Charge Exchange Recombination Spectroscopy (CXRS) on the Neutral Beam Injection (NBI)

(Ladungsaustauschspektroskopie am Neutralheizstrahl)

Design Review AEM21 Immserion Tube
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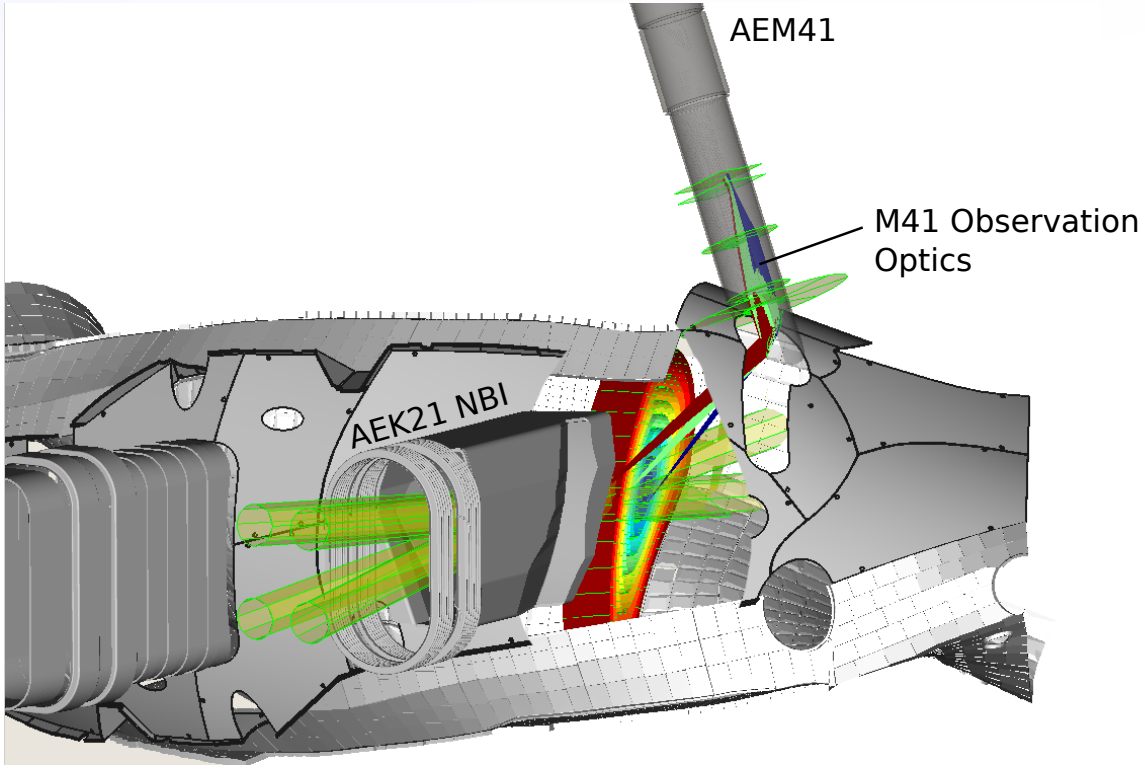
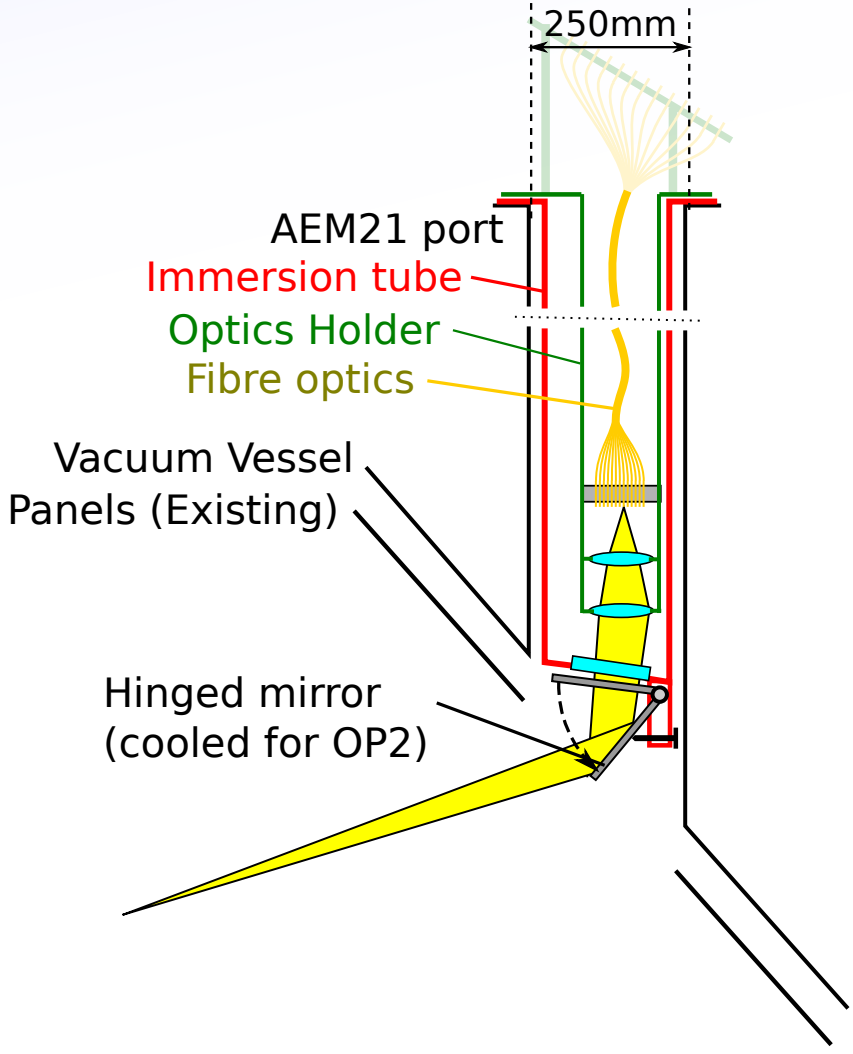
Concept

