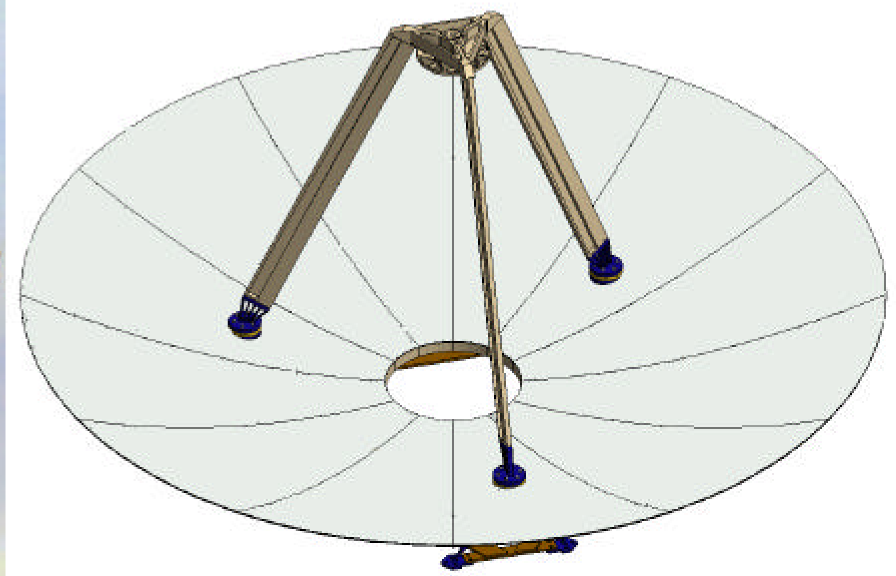


HERSCHEL SILICON CARBIDE TELESCOPE

Working meeting, ESTEC 19 June 2001

Purpose of the Presentation

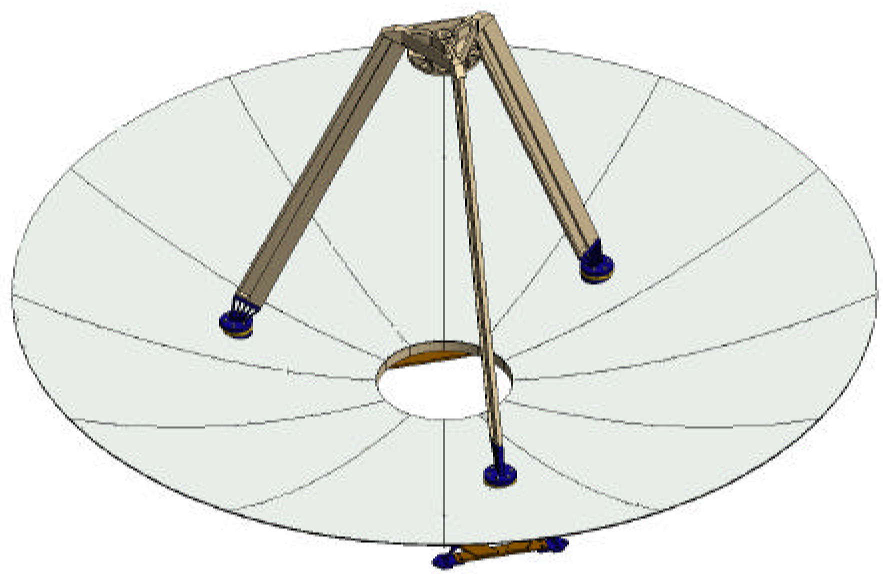
- **Astrium proposal will be submitted to ESTEC on the 22 June 2001**
  - Proposal detailed content not yet discussed with ESTEC

- **Presentation restricted to the following points:**
  - Overview of material properties
  - Overview of the manufacturing process
  - Identification and discussion of open points, mainly related to interfaces

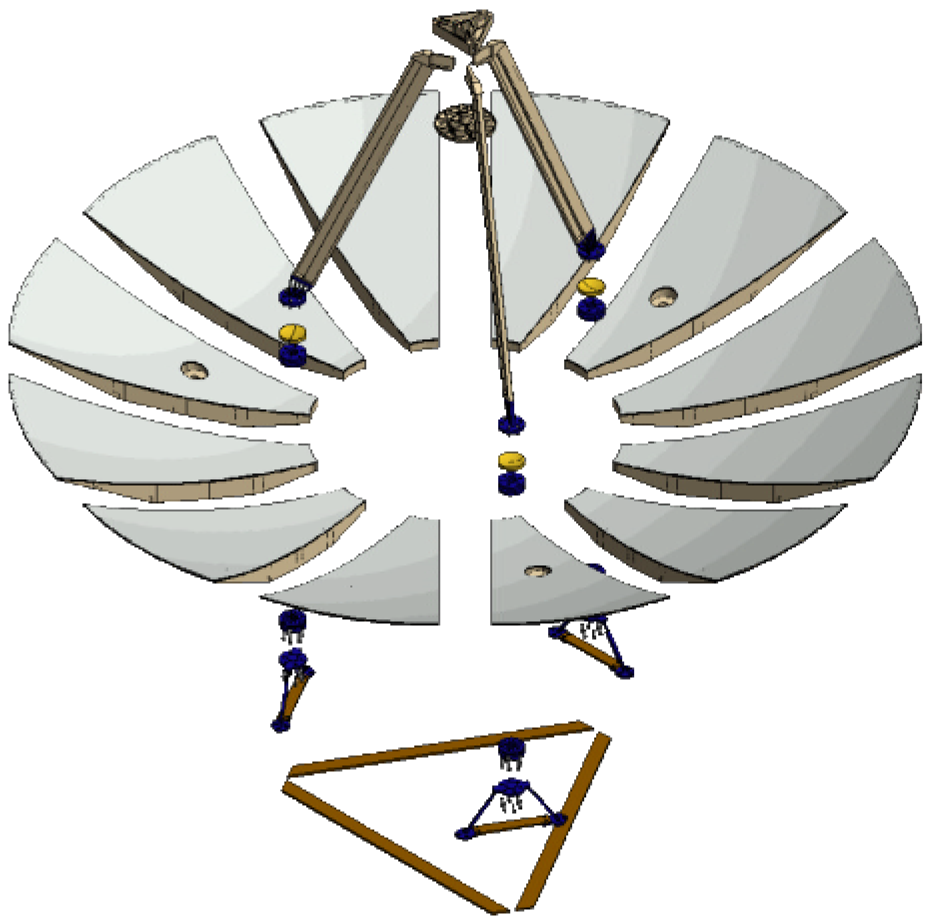
Telescope description

- Telescope mounted on a dedicated structure interfacing with the PLM cryostat (3 hard points),
- 3.5 m Cassegrain telescope, « all-SiC type »,
- Primary reflector made of 12 brazed segments
- Operational temperature: 70 K-90 K
- No refocussing mechanism
- Heaters required in orbit for decontamination

