WSO/UV Spectrographs

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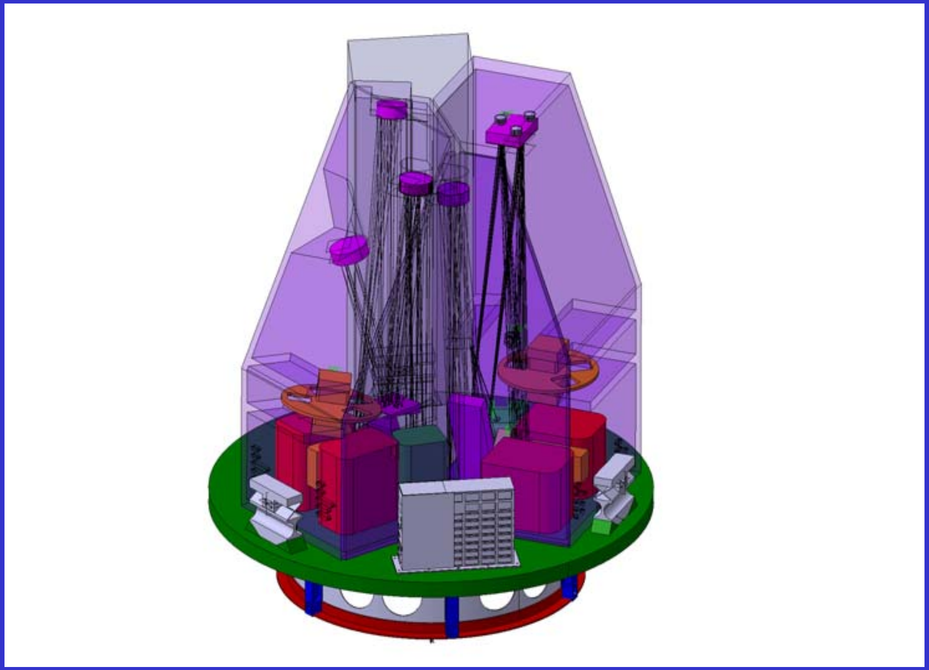
The Expected Performance of WSO/HIRDES



@ El Escorial, 2007

N. Kappelmann

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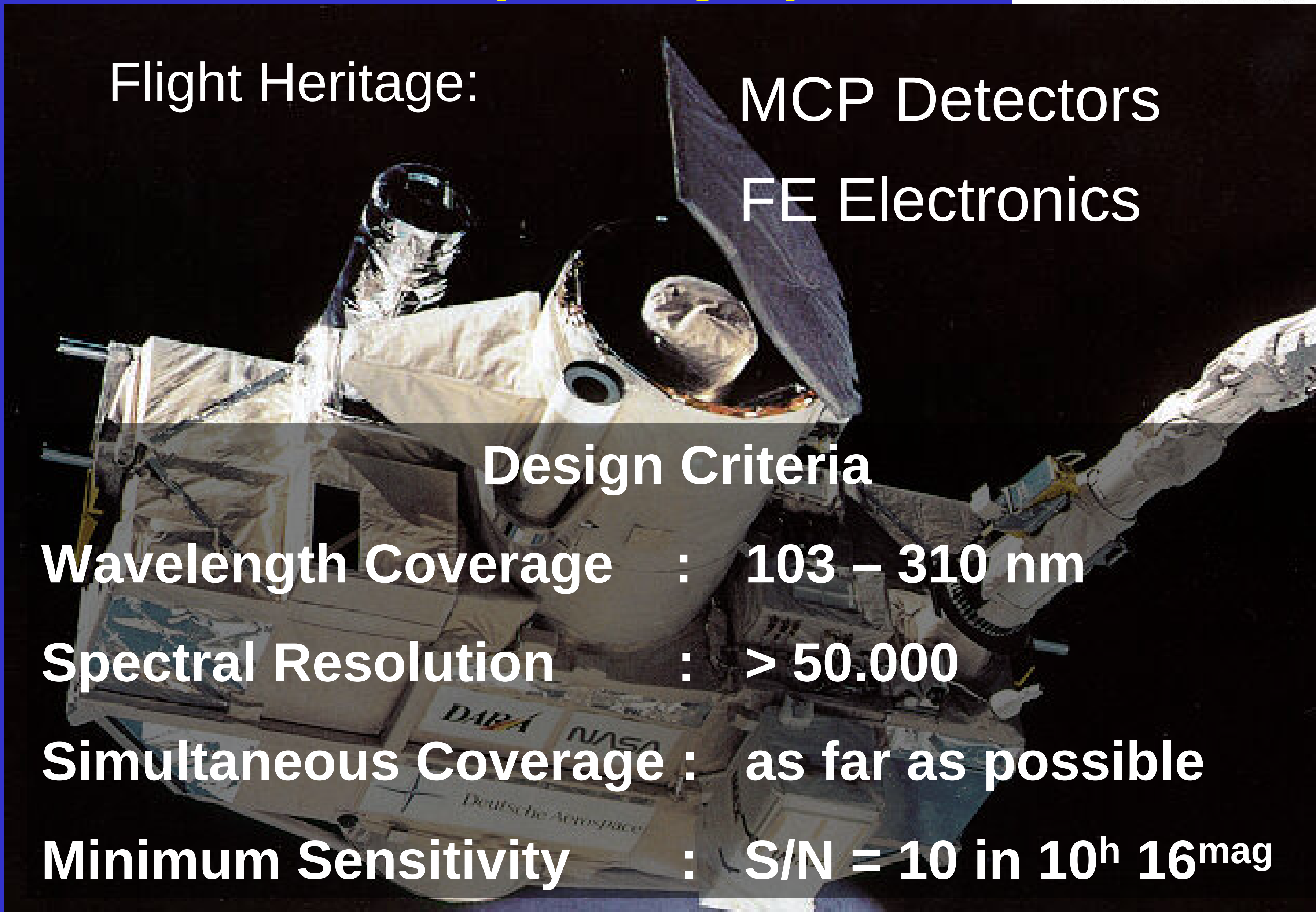

Flight Heritage:

MCP Detectors

FE Electronics

Design Criteria

Wavelength Coverage : 103 – 310 nm

Spectral Resolution : > 50.000

Simultaneous Coverage : as far as possible

Minimum Sensitivity : S/N = 10 in 10^h 16^{mag}

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History of the High Resolution Double Echelle Spectrograph:

1990 – 1997 (Spectrum UV):

1992 - 1993 **Feasibility Study of HIRDES**

1994 - 1997 **Financing of Technical Developments**

1998 –2007 (WSO/UV):

2000 - 2001 **HIRDES Phase – A - Study**
2005 - 2006 **HIRDES Phase - B1 - Study**
2007 **Interfaces Study**

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Design Criteria Phase B1

Wavelength Coverage : 103 – 310 nm

Spectral Resolution : > 50.000

Simultaneous Coverage : as far as possible

Possibility to Observe Bright Stars

Improvement of FE of the MCP-Detector

„Slit – Monitor“

Reduction of Mechanisms

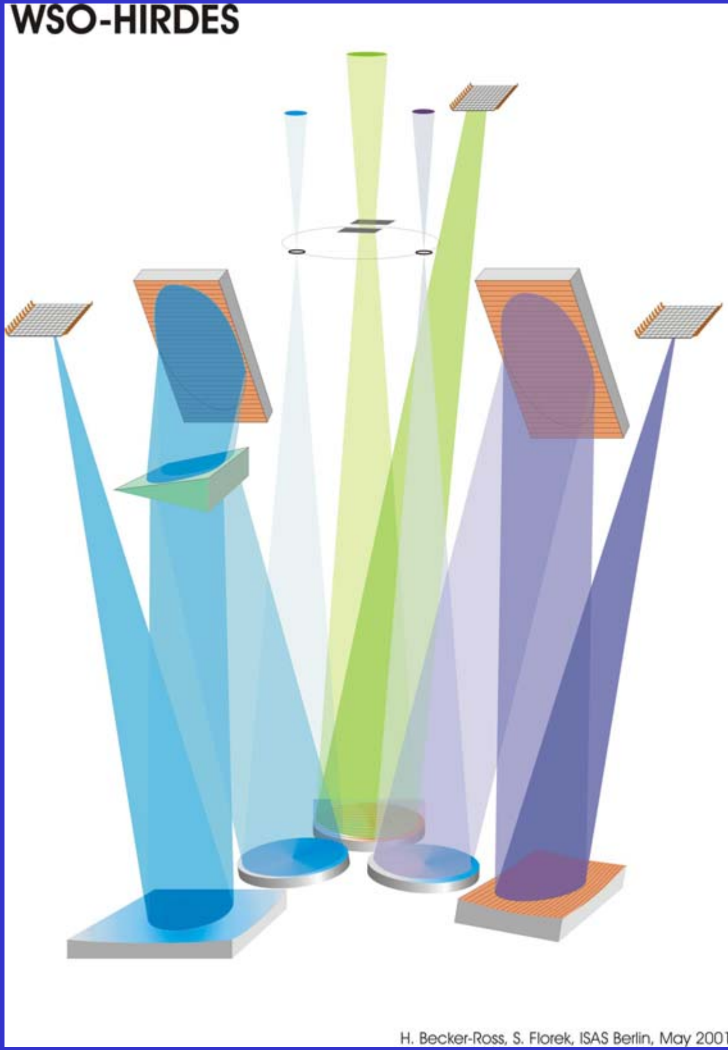
High Resolution Double Echelle Spectrograph (HIRDES)