Concept for AEM21 observation system:
1) Mirror to view beam, also as shutter.
2) Immersion tube similar to AEM41 (CXRS on RuDIX)
3) Lenses and fibres in internal holder.

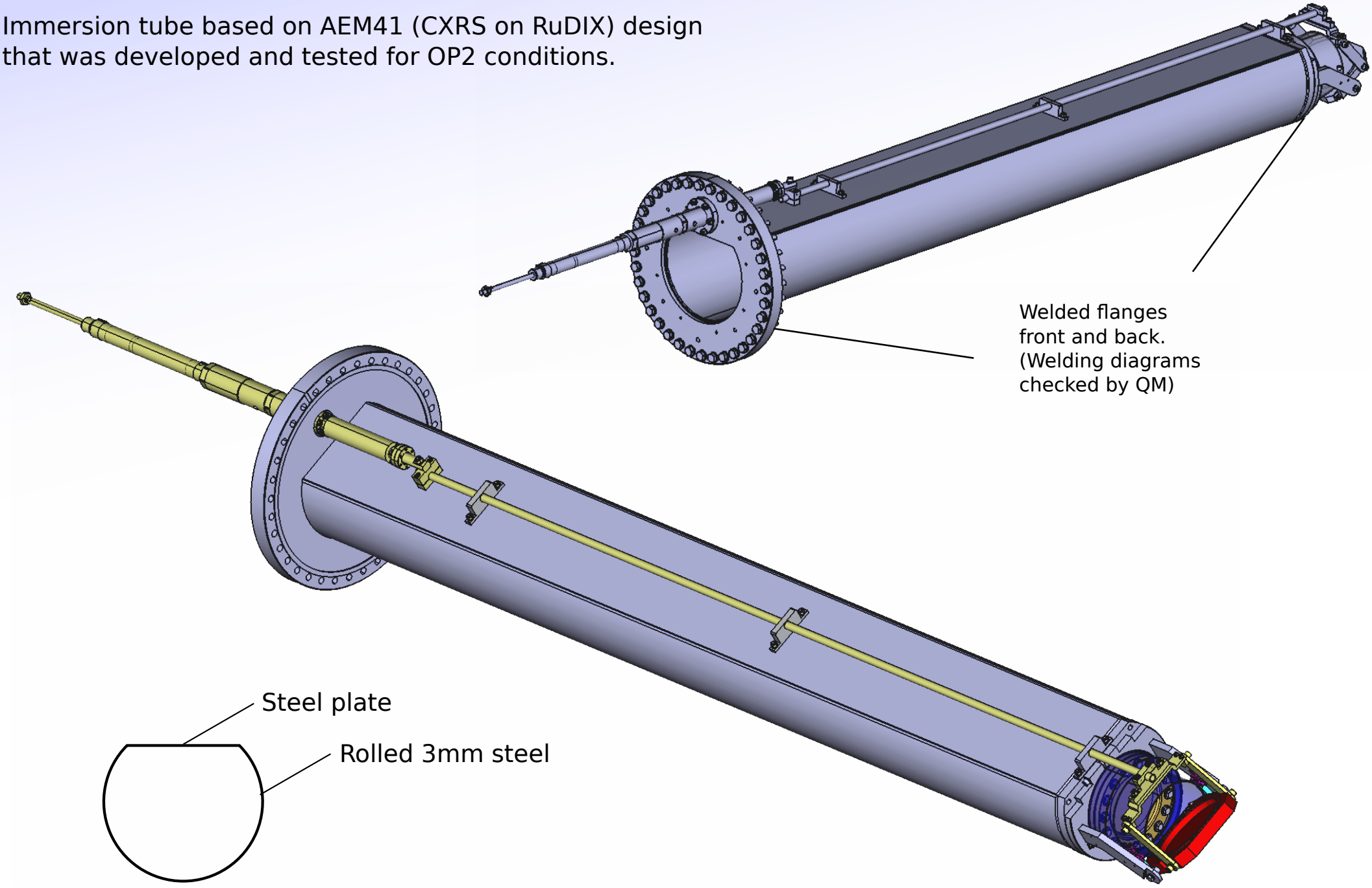
Design only for OP1.2!