  (T > 313 K, 600 W)



Exploded view of telescope parts (without thermal hardware)



Major Performance Requirements

❑ Optical

Operating wavelengths: 80 µm to 600 µm

Telescope total WFE: < 6 µm rms

❑ Mechanical

Longitudinal frequency: > 60 Hz

Lateral frequency: > 45 Hz, Torsion frequency > 45 Hz

Total telescope mass: < 280 kg

❑ Operating temperatures

Operational temperature: 70 – 90 K

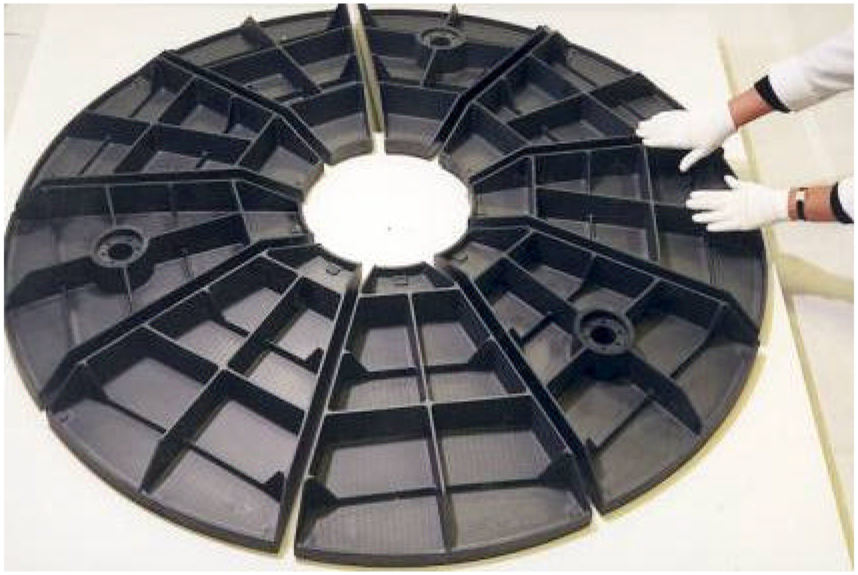
Contamination release temperature: 313 K (BOL, powered heaters)

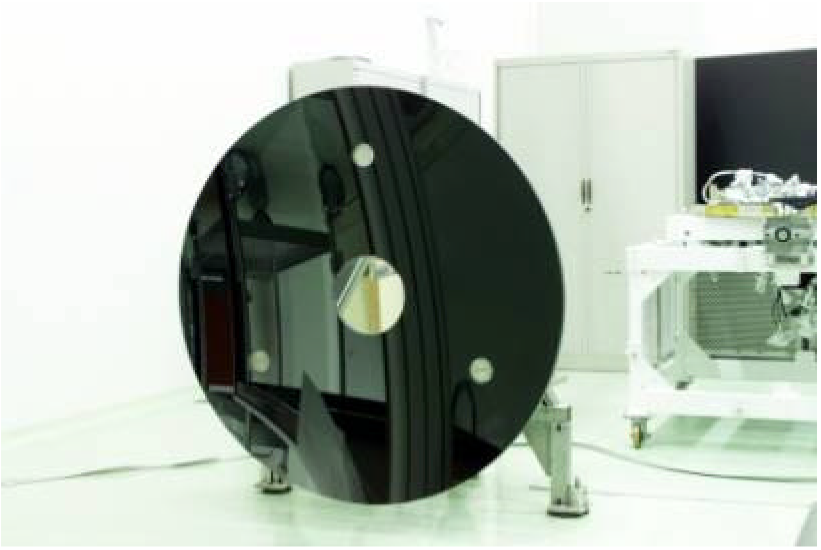
Technical background

- **Development and test of a 1.35 m spherical reflector (1999):**
  - Manufacturing processes representative of those proposed for the 3.5 m reflector, except for coating (not made)
  - Reflector made of nine brazed segments
  - Successful optical cold test (WFE) made at CSL
  - Sine and acoustic vibration tests

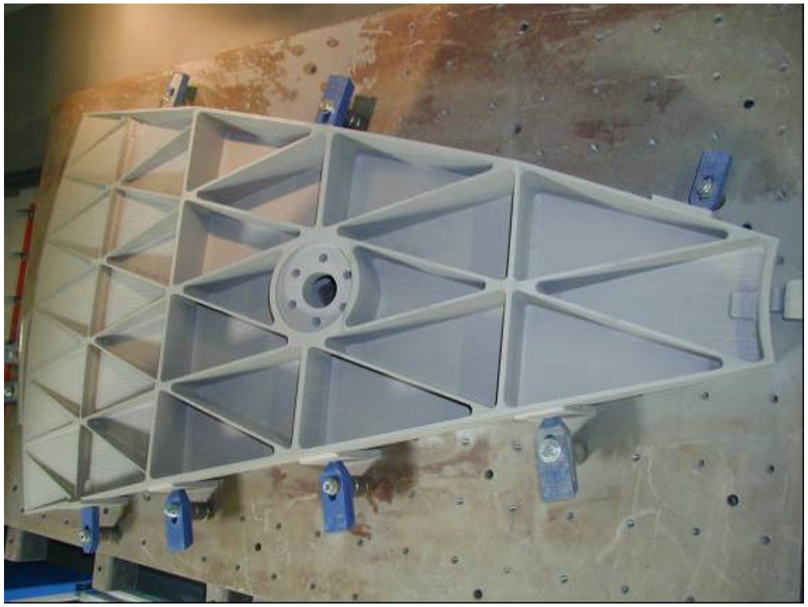
- **Preliminary telescope mechanical design and full scale petal manufacturing**

