VLT - DSM
Large convex aspherical Thin Shell Manufacturing

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I. VLT DSM

- Replace the actual secondary of one UT
- Goal: Correct for atmospheric turbulence inside the telescope
- Directly deliver a corrected wavefront at telescope focus

Technical characteristics:

- 1.1m diameter
- Convex hyperbolic
- 1170 voice coil actuators
- 2mm Thin Shell !!

Optical quality specification

1- The shape of the mirror can be partially corrected by the 1170 actuators. (1/10 of their peak force).

→ relaxation in terms of low spatial frequency errors (large scales on the mirror).

2- However, below the Nyquist scale (twice the actuator pitch), the system cannot correct for surface errors

→ restrictions in terms of high spatial frequency errors (low scales on the mirror)

3- The correction of BFs generates HFs

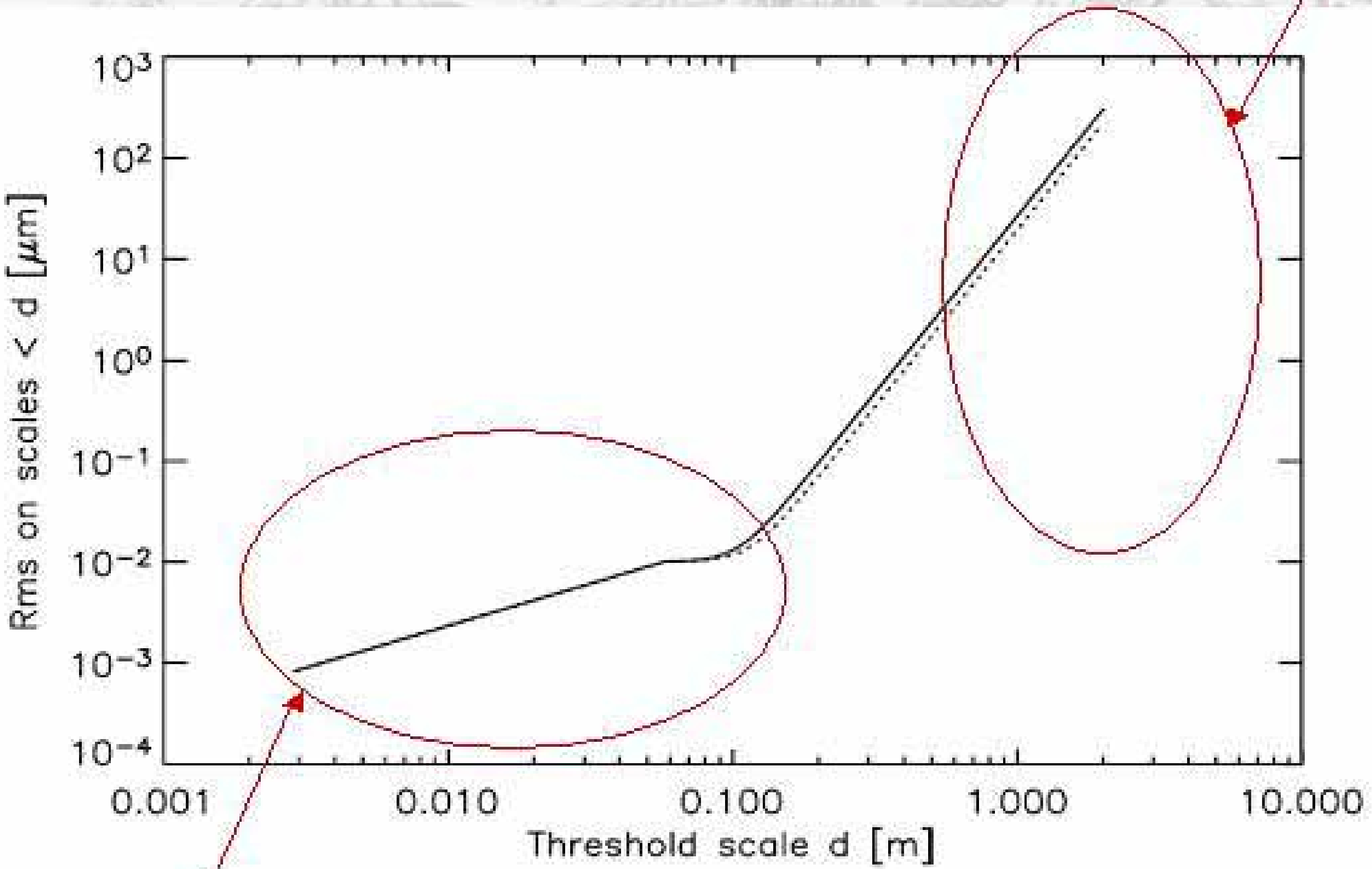
→ restrictions on BFs respect to HFs

→ Envelope of acceptable manufacturing errors

Envelope of acceptable manufacturing errors

Relaxed on low frequencies

> 10 μm



Severe on high frequencies

< 10nm

→ *Active optics - Stress Polishing*

Active Optics

Goal:

Generating and controlling deformations on telescopes and instruments mirrors.

