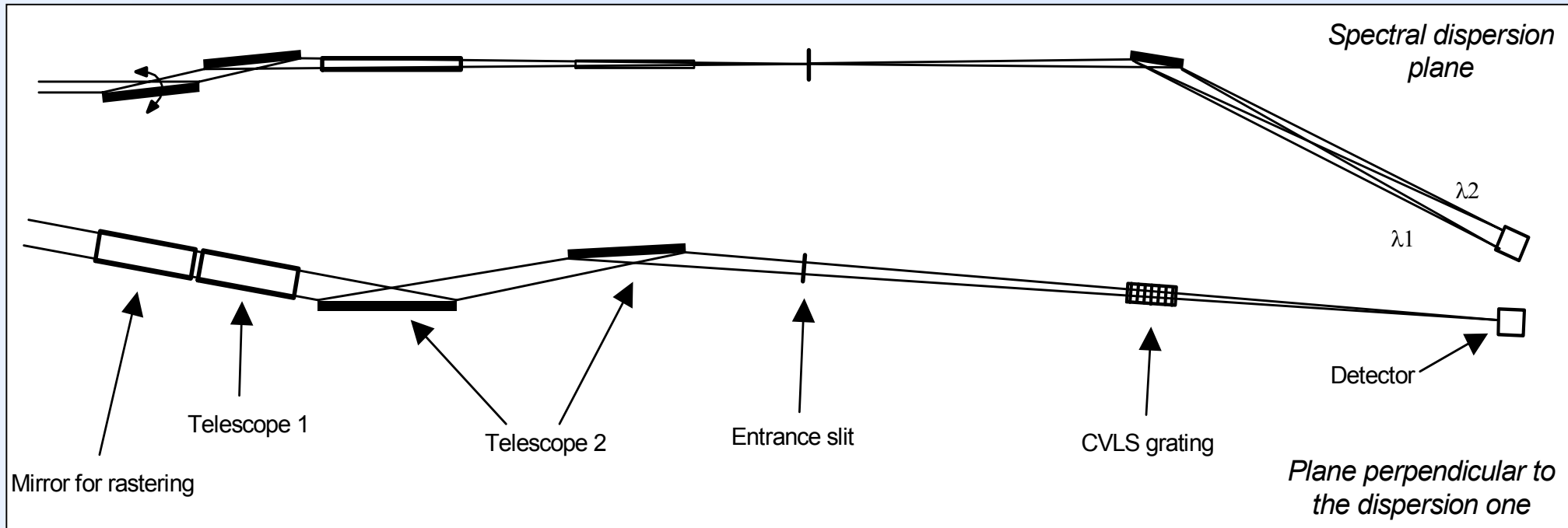
EUV spectrometer for SOLO

Configuration:

Two crossed grazing-incidence telescopes feeding a grazing-incidence variable-line-spaced-grating (VLS) spectrometer

**The spectral range of operation is the region 170-230 Å (first order)
and 85-125 Å (second order)**

Configuration: two crossed grazing-incidence telescopes and grazing-incidence VLS spectrometer (1/6)



SIZE:

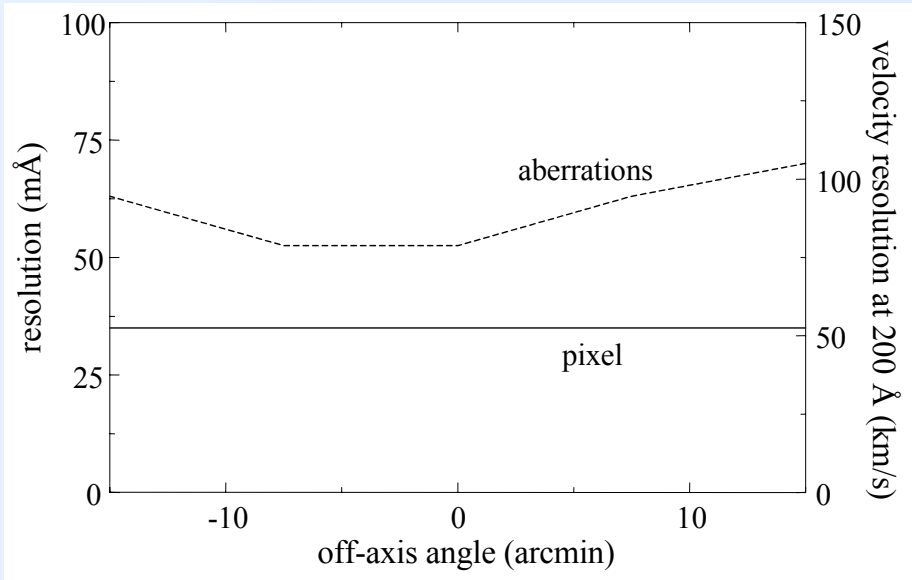
The size is 2.0 m \times 0.4 m \times 0.4 m