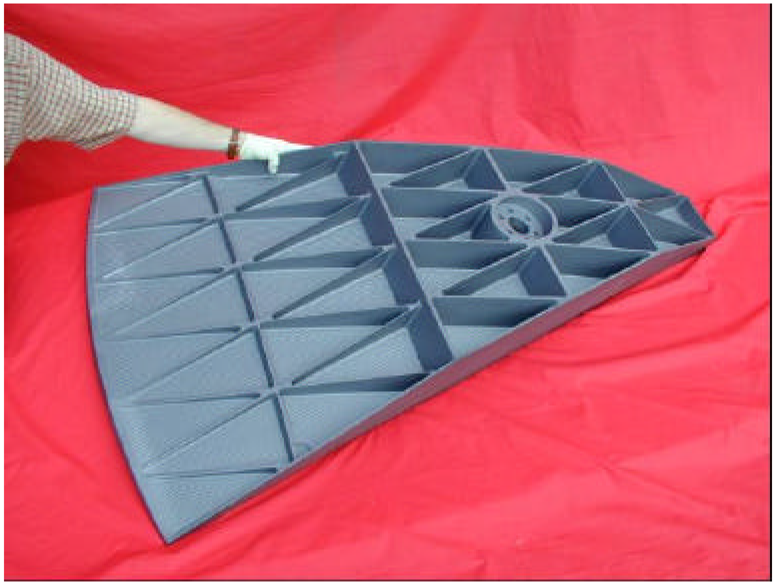
Breadboard 1.35 m





Full scale petal

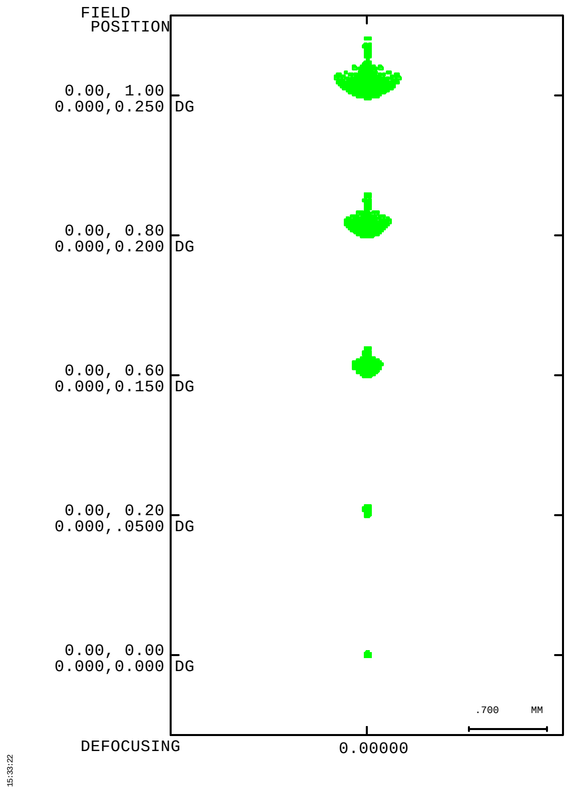


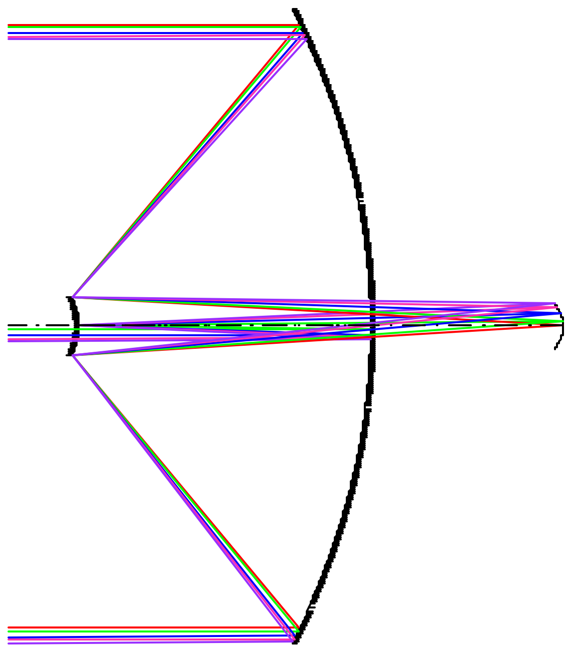


Optical parameters

Herschel Telescope optical parameters	M1 Parabola (Astrium proposal)	Typical tolerance or comment
Entrance pupil diameter (0 deg)	3283 mm	specified from f-number and focal length
		specified with tolerance +/- 50 mm
		specified 8.68; tolerance +/- 0.02
Primary vertex to best focus		specified with tolerance +/- 10 mm
	+/- 0.25 deg, circular	
Primary reflector		
Radius of curvature		
		beam motion +/- 93 mm for +/- 0.25 deg
		overall WFE 4 µm rms
Secondary reflector		
Radius of curvature	345.2 mm	+/- 0.4 mm
Conic constant	-1.279	overall WFE 1.5 µm rms
Diameter	308.12 mm	+/- 0.1 mm (tbc)
Image surface		
Radius of curvature	-165 mm	
Conic constant	-1	parabola
Diameter	246 mm	corresponds to +/- 0.25 deg

Combinaison Optique (2)

