DIAGNOSTIC INTEGRATION UPDATE ON ACTIVE AND X-RAY SPECTROSCOPY

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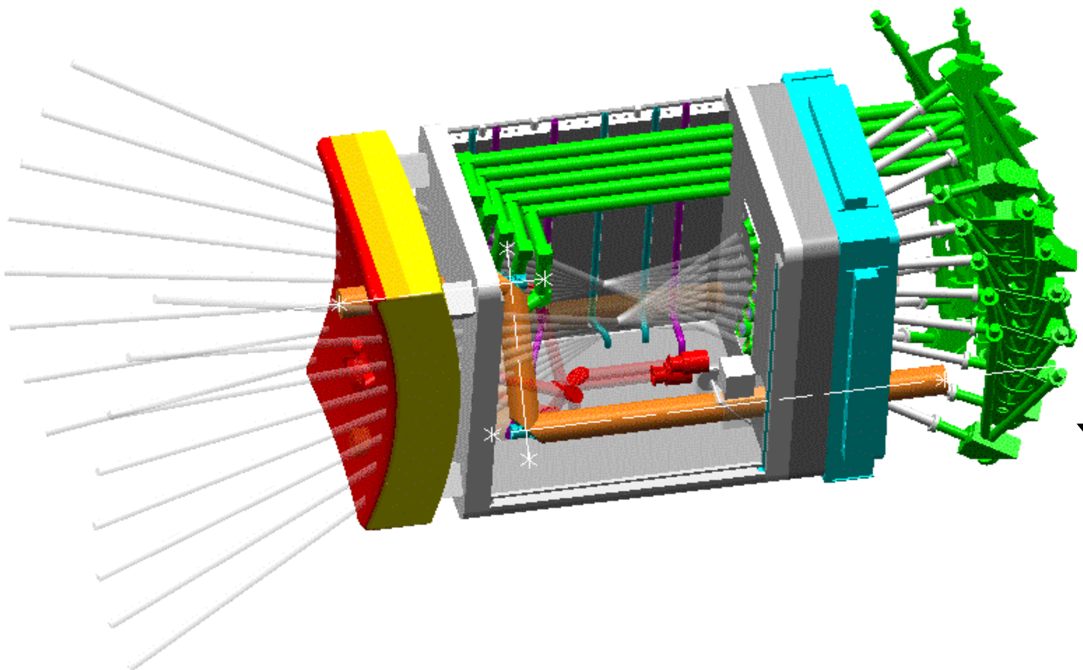
SUMMARY

- Eport9 and Uport9 integration
  - The X-ray imaging system
  - Neutronic analyses
  - Interfaces with toroidal polarimeter/interferometer
- Eport11 integration
  - Reflectometry new positions, Refractometry and Radar Reflectometry
  - Divertor VUV spectrometer integration
  - X-ray survey layout assessement
  - NPA
- Eport3 and Uport3 integration
  - Background design of optical systems for CXRS and MSE
  - Integration in port plug and blanket cutouts
- cumulative polarization effect and reflectivity on multimirror systems

EPORT9 – The X-ray imaging system (actual setup)

In previous arrangement the X-ray system located at eport9 was based on two secant arrays of 8 discrete viewing lines each.



X-ray spectrometers

Drawbacks of this arrangement

- maintenance complexity at the port plug end with many individual crystal/detector arms which in addition will require local shieldind cells
- spatial gap between viewing lines that would be desirable to improve.

EPORT9 – The X-ray imaging system (proposed setup)

The proposed arrangement for the X-ray is based on an equivalent imaging system located at uport9.

Some advantages of this setup are:

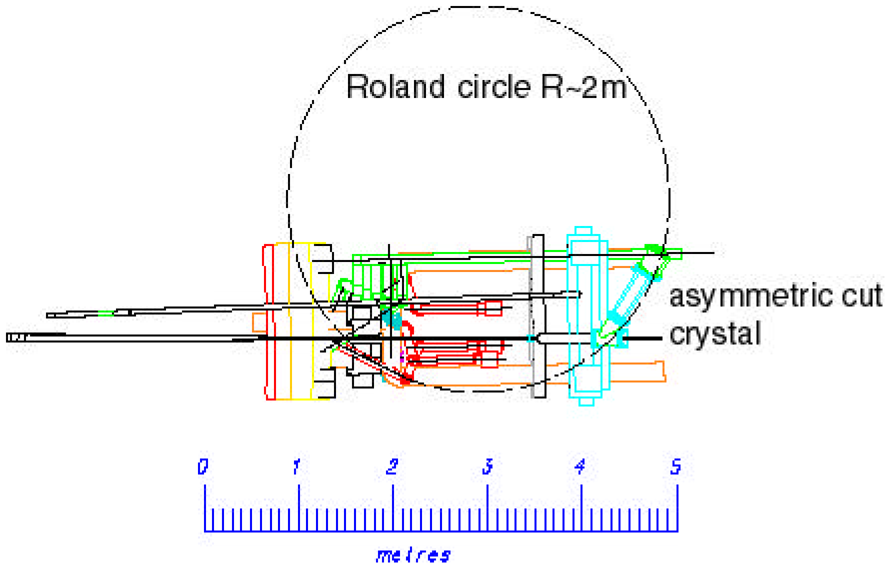
- location of the virtual slit near the plasma while taking full advantage of the same F# than the uport9 imaging system.

- decrease on the number of crystal/detector arms (to three) at the port plug end

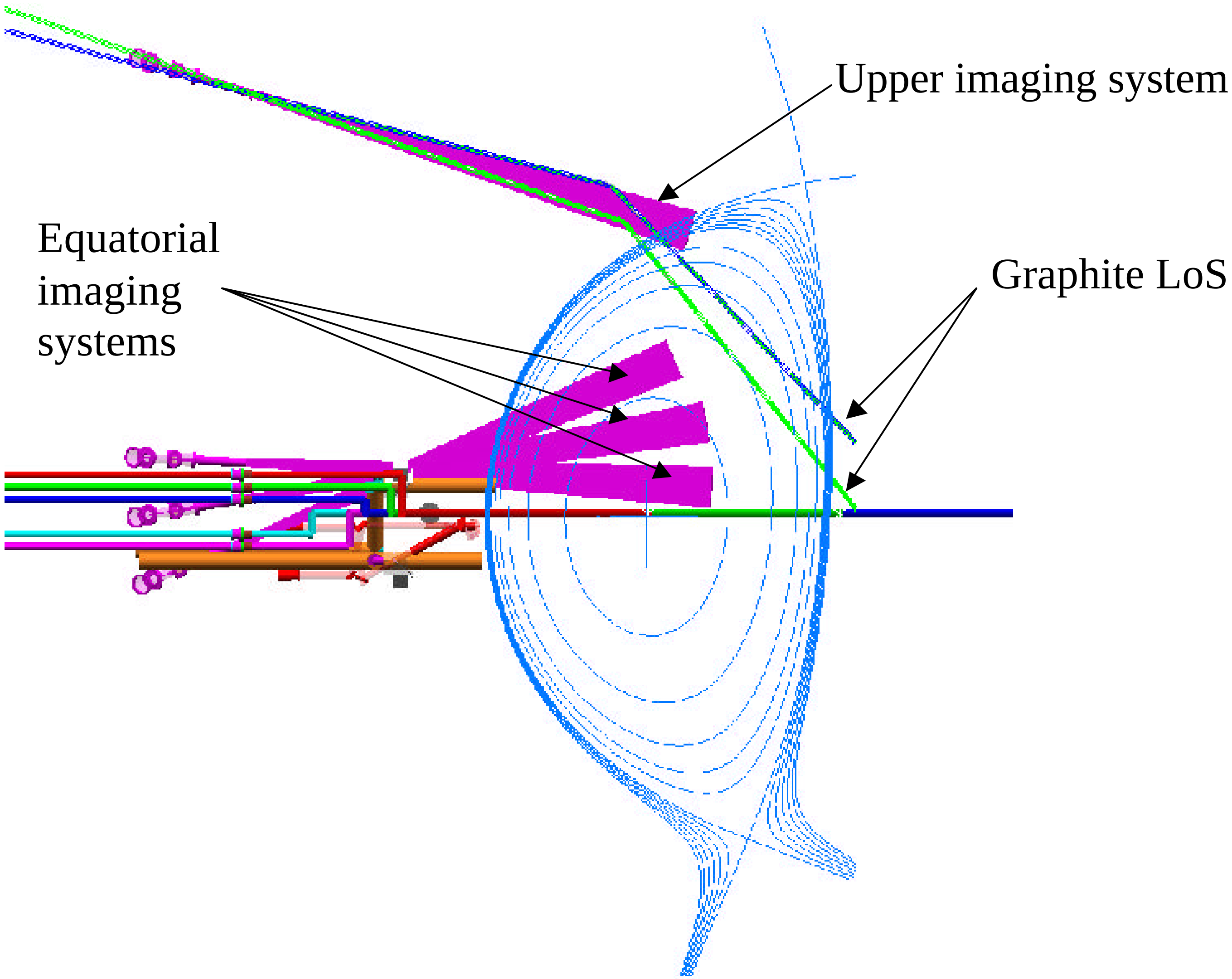
- reducion of the constrains inside the port plug imposed by the 16 discrete lines of sight