Characteristics (2/6)

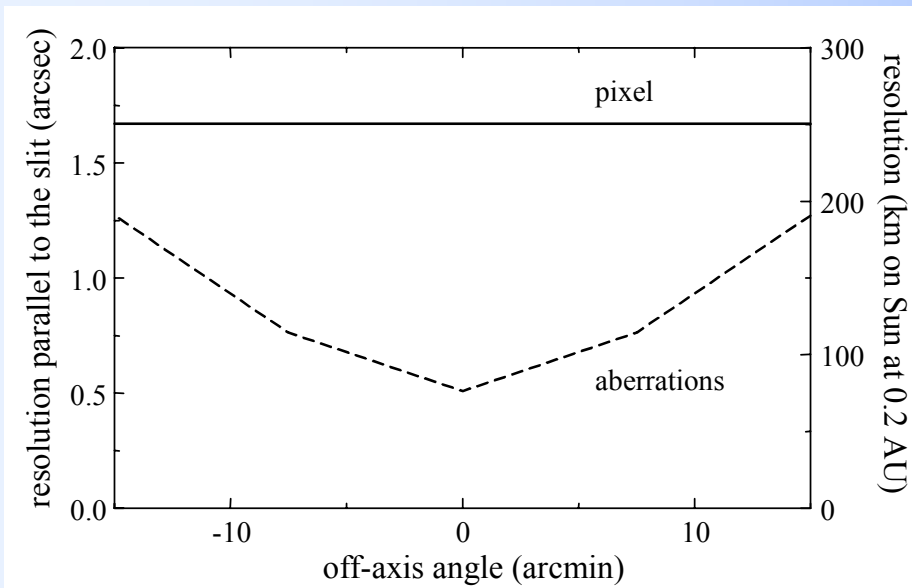
Field of view	30 arcmin (to the slit, simultaneous) 30 arcmin (\perp to the slit, to be acquired by rastering)
Entrance aperture	21 mm \times 41 mm
Mirror for rastering	Plane mirror (84°)
Size	200 mm \times 41 mm
Telescope 1	Cylindrical mirror with parabolic section (84°)
Size	200 mm \times 41 mm
Focal length	1000 mm
Telescope 2	Wolter II configuration (78-80°)
Size mirror 1	200 mm \times 20 mm
Size mirror 2	150 mm \times 20 mm
Focal length	2450 mm
Slit	
Size	8 μ m \times 25 mm
Resolution \perp to the slit	1.7 arcsec
Spatial resolution @0.2 AU (\perp to the slit)	250 km

Grating	VLS cylindrical grating
Groove density	1600 lines/mm
Wavelength	160-240 Å (I order) 80-120 Å (II order)
Entrance arm	300 mm
Exit arm	500 mm
Incidence angle	82°
Radius	3000 mm
Size	45 (\perp to the grooves) \times 25 mm
Plate factor (I order)	3.5 Å/mm
Plate factor (II order)	1.7 Å/mm
Detector	
Pixel size	10 μ m \times 20 μ m
Format	2400 \times 1200 pixel
Area	24 (\perp to the slit) \times 22 mm
Spectral resolving element	35 mÅ (I order) 18 mÅ (II order)
Velocity resolution	53 km/s
Spatial resolving element	1.7 arcsec
Spatial resolution @0.2 AU	250 km