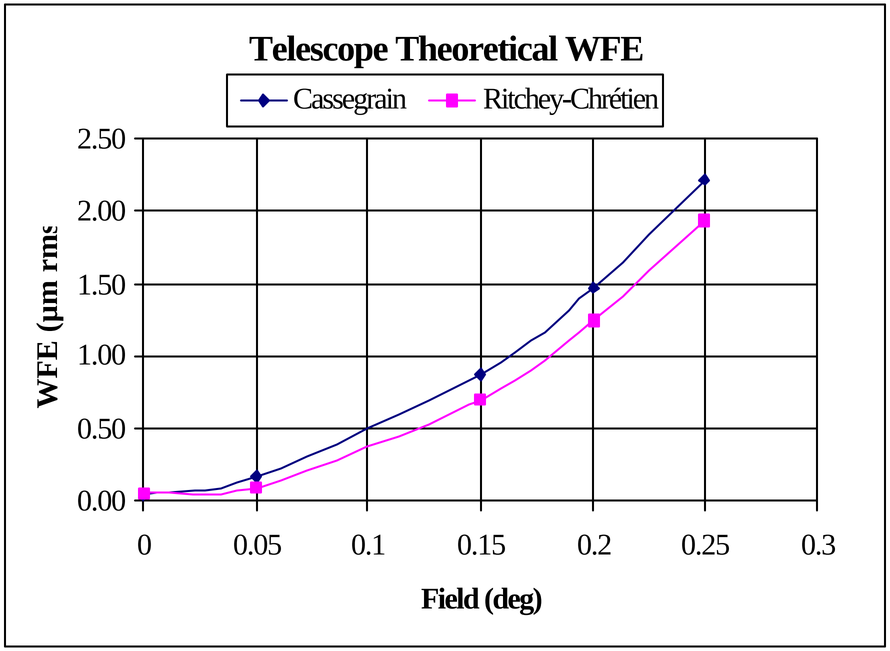




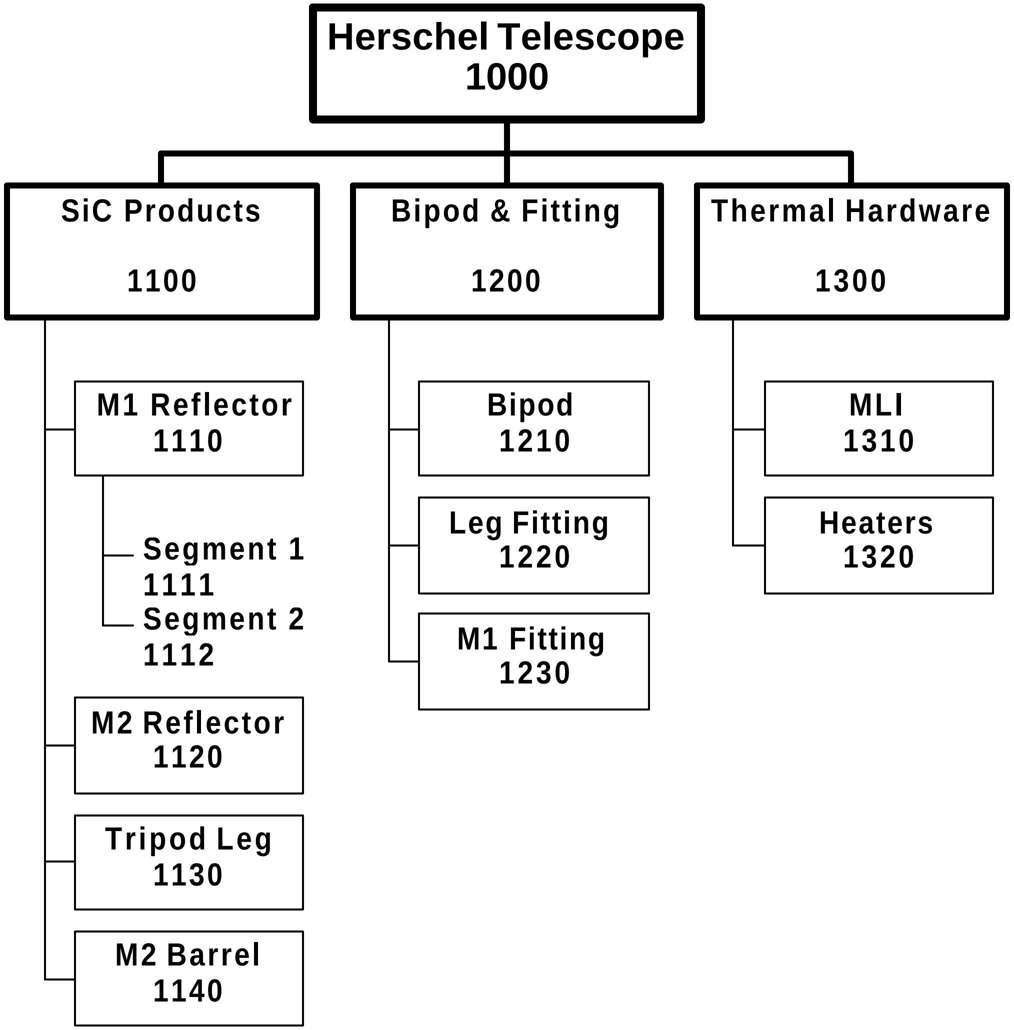
Telescope theoretical WFE: comparison between a pure Ritchey-Chrétien and the proposed Cassegrain configuration

- The focal surface is well represented by a parabola over the whole FOV

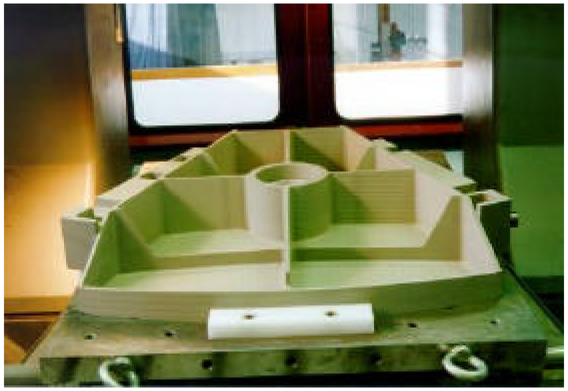
- Both theoretical WFE are extremely close, and are equivalent with respect to the overall telescope WFE budget (spec 6 µm)