Gain:

Obtaining complex optical surfaces of excellent quality, statically and/or dynamically

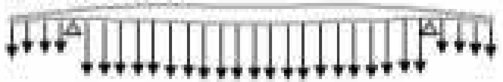
Applications:

1. **Stress polishing**
2. Maintaining an optimal shape of a mirror
3. Variable surface mirrors

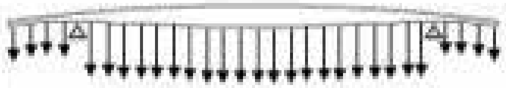
Stress Polishing Process

1 Plano-Convex Zerodur blank

2 Deformation of the substrate under air back pressures



3 Spherical polishing with full size tool



4 Stress relaxation and final form

5 Gluing on a spherical mould

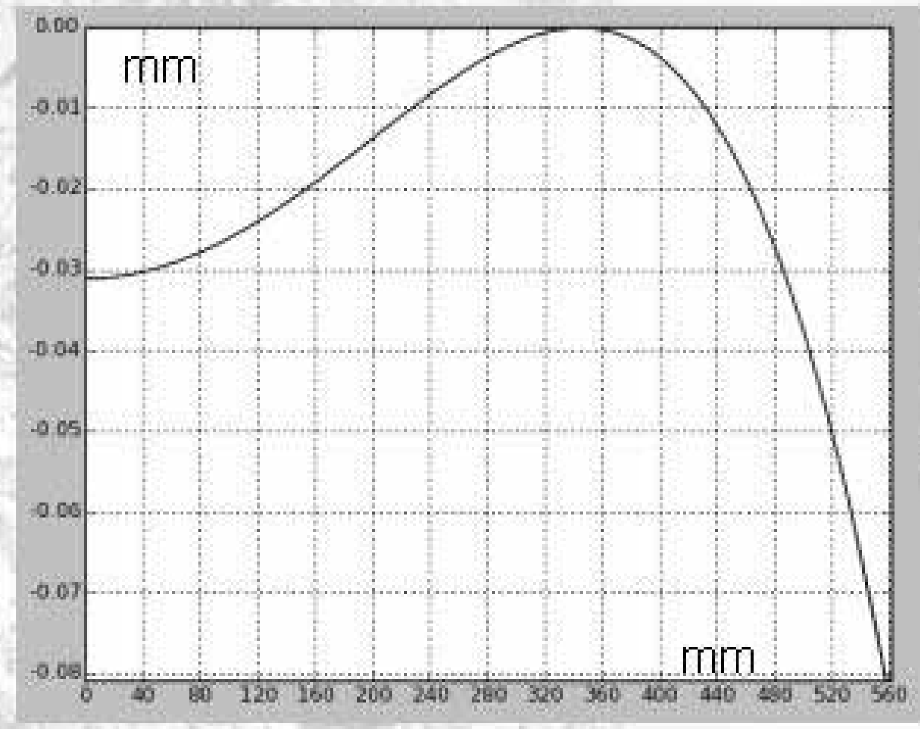
6 Back face spherical thinning

Desired flexure

- Inverse of the final aspherical form

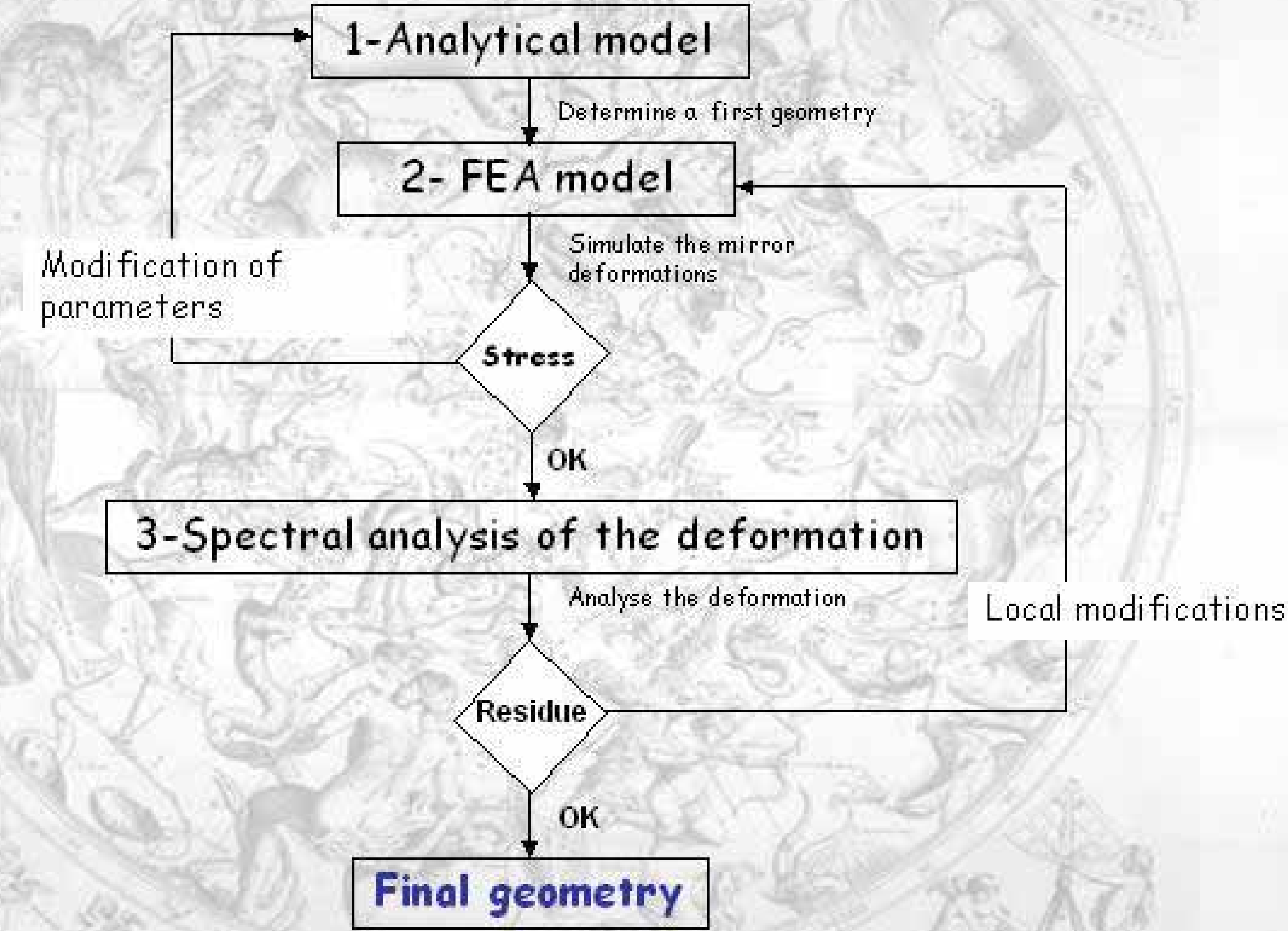
$$Z_a(r) = Z_s(r) - Z_{flex}(r)$$

Asphère — Sphère — Flexion



- Optical quality linked to the deformation function residuals → depends on the blank geometry