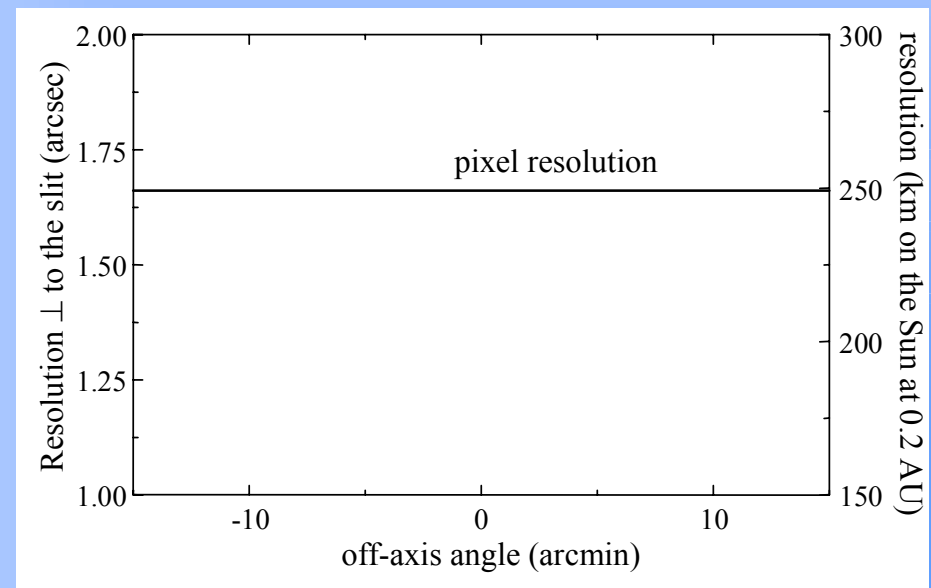
Optical performance (3/6)



- 1) 1) Spectral resolution
2) Spatial resolution parallel to the slit
3) Spatial resolution perpendicular to the slit



- 2) 3)



Optical performance (4/6)

- **The resolution is limited by slit width or pixel size on the whole FOV**
- The configuration is stigmatic even in the grazing-incidence region

⇒ **A 2-D IMAGE IS OBTAINED BY A 1-D RASTERING**

REMARKS

The **image stabilisation** is performed by two independent rotations of the plane mirror (simple mechanism)

The **rastering** is performed by a rotation of the plane mirror (simple mechanism)

OPEN QUESTIONS

The total length is 2 m

Effective area (5/6)

Plane mirror + Telescope 1	Gold	0.80@200 A	0.80@100 A
Telescope 2	Gold	0.65@200 A	0.65@100 A
Grating global efficiency	Gold	0.15@200 A	0.15@100 A
Detector efficiency	0.4		
No filter in front of the detector			

⇒ **EFFECTIVE AREA** 0.14 cm² @200 A 0.14 cm²@100 A

Emission from the line **10¹³ photons/cm²/sr/s**

⇒ **COUNTS/LINE/S ON 1.7 × 1.7 ARCSEC** **95 c/s @200 A** **95 c/s @100 A**

OPEN QUESTIONS:

⇒ **INTEGRATION TIME ≥_≈ 30 sec**

⇒ **VERY HIGH SPATIAL RESOLUTION (0.34 arcsec from Earth) AND RELATIVELY LOW TEMPORAL RESOLUTION**

Thermal load @ 0.2 AU (6/6)

Entrance aperture area	8.6 cm ²
Entrance thermal load @ 0.2 AU	30 W
Thermal load on the plane mirror	30 W
Absorption	5 W 0.07 W/cm ² (0.5 solar constants)
Thermal load on telescope 1	25 W
Absorption	4 W 0.05 W/cm ² (0.4 solar constants)
Thermal load on telescope 2: mirror 1	21 W
Absorption	4 W 0.12 W/cm ² (1 solar constant)
Thermal load on telescope 2: mirror 2	9 W
Absorption	2 W 0.13 W/cm ² (1 solar constant)

REMARKS:

⇒ **RADIATORS (30 W entering, 30 W absorbed by the optics/structure)**

Conclusions (1/3)

- **Configuration of an imaging spectrometer at 200 Å (100 Å)**
 - **stigmatic configuration**
- **Optical performance**
 - **the spatial resolution is 1.7 arcsec (250 km on Sun @ 0.2 AU)**
 - **the spectral resolution is 35 mÅ**
 - **THE PERFORMANCE ARE LIMITED BY PIXEL SIZE AND SLIT WIDTH WITHIN THE WHOLE FOV**