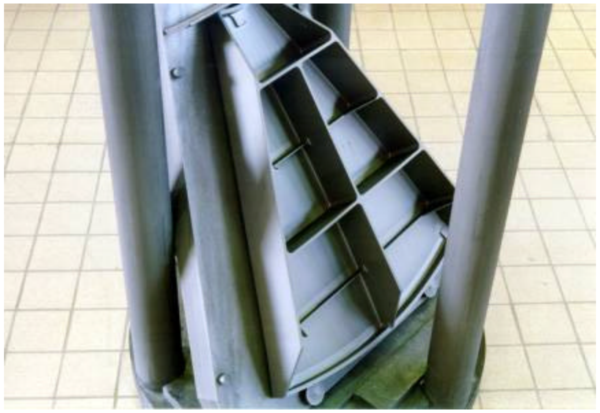
Product tree



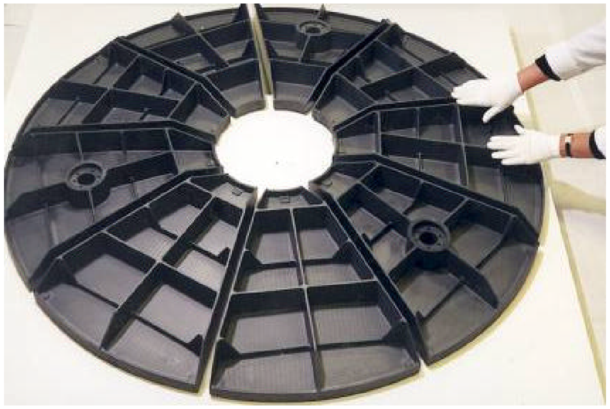
Major manufacturing steps for the 3.5 m reflector (1)



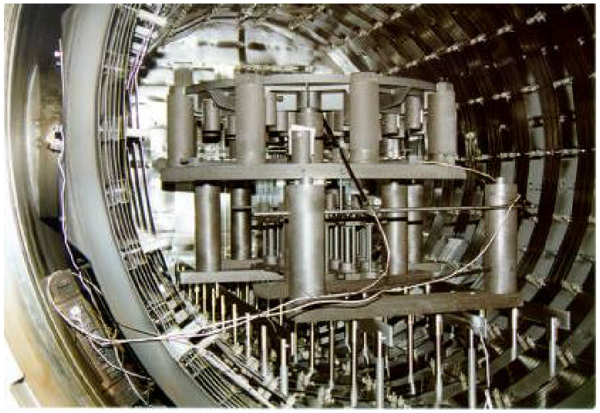
1- Segment green body machining (Boostec)



2- Segment sintering (Boostec)



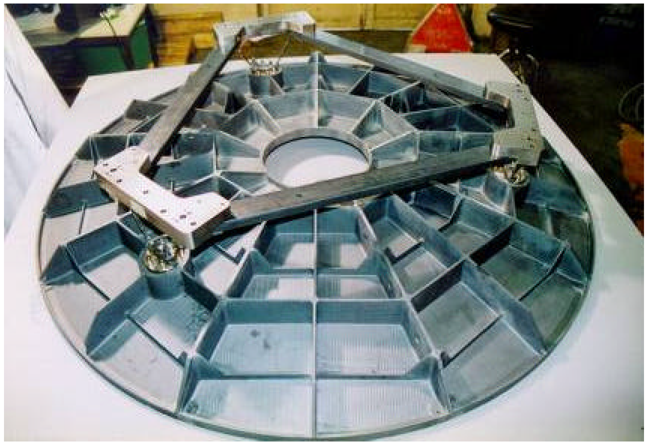
3- Grinding of brazed areas (Boostec)



4- Brazing (Boostec + Astrium support)
IABG oven TBC

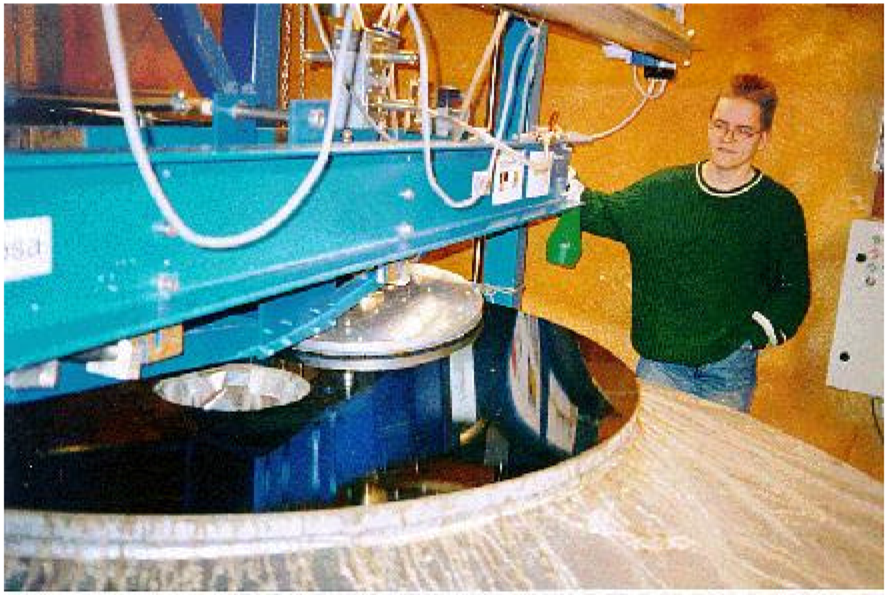
Major manufacturing steps for the 3.5 m reflector (2)

5- Grinding of optical face (Boostec)



6- Bipod integration (Astrium)

Major manufacturing steps for the 3.5 m reflector (3)