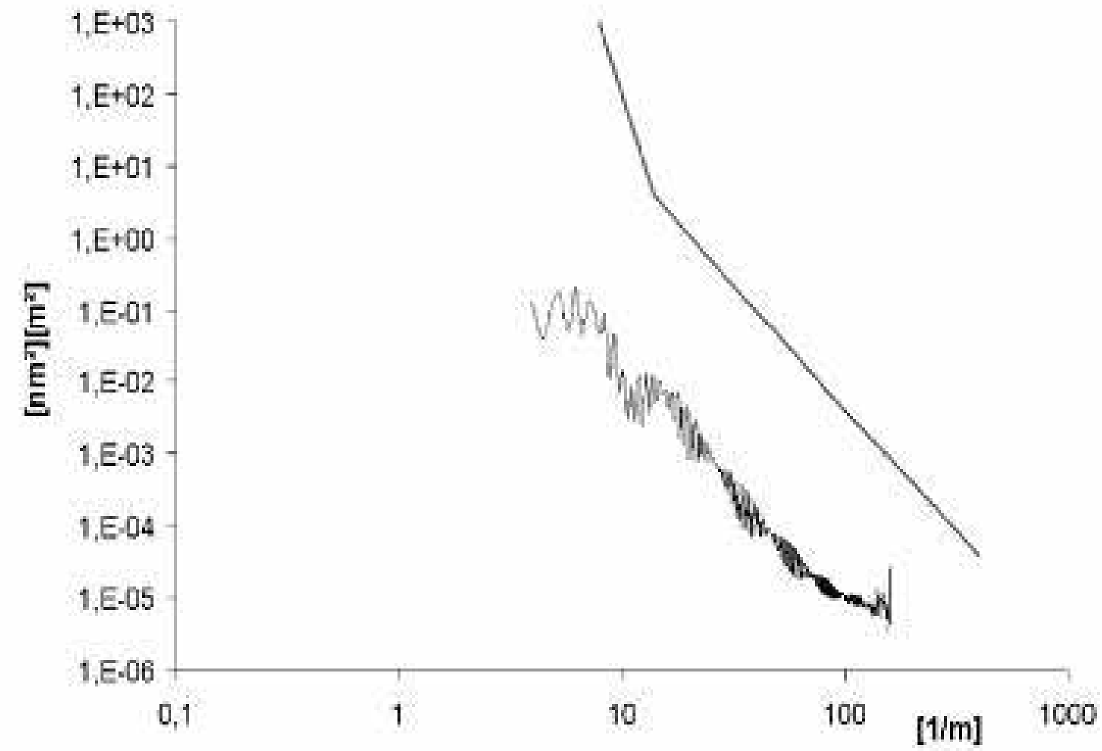
Definition of the blank geometry



Manufacturing residuals estimations

- Comparison of residuals with specifications

  → estimates the optical quality of mechanical deformations

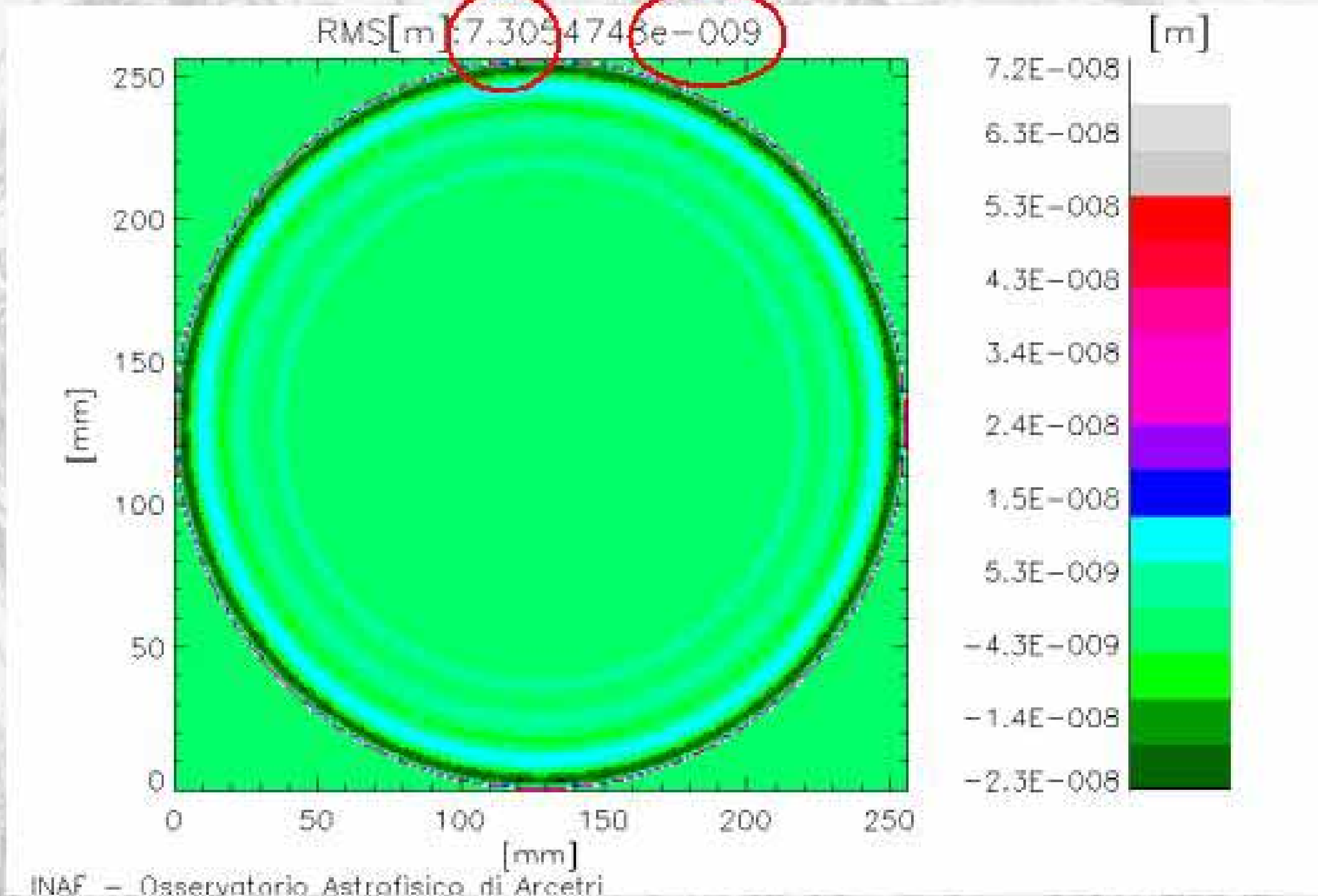