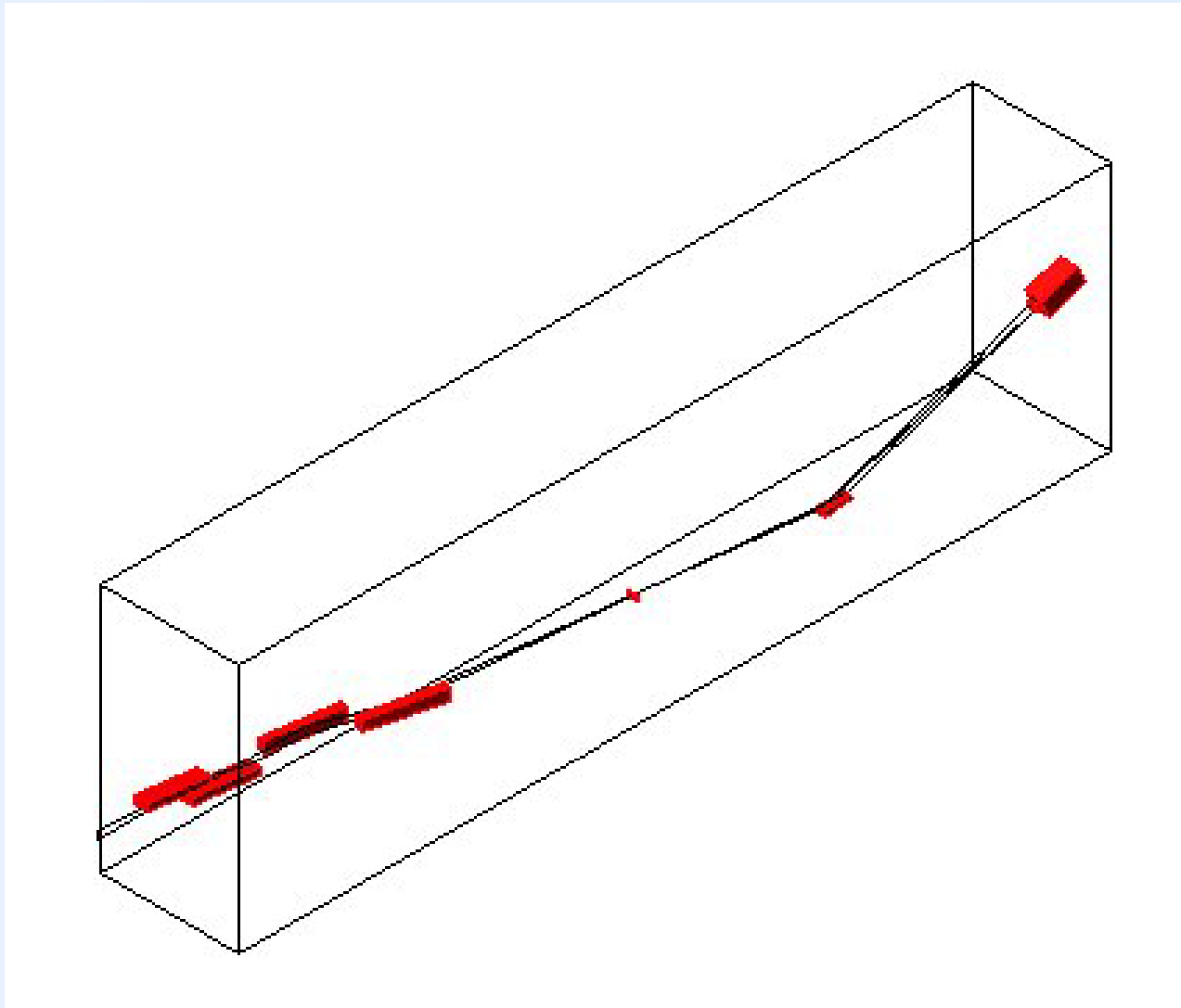
The configuration gives a stigmatic spectrum and almost constant aberrations on the field-of-view. The spatial resolution is about 5 times better than the best spatial resolution on Earth (at the present)

- **Rastering**
 - **The rastering is performed by a simple rotation of a plane mirror**

Conclusions (2/3)

- **Grating feasibility**
 - The grating is small and easily feasible
- **Effective area and counts**
 - The counts per line are less than one hundred counts/sec
 - Optics degradation: the decrease in reflectivity due to contamination effects is expected to be moderate, due to the grazing incidence and to the low thermal load
- **Thermal load**
 - ≈ 30 W are entering into the instrument and absorbed by the optics/structure
 - The thermal load on the optics is relaxed and the corresponding degradation in time could be much lower than other configurations
- **Size**
 - The total length is 2.0 m

Conclusions (3/3)



APPROXIMATE SIZE

$2\text{ m} \times 0.3\text{ m} \times 0.3\text{ m}$

Double-channel spectrometer (1/2)

THE SPECTROSCOPIC CAPABILITY OF SOLO COULD BE INCREASED BY A SPECTROMETER WITH TWO CHANNELS

CHANNEL A: grazing incidence telescope + normal incidence spectrometer

Wavelength selection: two regions (I order and II order) at wavelengths longer than 400 Å