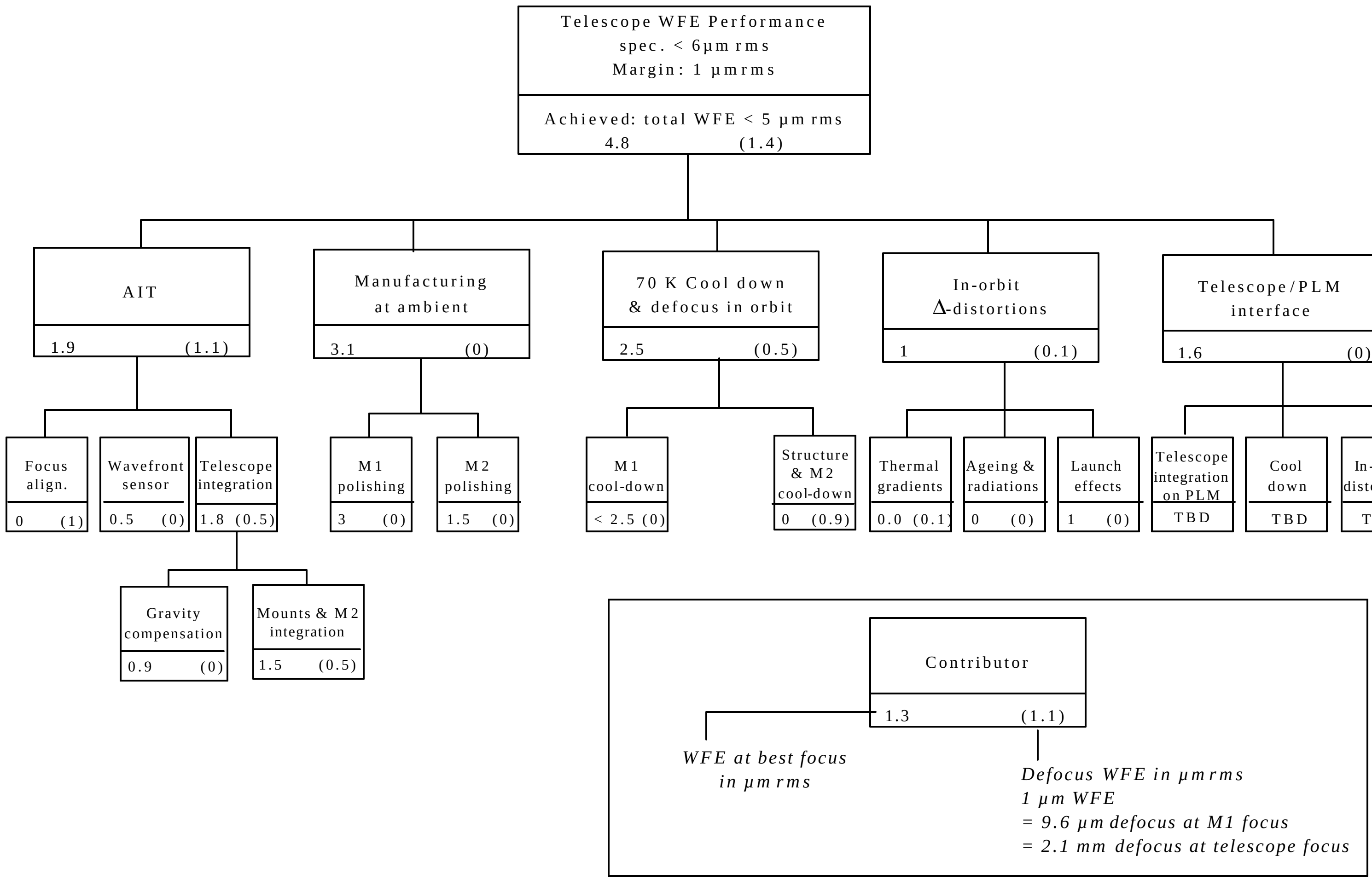


Not achieved
on the 1.35 m
reflector

7- Polishing (Opteon)

8- Coating (Calar Alto)

Telescope WFE budget



Telescope WFE budget (2)

- **The WFE budget does not include:**
  - Instrument internal WFE
  - Instrument focus alignment errors
  - Focus errors induced by Telescope mounting on PLM (shimming).

Telescope interfaces

- Telescope interfaces are relatively simple for all aspects: optical, mechanical, thermal and straylight
- Nevertheless, the interfaces are not yet fully frozen (which is a normal situation at this stage)
- Astrium objective is to close all interface open points by MTR. Interfaces must be confirmed and frozen at CDR.

Key development dates

- Kick-off: July 2001
- Mid-term review: October 2001
- Critical design review: March 2002 (end of phase 1)
- Primary reflector blank brazing: January 2003
- Primary reflector polishing and coating: April 2004
- Telescope assembly & test in clean room: July 2004 (end of phase 2)
- Telescope vibration & thermal vacuum tests: Oct 2005
- Telescope delivery: Nov 2005
- Overall schedule margin: ~ 4 months

Open Points

- Brazing oven: IABG oven selected, contractual aspects with IABG not yet finalised
- Mechanical interfaces: diameter, stability requirements
- Thermal interfaces: assumptions to be completed
- Optical alignment: devices concept and location to be defined
- Straylight aspects: design of central area of M2
- Contamination aspects: need/spec figures to be debated

Brazing oven

- Baseline is to use existing IABG oven. Contractual & technical aspects will be finalised by September 2001

- IABG oven available diameter is ~ 3 490 mm

- Two small cuts may be required at the edges of one reflector diameter. Cut width is ~10-20 mm tbc. Exact figures will be determined with the help of a mock-up.

- The orientation of this diameter w.r.t. telescope frame is relatively free. It should be possible to orient this diameter for having no impact for the actual field area used by the instruments (no vignetting)