VUVES : 102.8 – 175.6 nm

$\lambda/\delta\lambda$: 55.000

UVES : 174.5 – 310.0 nm

$\lambda/\delta\lambda$: 50.000



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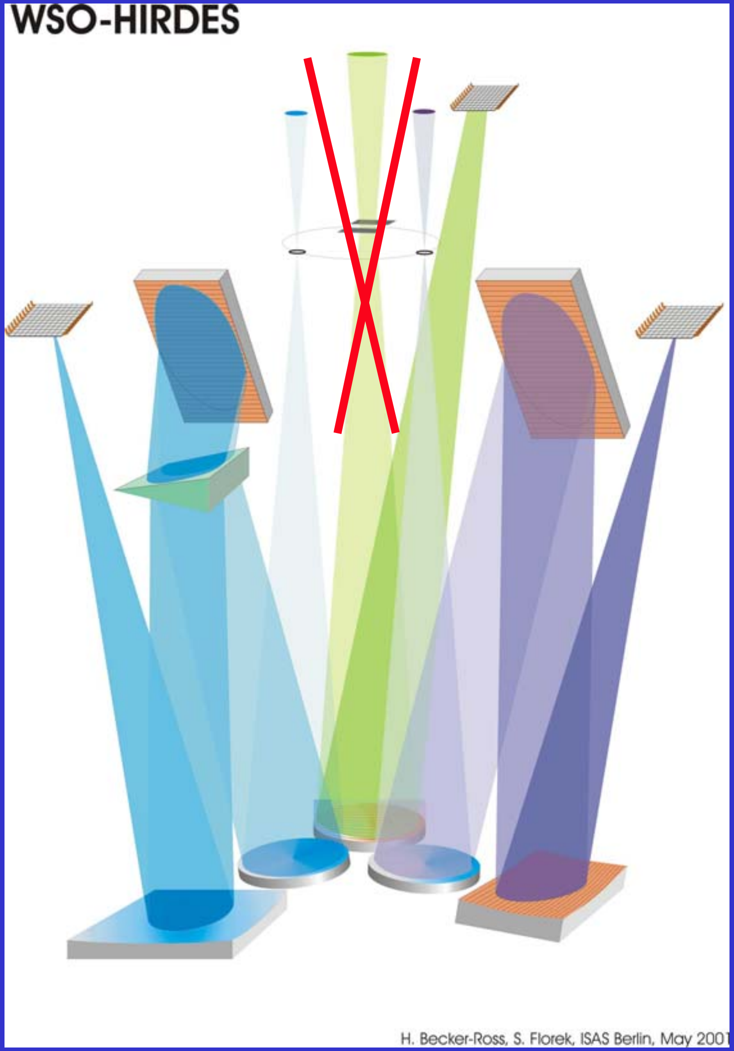
LSS – Rowland Mounting

Detector: 40 mm (grating dispersion), 40 µm resolution (pixel-width

Resolving Power:

R=1000	140 nm – 200 nm
R= 500	120 nm – 240 nm
R= 320	103 nm – 310 nm

Spatial Resolution: 1 arcsec



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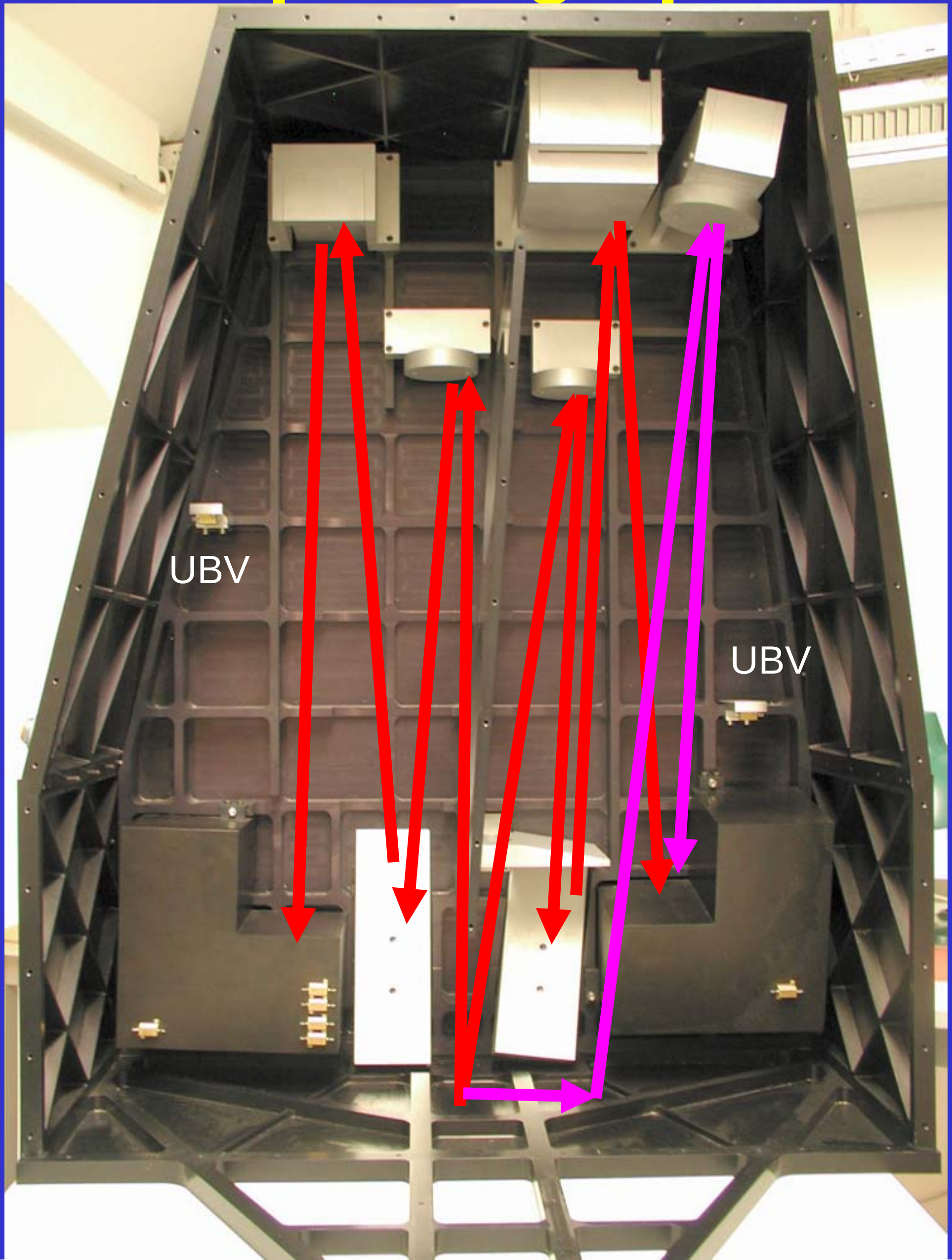
VUVES



UVES

+ LSS

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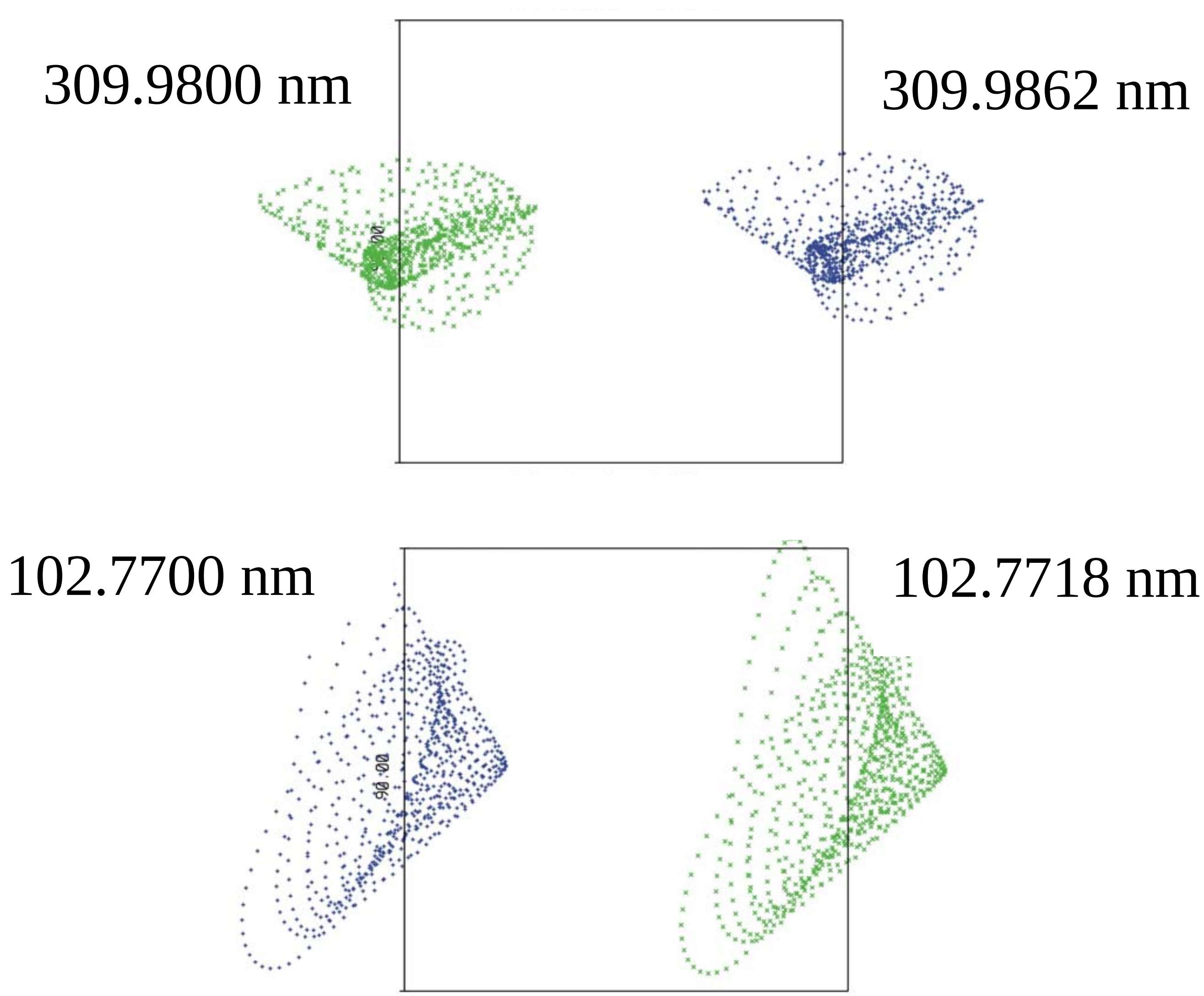