PSD of flexure residuals vs PSD spec

- Numerical validation of the manufacturing process

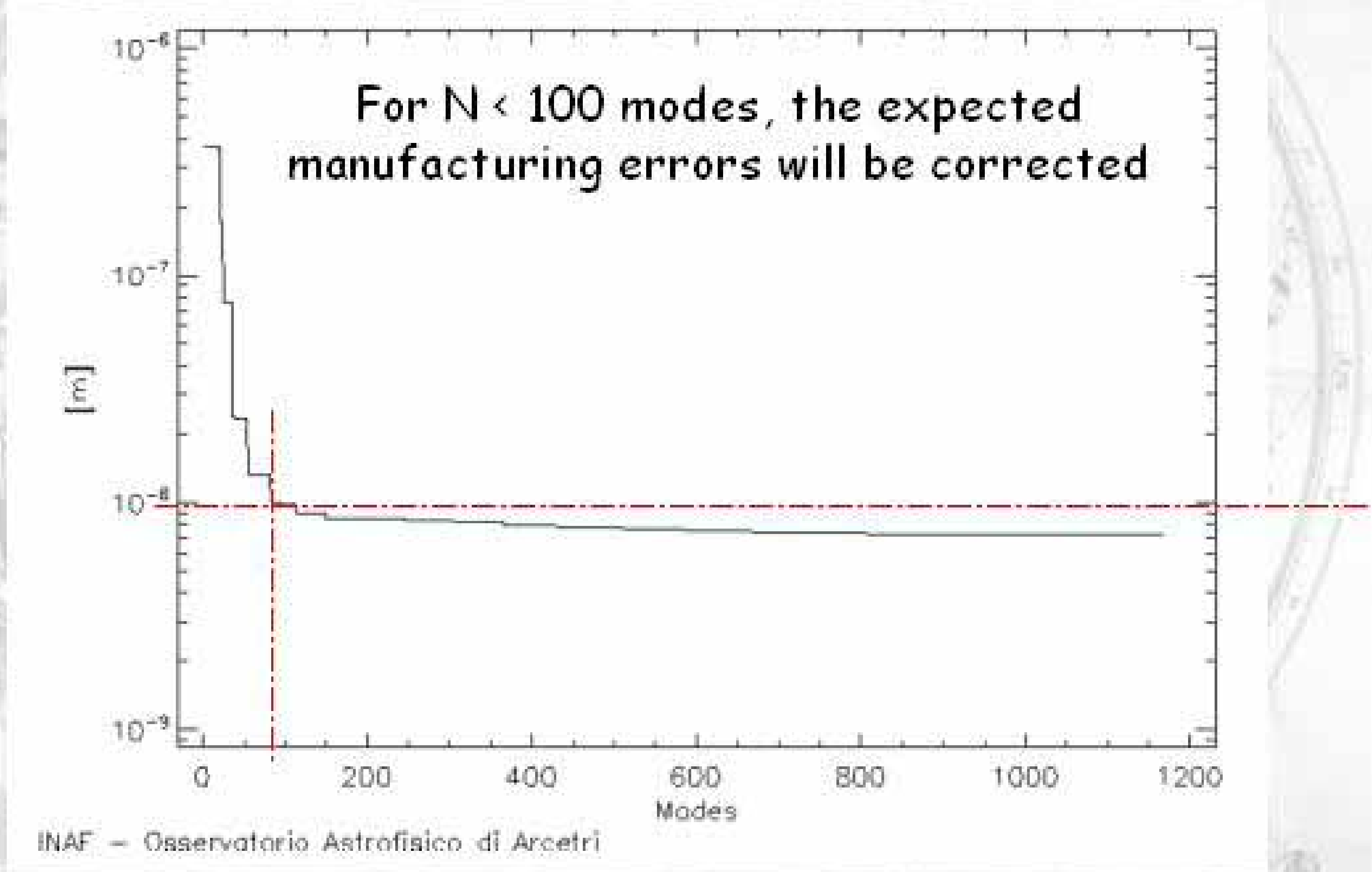
Manufacturing residuals estimations

Flattening residuals estimation < 8nm



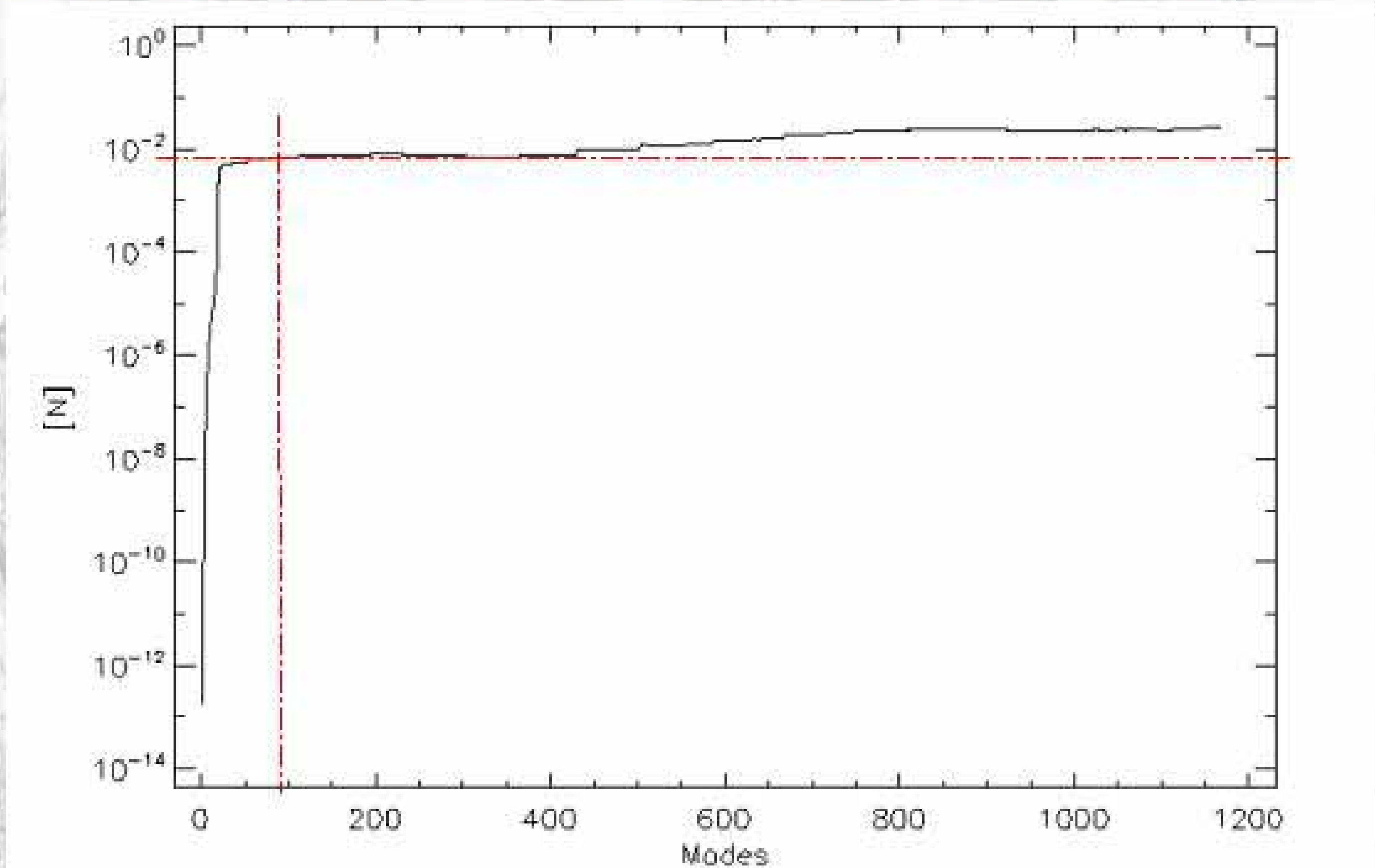
Manufacturing residuals estimations

