TCM-43 Frascati

Divertor VUV Spectrometer

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Overview [1/2]

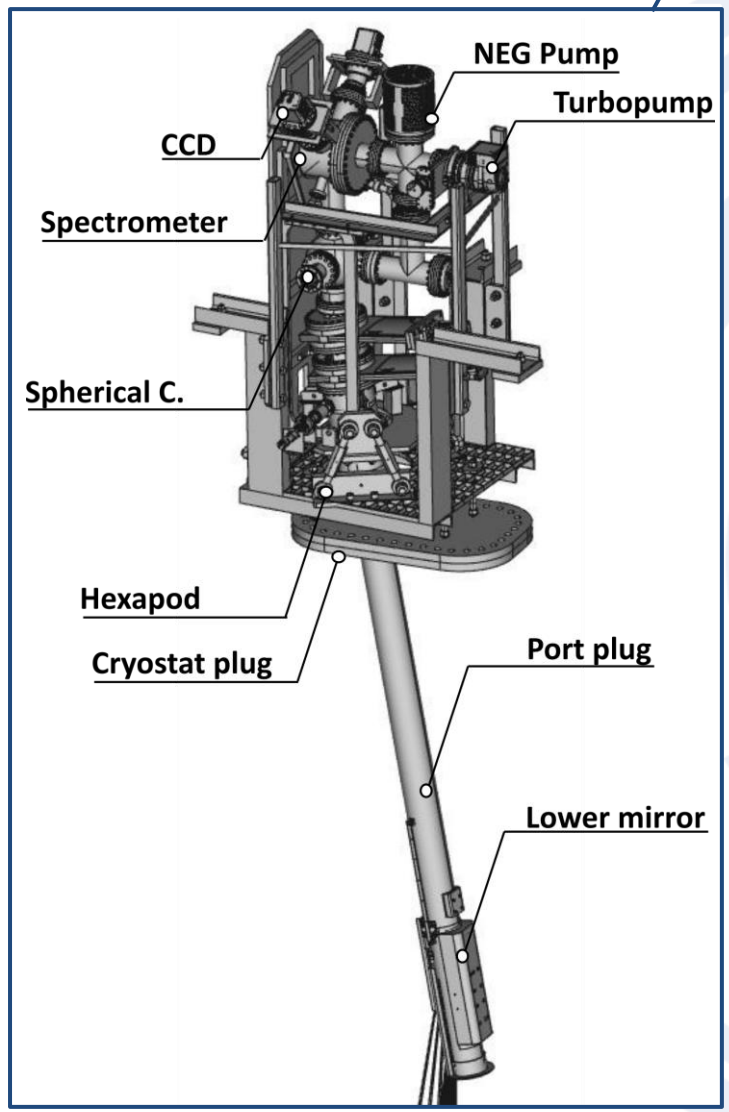
Purpose:

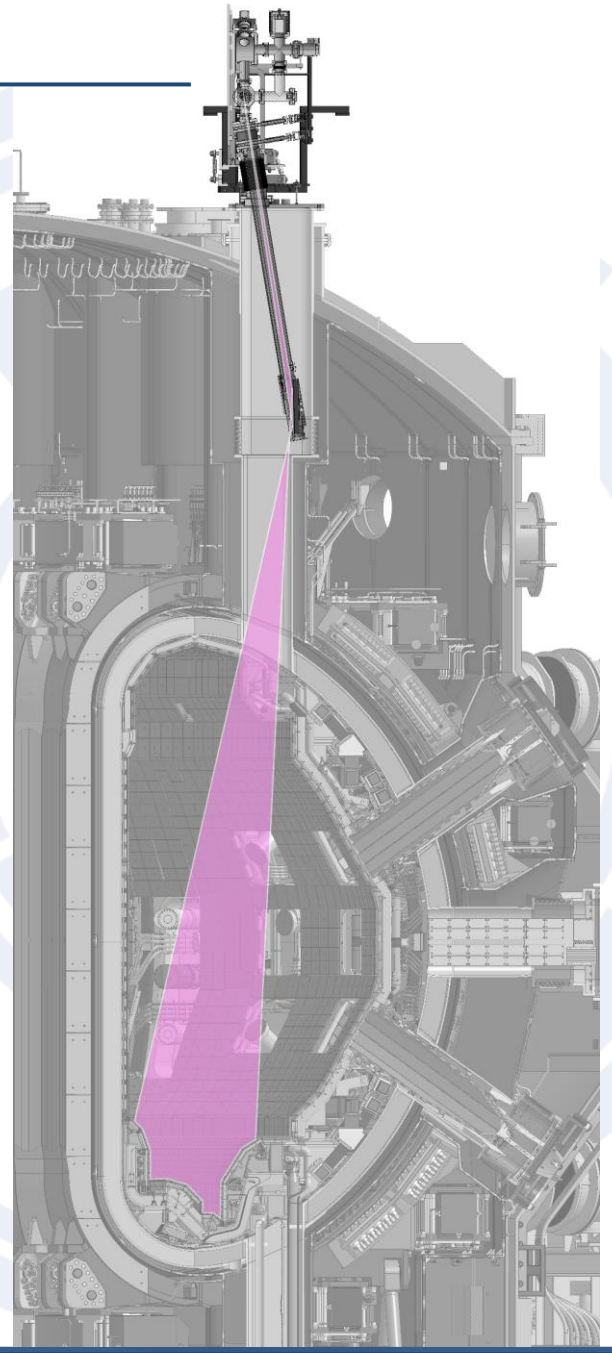
- Resolve emission from intrinsic and extrinsic impurities to evaluate the relative/absolute contribution to radiation losses
- Resolve C and Ne lines to detect volume recombination processes (in the proximity of detachment)
- Contribute to physics studies of the divertor by distinguishing radiation from inner/outer legs and X-point

Wavelength range: 10-48 nm and 44-125nm double channel

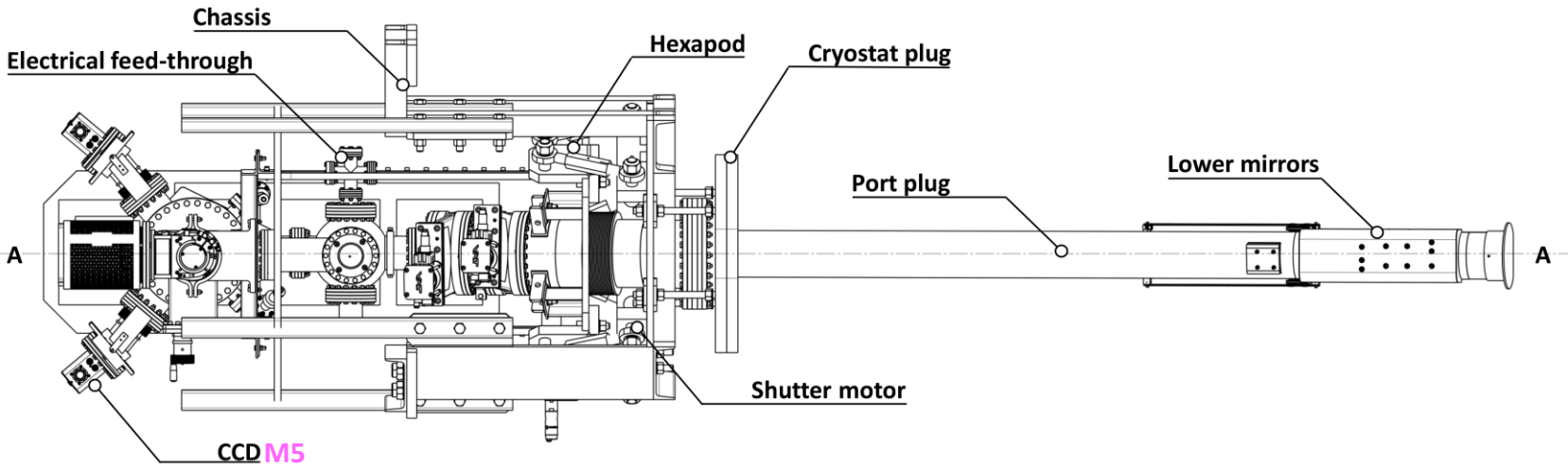
Gratings: **t**oroidal gratings with 1-D imaging capability

Position: upper port sector 12

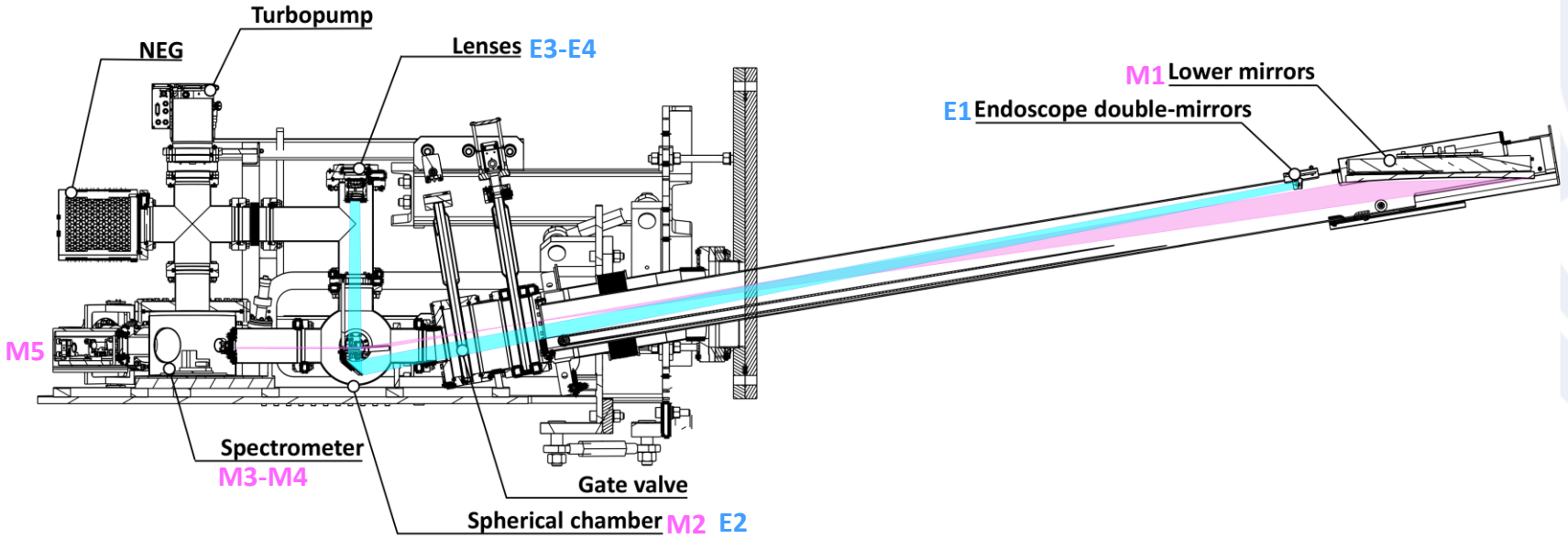




Overview [2/2]