Mechanical interfaces

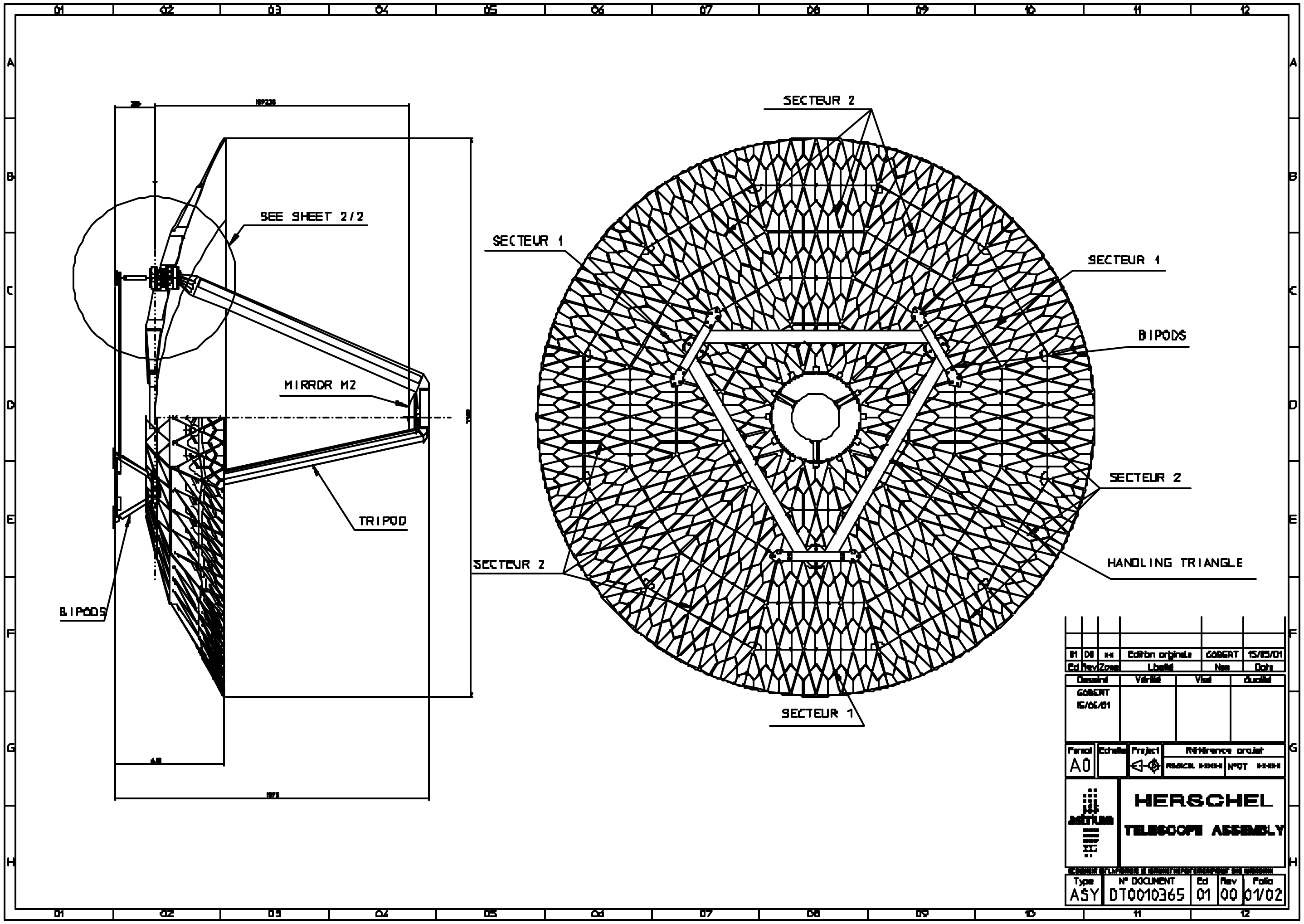
- **Interface radius is 875 mm**

- **The interface structure between the telescope and the cryostat must:**
  - Absorb thermal shrinkage of the crysotat vessel
  - Not distort the telescope,
  - Provide a low conductivity (5 mW/K, according to ESTEC spec.)
  - Withstand launch loads

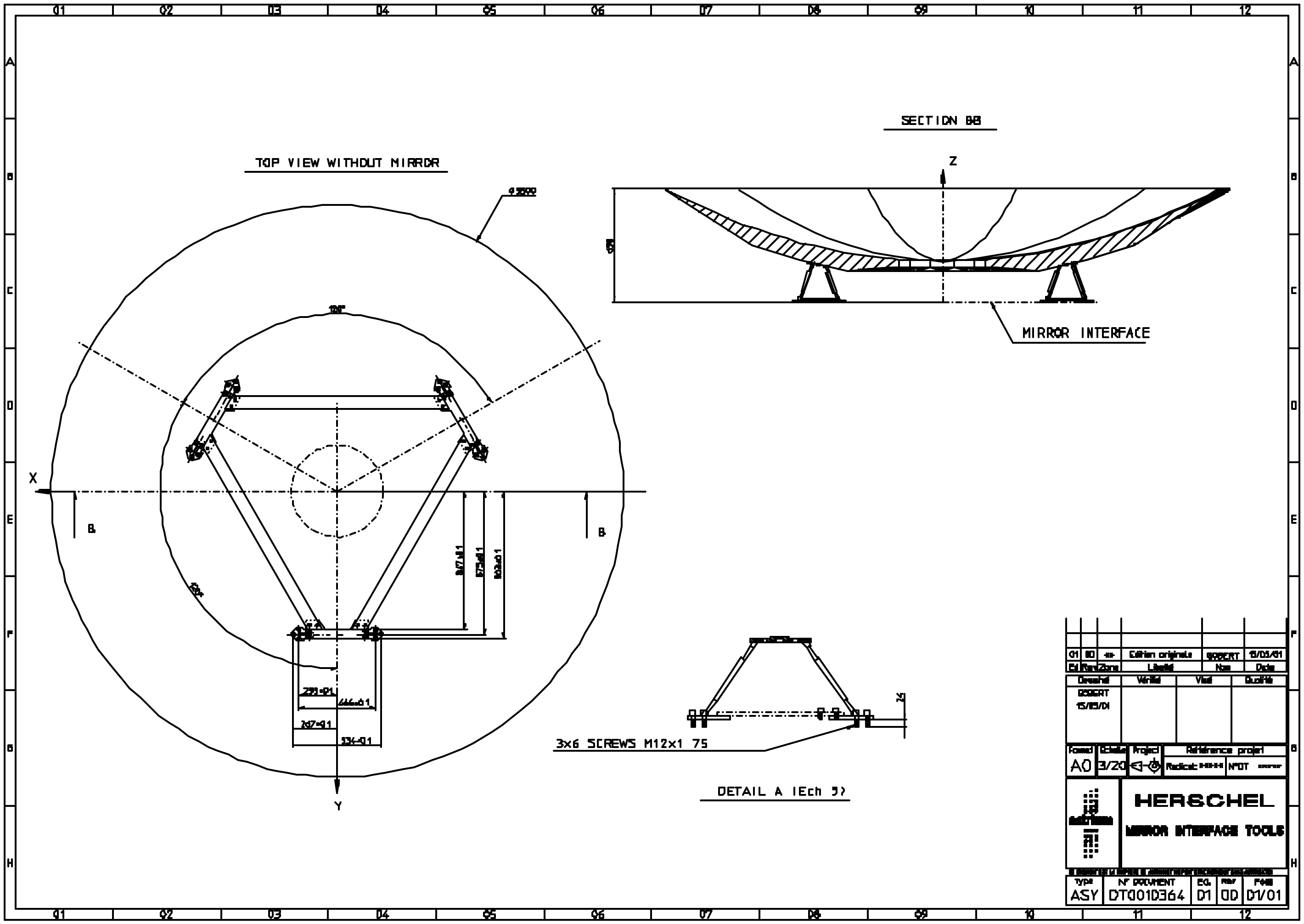
A low CTE material should be selected, at least at telescope interface