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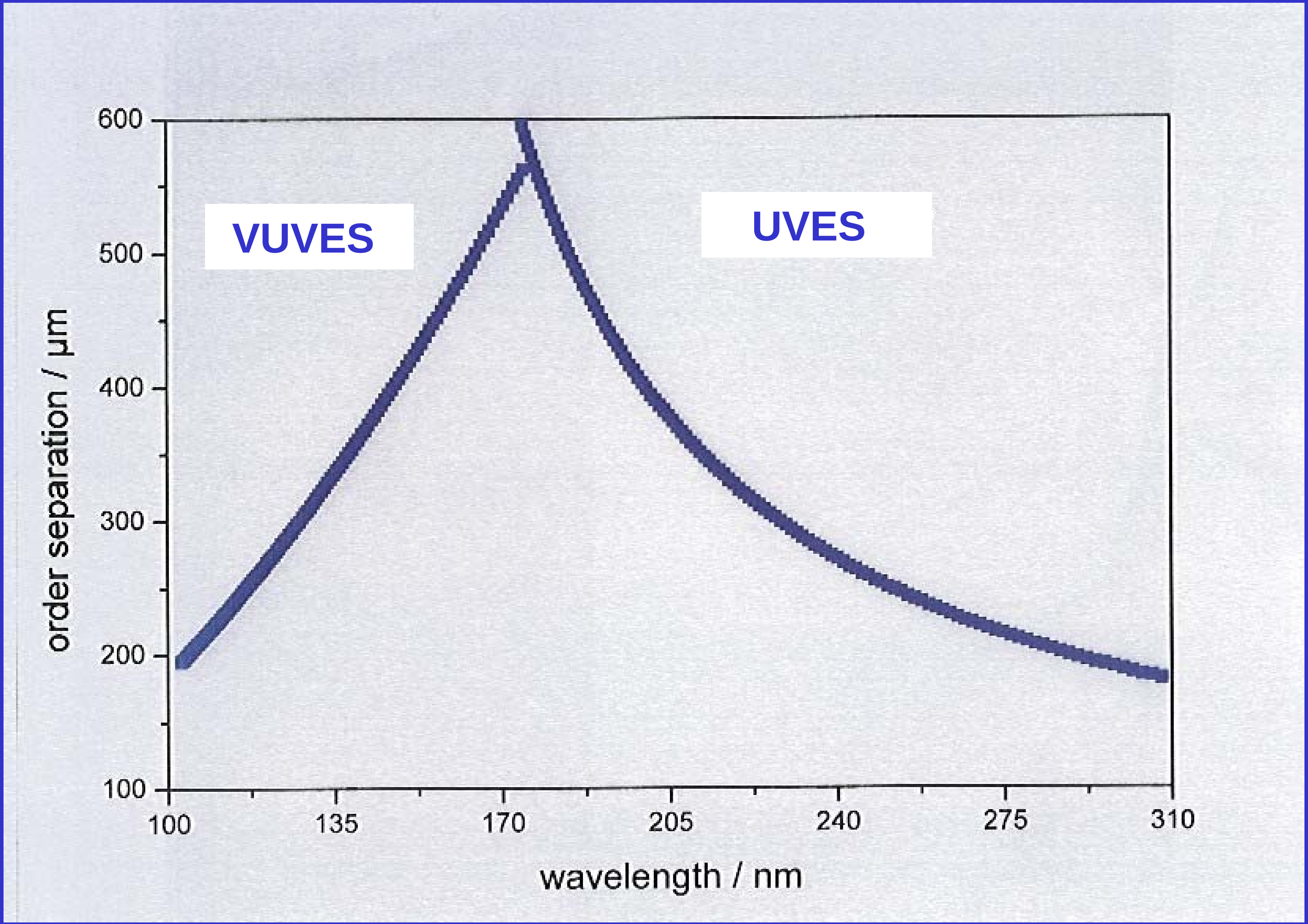

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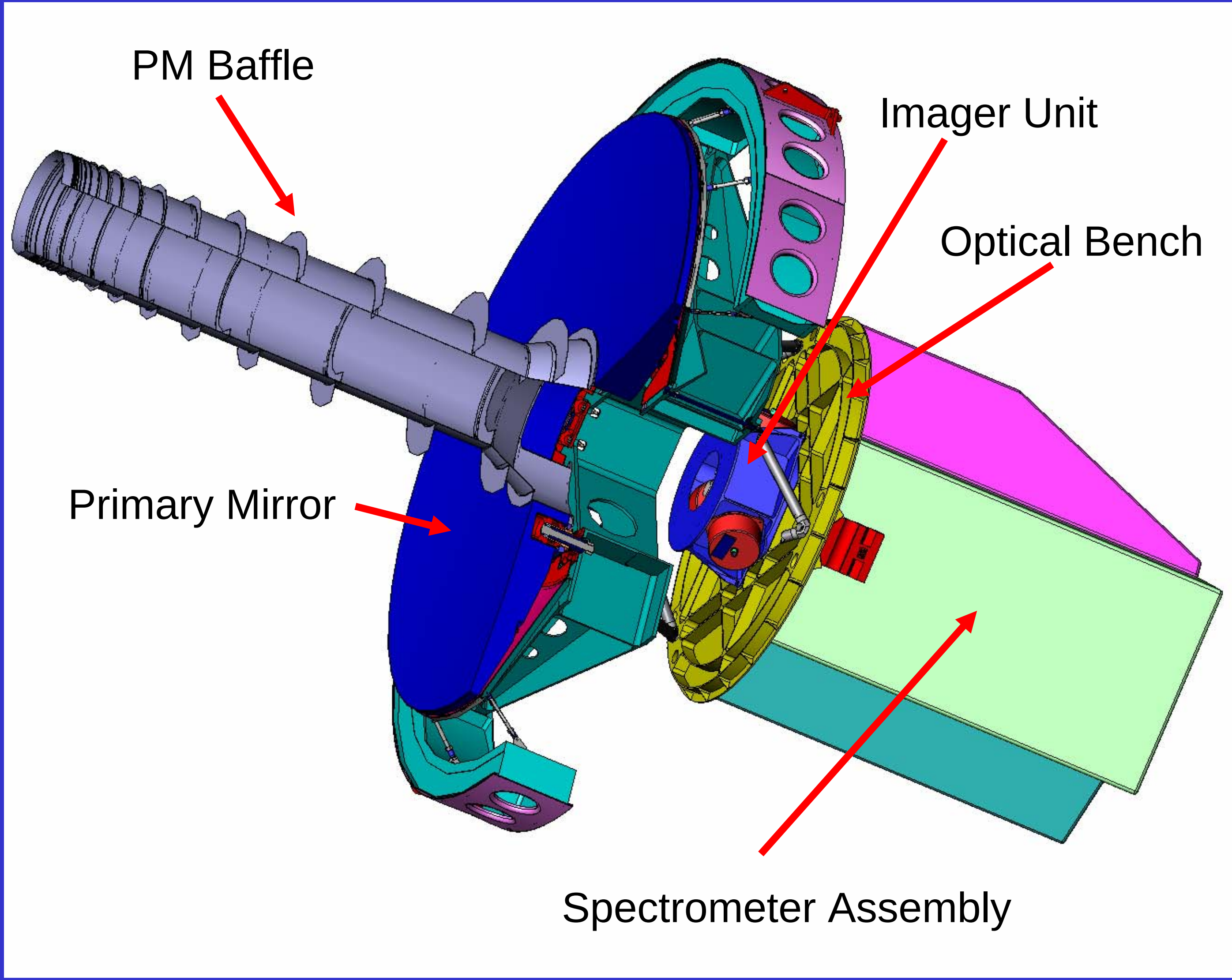