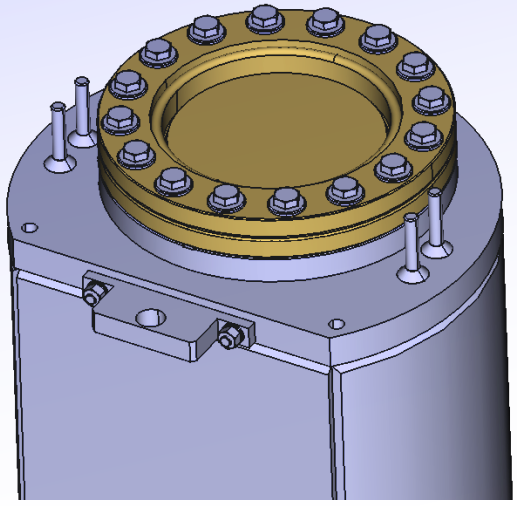
Immersion Tube

Immersion tube based on AEM41 (CXRS on RuDIX) design that was developed and tested for OP2 conditions.



Vacuum Window

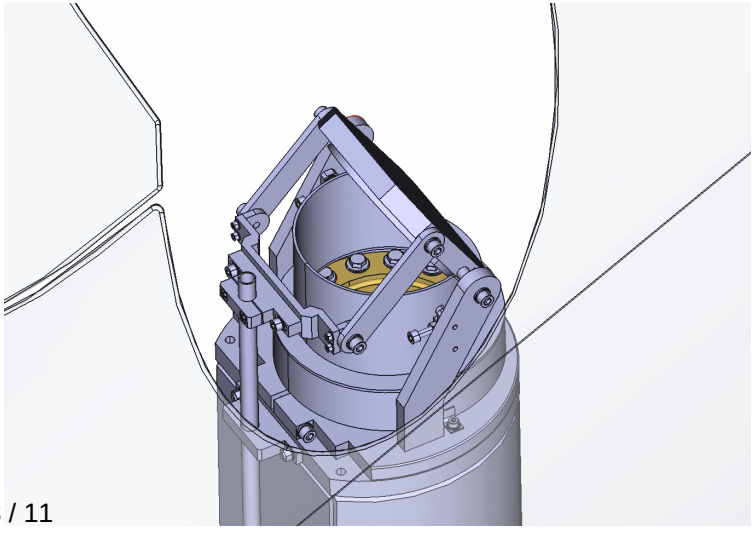
Vacuum window to be purchased and bolted to front flange:

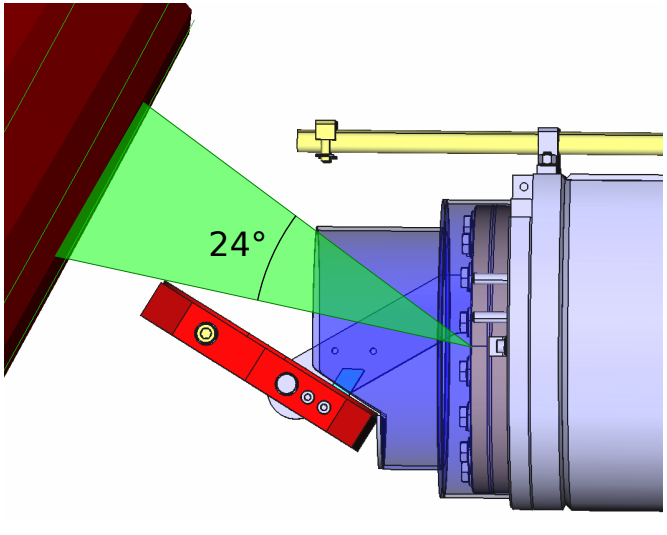


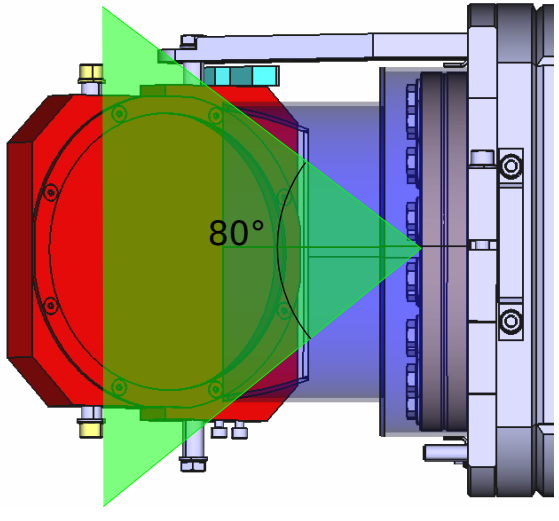
Pfeiffer Vacuum standard CF100 Fused Silica vacuum window UHV compatible. Max 200'C.

ITO coated to exclude ECRH stray radiation and to block UV (250-300nm) which damages the fibres.

Mirror/Shutter limits exposure of window to plasma < 5% of full hemisphere:

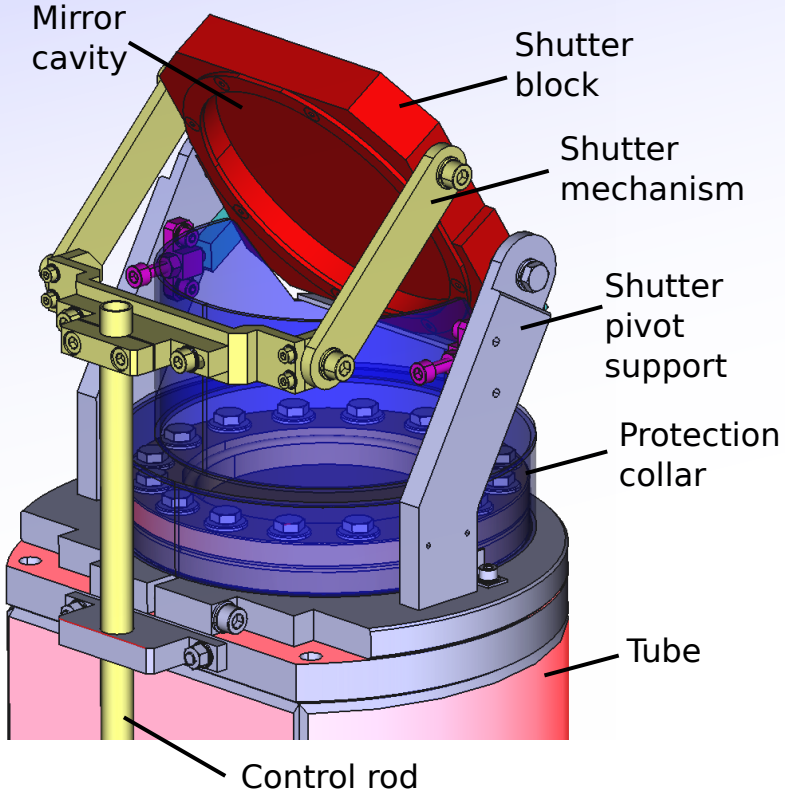


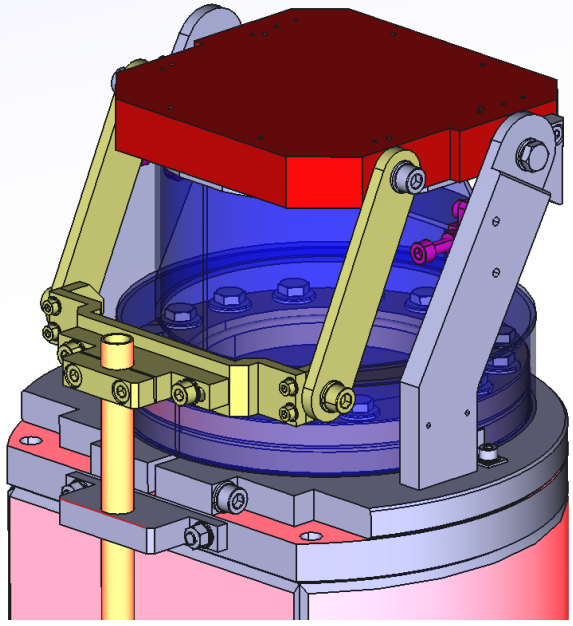


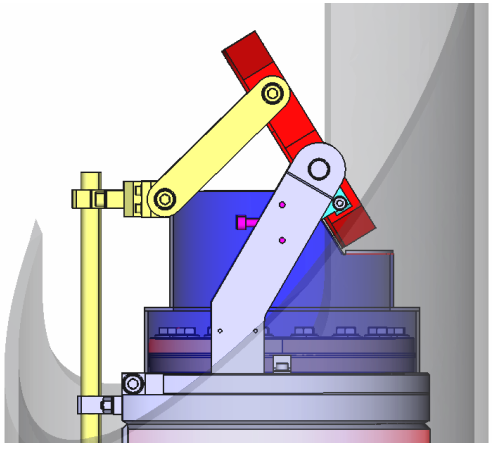


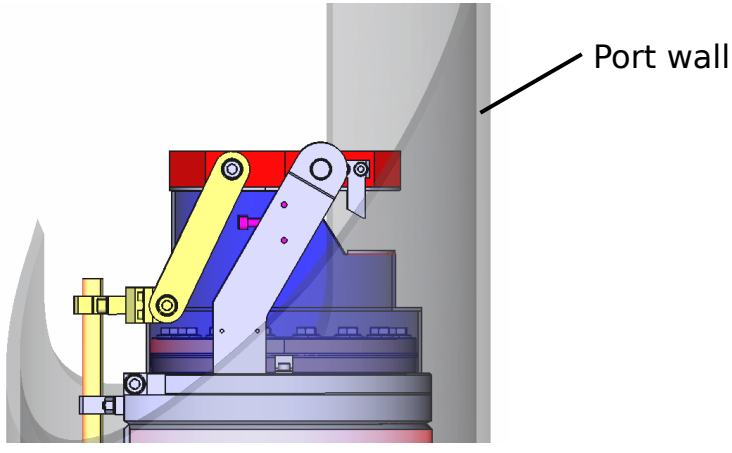
Shutter

Mirror is mounted to a steel block used as the shutter.