- increase of spatial resolution

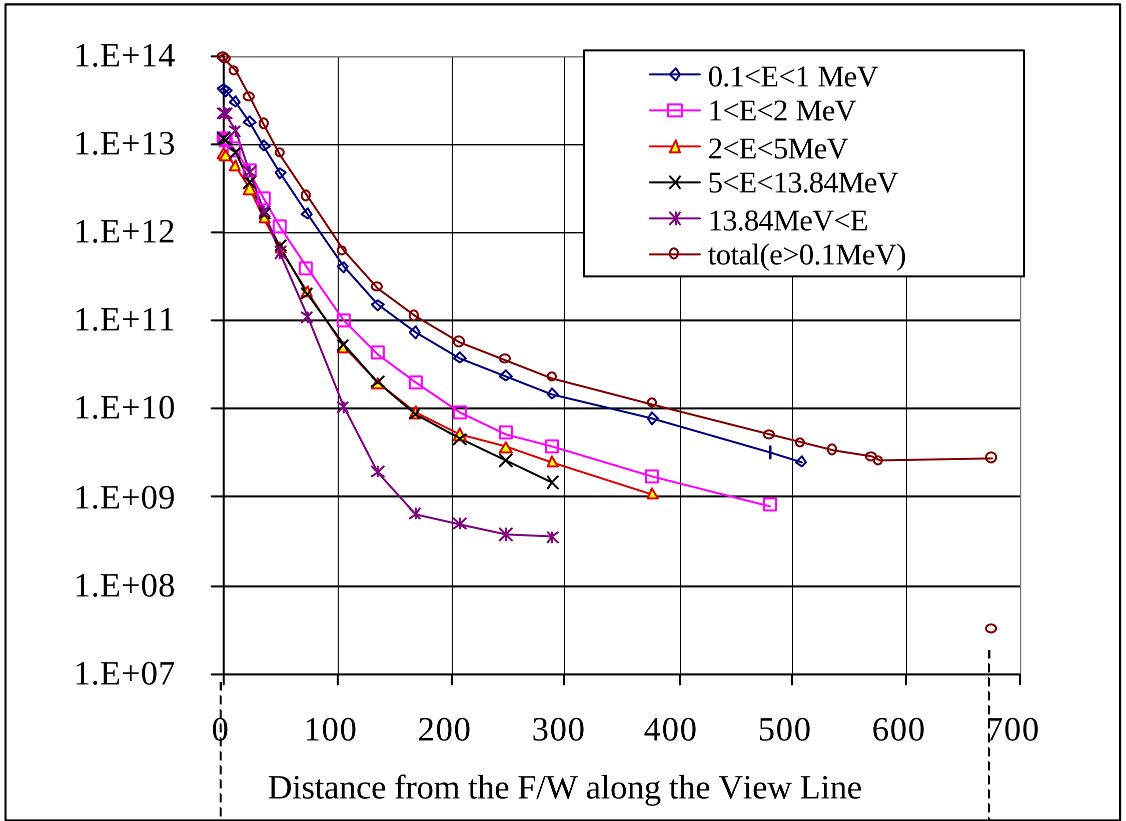
EPORT9 – The X-ray imaging system



EPORT9 & UPORT9 – The X-ray imaging system

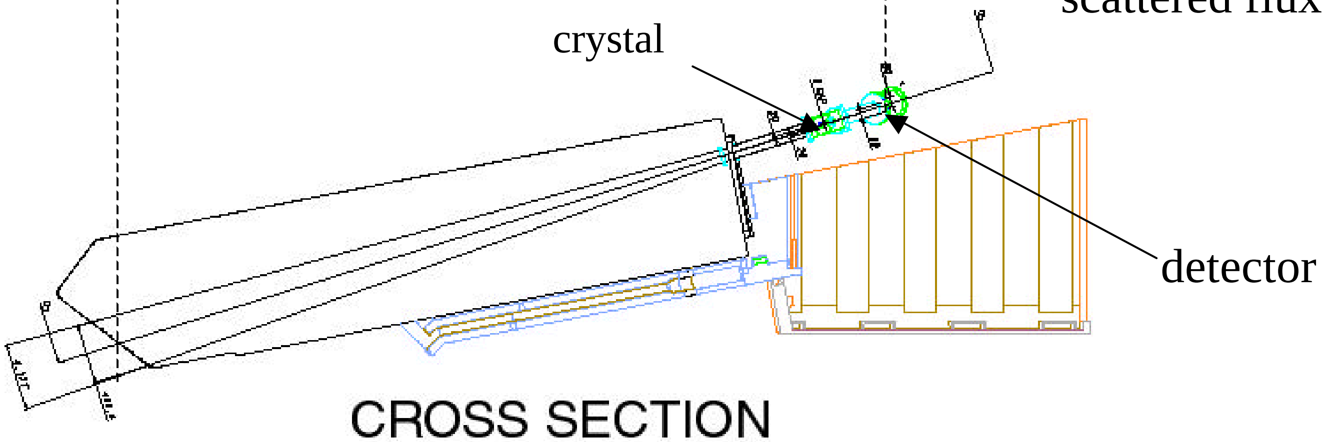


UPORT9 – The X-ray imaging system



Neutronic analysis has been performed at Garching by Dr. Lida for the Uport9 X-ray system.
No gamma ray neither heat deposition analyses have been adressed yet

- Radiation level at detector is acceptable.
- Man access is to avoid at crystal location
- Shield is required at crystal location which may increase the scattered flux at detector



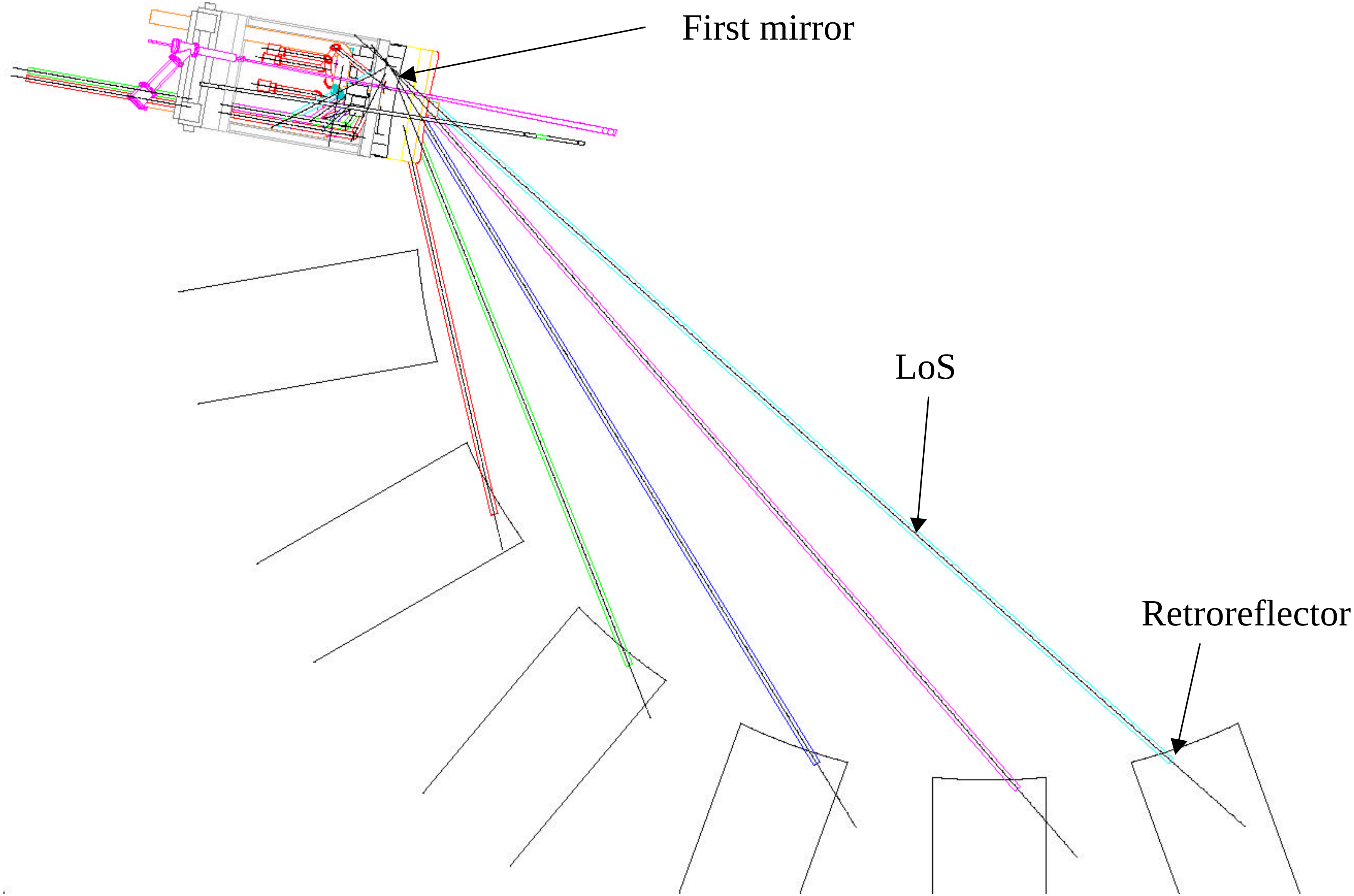
EPORT9 – The toroidal polarimeter/interferometer

Integration of the X-ray imaging systems in eport9 was accomplished by rearrangement of the polarimeter/interferometer first mirror and sight lines outside and inside the port plug

- Positions for the retroreflectors have been changed

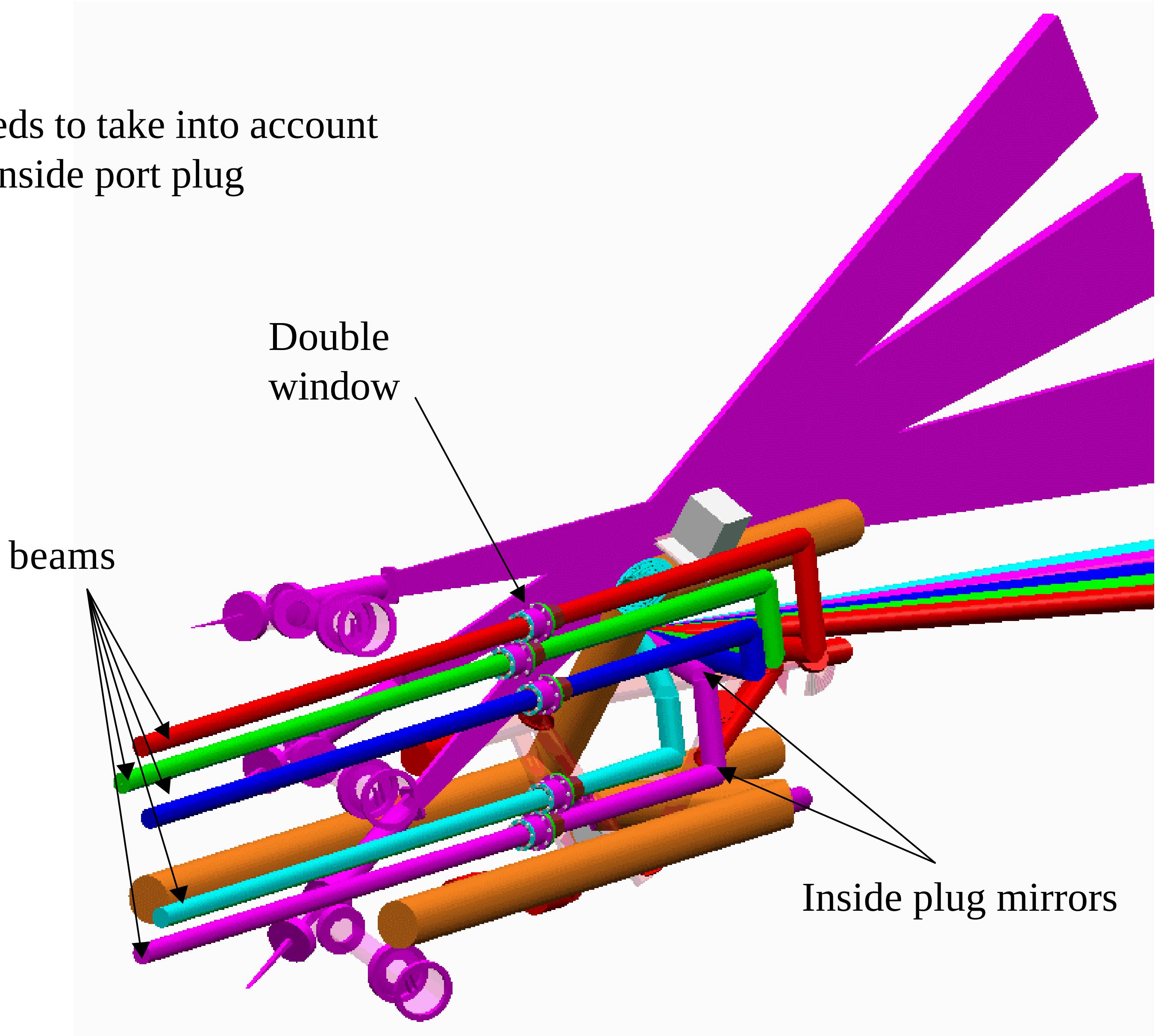
- First vacuum window clearance diameter has been reduced to accommodate standard secondary vacuum windows (ϕ=100 mm) (to be check if this is allowed for the diagnostic)