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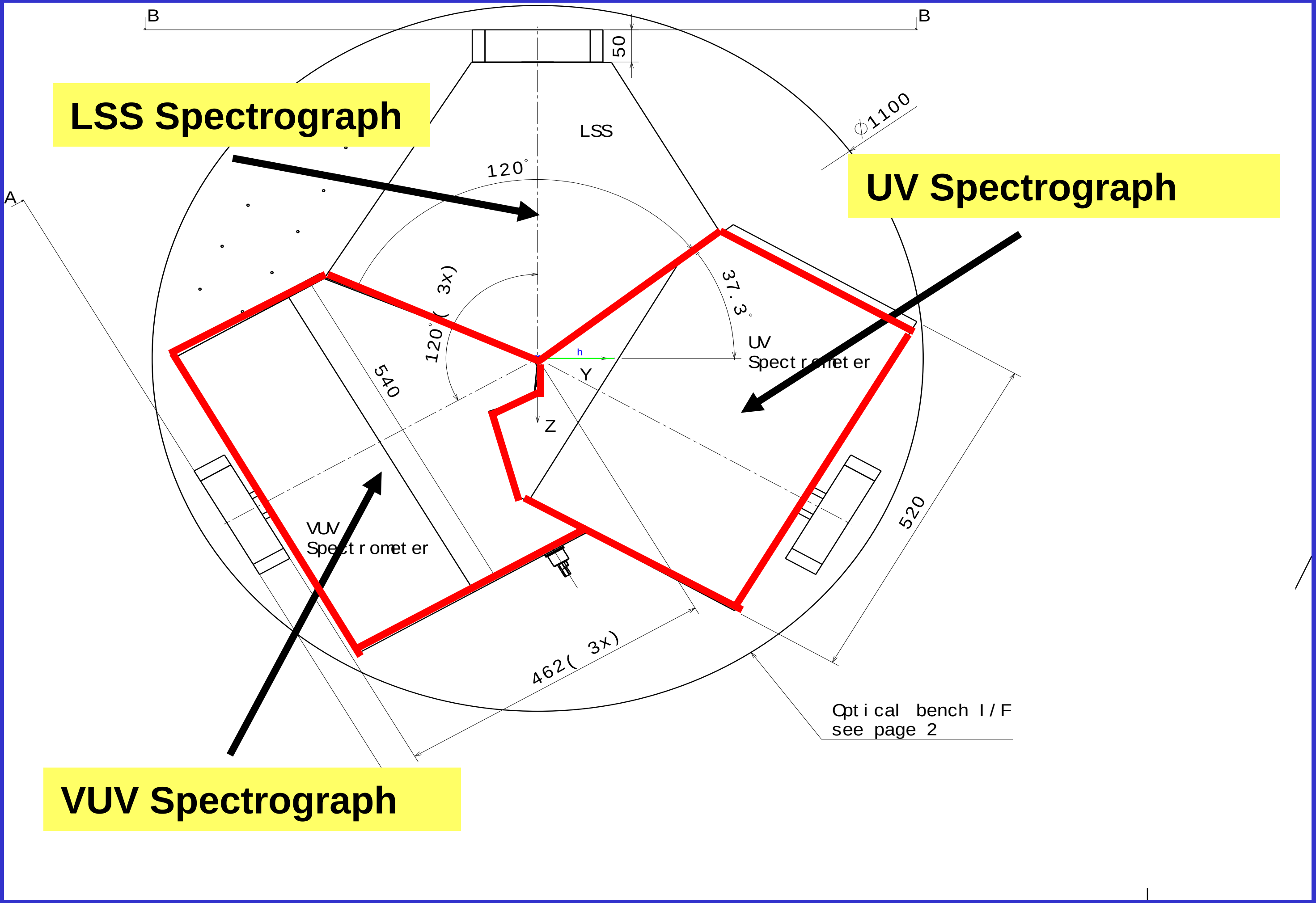
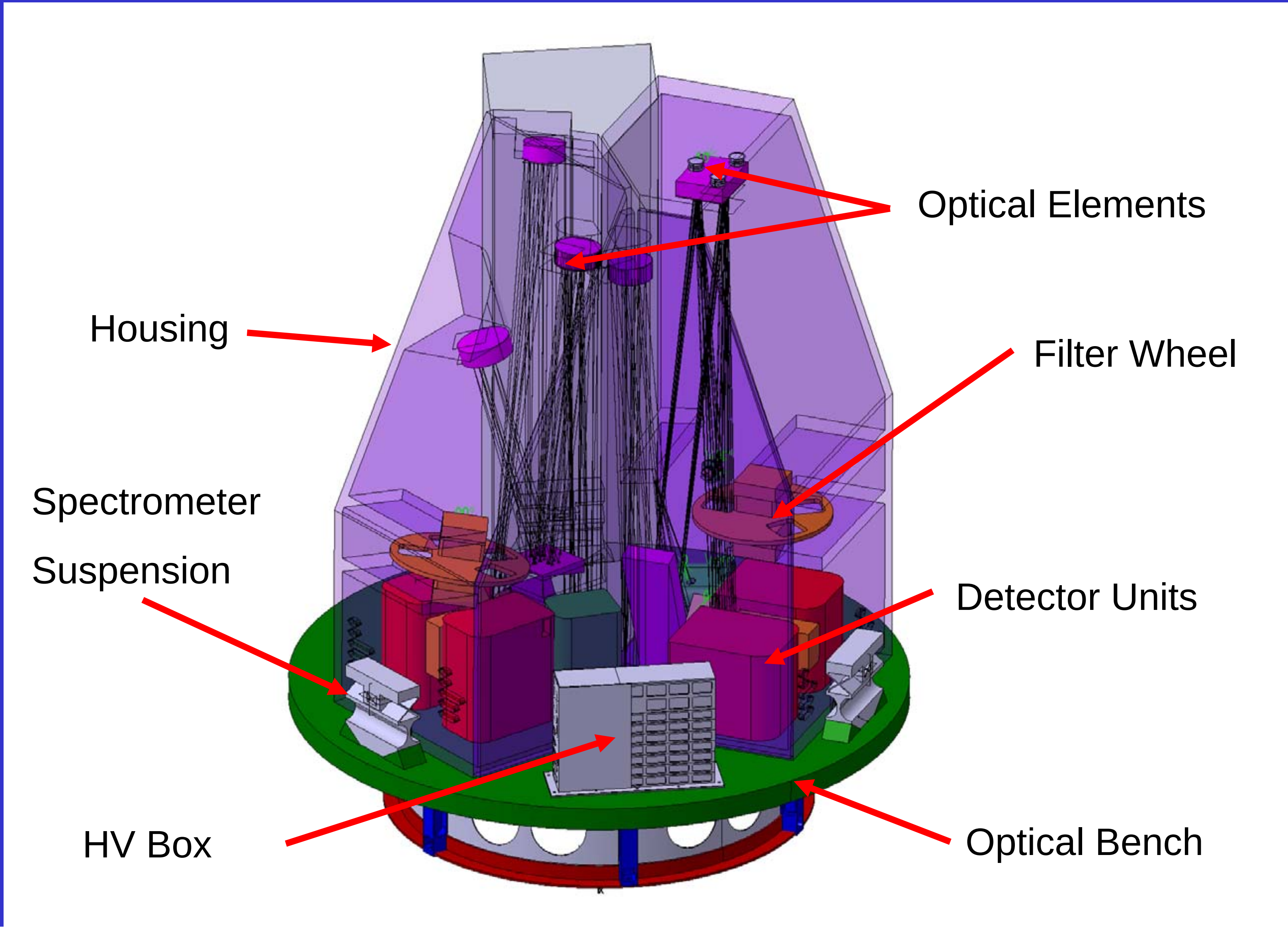
Spectrographs Arrangement



WSO/UV Spectrographs Spectrometers with Housing



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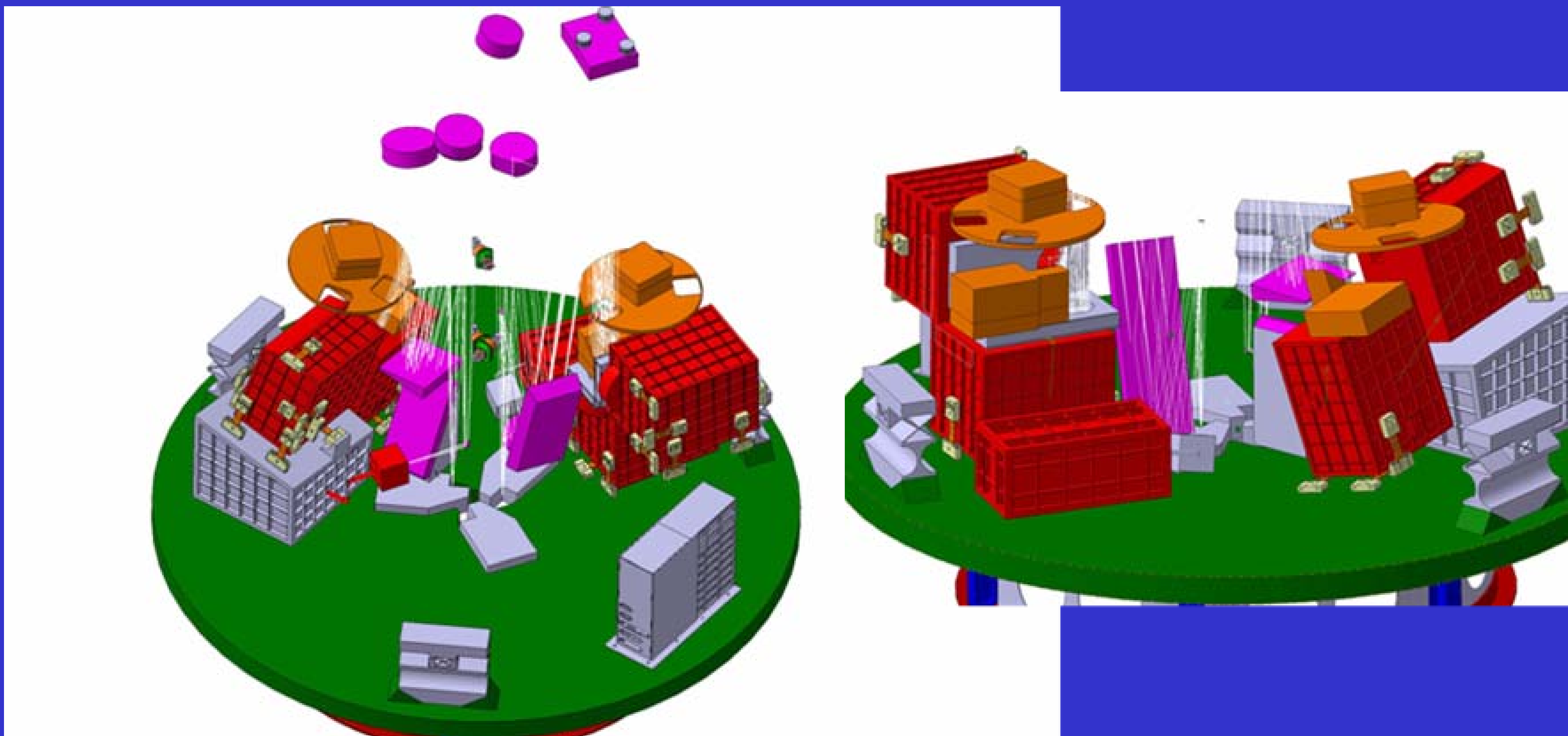
Spectrometers without Housing