- **Stability requirements: Astrium will propose a set of figures by MTR (forces/torques or displacements) for meeting WFE requirements**

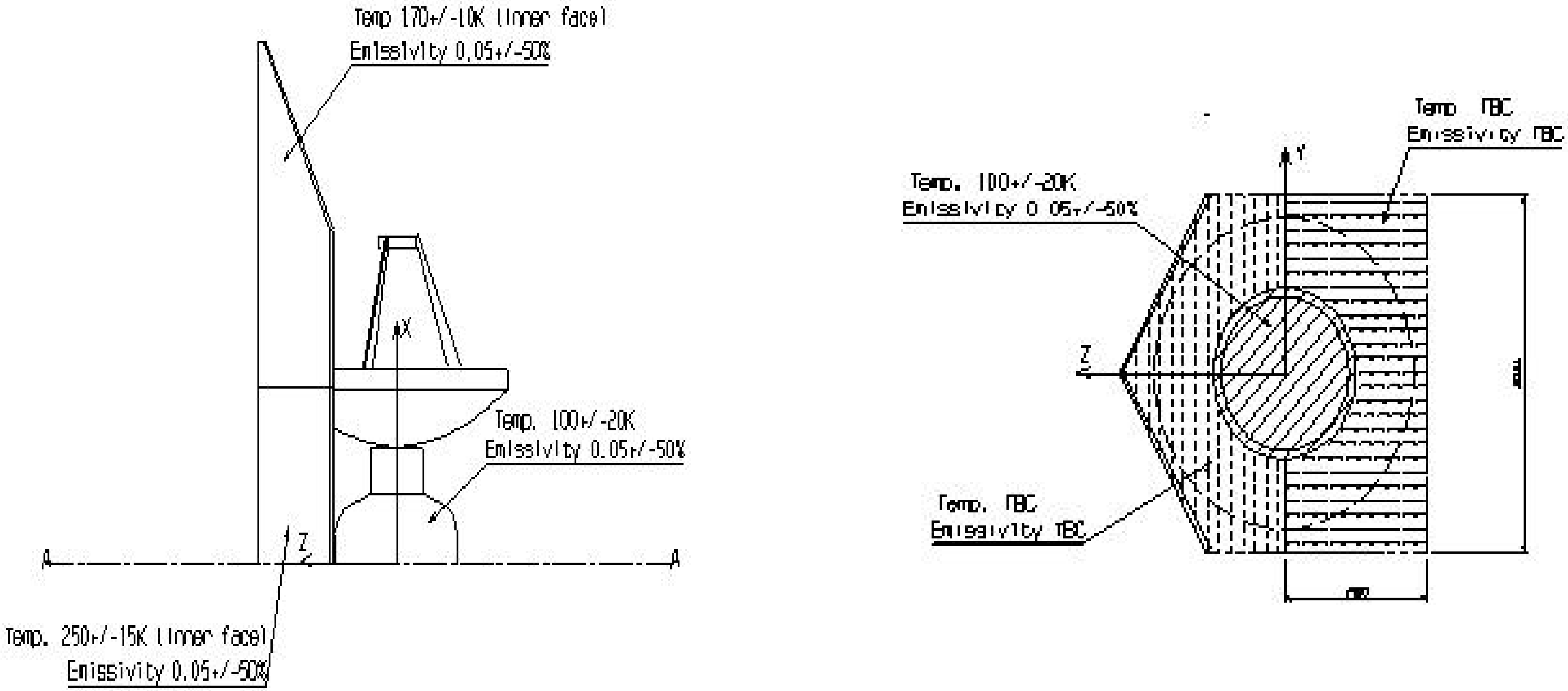
Mechanical interfaces (2)



Mechanical interfaces (3)



Thermal interfaces



Optical alignment devices

- Nature, purpose
- Number & location
- Accessibility

Devices to be defined by the alignment working group

Straylight aspects

- **Both reflectors will be specular in the visible range,**
- **Reflector roughness < 50 nm rms, should strongly reduce straylight effects**
- **Straylight analyses will be performed with ASAP/APART by including the instrument starylight model (to be provided at KO):**
  - Identify and quantify major starylight paths by taking into account the instrument cold stop
  - Define straylight needs: baffle at the centre of M1? shaping tripod legs? Etc
  - Central area of M2 must be designed for suppressing narcissus effect
  - Evaluate particulate contamination effects (Mie model)
  - All the design/analyses work will be completed by CDR

Suppression of Narcissus effect (preliminary figures)

- **Neutralized area diameter at the centre of M2 for Narcissus effect suppression: 29 mm**
- **Neutralized area diamater at the centre of M2 for 1) no narcissus effect and 2) no variable vignetting in the entire FOV: 45 mm**
  - Equivalent primary inner hole diameter is 440 mm
- **Telescope design:**
  - Primary inner hole: 560 mm
    - Limited by press size for petal manufacturing
    - Useful for AIT aspects
    - Minor impact on telescope performance (SNR and resolution)
  - Corresponding obscured area diameter on M2: 57 mm
  - Neutralised area at the centre of M2: between 29 mm and 50 mm
  - No narcissus effect
  - No vignetting in the entire FOV
- **M2 central area neutralisation: hole, to be discussed w.r.t. HIFI needs**

Contamination aspects

- **Current specification is 300 ppm for particulate contamination, and 2 E-7 g/cm² for molecular contamination**
- **Figures correspond to strong requirements for instruments working in the visible range. No equivalent requirements exist for RF antennas**
- **Figures to be debated, in relation with straylight analyses**
  - Particulate requirement could be, for example, < 300 ppm for particle size larger than x fraction of 80 µm
  - Molecular contamination to be assessed by sample tests