EPORT9 – The toroidal polarimeter/interferometer

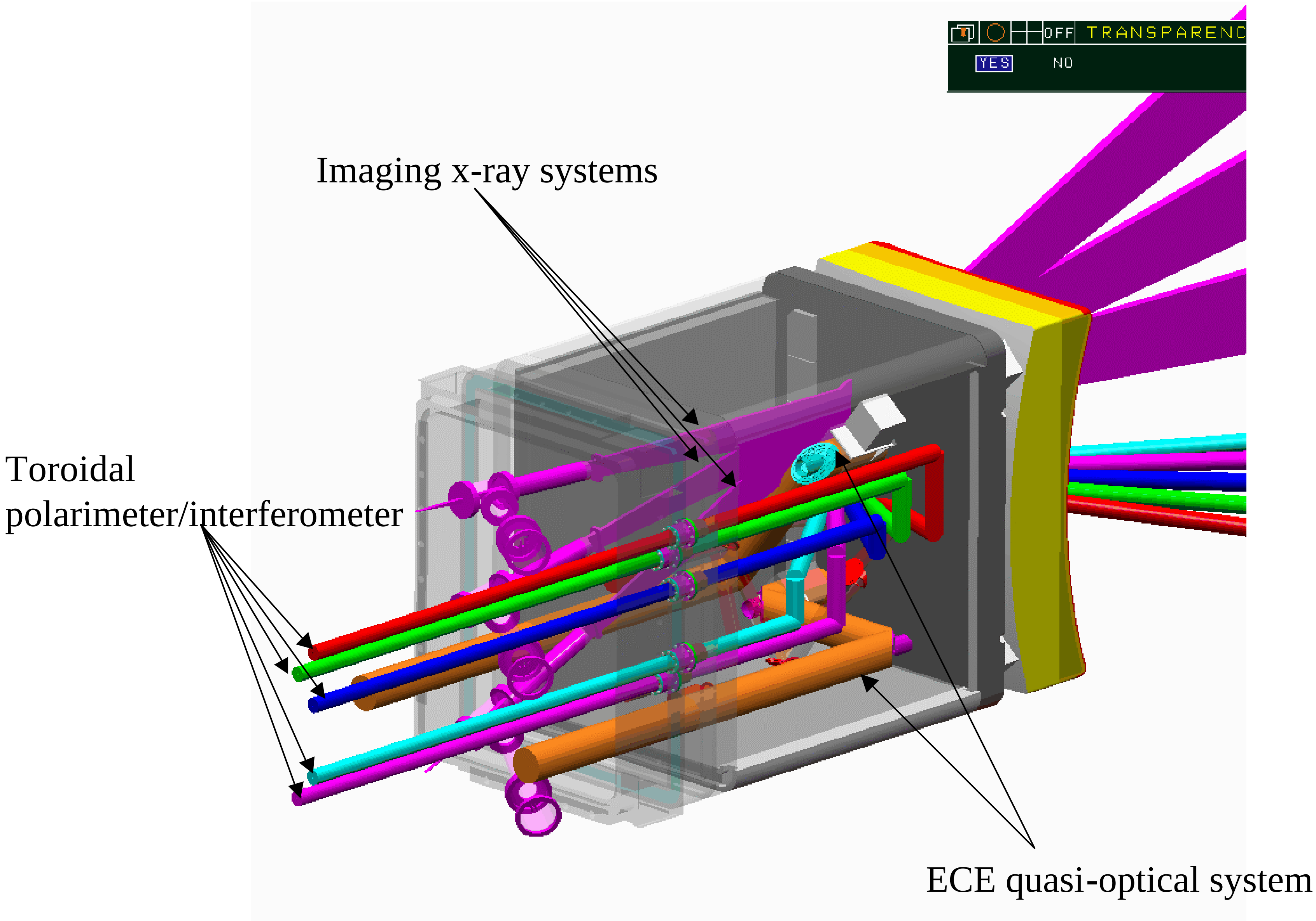


EPORT9 – The toroidal polarimeter/interferometer

• Optical design needs to take into account diagnostic routing inside port plug



EPORT9 – The toroidal polarimeter/interferometer

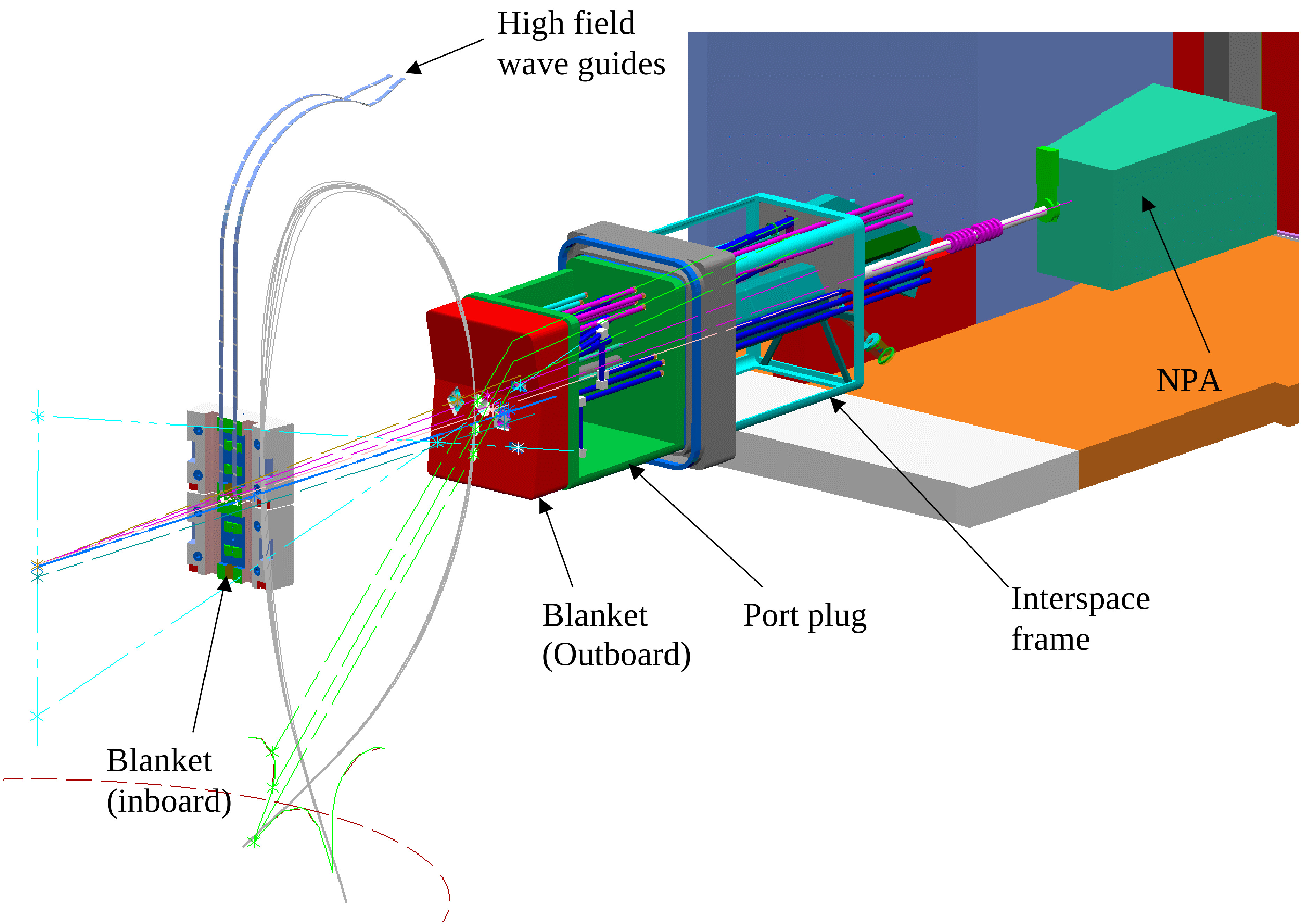


EPORT11

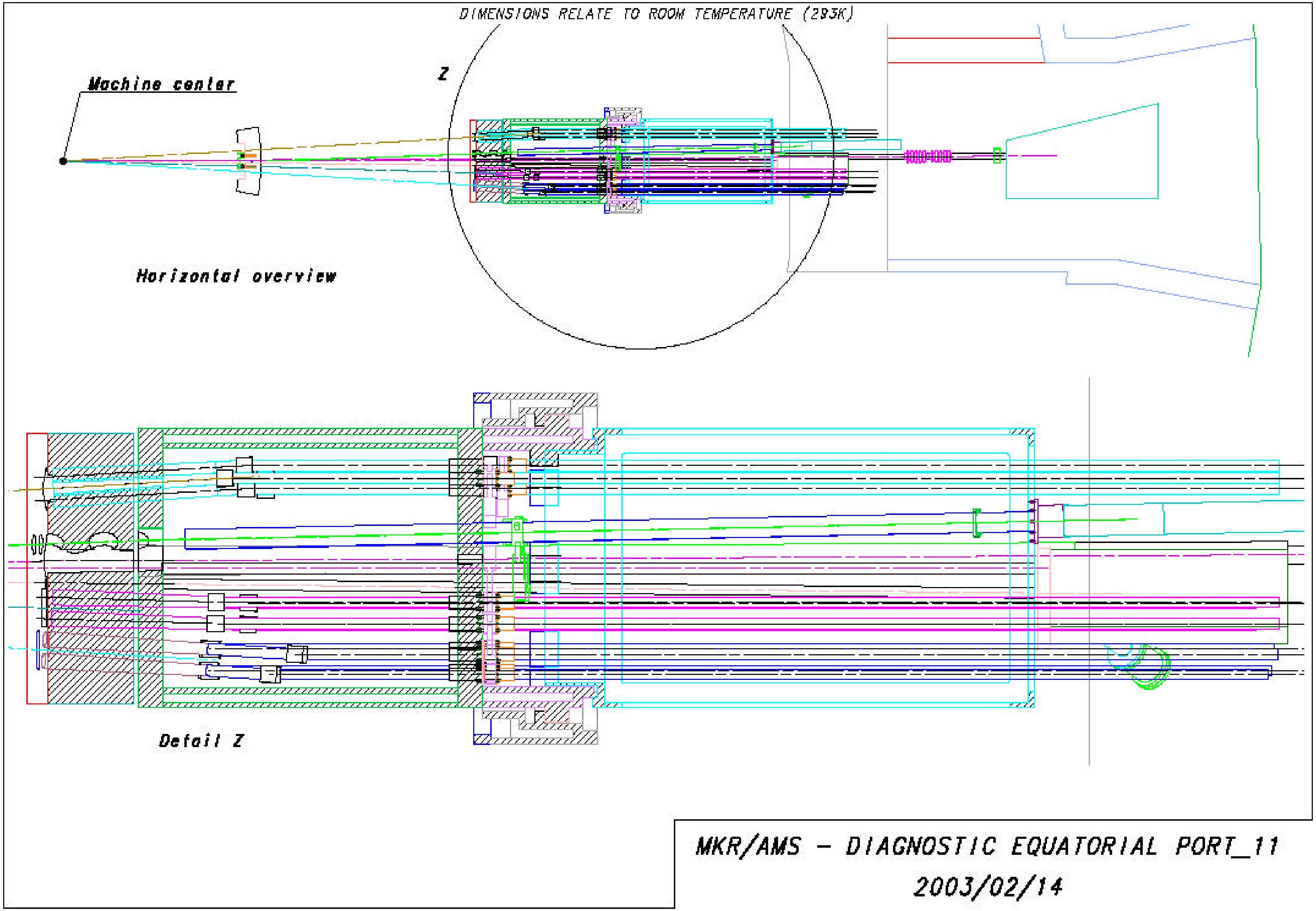
This port has been completly reviewed in order to accommodate:

- a Doppler reflectometer
- a refractometer
- repositioning and redesign of the reflectometer antennas
- new arrangement for the VUV divertor spectroscopy
- new vacuum boundary rules