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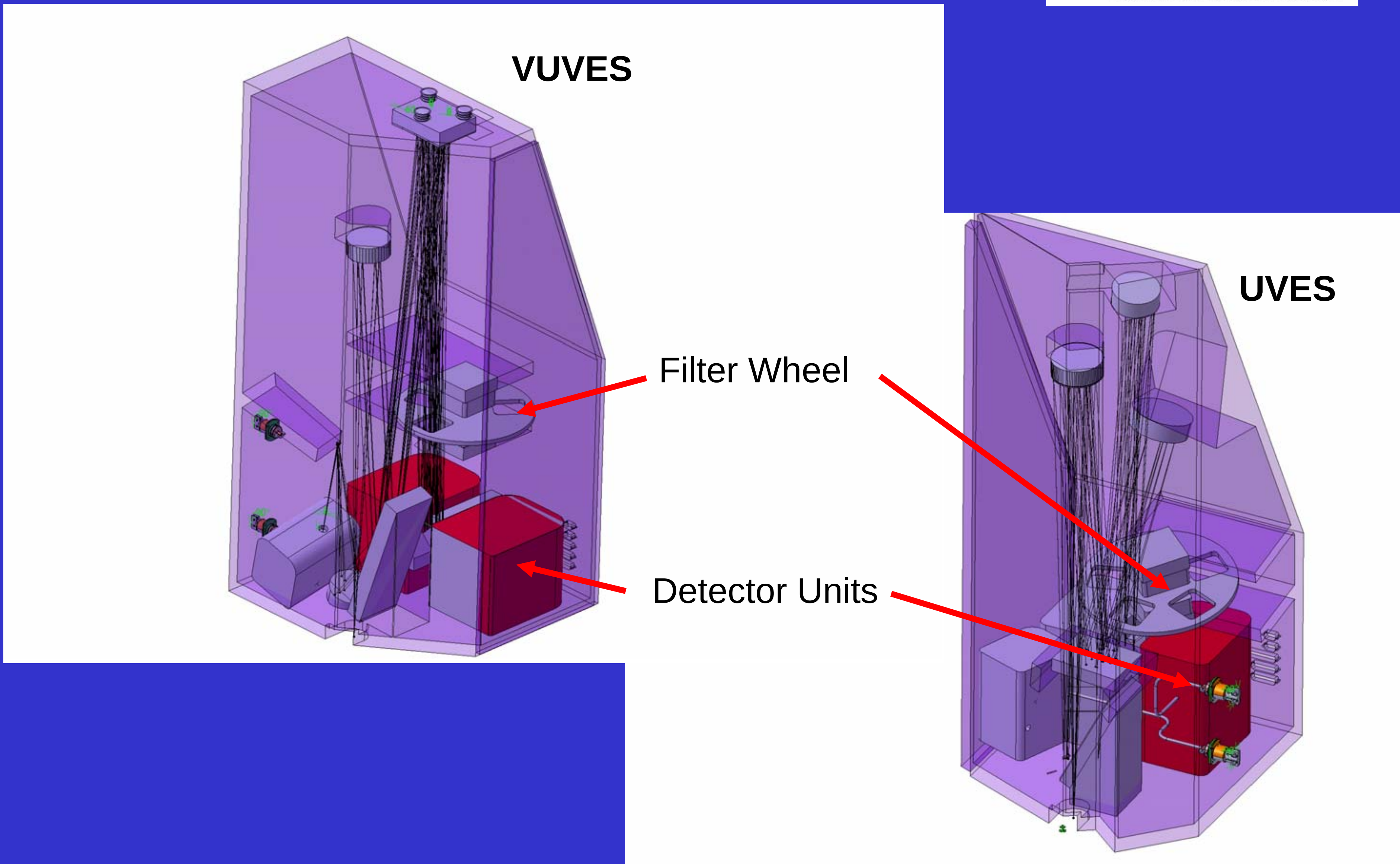

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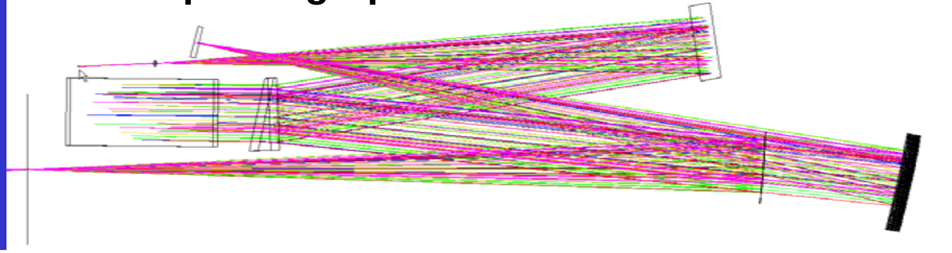
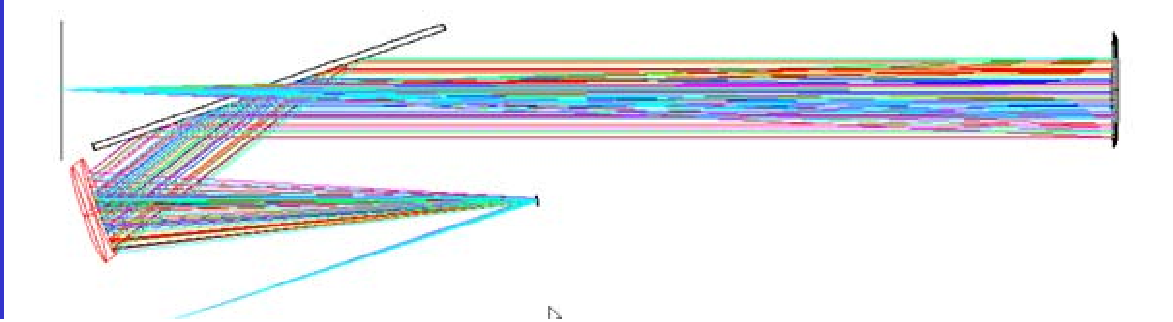
In Field Guidance Sensor

UV Spectrograph - In Field Fine Guidance



In field reflected at prism front surface towards focus mirror via lens onto fine guidance detector

VUV Spectrograph - In Field Fine Guidance



In field decoupled from 0th order reflection of grating via 2 mirrors onto fine guidance detector

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■ Phase A Baseline

Thermally unstable Aluminum structure

- 2 critical Focus Mechanisms (Collimator Mirror , Echelle Grating)
  - Compensation of thermal gradients, temperature change, (drift)
  - Multi axes adjustment with very high accuracies required

	Translatoric Accuracy	Rotational Accuracy
Travel Range	200 µm	20 arcsec
Accuracy	5 µm	2 arcsec
Repeatability	2 µm	1 arcsec

- Critical In Orbit Operation to find best focus position

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Trade Off:

Thermomechanical Performance

Maturity

Costs

Candidate Materials:

- **Aluminum**
- **Composite materials**
- **Ceramics**

- **Thermostable CeSiC Structure**

⇒ **Required Spectral Resolution without Active Control of Optical Elements**

⇒ **Complex Collimator and Echelle Grating Mechanisms Skipped**

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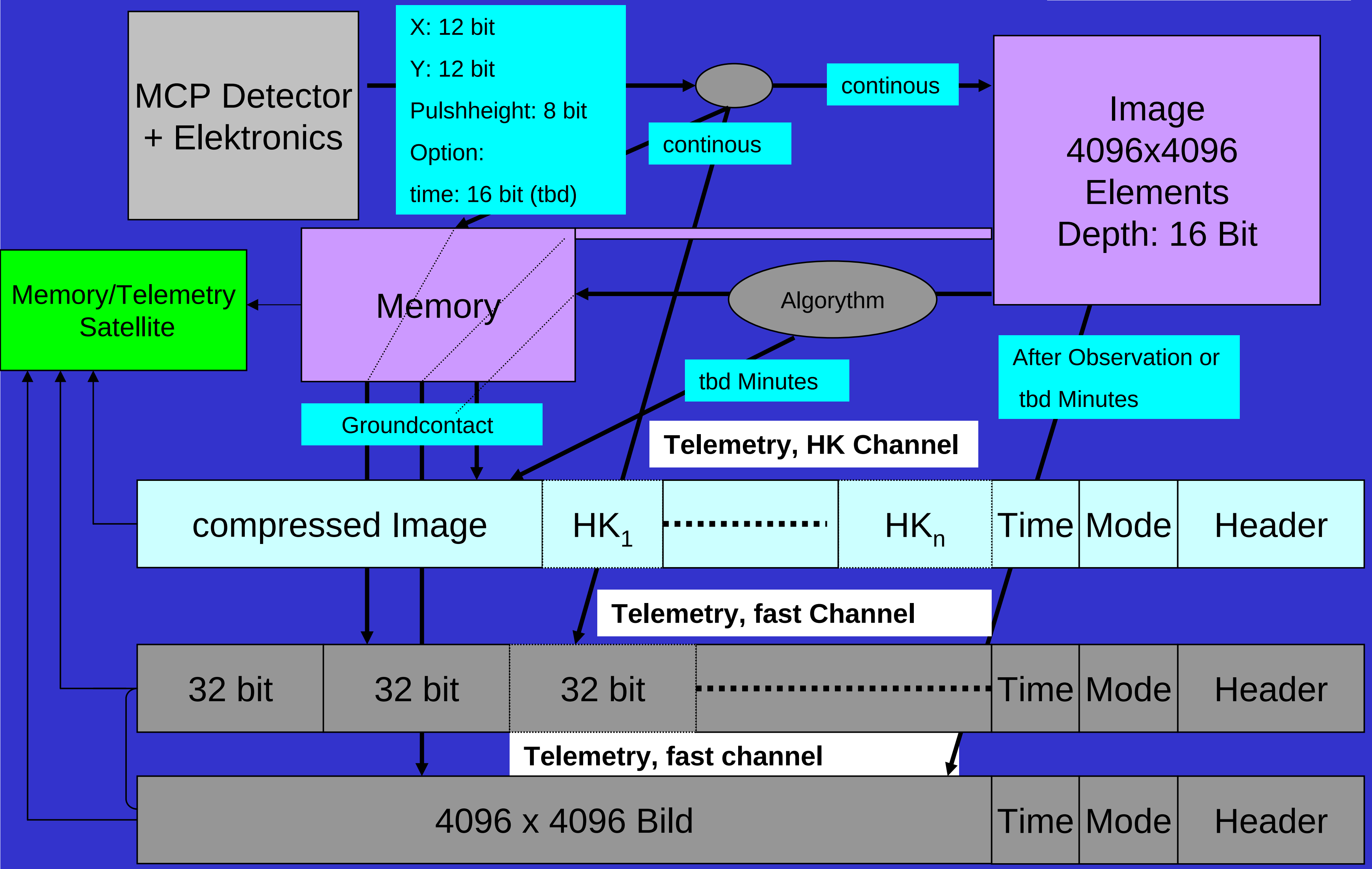
CeSiC Test Structure