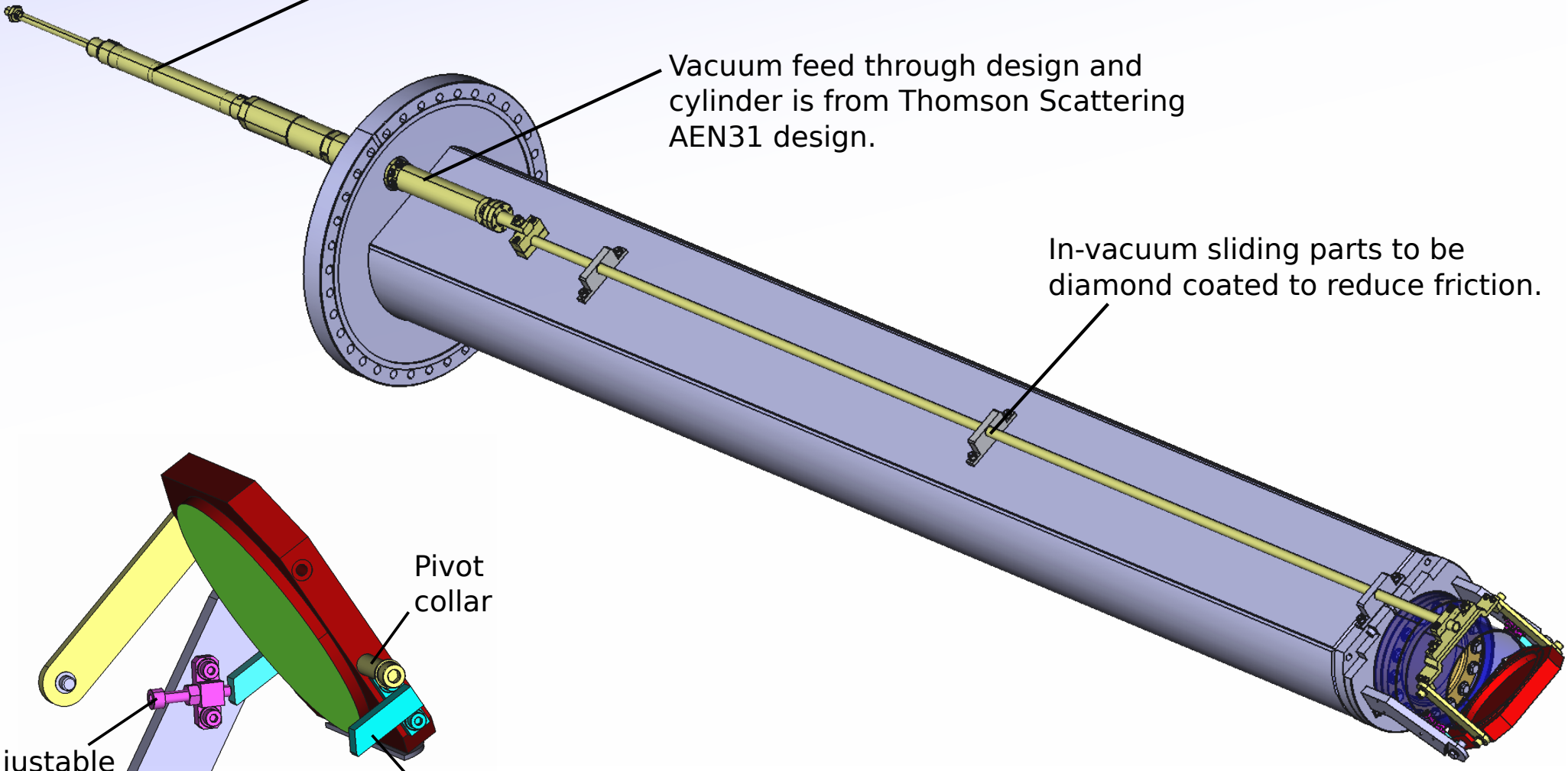






Shutter Drive

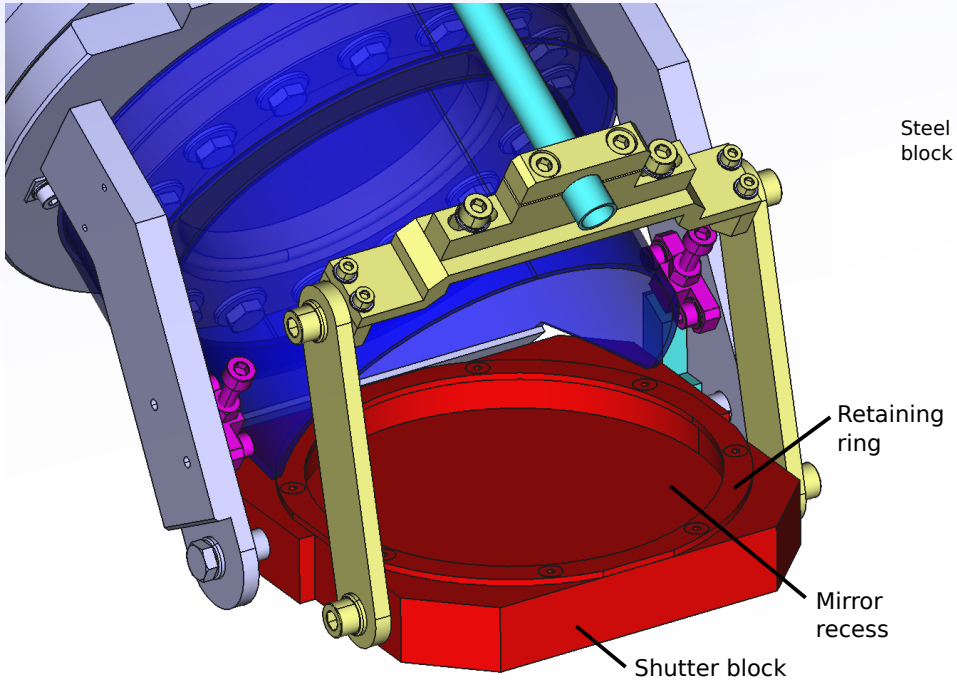
Shutter is driven from a pneumatic cylinder outside the vacuum.