Section A-A



Measurement system:

The system is composed by refurbished double channel SPRED:

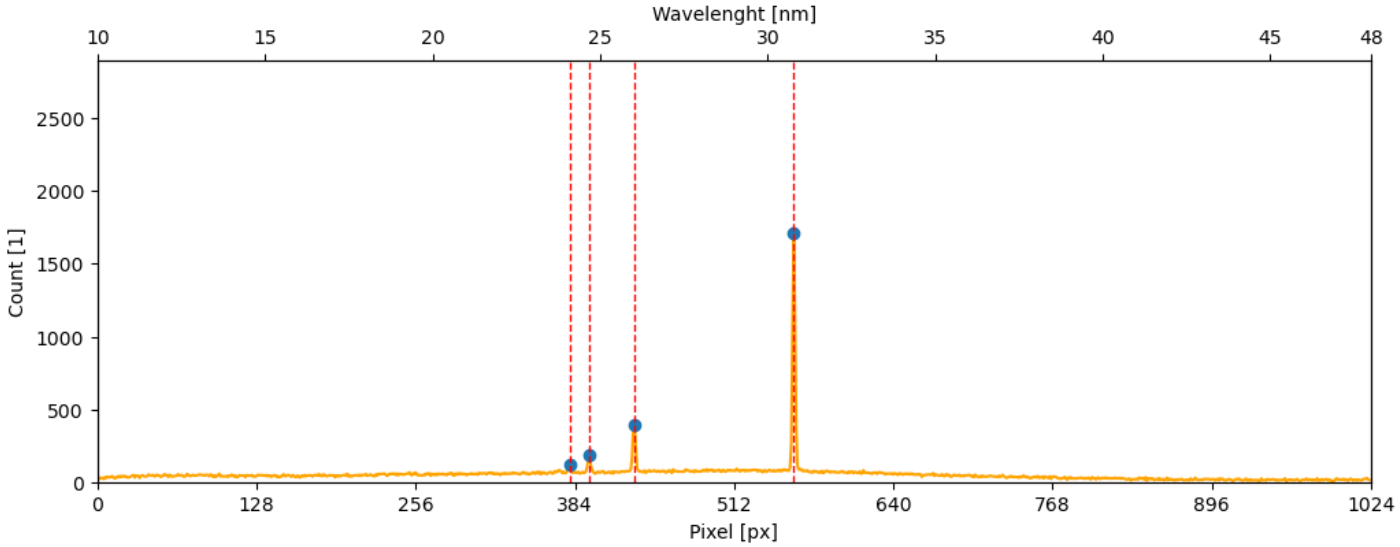
- **M1** Lower mirrors
- **M2** Upper mirrors
- **M3** Slits
- **M4** Gratings
- **M5** CCD

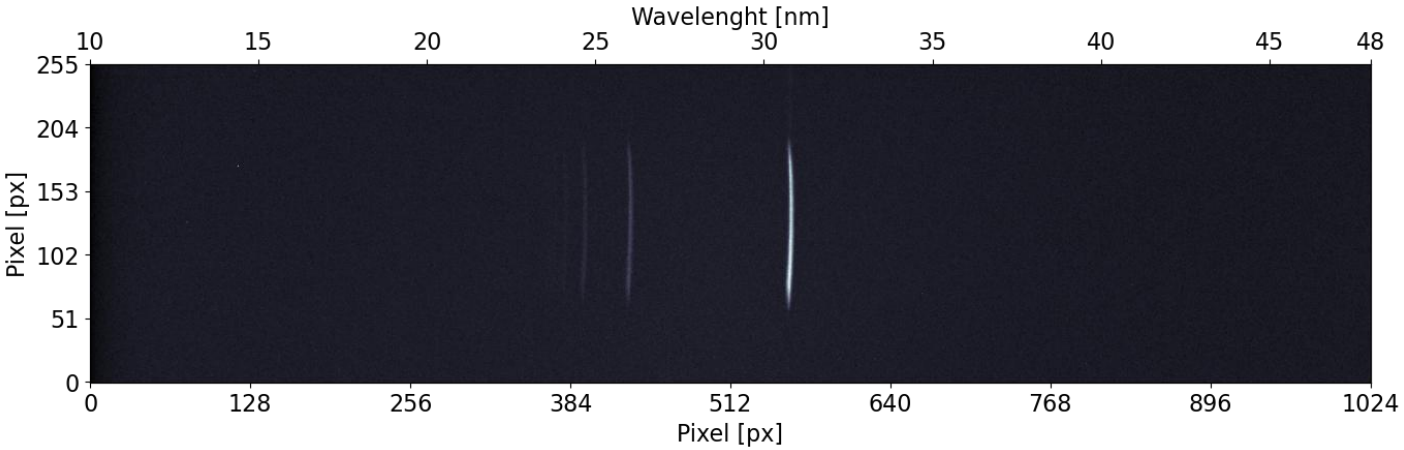
Endoscope system:

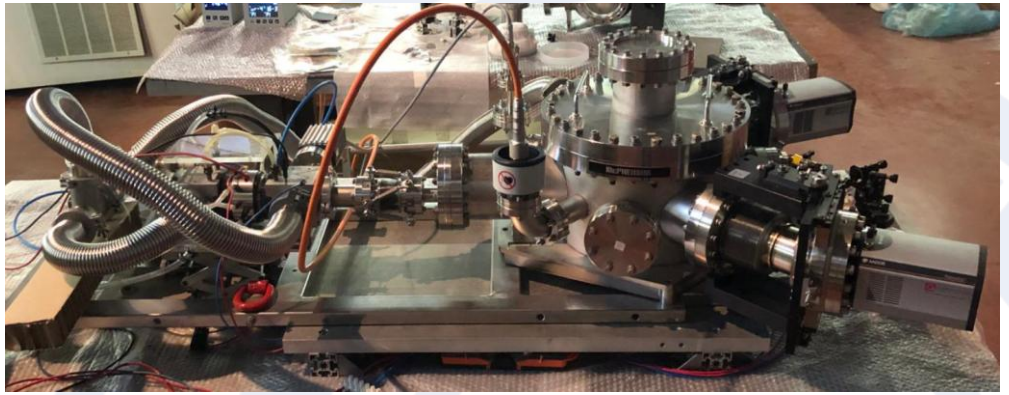
To check the alignment, a laser is cast through the 0-order [**E0**] and the footprint on the divertor is observed with a custom endoscope:

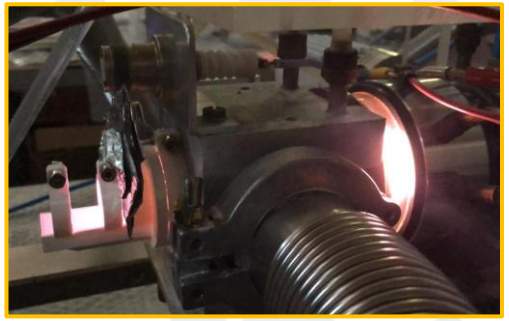
- **E1** Double mirrors
- **E2** Flat mirror
- **E3** Lenses
- **E4** CCD Visible camera

Wavelength calibration SPRED A [10-48 nm] [1/3]







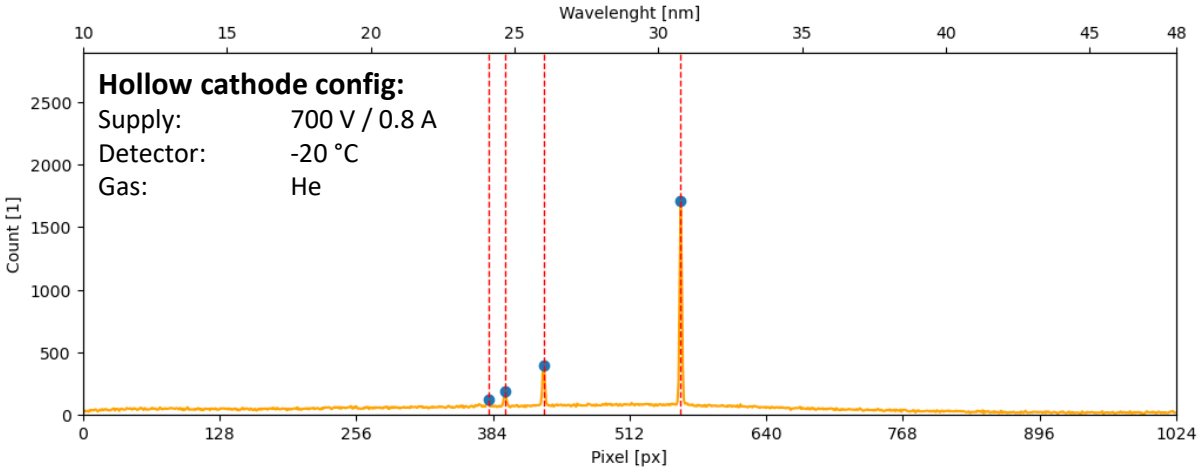


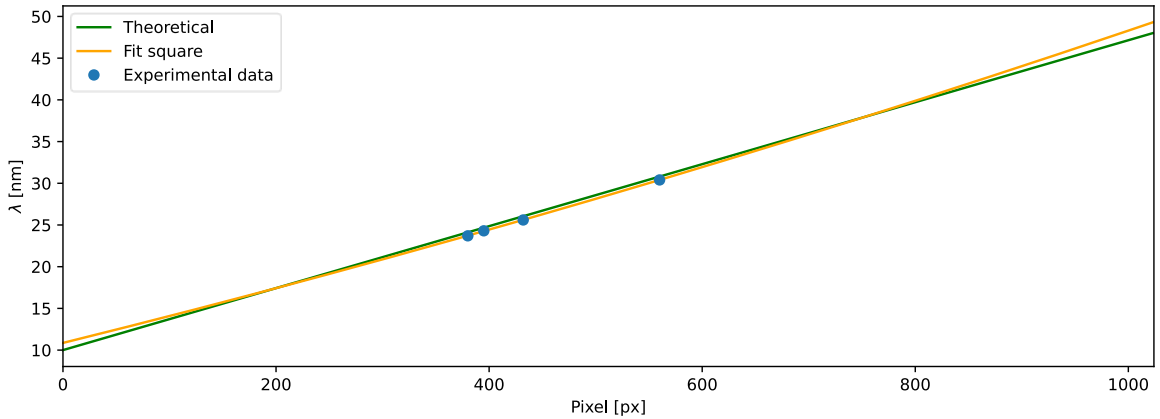
Hollow cathode config:

Supply: 700 V / 0.8 A
Detector: -20 °C
Gas: He

Species	Wavelength [nm]	Pixel position
He I	23.7	380
He I	24.3	395
He I	25.6	420
He I	30.4	549

Wavelength calibration SPRED A [10-48 nm] [2/3]





The wavelength resolution fits with the nominal one: **0,08 nm**

Theoretical calibration curve:

$$\frac{\delta\lambda}{\delta px} = \frac{\text{Range}}{\text{N. Pixel}} = \frac{48\text{nm} - 10\text{nm}}{1024\ \text{px}} = 0.0371\ \text{nm/px}$$

$$\lambda(\text{px}) = \frac{\delta\lambda}{\delta_{\text{p x}}}\text{px} + \lambda_{\min} = 0.0371 \cdot \text{px} + 10$$

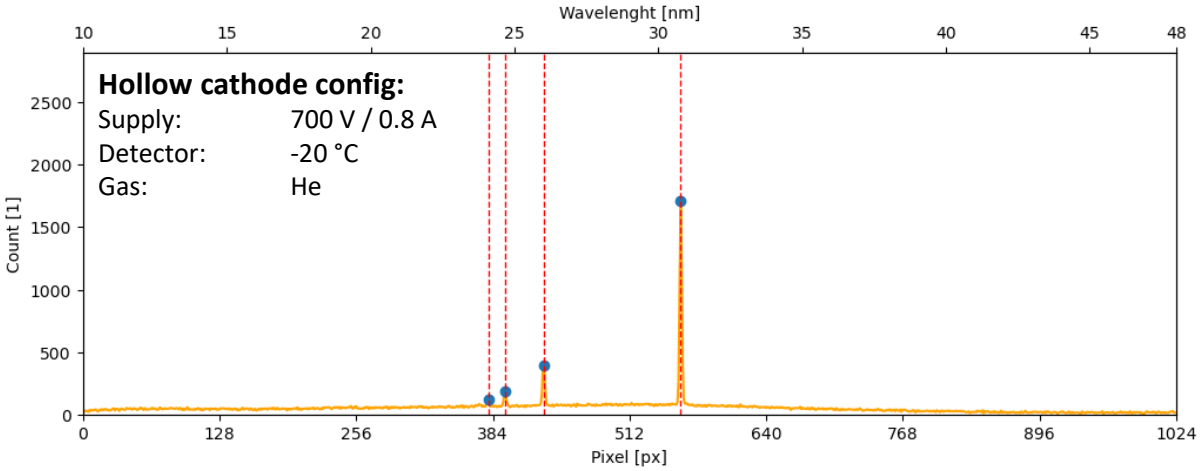
Experimental calibration curve:

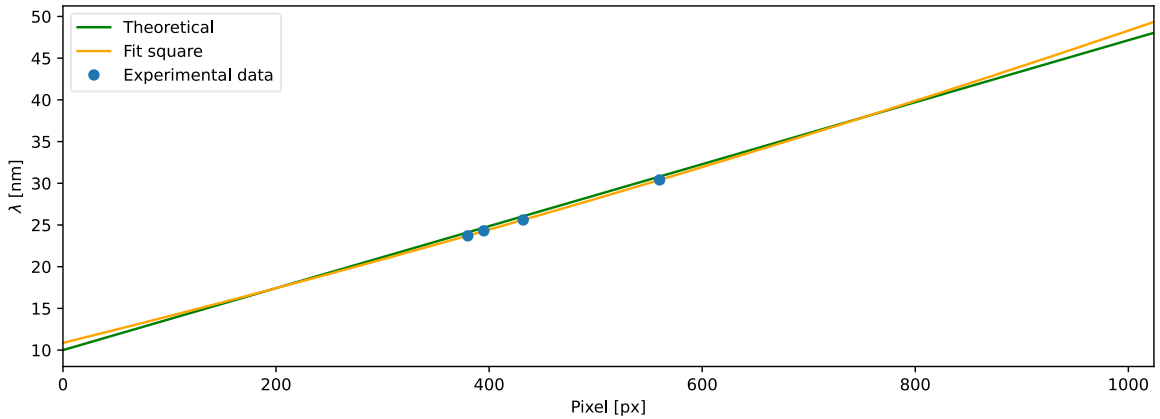
Linear fitting: $\lambda(\text{px}) = 0.0371 \cdot \text{px} + 9.592$

Quadratic fitting: $\lambda(\text{px}) = 5.79 \cdot 10^{-6} px^2 + 0.0316 \cdot \text{px} + 10.86$

Species	Wavelength [nm]	Pixel position	Theory	Δpx
He I	23.7	380	369	-11
He I	24.3	395	385	-10
He I	25.6	420	420	-12
He I	30.4	549	549	-11

Calibration SPRED A [10-48 nm] [2/3]





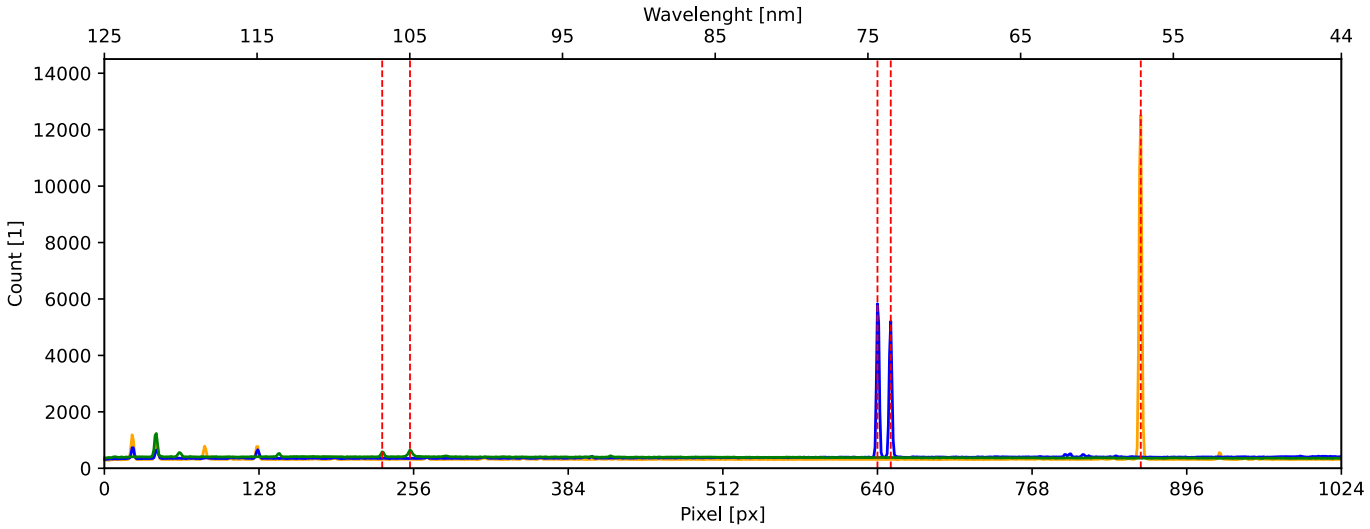
Theoretical calibration: $\lambda(\mathrm{px}) = \boxed{0.0371} \cdot \mathrm{px} + 10$

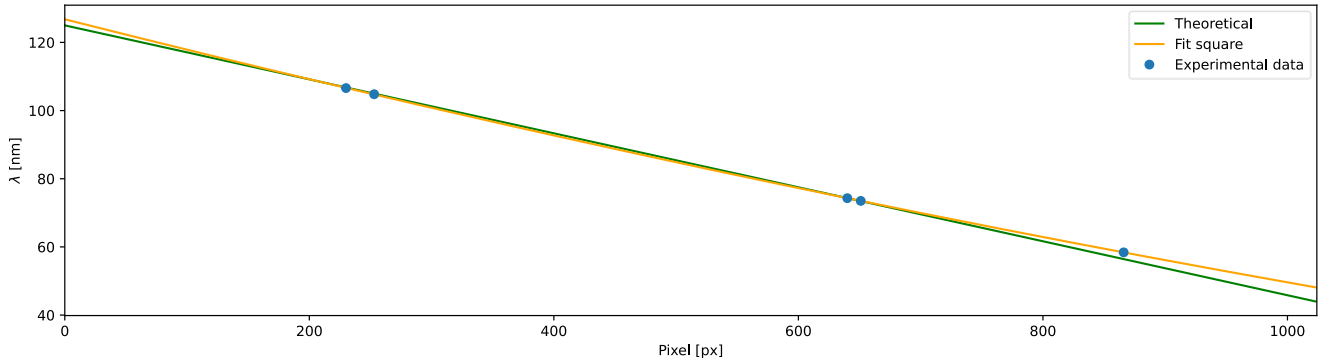
Experimental calibration : $\lambda(\mathrm{px}) = \boxed{0.0371} \cdot \mathrm{px} + 9.89$

The wavelength resolution fits with the nominal one

Species	Wavelength [nm]	Pixel position	Theory	Δpx
He I	23.7	370	369	1
He I	24.3	385	385	0
He I	25.6	421	420	1
He I	30.4	549	549	0

Calibration SPRED B [44-125 nm]





Theoretical calibration: $\lambda(\mathrm{px}) = -0.0791 \cdot \mathrm{px} + 125$