Residue rms on surface vs N modes corrected



Manufacturing residuals estimations

RMS Force needed to flatten the shell vs N modes < 0.1N



Manufacturing Plan

I - Preparation and installation

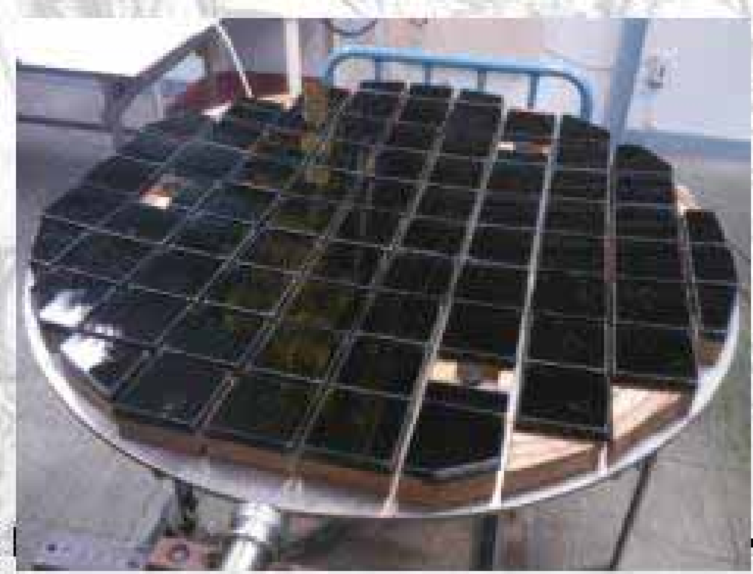
II - First spherical polishing under stress