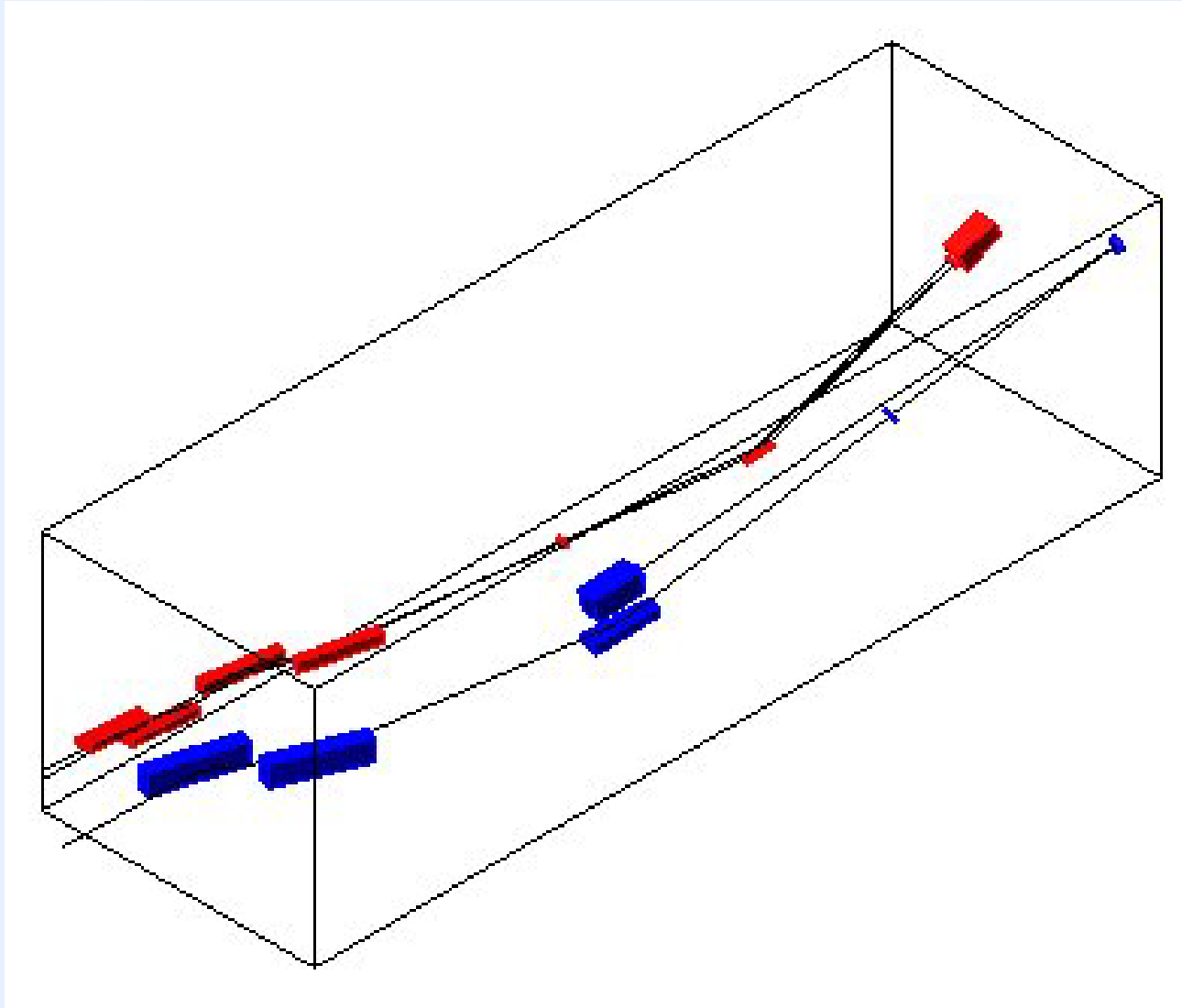
Example: 1200 Å (I order) - 600 Å (II order)

CHANNEL B: grazing incidence telescope + grazing incidence spectrometer

Wavelength selection: two regions (I order and II order) at wavelengths shorter than 300 Å

Example: 200 Å (I order) - 100 Å (II order)

Double-channel spectrometer (2/2)



APPROXIMATE SIZE

$2\text{ m} \times 0.6\text{ m} \times 0.6\text{ m}$