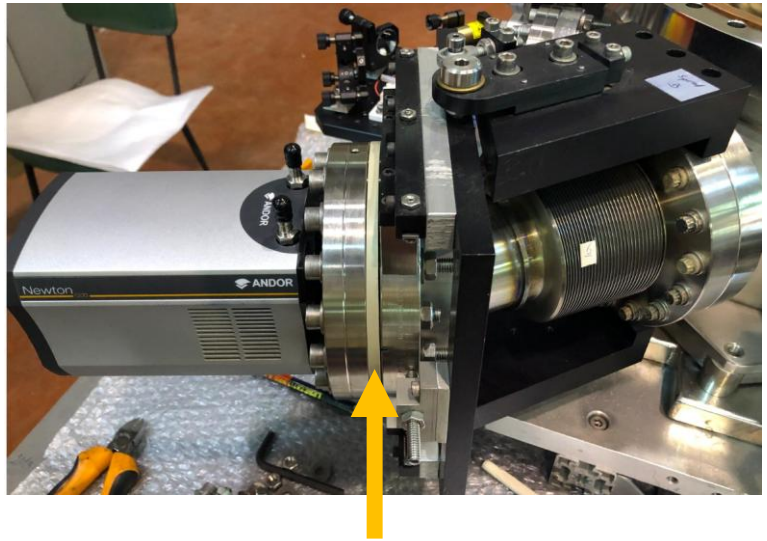
Experimental calibration curve:

Linear fitting: $\lambda(\mathrm{px}) = -0.0766 \cdot \mathrm{px} + 124$

Quadratic fitting: $\lambda(\mathrm{px}) = 1.34 \cdot 10^{-5} px^2 - 0.0905 \cdot \mathrm{px} + 126.8$

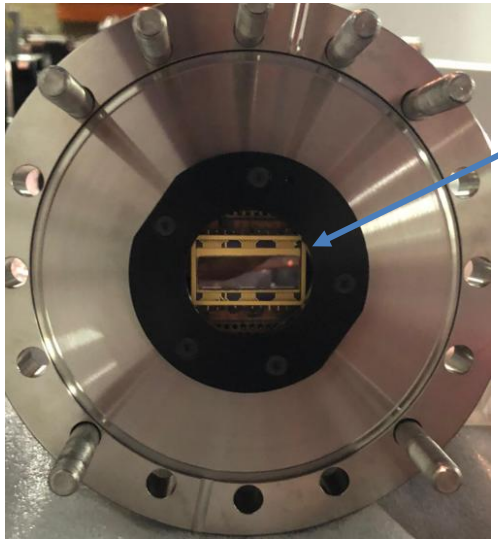
The wavelength resolution fits well with the nominal one

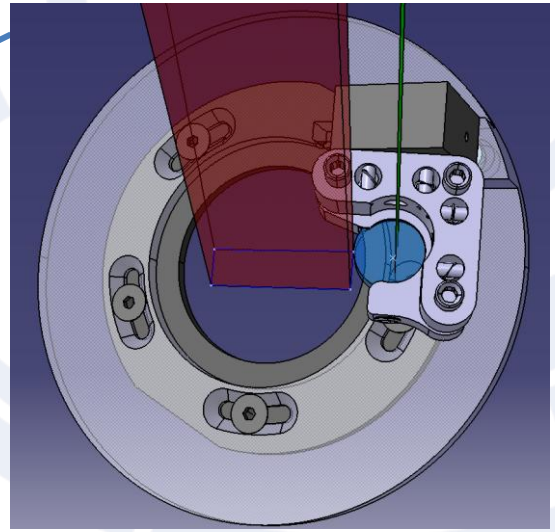
Zero order [1/3]



The PEEK has been moved to the first flange so that it does not have to be removed each time the CCD is removed

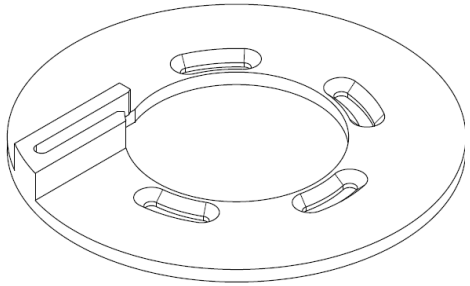
The PEEK was used to support a mirror of the 0th order optical chain

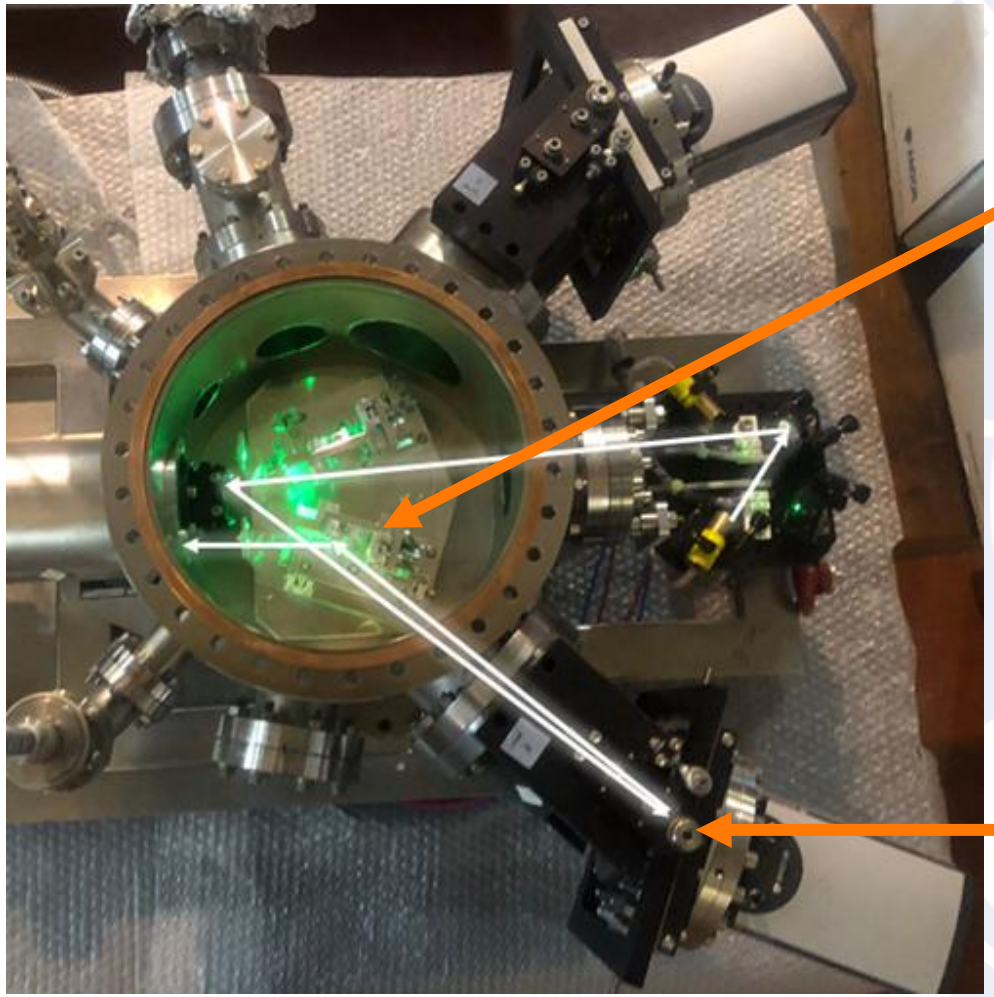


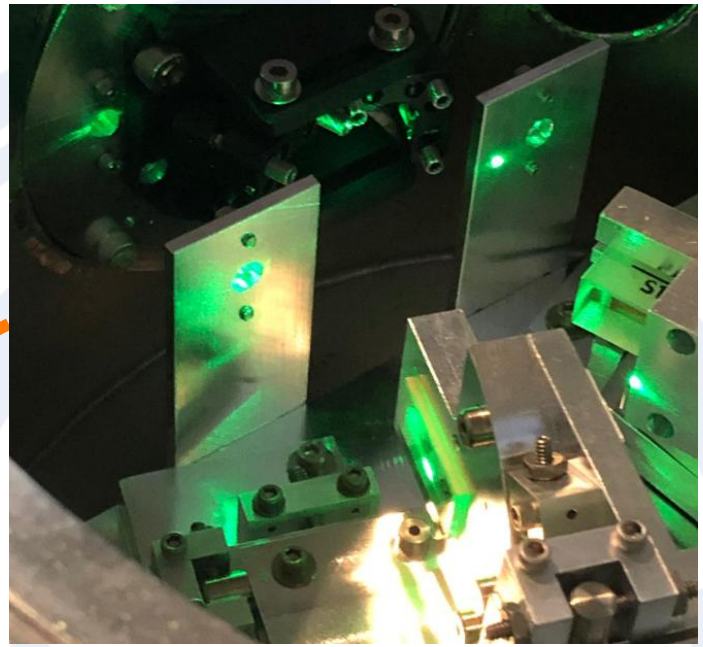


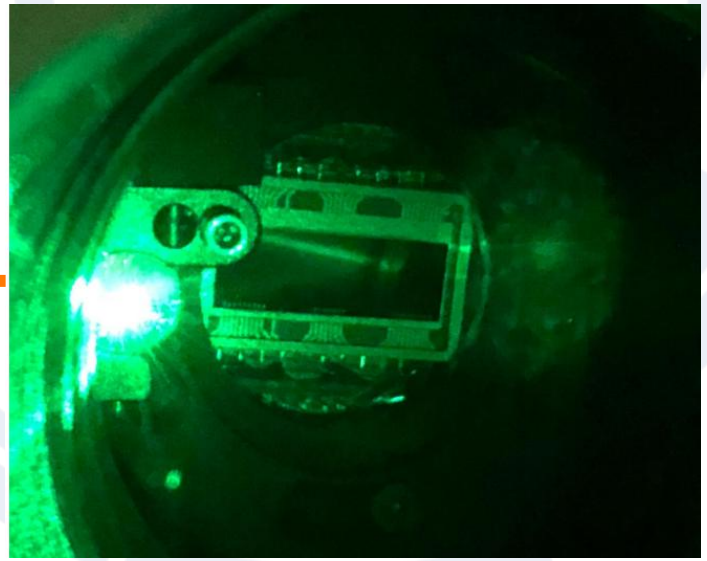
Zero order [2/3]