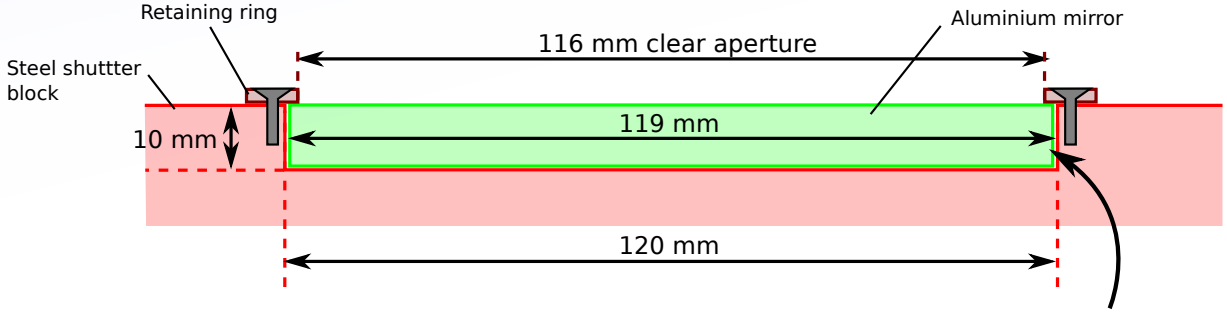


Shutter driven against adjustable stop.
Adjustable only from inside (OP1.2b+)
Set initially in lab.
(Further adjustment at fibre head)

Mirror

Material selection:
- Aluminium or silver for required reflectivity < 400nm.
- No dielectric coating - causes arcing and damage to layer.
--> Aluminium, polished to optical quality.





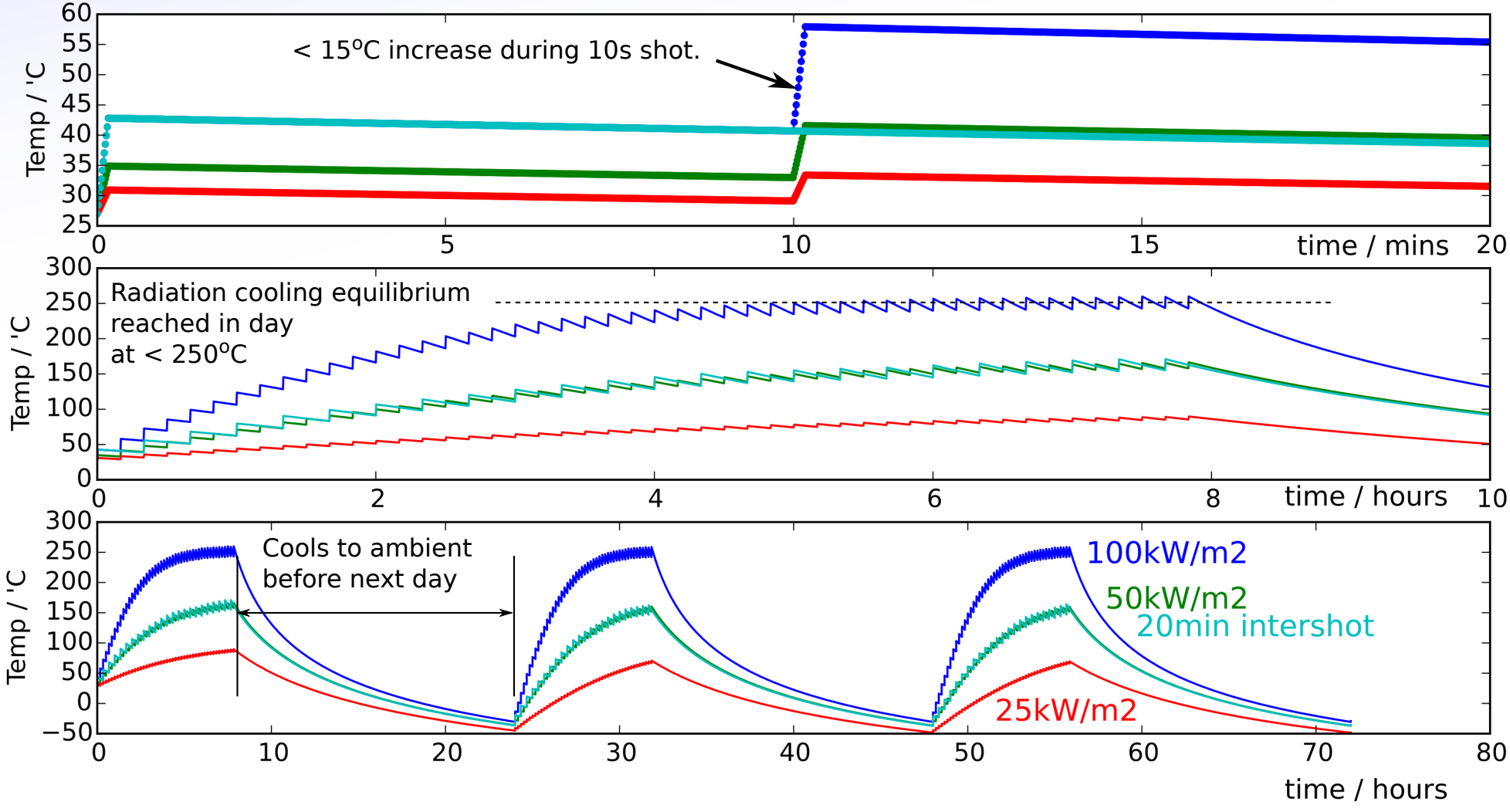
Space for thermal expansion up to > 300'C and thick mirror to avoid bending when hot.