EPORT11 - Layout



EPORT11 – The microwave systems



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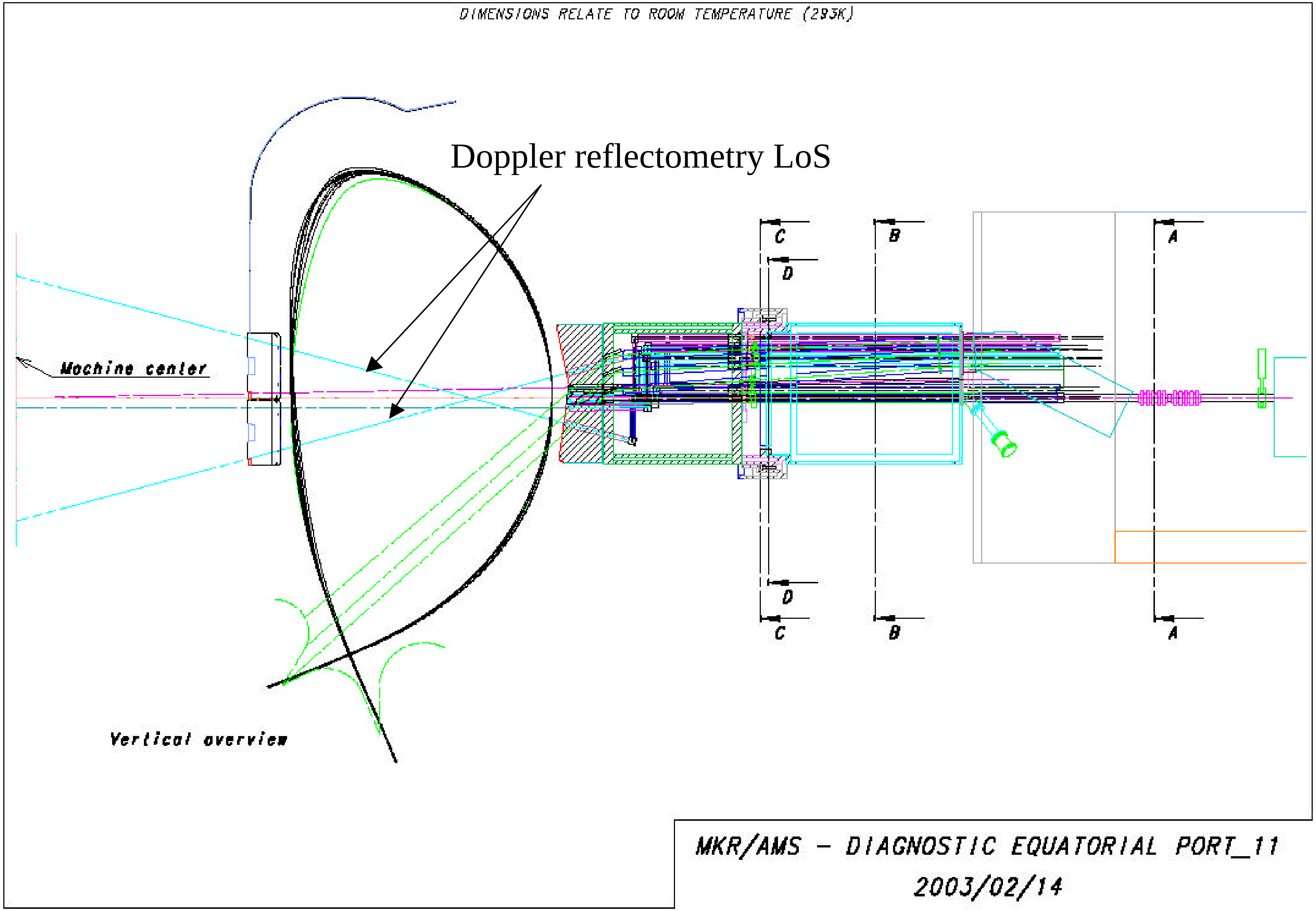
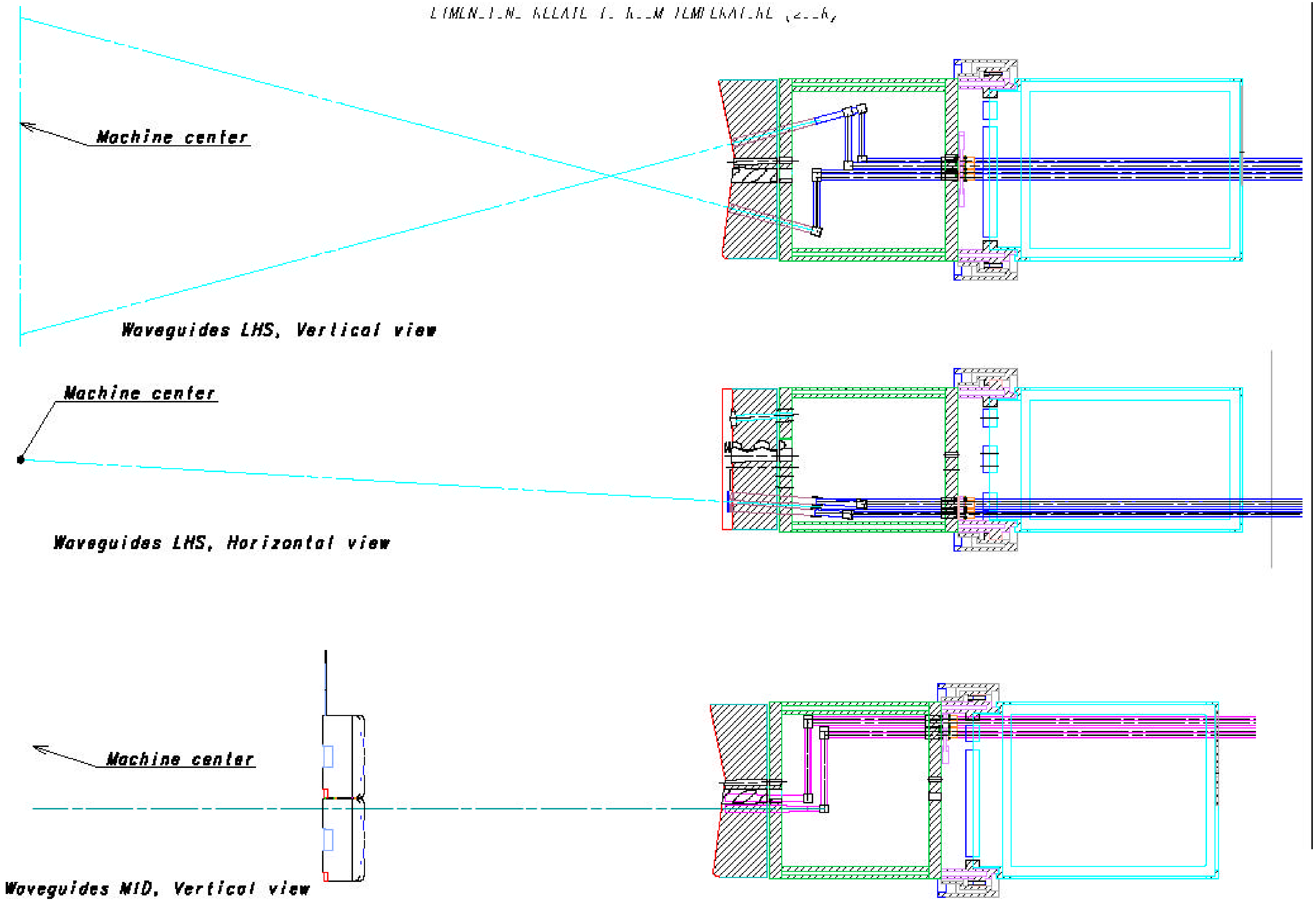
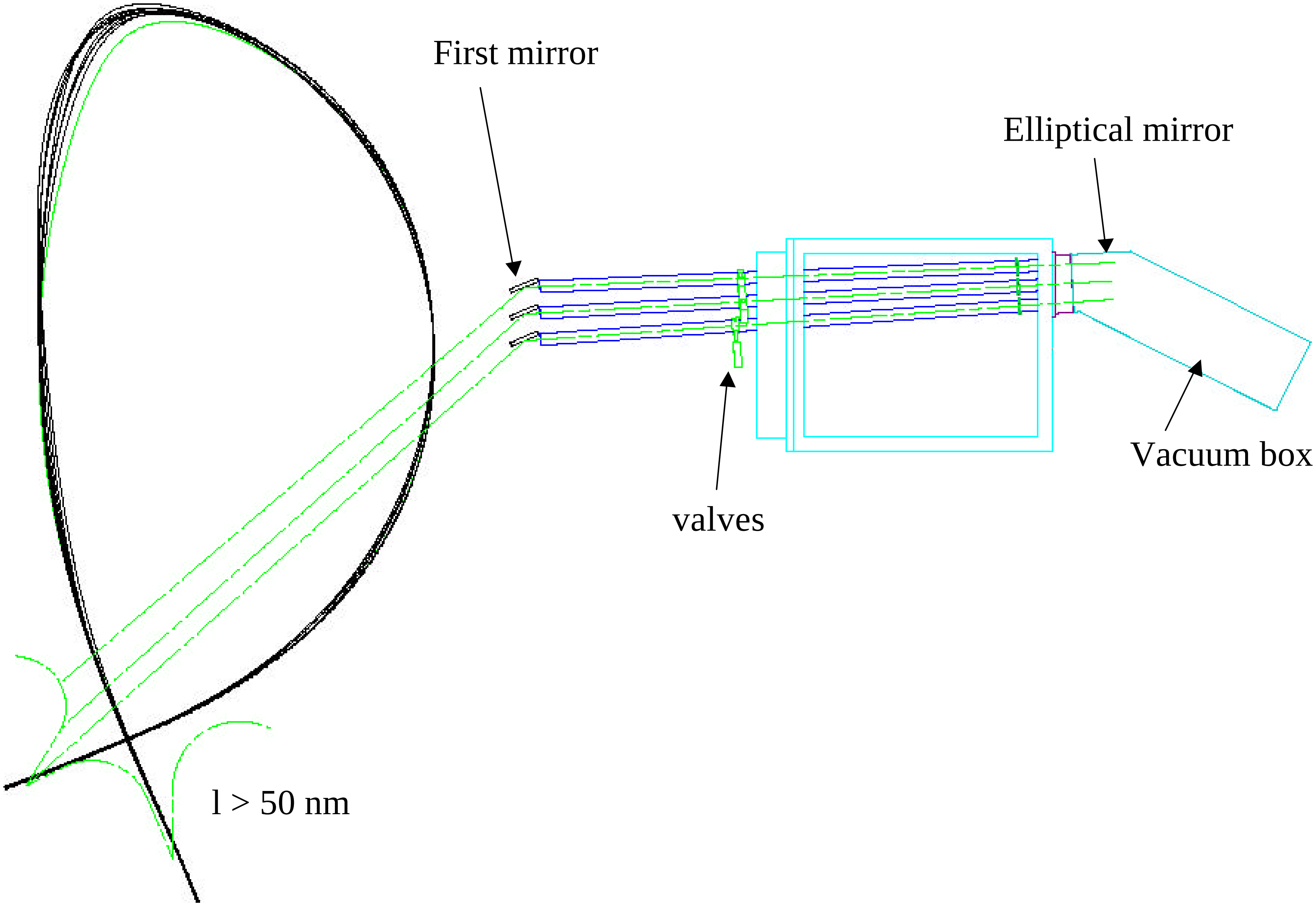


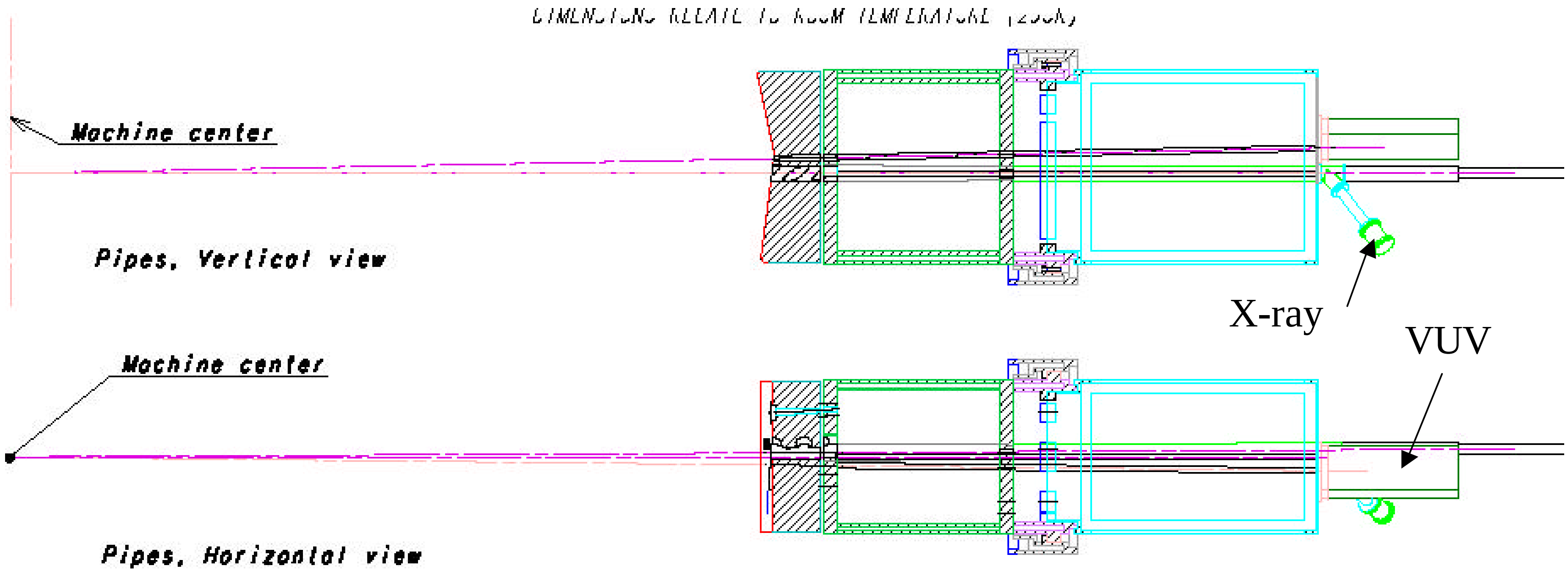
EPORT11 – The microwave systems



EPORT11 – Divertor VUV spectrometer (3 channels)