The new system has been designed, manufactured and installed



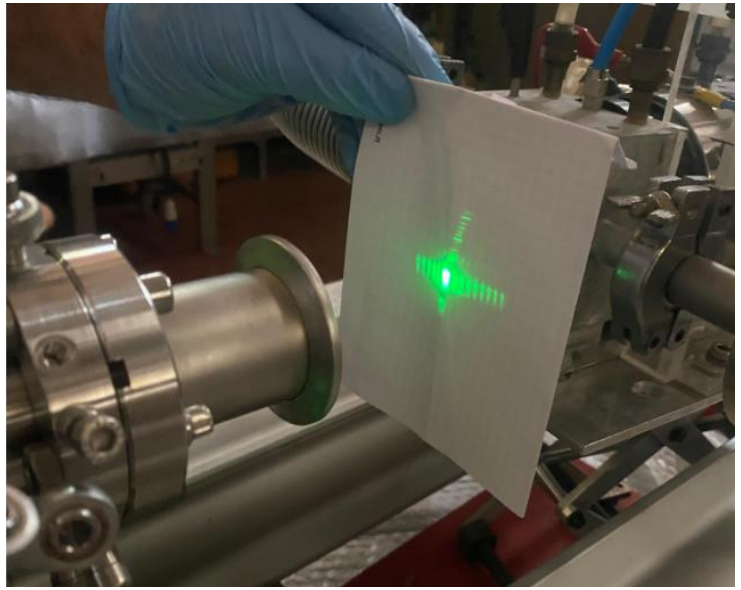


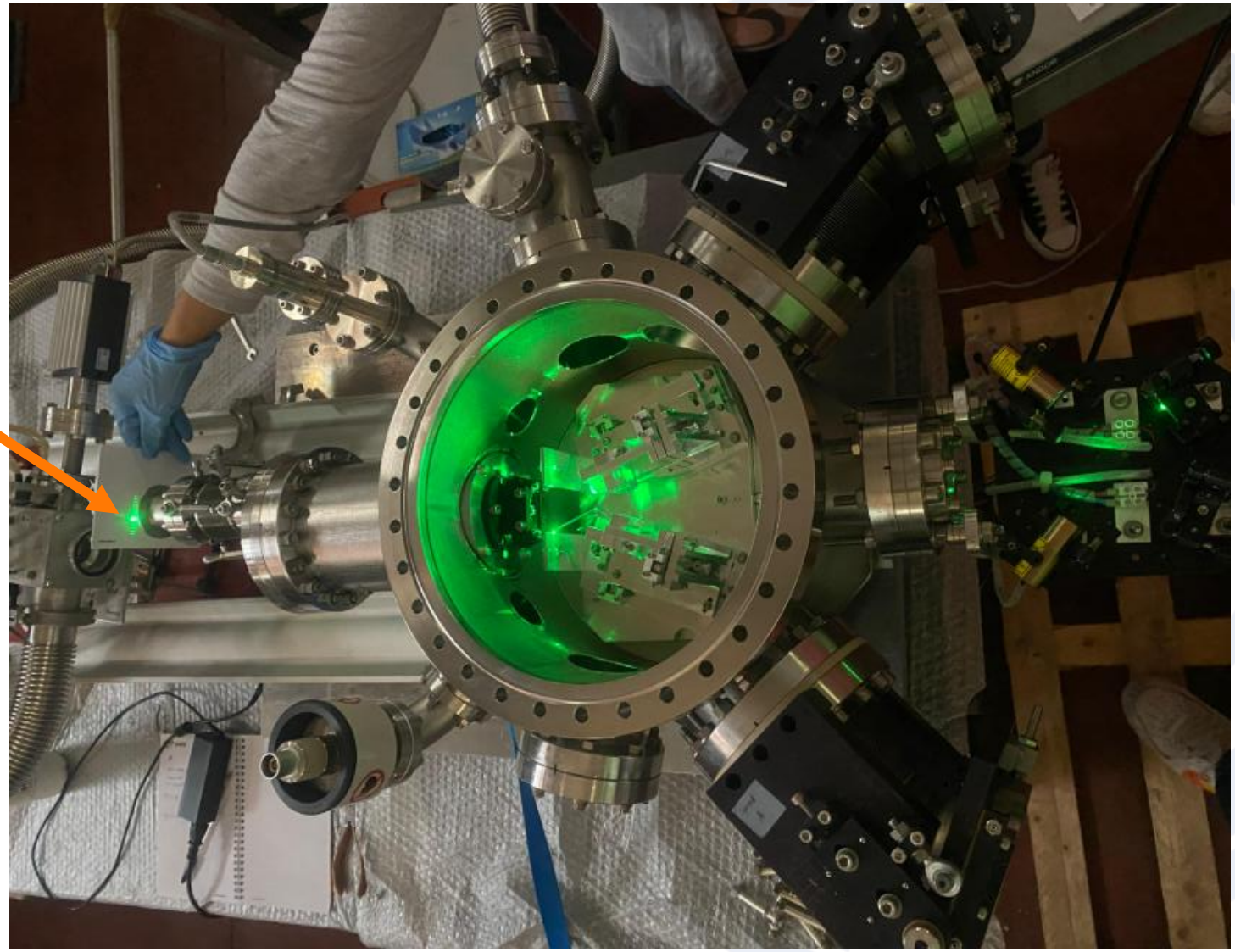




Zero order [3/3]

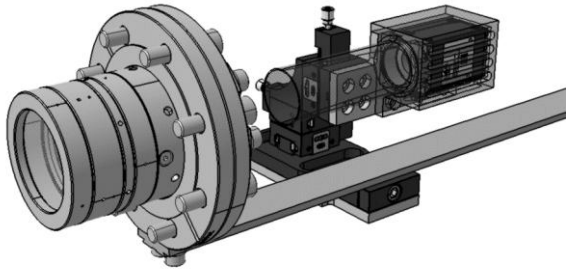
Laser that will be directed along the instrument for the alignment

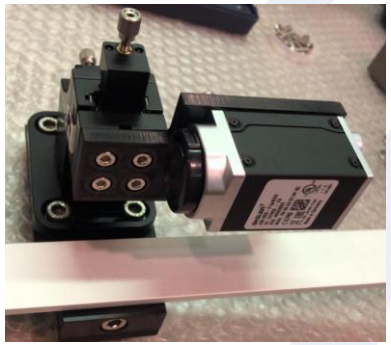


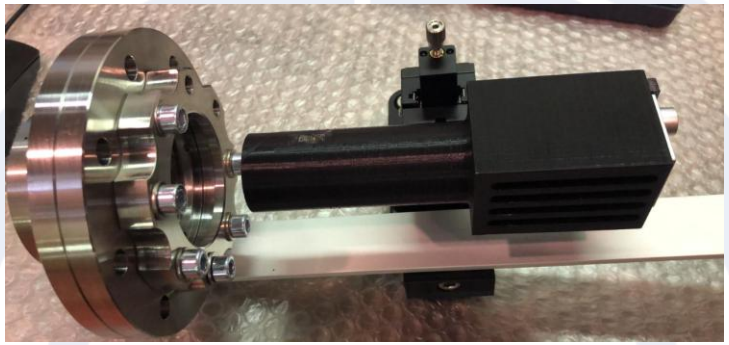


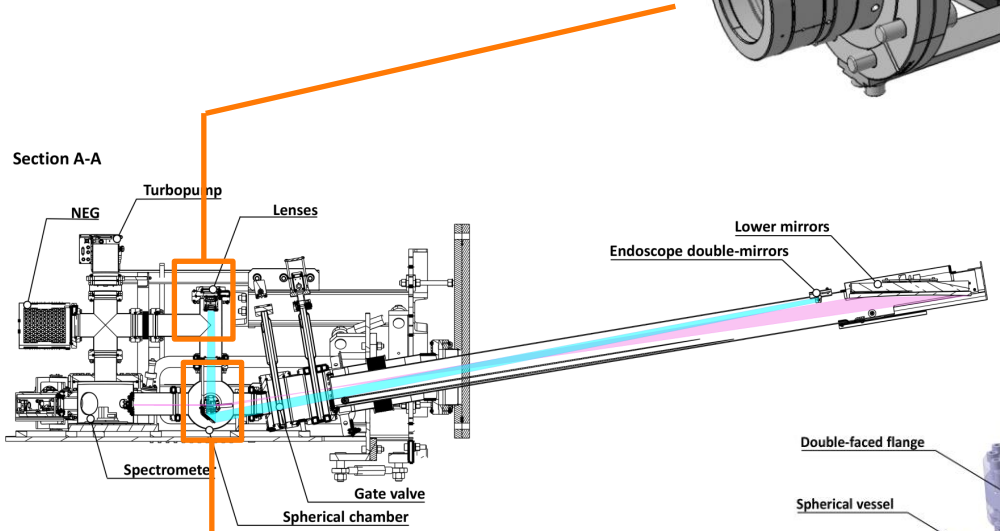
Endoscope

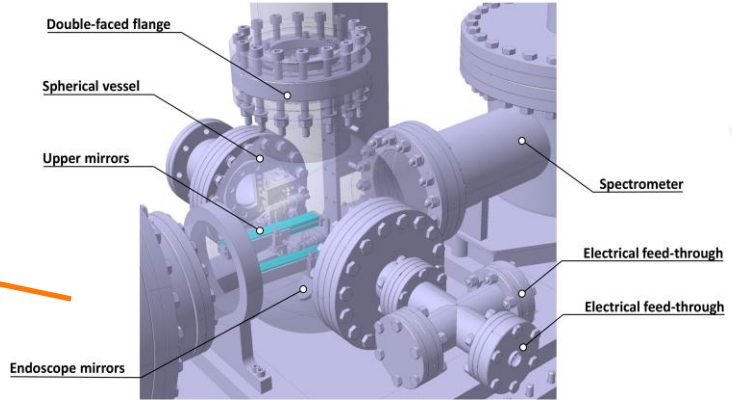
Endoscope used to align the instrument with respect to the divertor. The path is indicate in **light blue**.