WSO/UV Spectrographs



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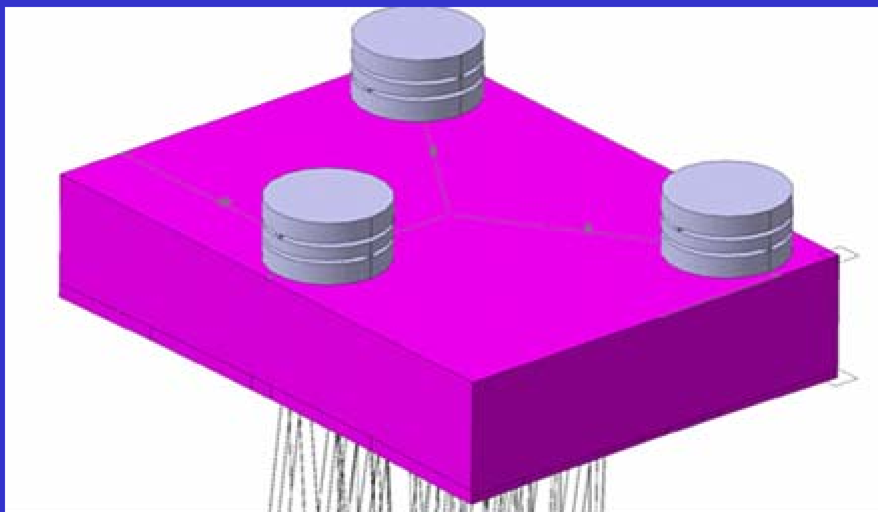
Critical Components Design



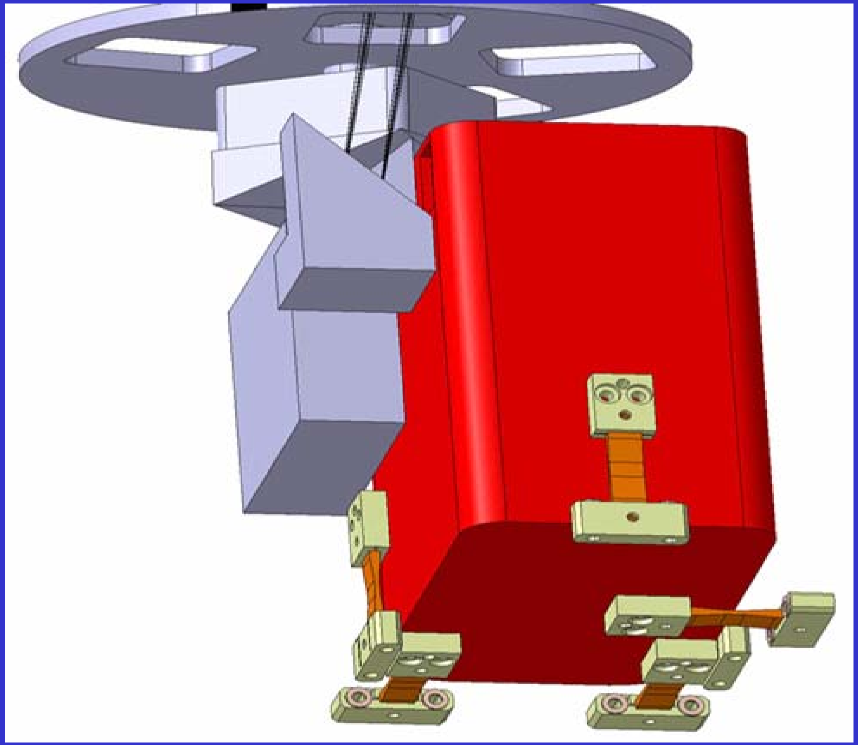
Mirrors and Gratings

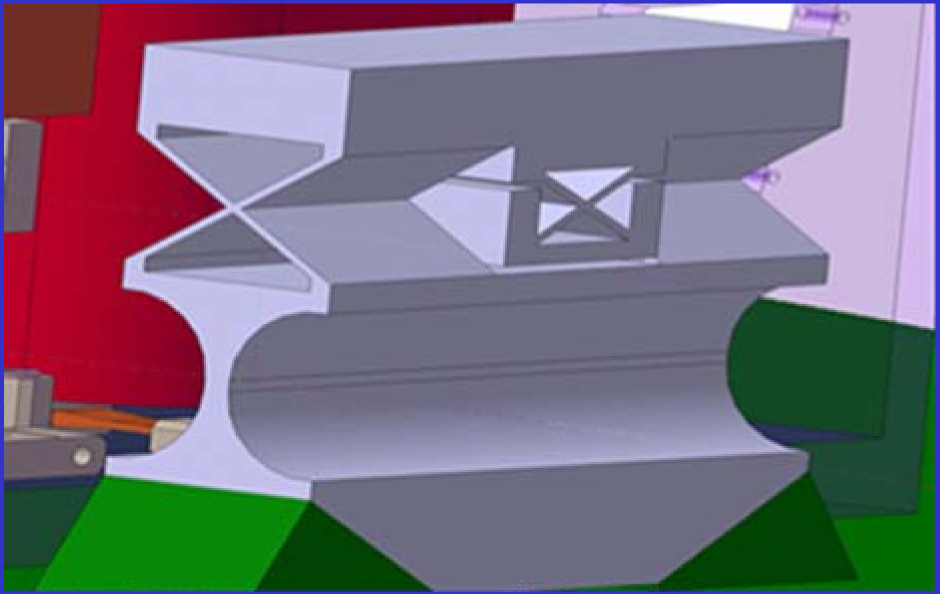
- **Quartz Glas with Invar flexural mounts**
- **WFE: λ/20 at λ = 633 nm**
- **Surface Roughness: < 1 nm**
- **Coatings:**
  - **UV : Al + SiO_2**
  - **VUV: Al + MgF_2**
  - **VIS: Al + SiO_2 (Option: Au)**

Isostatic Mirror Suspension (ORFEUS Heritage)

WSO/UV Spectrographs

Critical Components Design





Isostatic Suspension made from CFRP

(PACS heritage)

Invar Suspension with SS flexural Blades

(ORFEUS Heritage)

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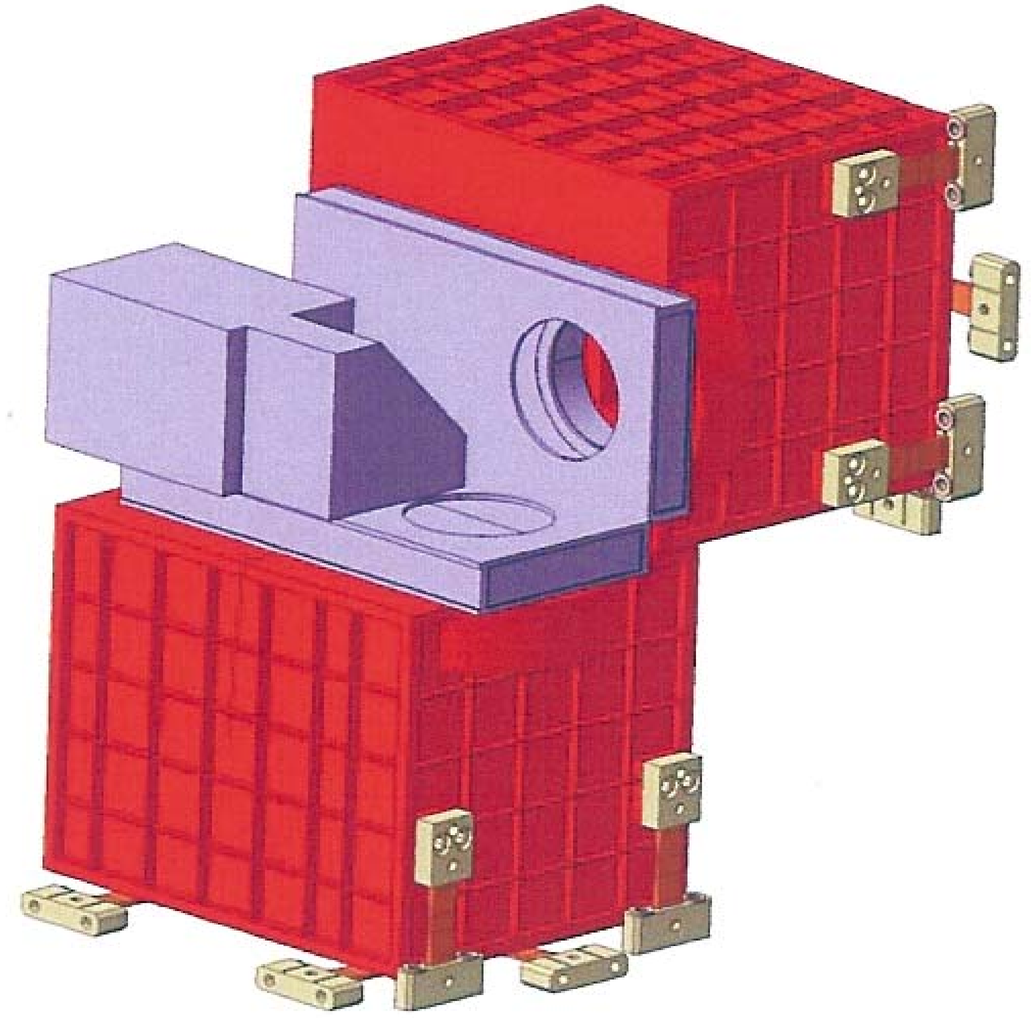