Solid Aluminium:
- Requires material exception for plasma exposed use.
- Non-magnetic, vacuum compatible, no significant issue with radiation.
- Used as ASDEX Upgrade for CXRS, no significant problems (built themselves and polished externally).
- Expect slow loss of reflectivity due to coatings from plasma.

High temperature tolerant (up to 300'C), polishing friendly aluminium alloys (RSA-205) available.
Status: Searching for supplier.

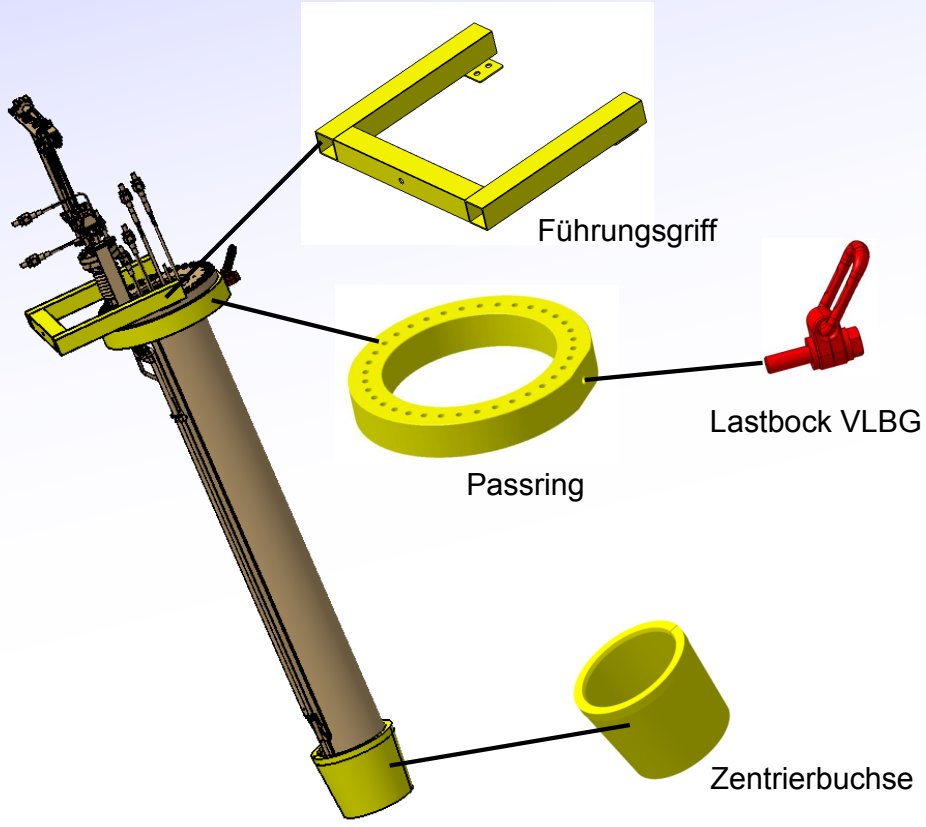
Mirror/Shutter thermal consideration.

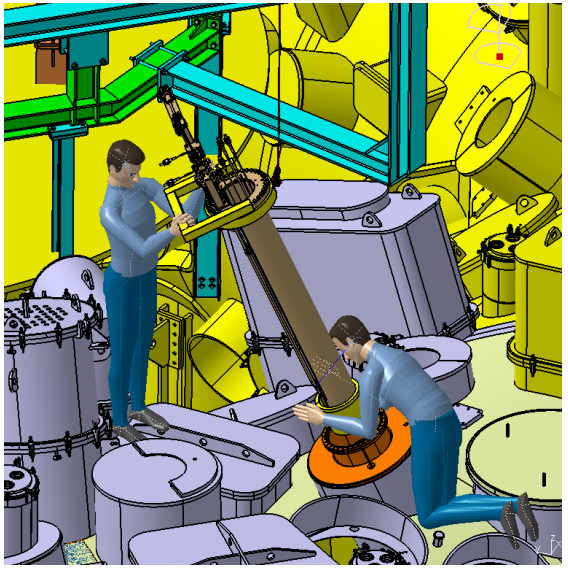
Calculated heating of mirror and shutter for 100kW m^{-2}, 10s shots, 10 minute pause.
- Mirror surface max 30'C above bulk.
- Bulk temperature equilibriates at max 250'C (worst case scenario)
- Cools before start of next day.

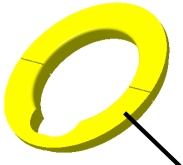


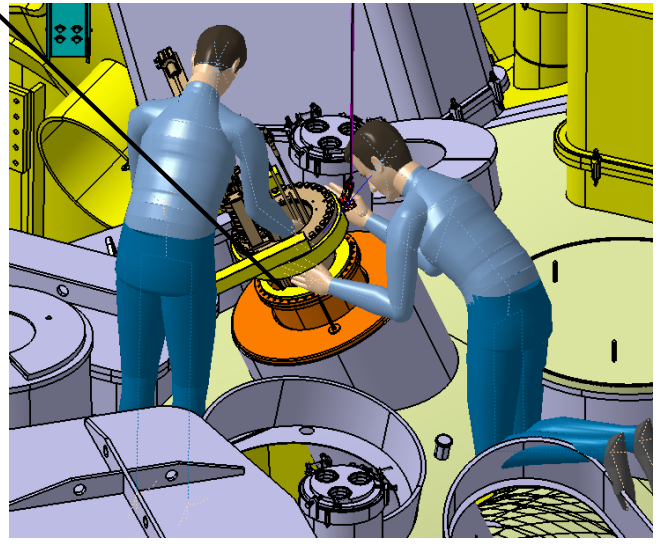
Assembly concept

Assembly concept almost identical to AEM41:









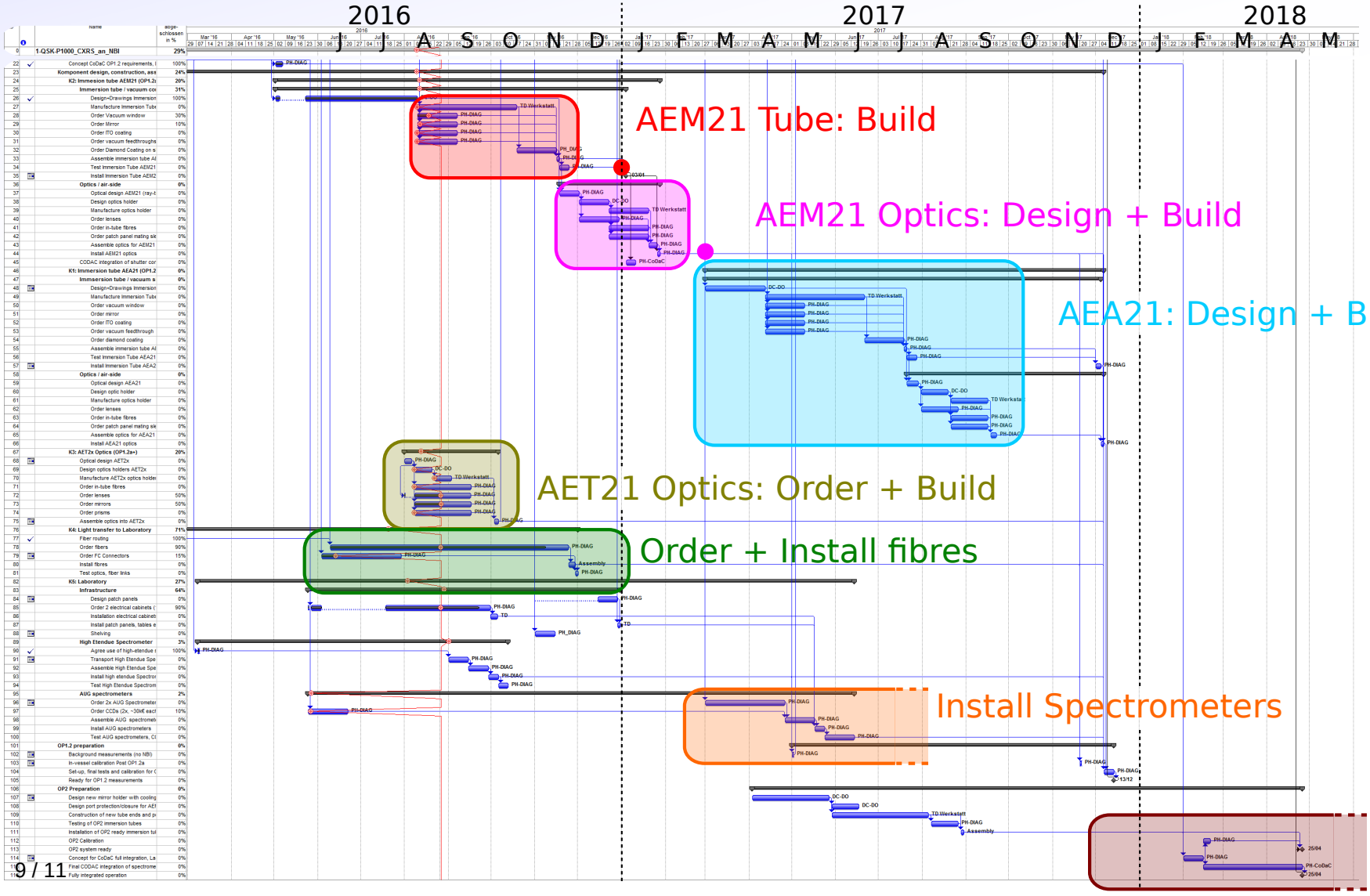
- Insertion grip must be adapted to AEM21 flange.
- Centralisation ring must be adapted to fit shutter.

- Port plane and axis measurements done.
  Error will be corrected with Passring, but is small enough to be corrected with external optics adjustment.

- Rotation (Bolt positions) also needed.

Time plan

Jan 2017:	AEM21 immersion tube ready to install.
March 2017:	AEM21 optics ready (alignment possible).
June 2017:	Plasma background measurements
when NBI available:	First exploratory measurements (T_i, n_i)
Start OP1.2b:	Full measurements possible (E_r, ω_φ)



Alignment/Calibration

Optics will not be ready until ~March 2017 (possibly later), so alignment and calibration not possible for OP1.2a.

Alignment easily adjusted from back of immersion tube after first NBI shots, if required.

Before OP1.2b: in-vessel alignment and absolute calibration ~1/2 day.