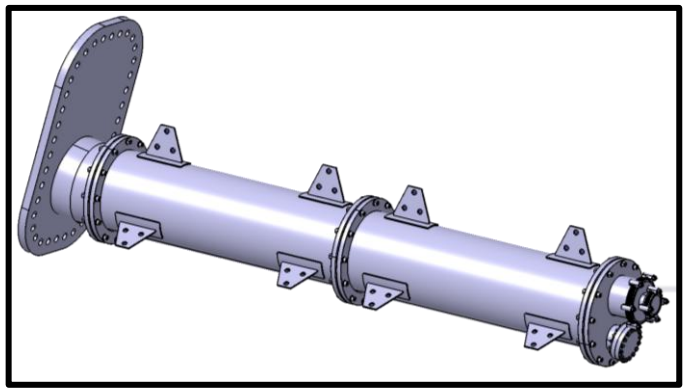




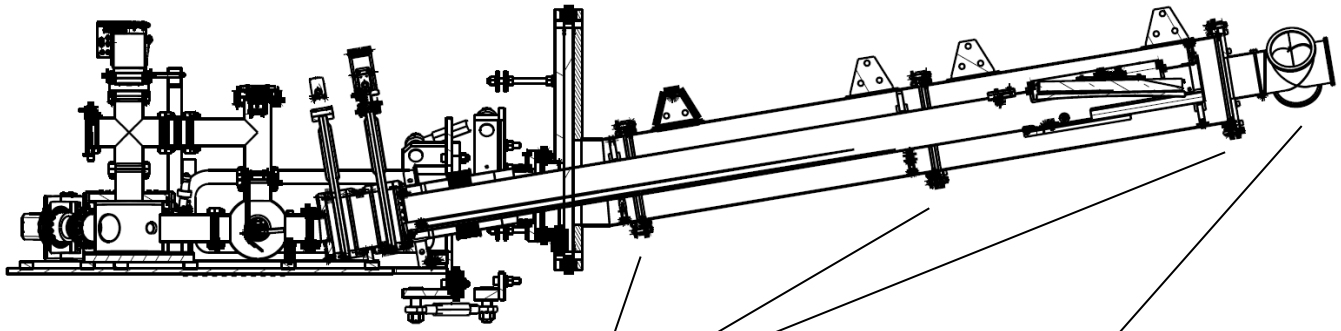


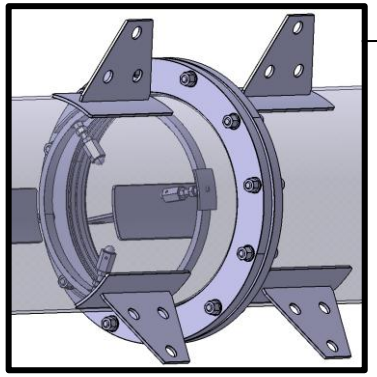


Leak test chamber

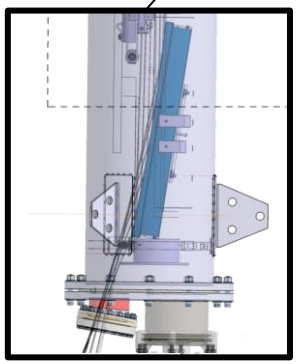


Designed by **S.Soare**
The chamber is completed.
The leak test must be scheduled.





Three ring supports arranged inside the chamber to stabilize the tube during transportation

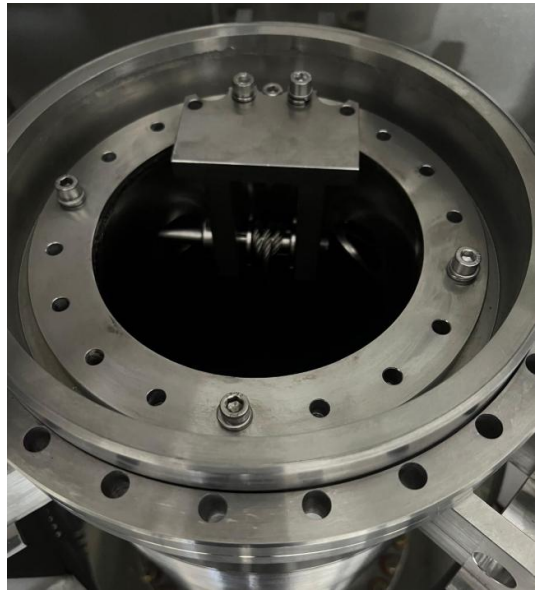


Connect the hollow cathode and illuminate the lower mirror, testing the entire optical chain in VUV [**To be tested**]. Alternatively, it can be used with visible light.

Chassis and assembled components

End of the port plug.

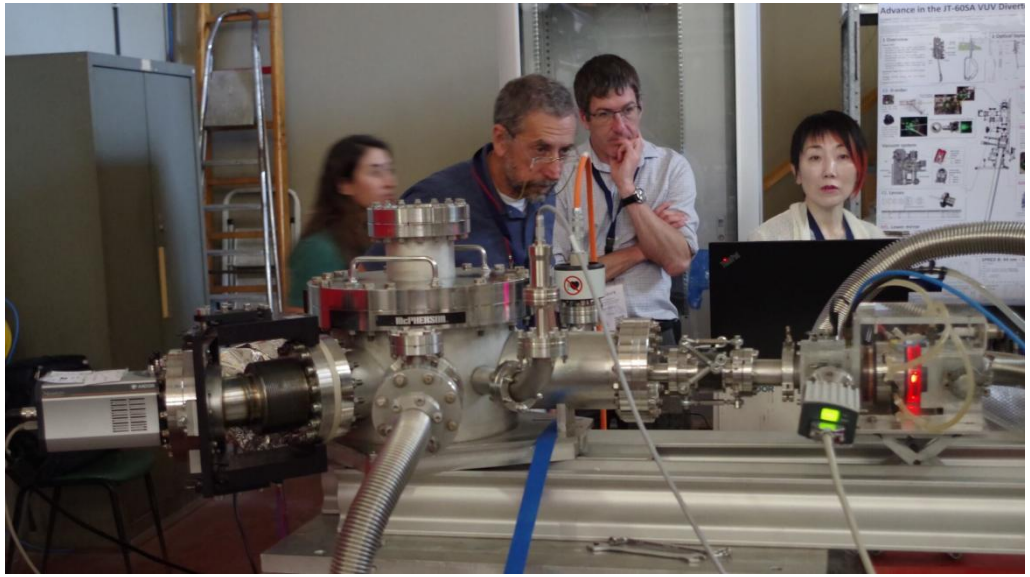
Arm of the pneumatic motor for the shutter

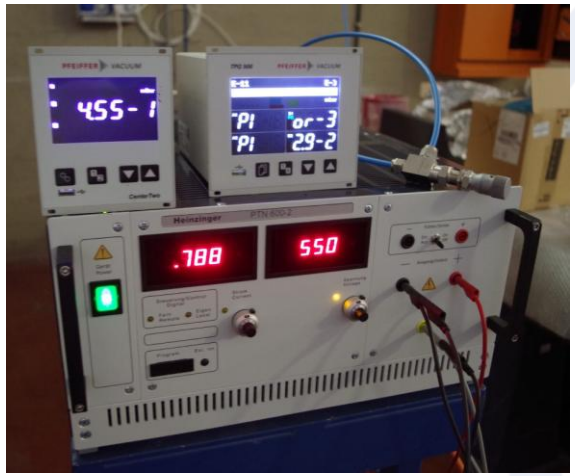


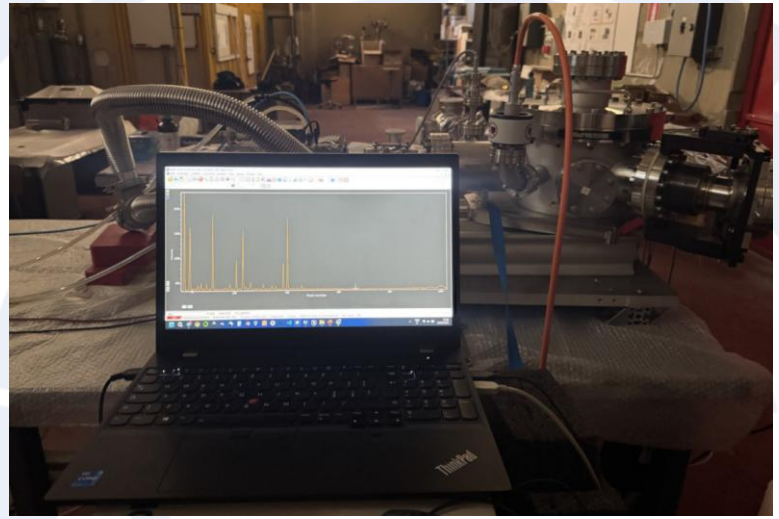
Mechanical connection of the cable

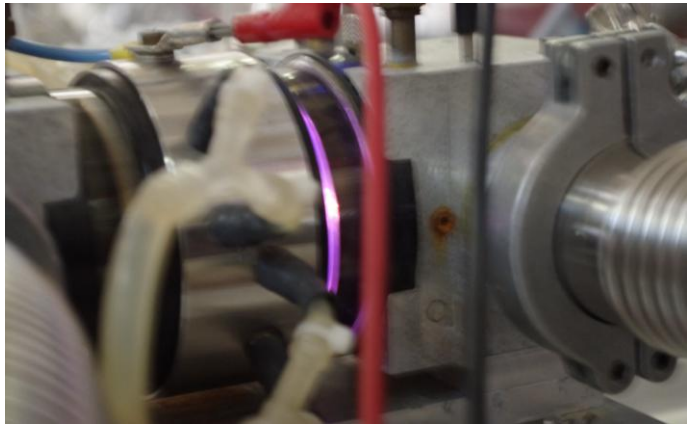
Entire structure

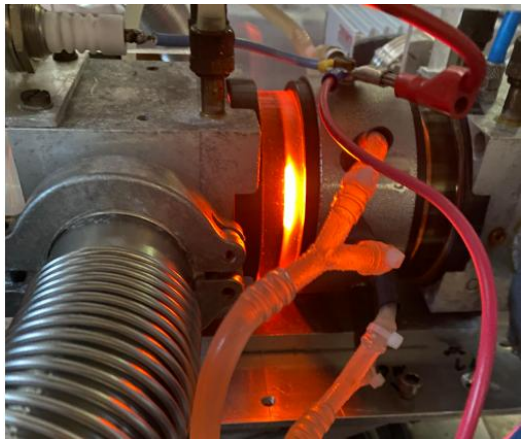
Witness [1/2]