MCP Detector Housing

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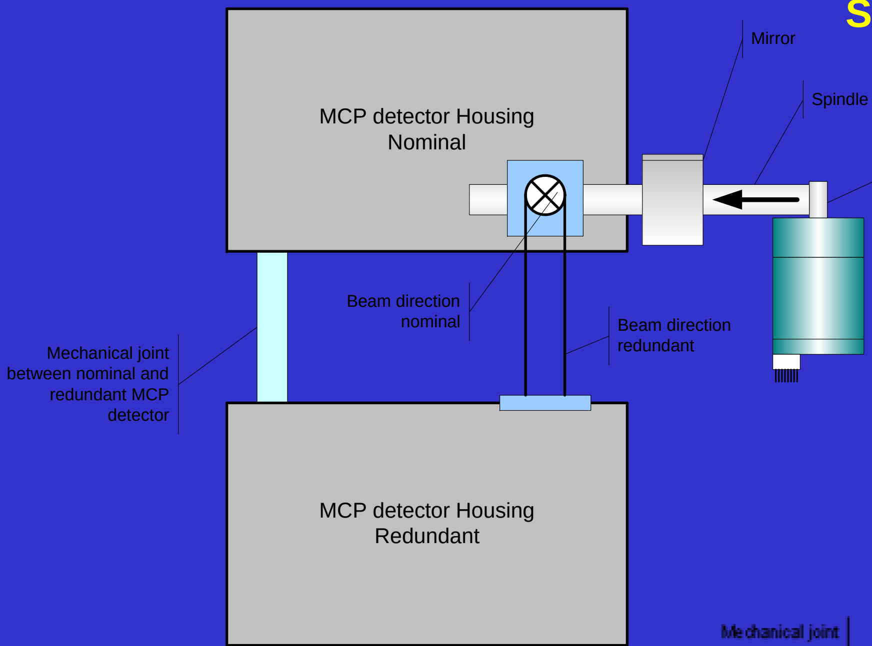
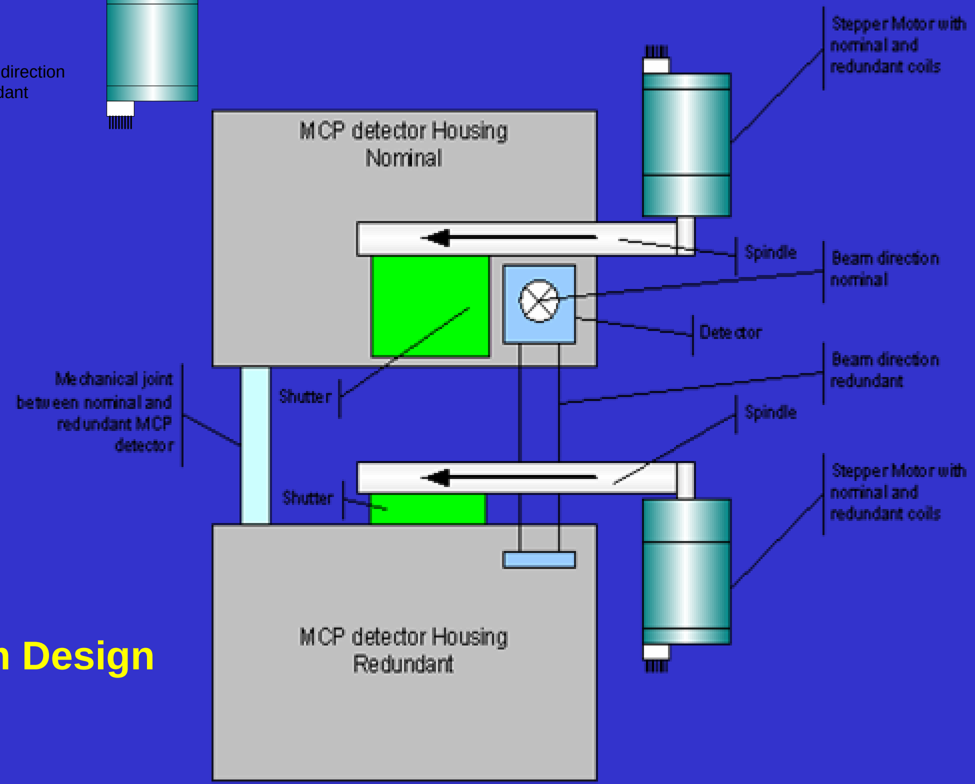
Servo Mirror – Mechanism Design



Vacuum Shutter – Mechanism Design



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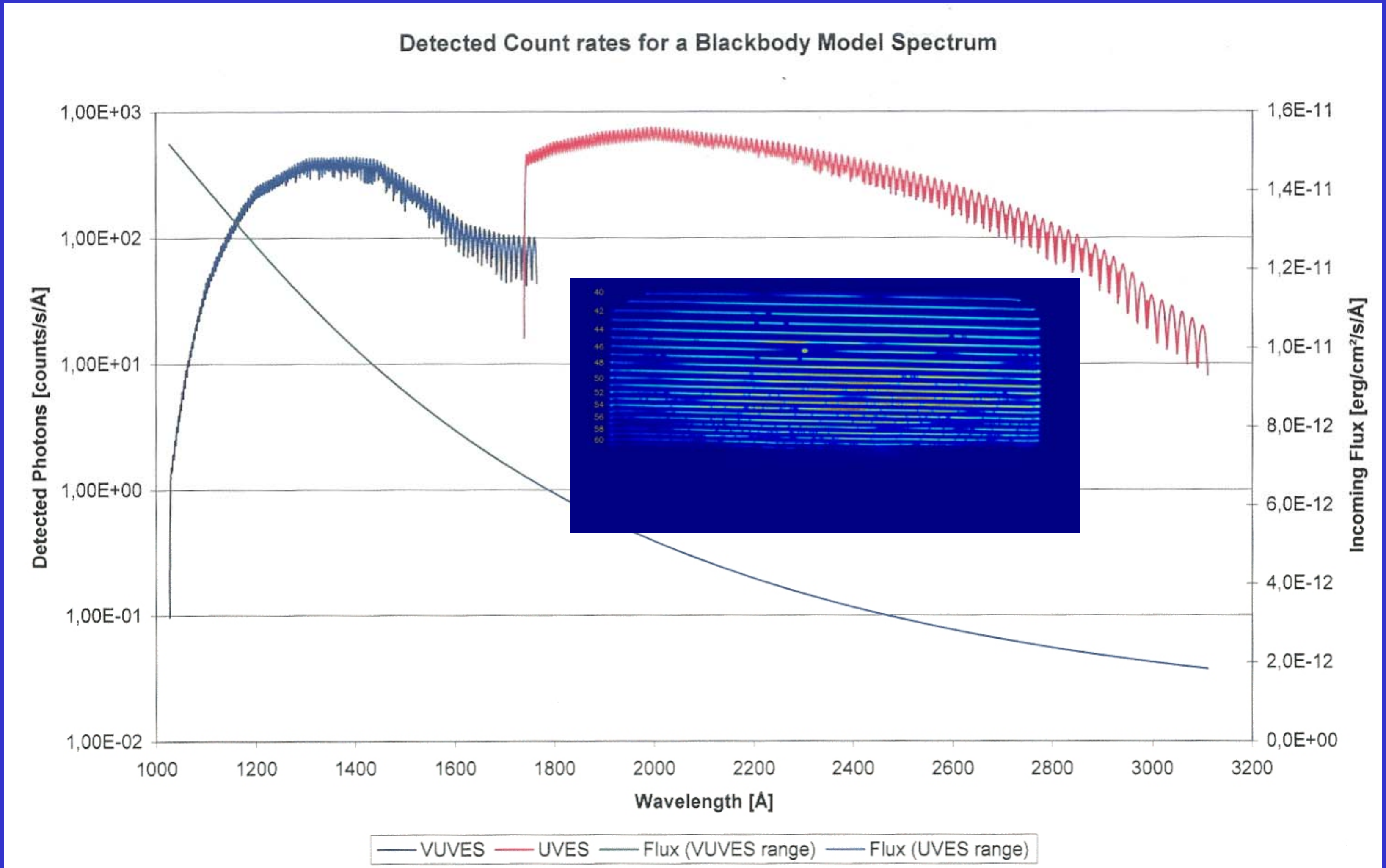

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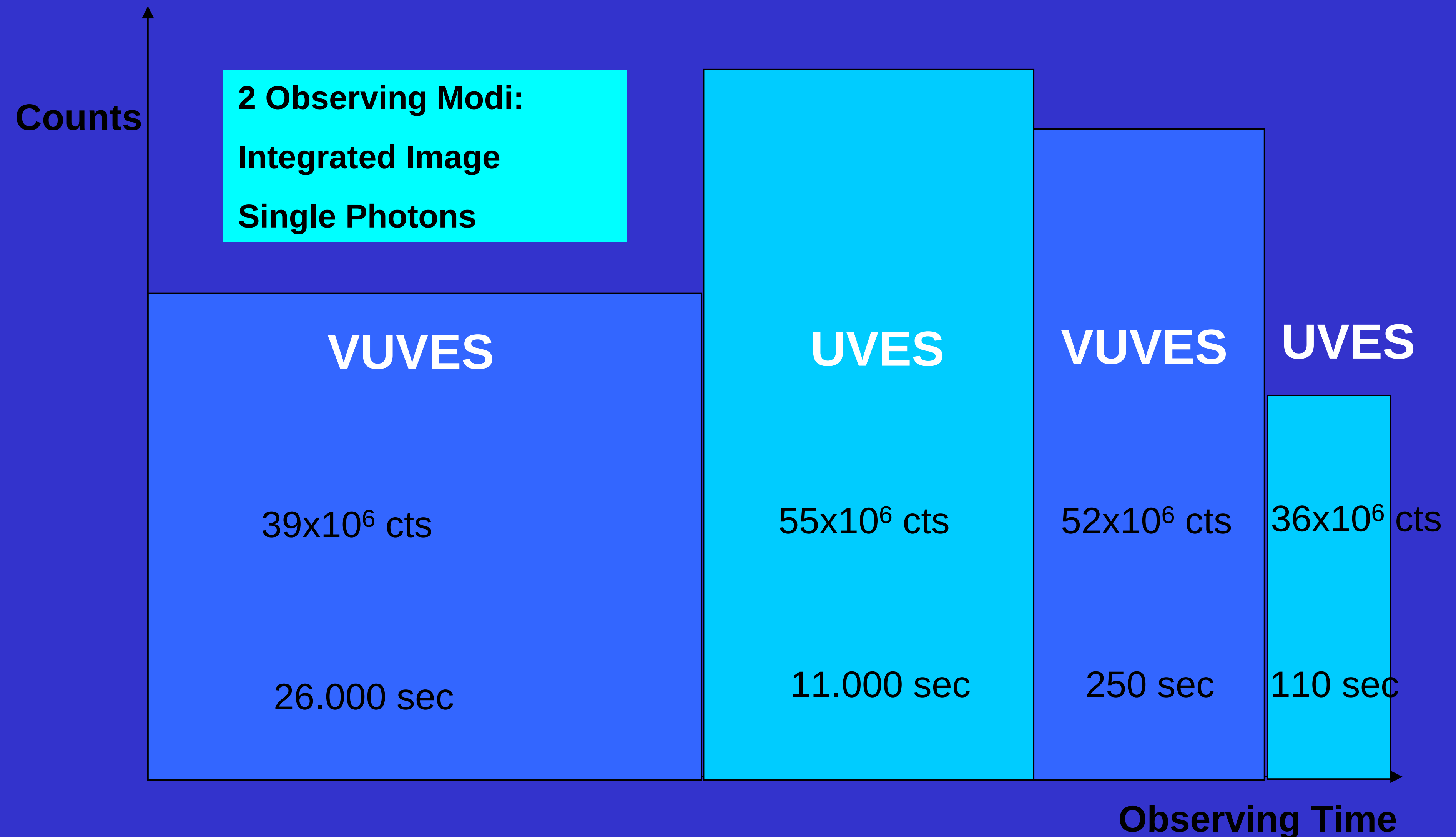