EPORT11 – X-ray Survey and VUV monitor



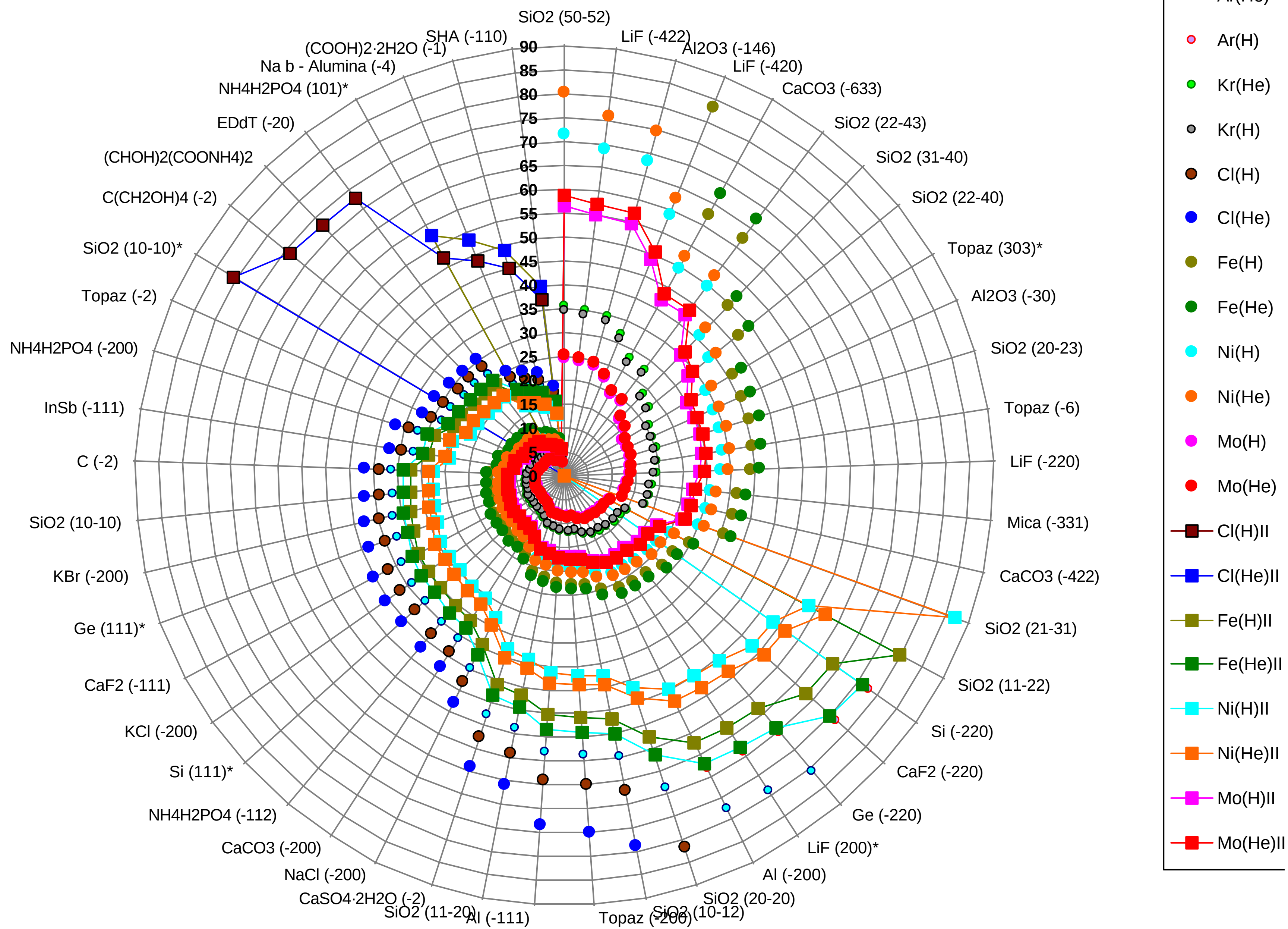
EPORT11 – X-ray Survey

• The actual X-ray survey is based on double crystal spectrometer and a rotary tourniquet for changing the diffracting crystal.

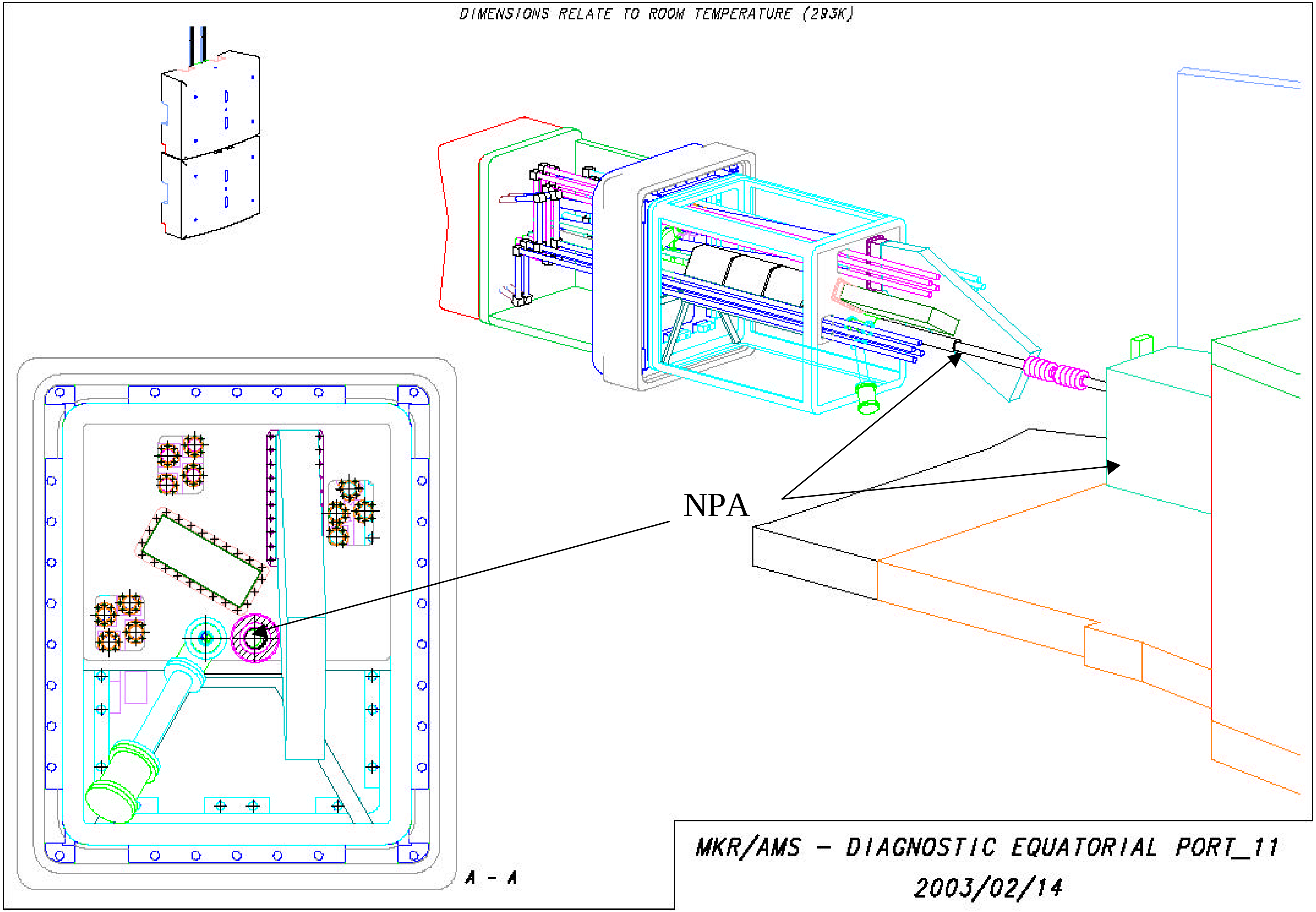
• A new system is proposed based on a Johan type instrument with single or two crystals to cover a large range of wavelengths

• A wavelength plot of impurity lines of interest against a range of available crystals allows to identify a range of crystal pairs that will be suitable to implement such a system. The angular coverage of the detector should cover about 25º spread from the crystals. This will determine the use of a movable crystal instead of a cheese like input shape due to the need of a wide aperture in the blanket

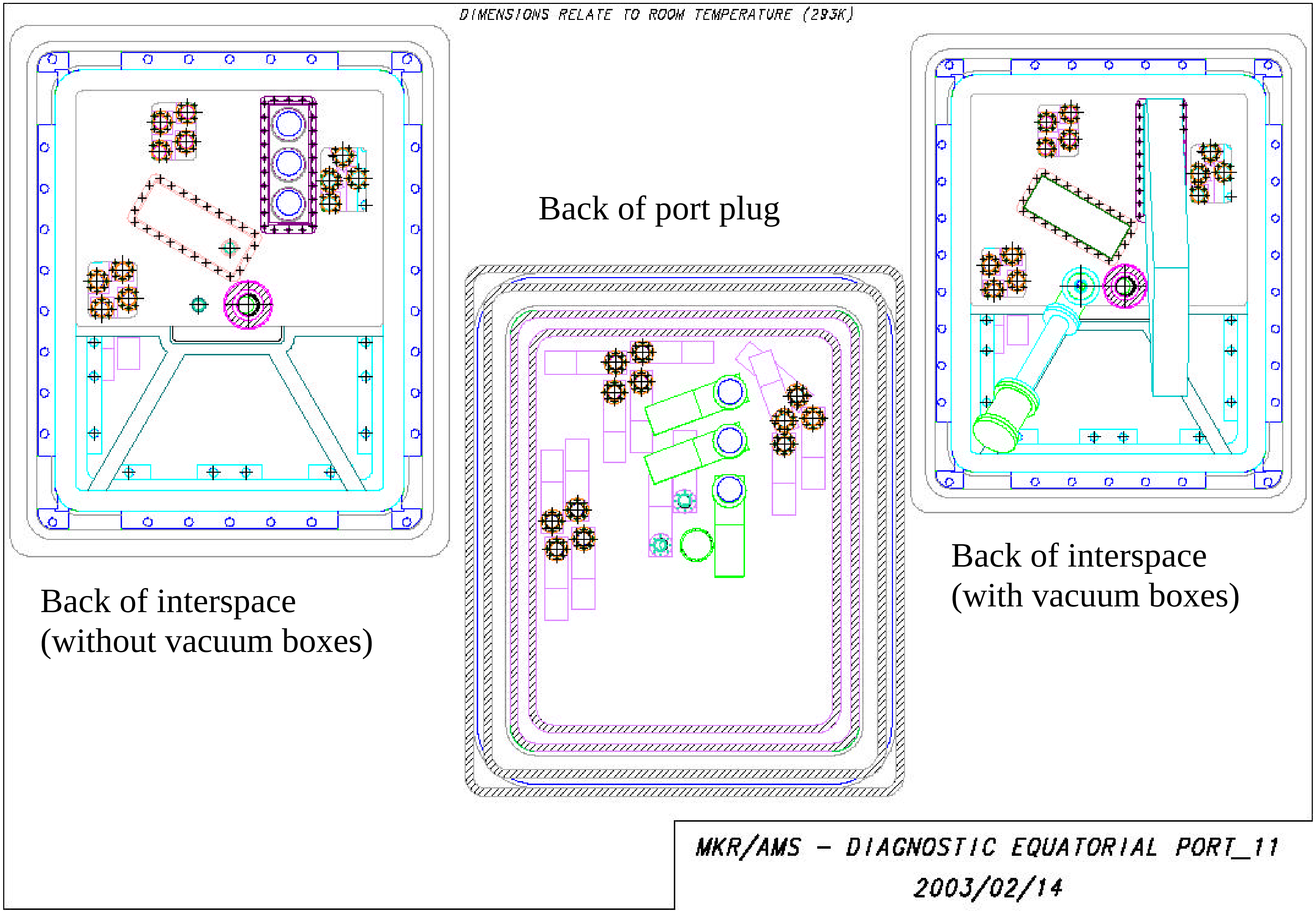
EPORT11 – X-ray Survey



EPORT11 – NPA (neutral particle analyser)



EPORT11 – Back Views



EPORT3 & UPORT3 – CXRS and MSE on Heating Beams

Design of optical systems:

Actual Criteria:

• Minimize blanket aperture

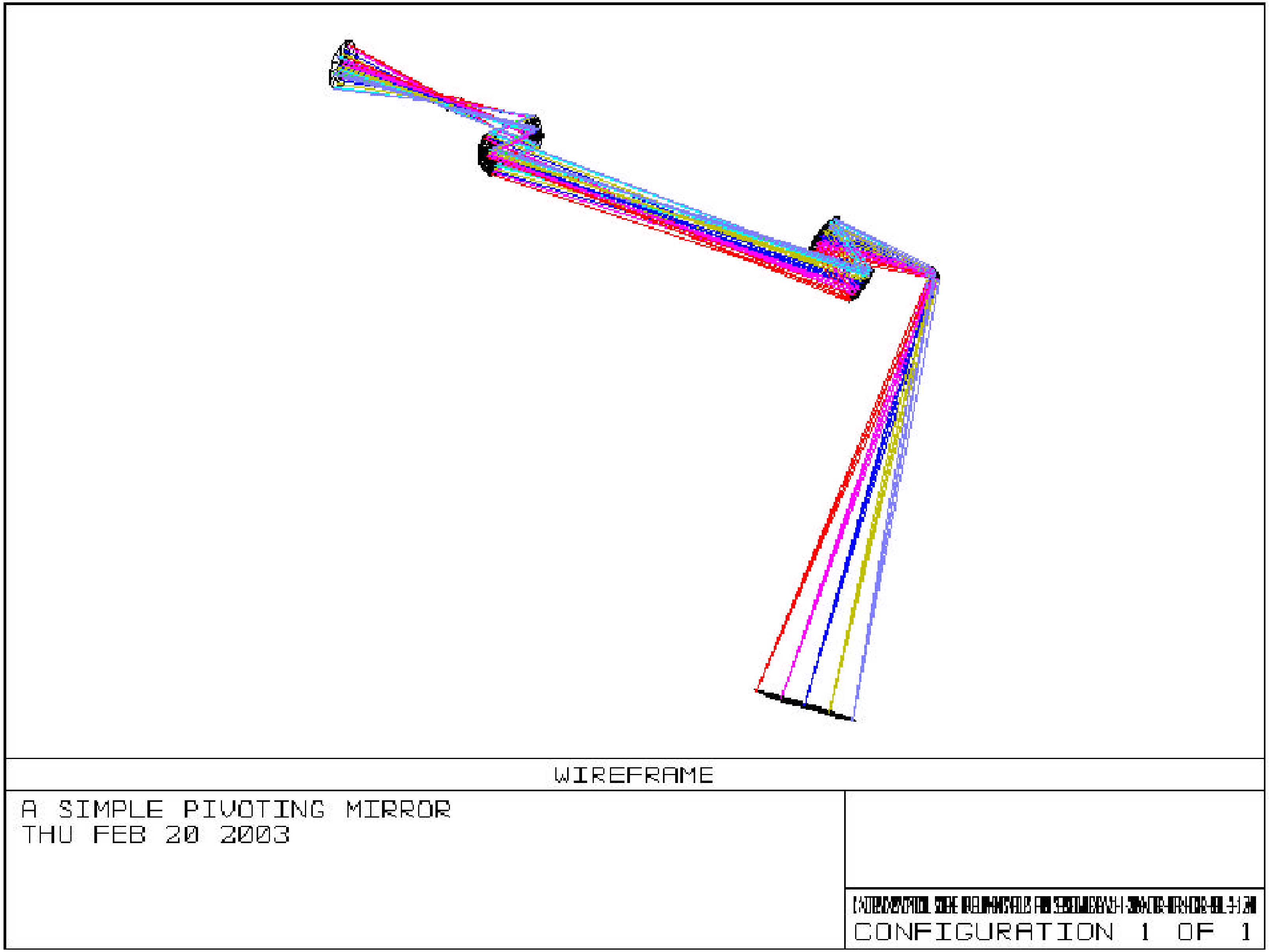
• Minimize mirror size

• F/# at image ~ 3

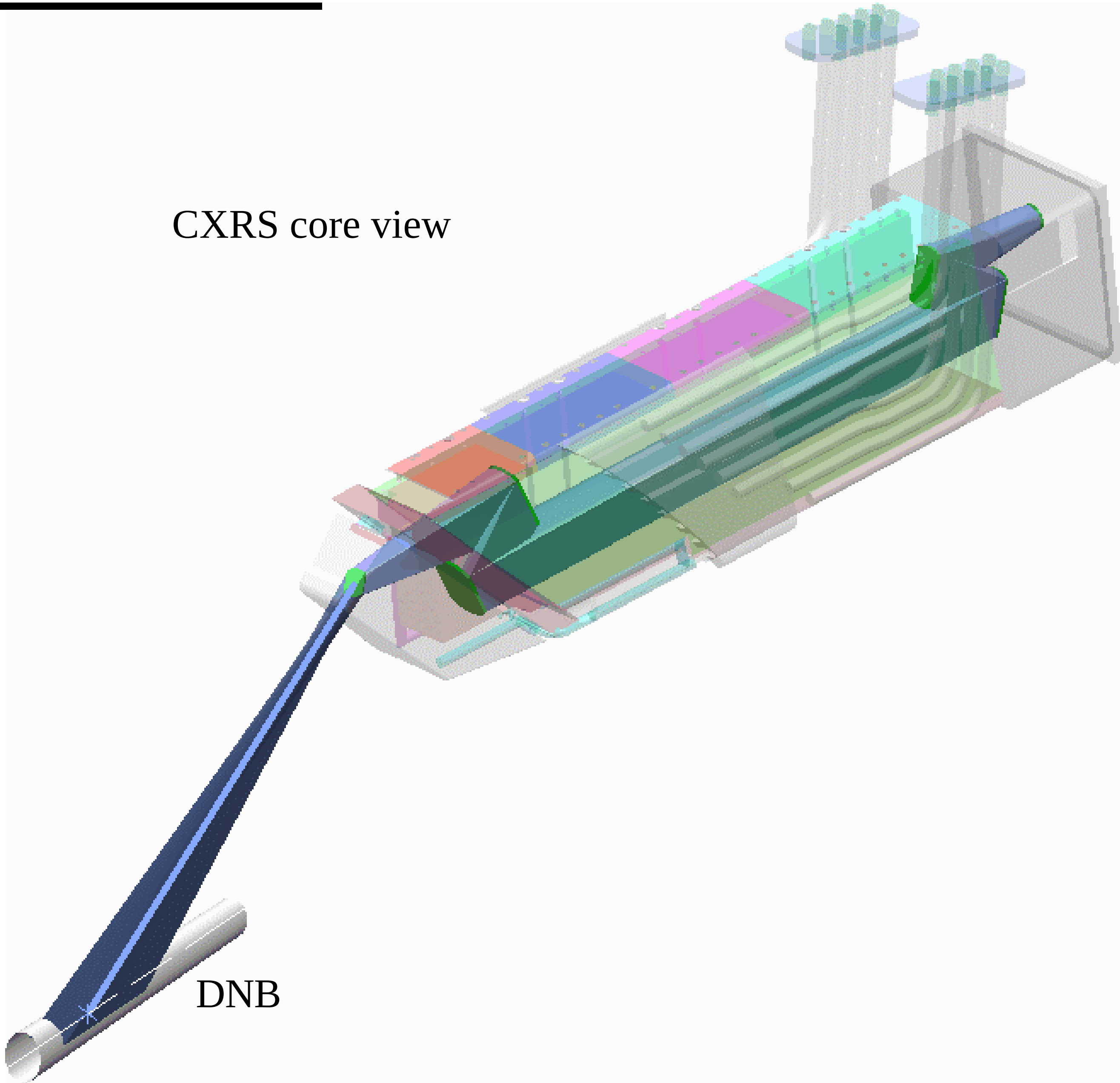
• Maximize reflectivity level and polarization stability (helps for measurement accuracy) against mirror number (helps for good image)

UPORT3 – CXRS

- Design of the Uport3 optical system for CXRS (in RFHT).