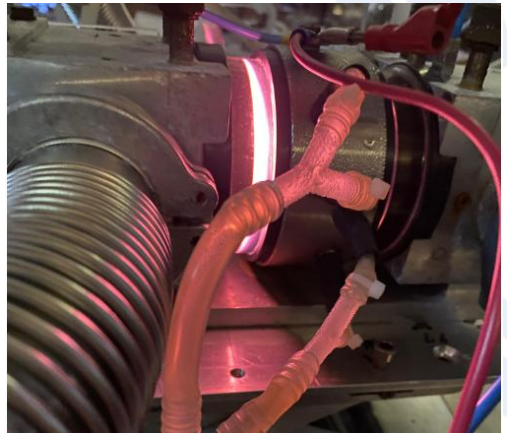


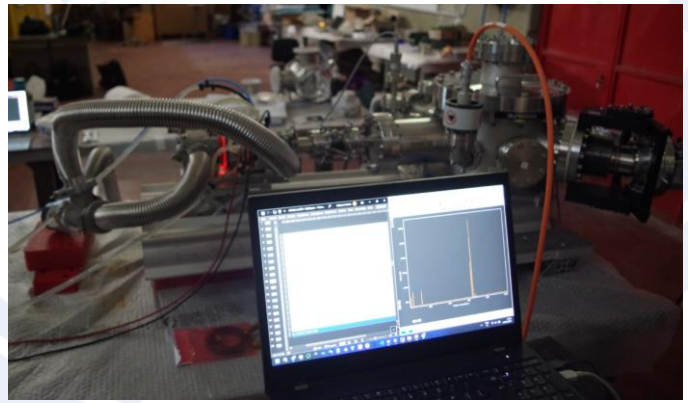




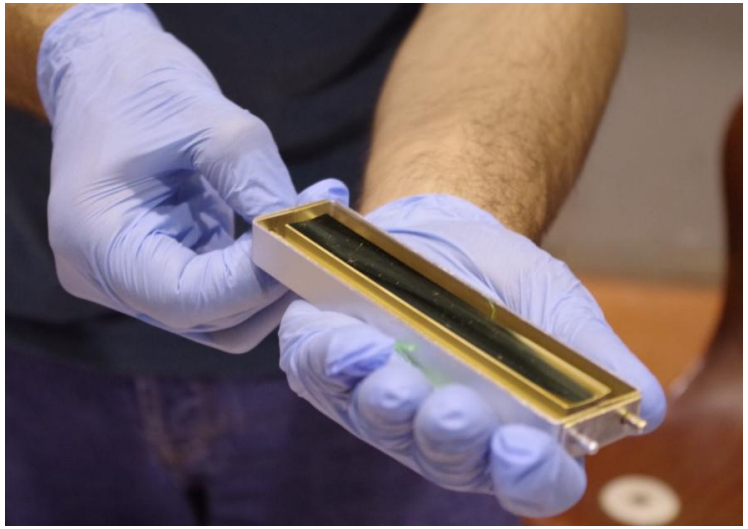




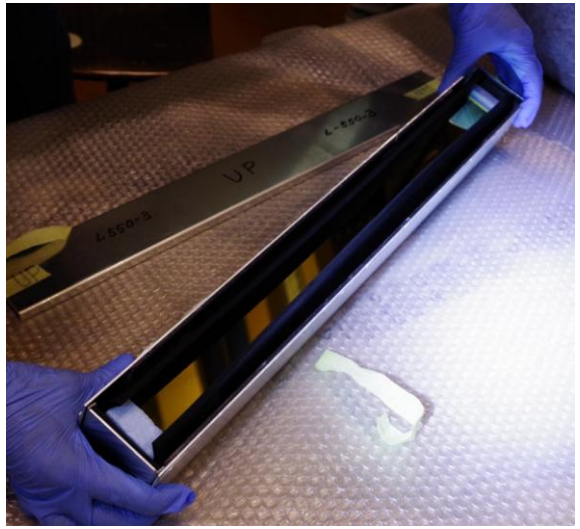




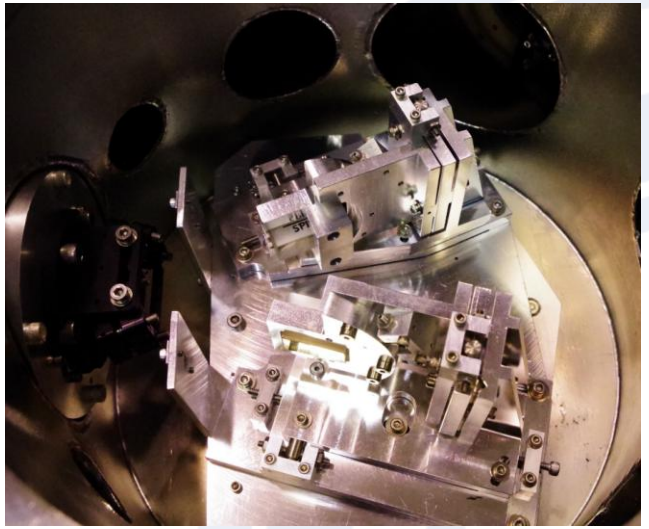
Witness [2/2]



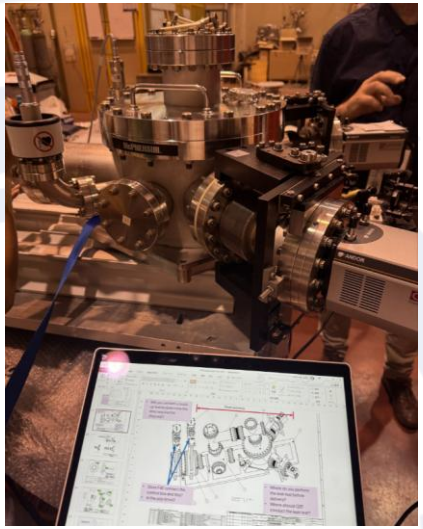
Upper toroidal mirror



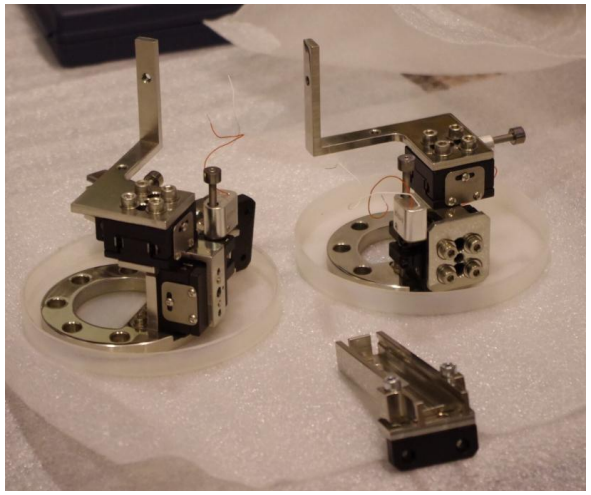
Lower toroidal mirror



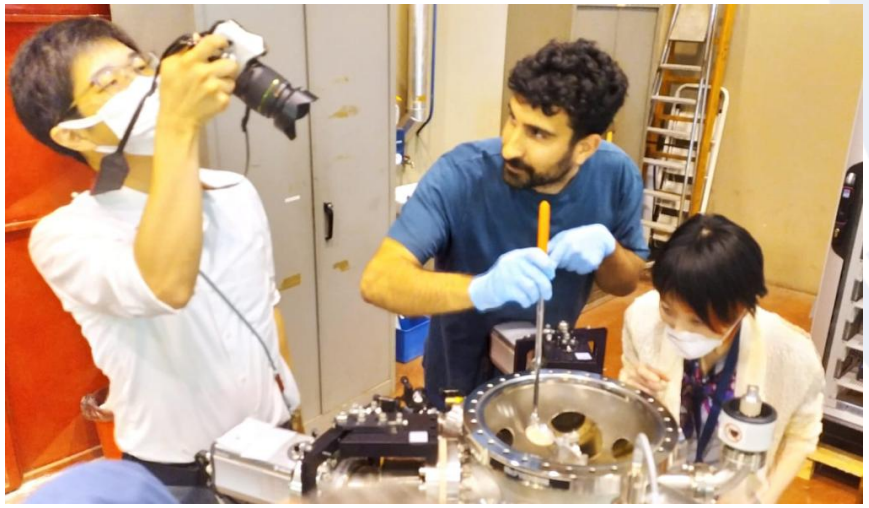
Inside vessel components



Spectrometer

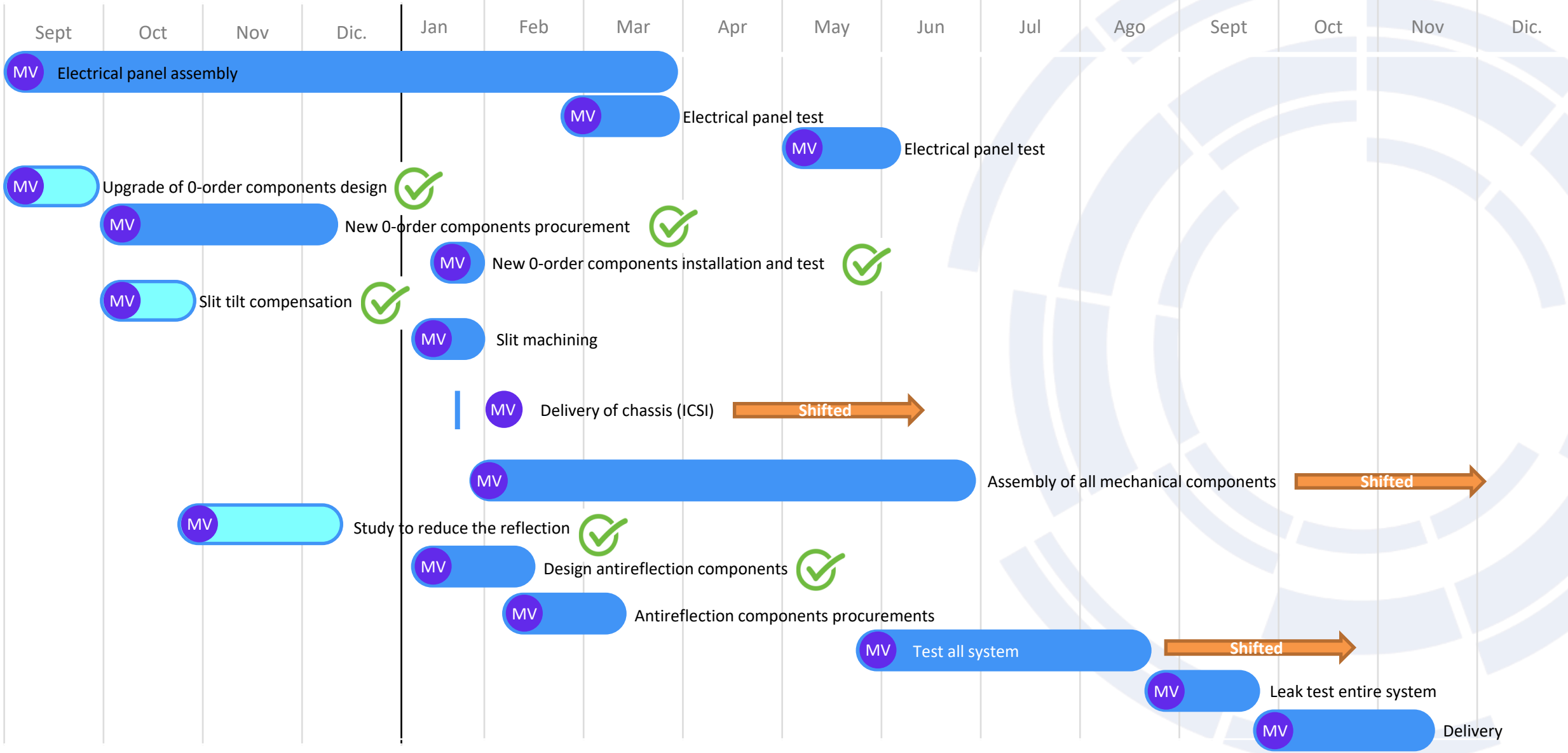


Upper mirror supports



Team

Schedule [1/2]