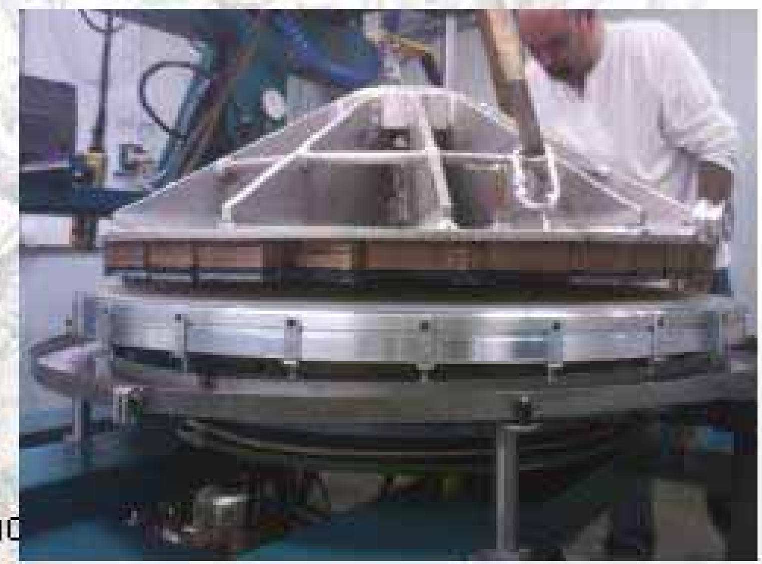
III - Final aspherisation under stress

IV - Final thinning (@ SESO)

LAM Polishing Machine

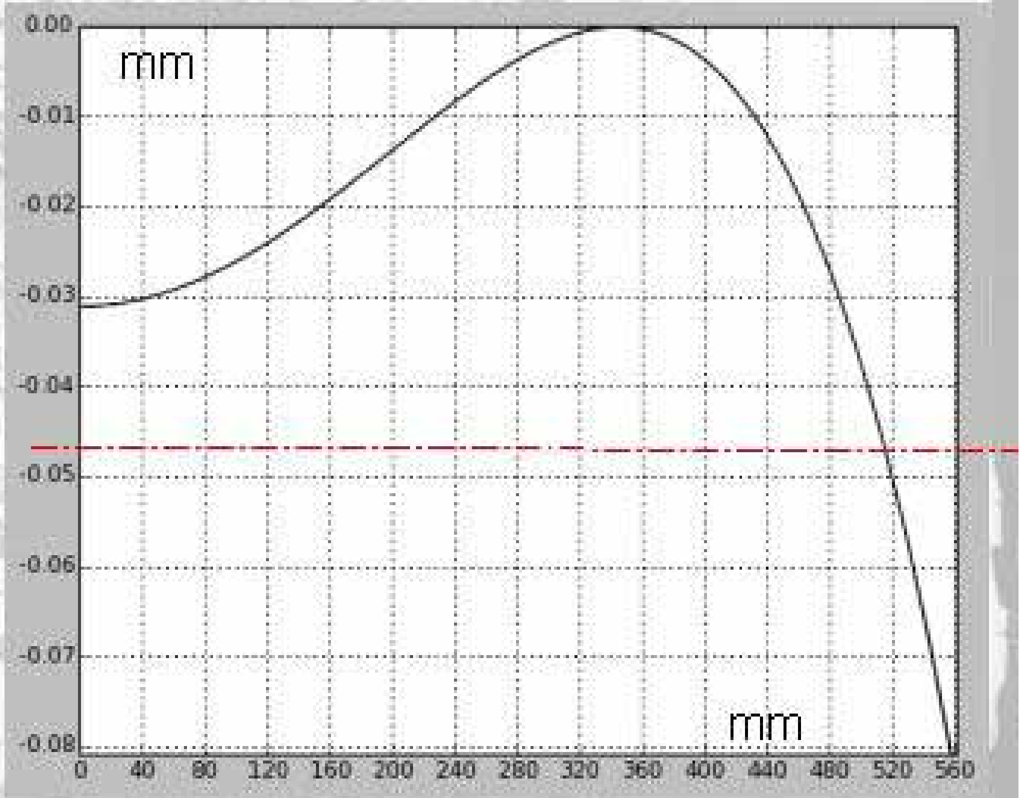
- New 1.3m active polishing machine





LAM Polishing operations

Removed matter



First measurements

- Before interferometric tests, several mechanical measurements are done, regarding the polishing ROC and the real "centre-to-edge" flexure obtained.
  - Nominal "centre-to-edge" flexure obtained with a slight re-adjustment (<1%) of the theoretical pressure (-300.9 mb = safety pressure…)
  - Radius of curvature measured during grinding = 4580.3mm
    To be compared with best sphere specification = 4575mm +/-10mm

Good Departure ☺

VLT M2 Matrix

- Spectral qualification of the VLT M2 matrix (May-June 2007) on High spatial frequencies