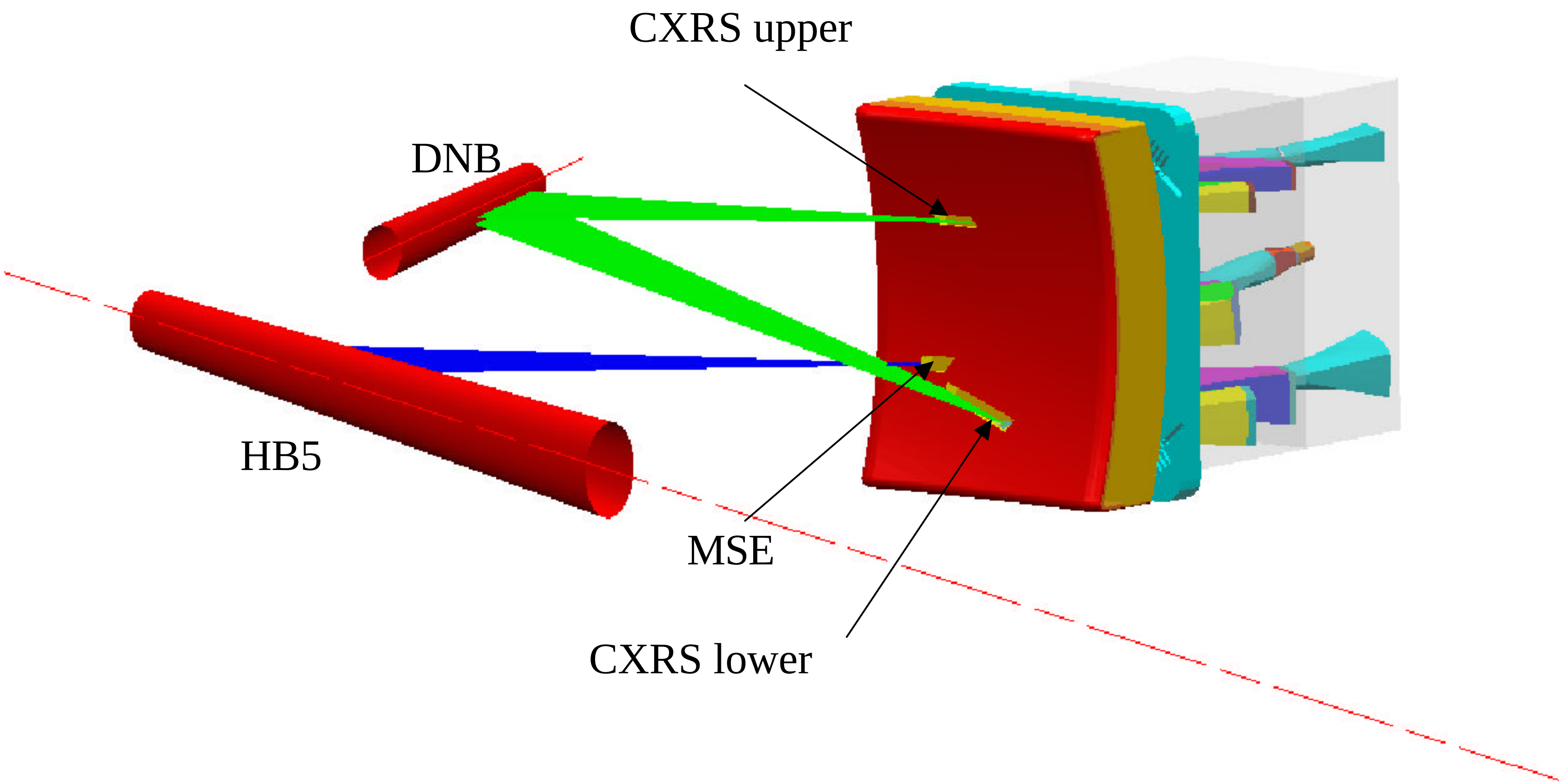


UPORT3 – CXRS



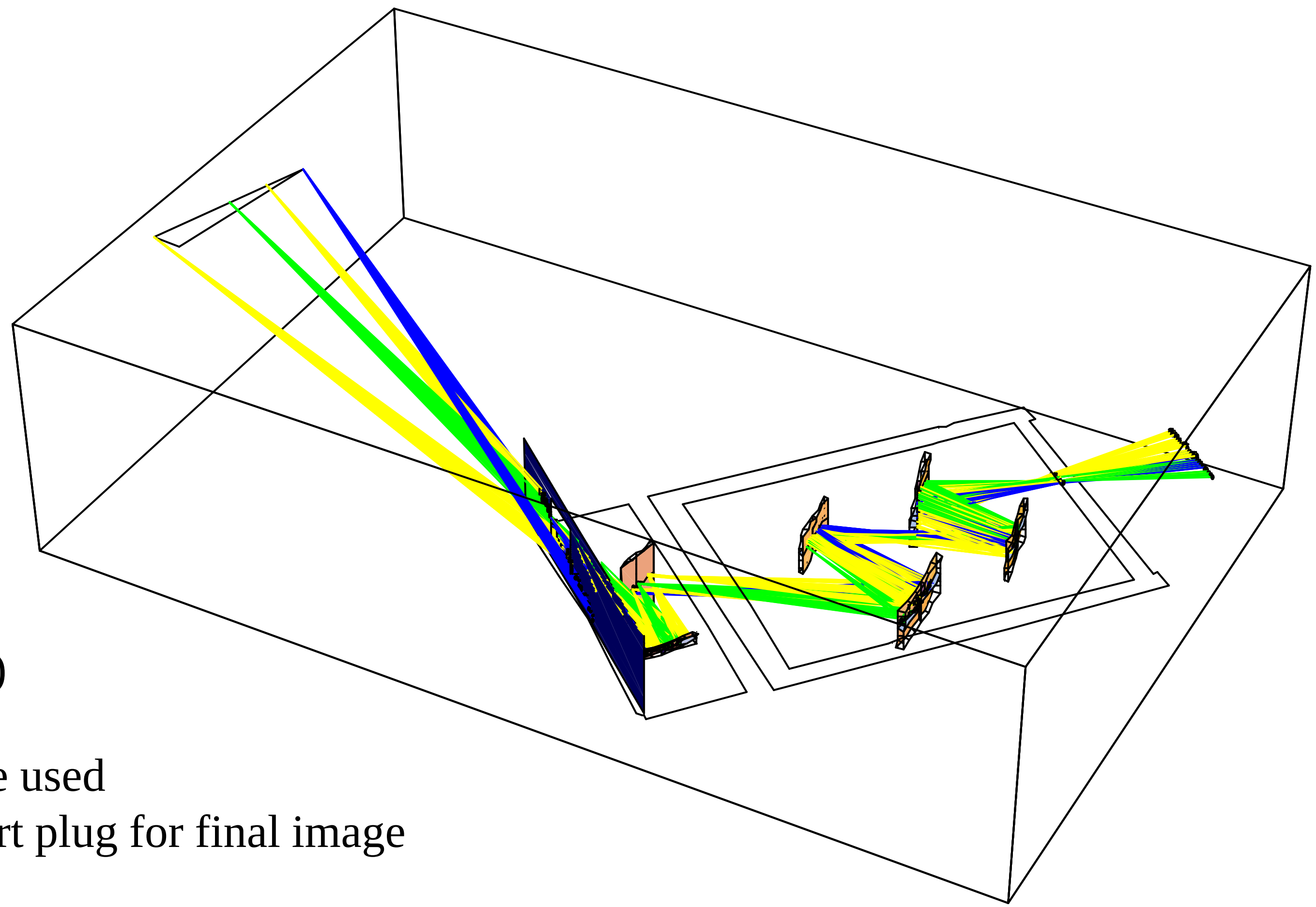
EPORT3 – CXRS and MSE on Heating Beams

MSE was moved up from previous position due two interference with CXRS_lower system. Needs assessment of influence on measuring capability for the new position



EPORT3 – CXRS Lower view

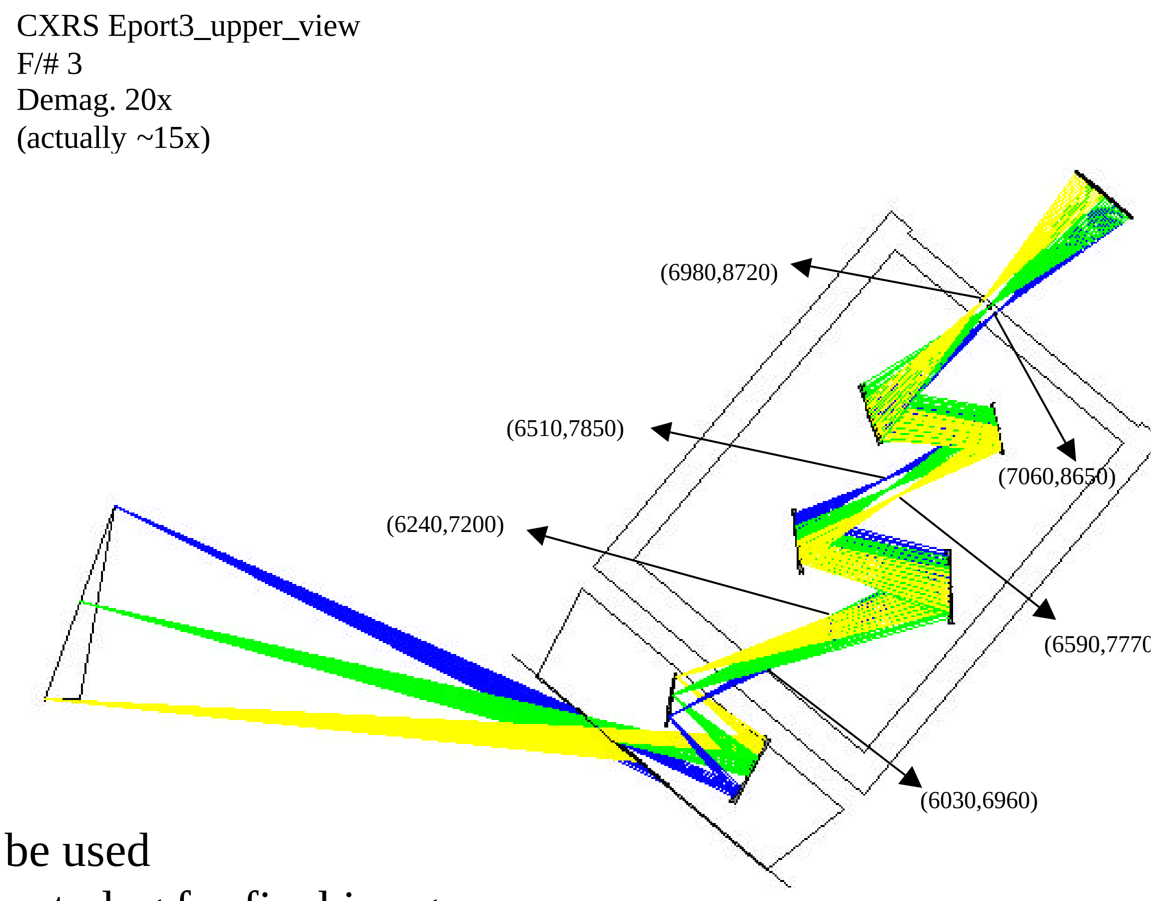
Design of optical systems for CXRS equatorial views – IT Garching



F/# 3
Demag. 20x
(actualy ~ 15x)

Lenses are to be used
at the end of port plug for final image

EPORT3 – CXRS Upper view



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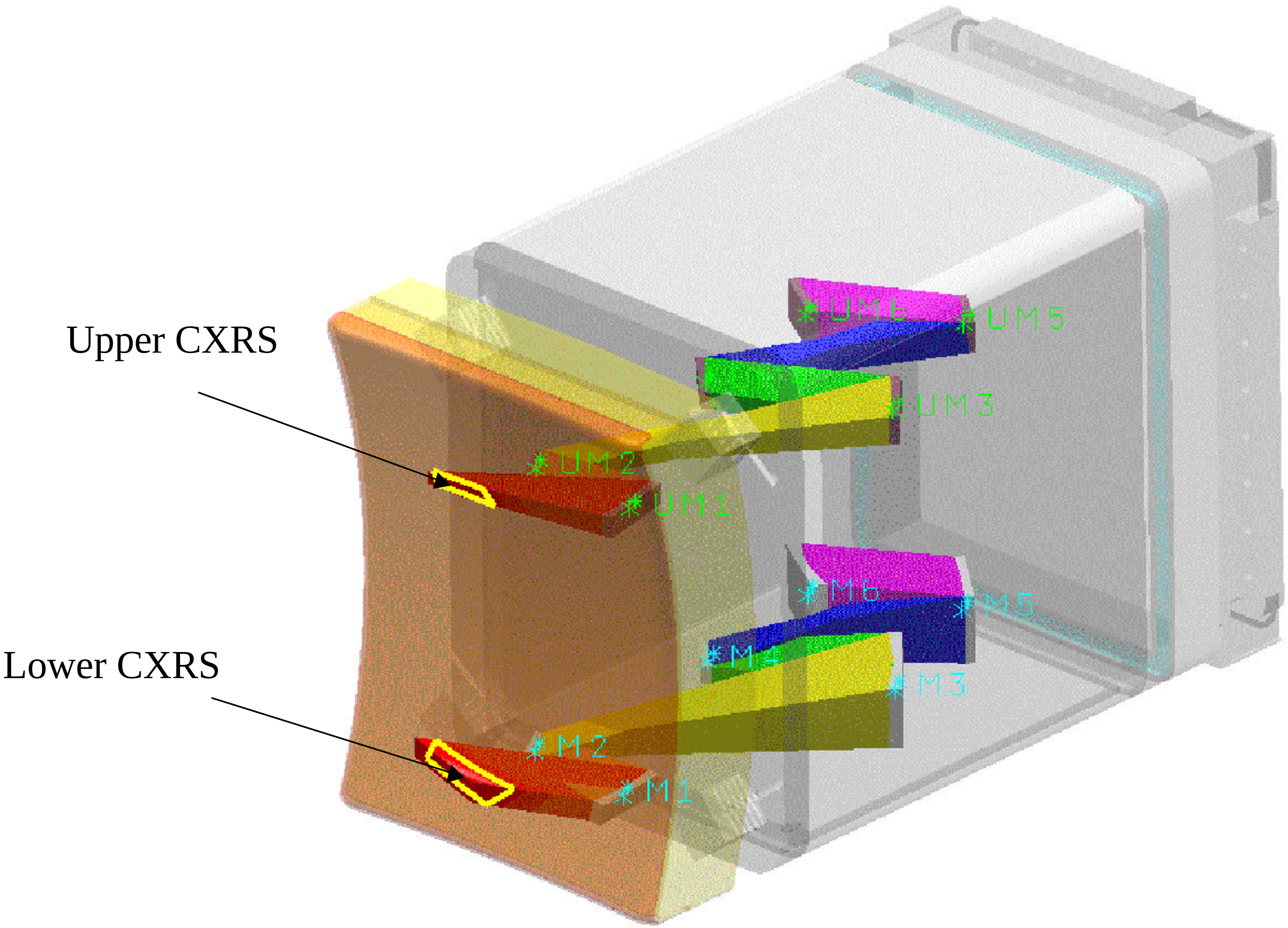
EPORT3 - CXRS



Cumulative mirror effect on reflectivity and phase shift blur of s and p components