Sept
Oct
Nov
Dic.
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Ago
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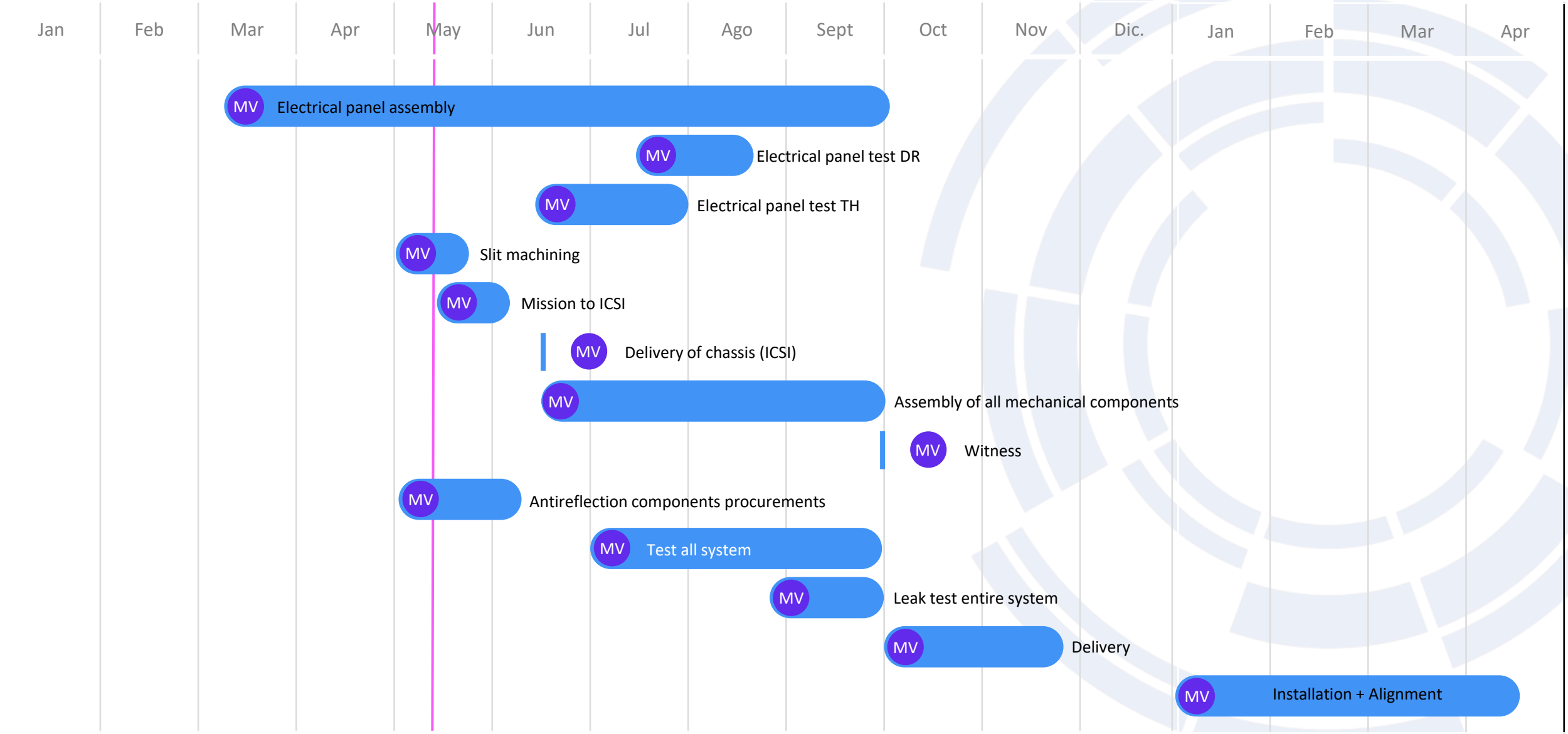
Dic.
MV
Electrical panel assembly
MV
Electrical panel test
MV
Electrical panel test
MV
Upgrade of 0-order components design
MV
New 0-order components procurement
MV
New 0-order components installation and test
MV
Slit tilt compensation
MV
Slit machining
MV
Delivery of chassis (ICSI)
Shifted
MV
Assembly of all mechanical components
Shifted
MV
Study to reduce the reflection
MV
Design antireflection components
MV
Antireflection components procurements
MV
Test all system
Shifted
MV
Leak test entire system
MV
Delivery

Schedule [2/2]


Jan
Feb
Mar
Apr
May
Jun
Jul
Ago
Sept
Oct
Nov
Dic.
Jan
Feb
Mar
Apr
MV
Electrical panel assembly
MV
Electrical panel test DR
MV
Electrical panel test TH
MV
Slit machining
MV
Mission to ICSI
MV
Delivery of chassis (ICSI)
MV
Assembly of all mechanical components
MV
Witness
MV
Antireflection components procurements
MV
Test all system
MV
Leak test entire system
MV
Delivery
MV
Installation + Alignment

TCM-43 Frascati

Thanks for the attention

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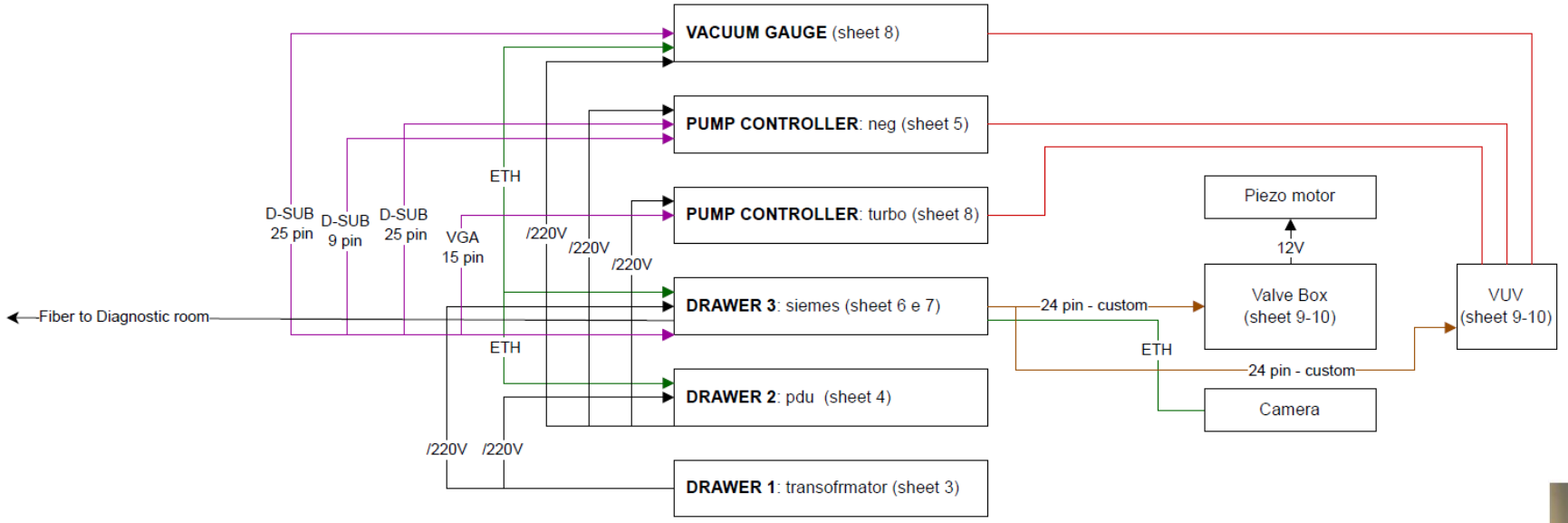
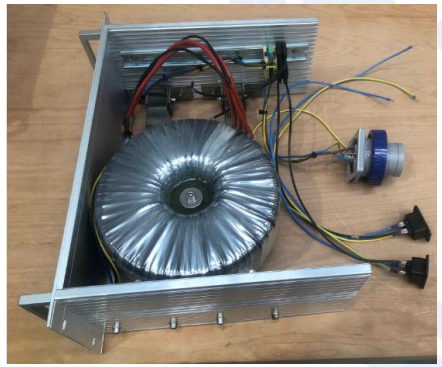
Back-up: Electrical panel

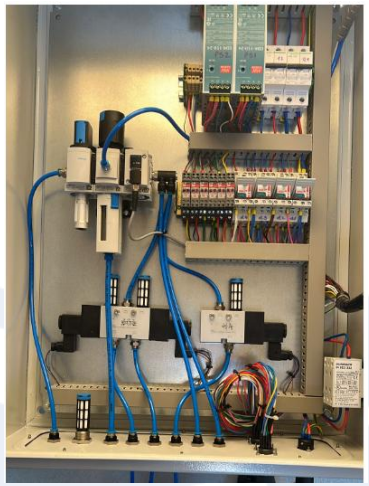


Rack diagnostic room

DRAWER 3: **siemens**



DRAWER 1: **transformator**



Valve box