Target: $1x10^{-13}$ erg/cm²/sec/A **Target: $1x10^{-11}$ erg/cm²/sec/A**

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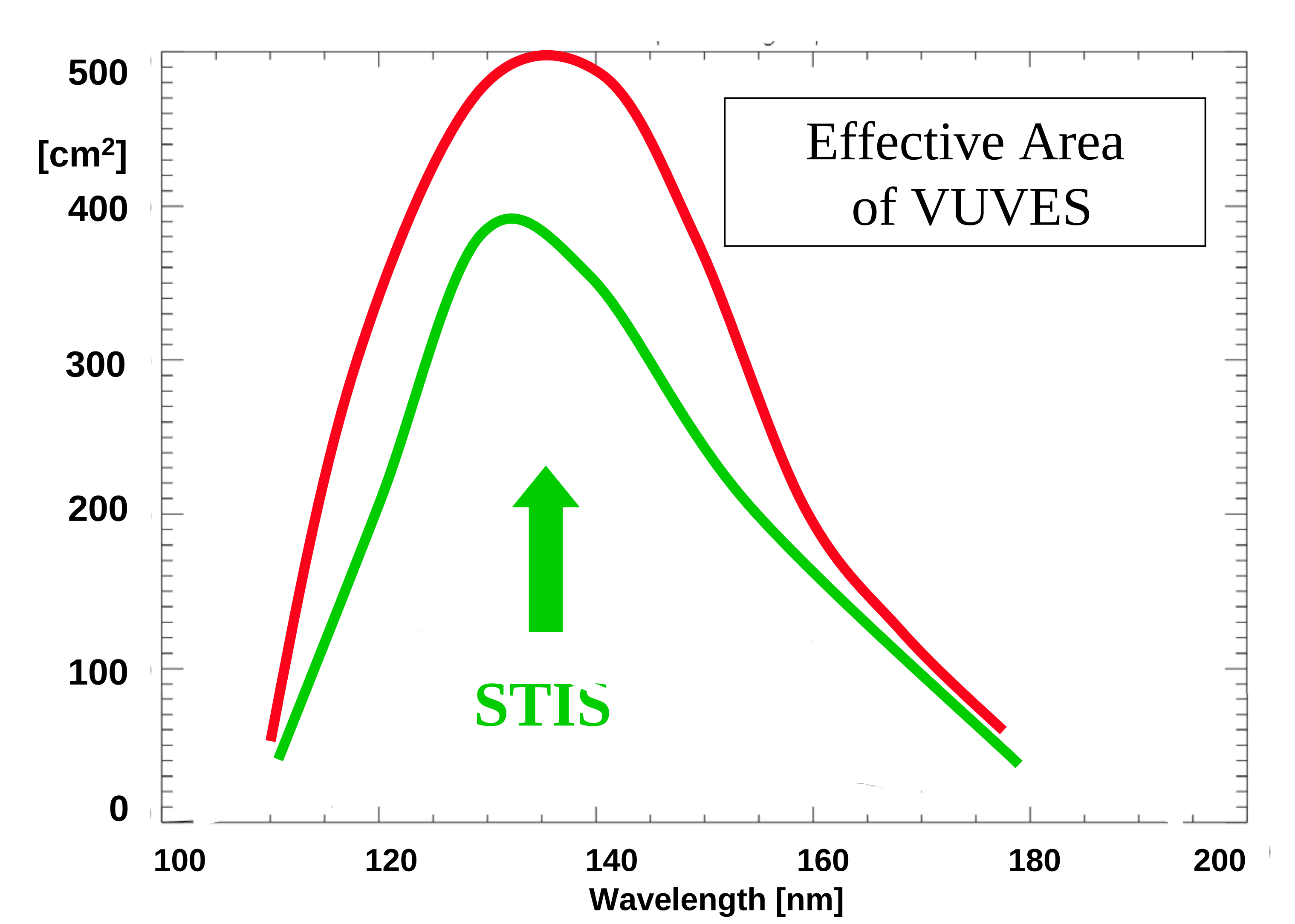

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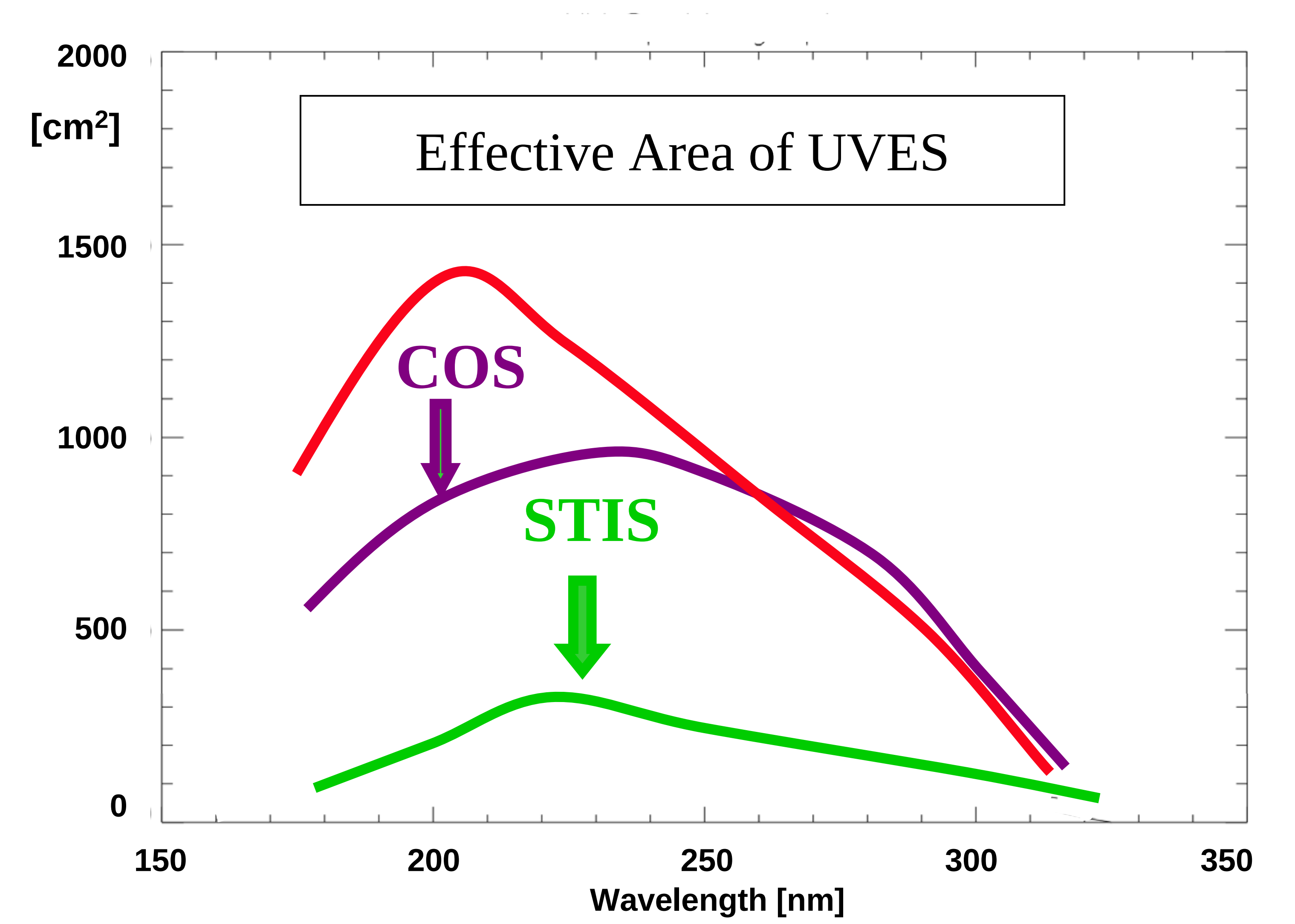

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Comparison with HST-COS:

Wavelength Range	Resolving Power	Eff. Area (cm^2)	
115 – 145	20.000 – 24.000	2.200	VUVES
140 – 178	20.000 – 24.000	1.200	
170 – 210	20.000 – 24.000	600	UVES
210 – 250	20.000 – 24.000	700	
250 – 320	20.000 – 24.000	450	
123 – 205	2.500 - 3.500	1000	
170 – 320	1.550 - 2.900	500	

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Element	Risk Type	Risk Mitigation Strategy
MCP	Schedule risk due to customized MCP development and technical risks (quantum efficiency; Coatings)	■ Selection of experienced stacks developer (Hamamatsu);coating facilities, etc.) ■ Use of FEE heritage partly available at IAAT ■ Early MCP procurement & bread boarding
IFGS	Schedule risk due to customized CMOS development	■ Selection of experienced CMOS developer (Fill Factory) ■ Adequate Subcontractor control;
Structural materials and Hybrid Structure (CeSiC; Invar, Quartz Glas)	Technical risk due to missing space qualification	■ Extensive technology programs performed by ECM (ESA contract) ■ Qualification to be performed in phase B ■ Potential fallback: Space qualified C/SiC (Astrium F); but not considered for baseline approach

WSO/UV Spectrographs

END