Complementary criteria to design optical systems

Dielectric mirrors where's possible

Smaller mirrors

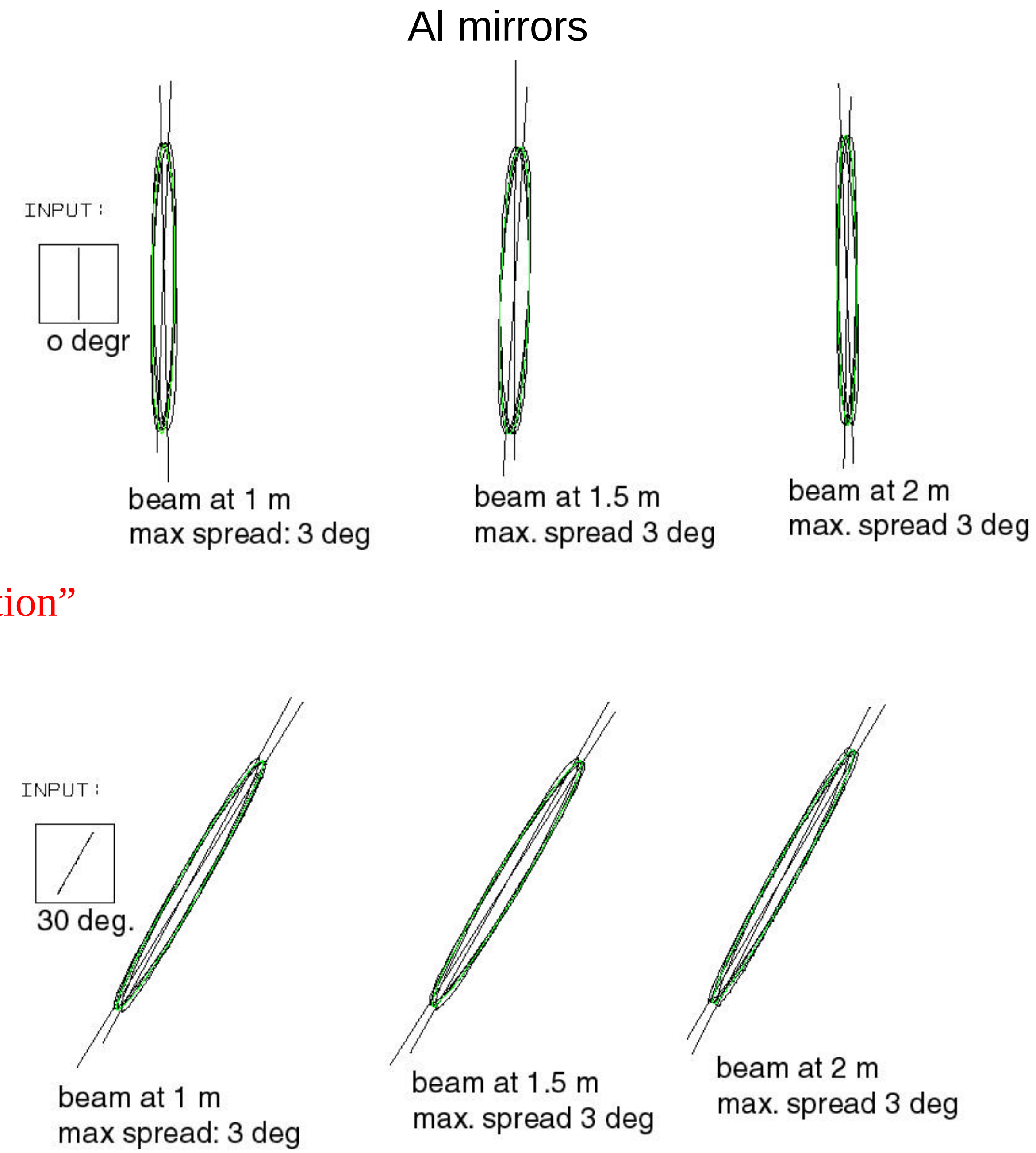
Reduced focal power (increase of mirror radius)

Implications – one has to work at higher F/# (9?)

Cumulative mirror effect on reflectivity and phase shift blur of s and p components

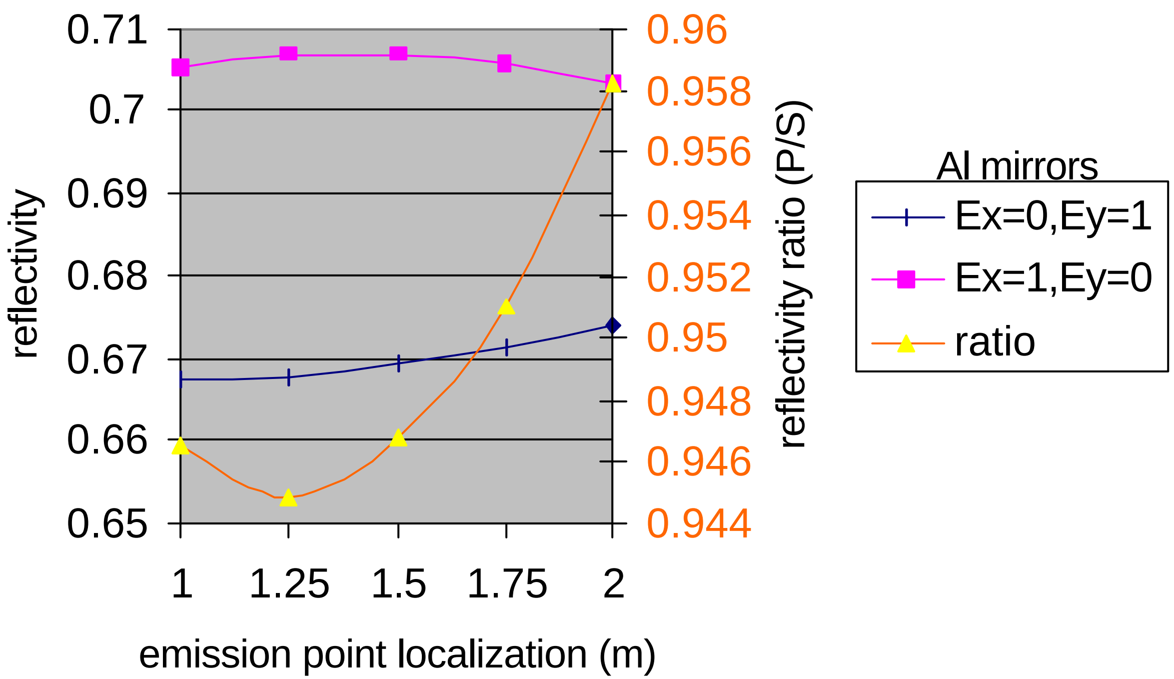
The data presented
is only based on maximum
polarization change across
exit pupil; no “polarization apodization”
is taking into account

Optical system
for CXRS at Uport3



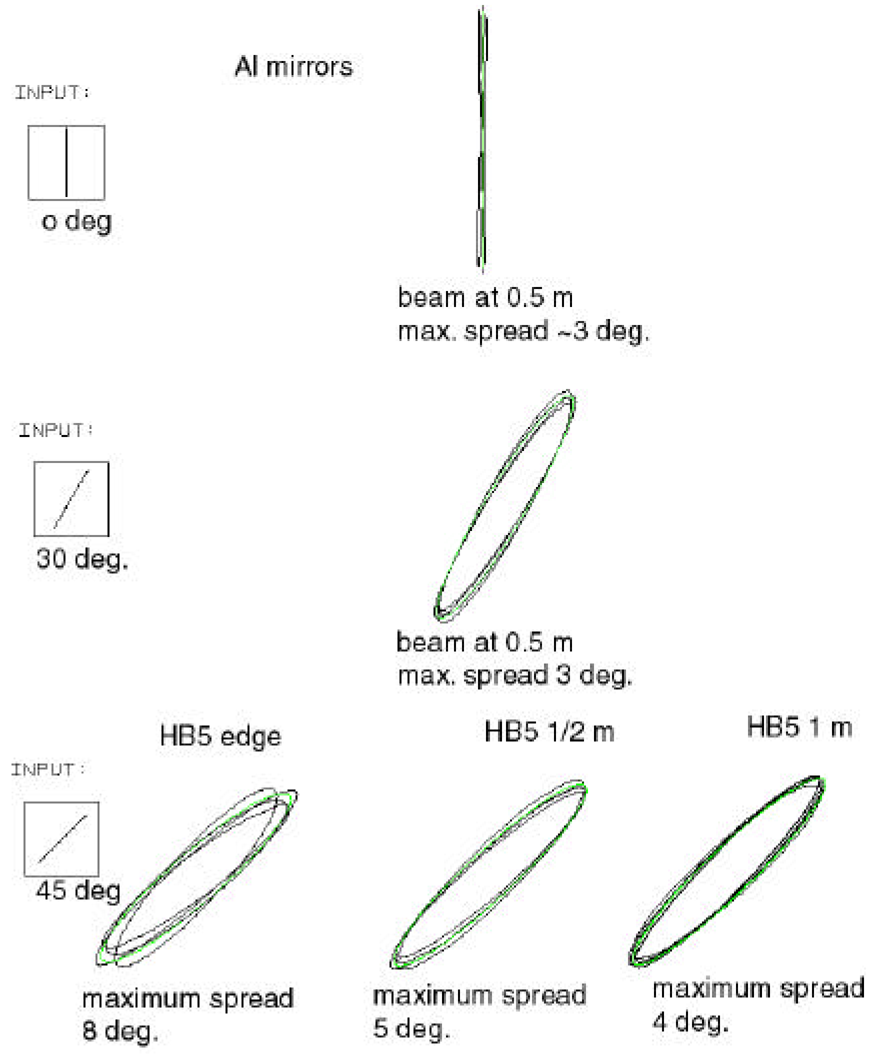
Cumulative mirror effect on reflectivity and phase shift blur of **s** and **p** components

Uport3_CXRS mirror system reflectivity

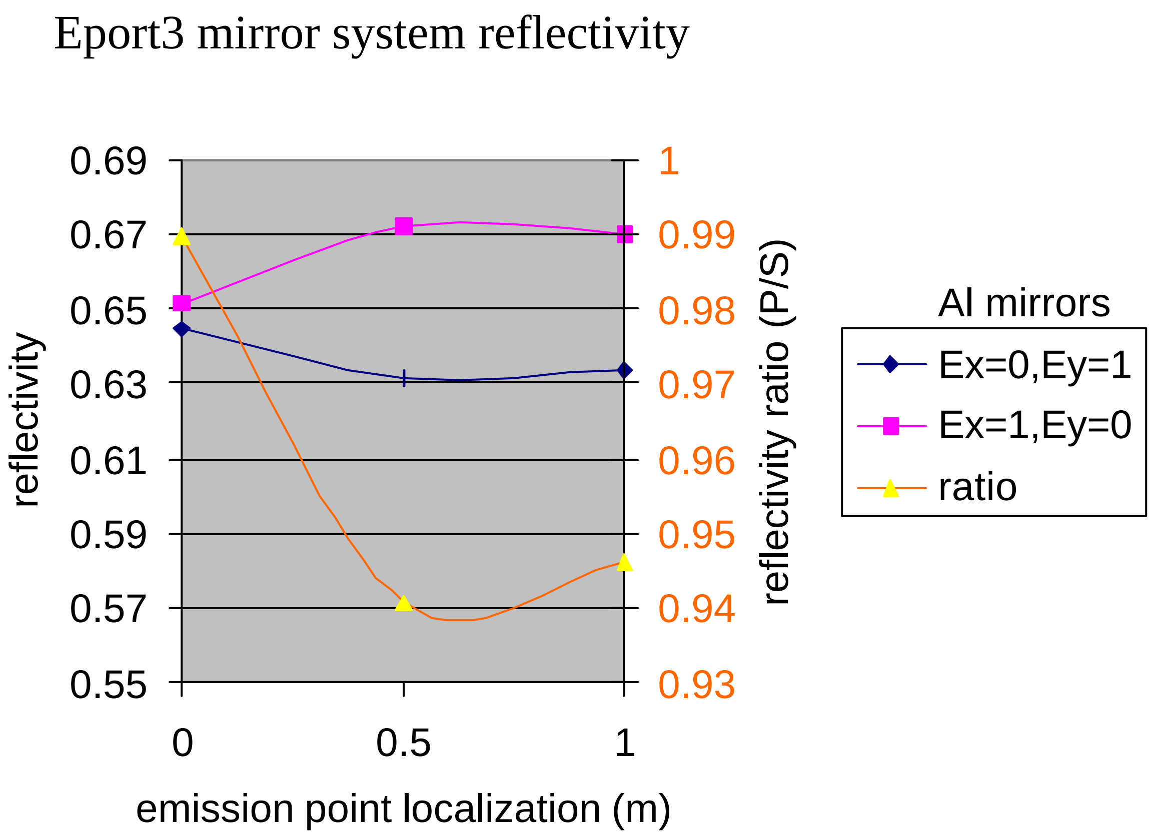


Cumulative mirror effect on reflectivity and phase shift blur of s and p components – Eport3 optical systems

For MSE measurements the blur effect will be reflected in the minimum achieveable spatial resolution. One needs to clarify the minimum tolerable polarization blur to accommodate the spatial resolution requirements and use that as a constrain for the optical system design (as possible).



Cumulative mirror effect on reflectivity and phase shift blur of s and p components – Eport3 optical systems



IMPROVEMENTS ON OPTICAL SYSTEMS

Increase mirror radius

Reduce mirror size

Reduce mirror number

Use dielectric mirrors as much as possible

Work at higher F/#'s (this realy needs to be squeezed)

Final statements

Integration as been carried on to accommodate changes on diagnostic systems and on vacuum boundaries (elimination of cryostat door)

Optical systems design has been developed for CXRS new locations.

Cumulative polarization change effect in optical systems as been addressed and as it stands we can forget about high resolution polarization measurements of the Stark field.

Improvements have been suggested to help minimise cumulative mirror effect.

Work will continue to address these issues more quantitatively.