Test Plan

- Two set-up for LF/MF and High Spat. Freq. Errors
  - Low/Medium spatial frequencies errors → ESO Matrix
  - High spatial frequencies errors → Dedicated HQ 200 mm Ø Sphere

- Low/Medium Spatial Freq. errors [1/1000 - 1/100] mm^{-1}
  - -Control during active polishing (meniscus)
  - -Control after final active polishing (meniscus)
  - -Control after thinning to 2mm (shell)

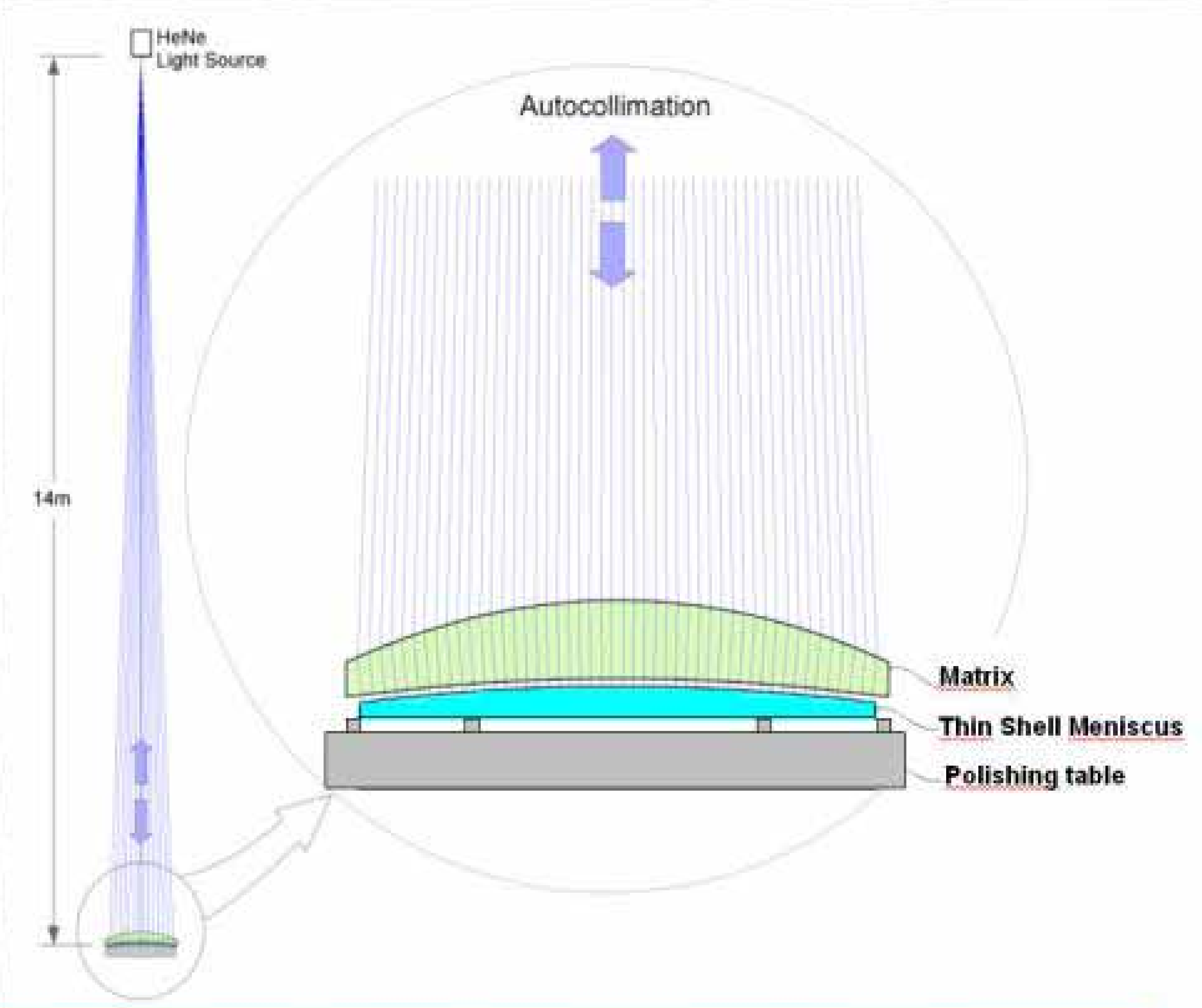
- High Spatial Freq. errors [1/200 - 1/10] mm^{-1}
  - -Control after final active polishing (meniscus) on sphere

Test N°1

- Low/Medium Spatial Freq. errors

Using ESO
VLT - M2 Matrix

Active system : OFF
Aspherical surface



Control during active polishing, after final active polishing (meniscus) and after thinning to 2mm (shell)

Test N°2

- High Spatial Freq. errors

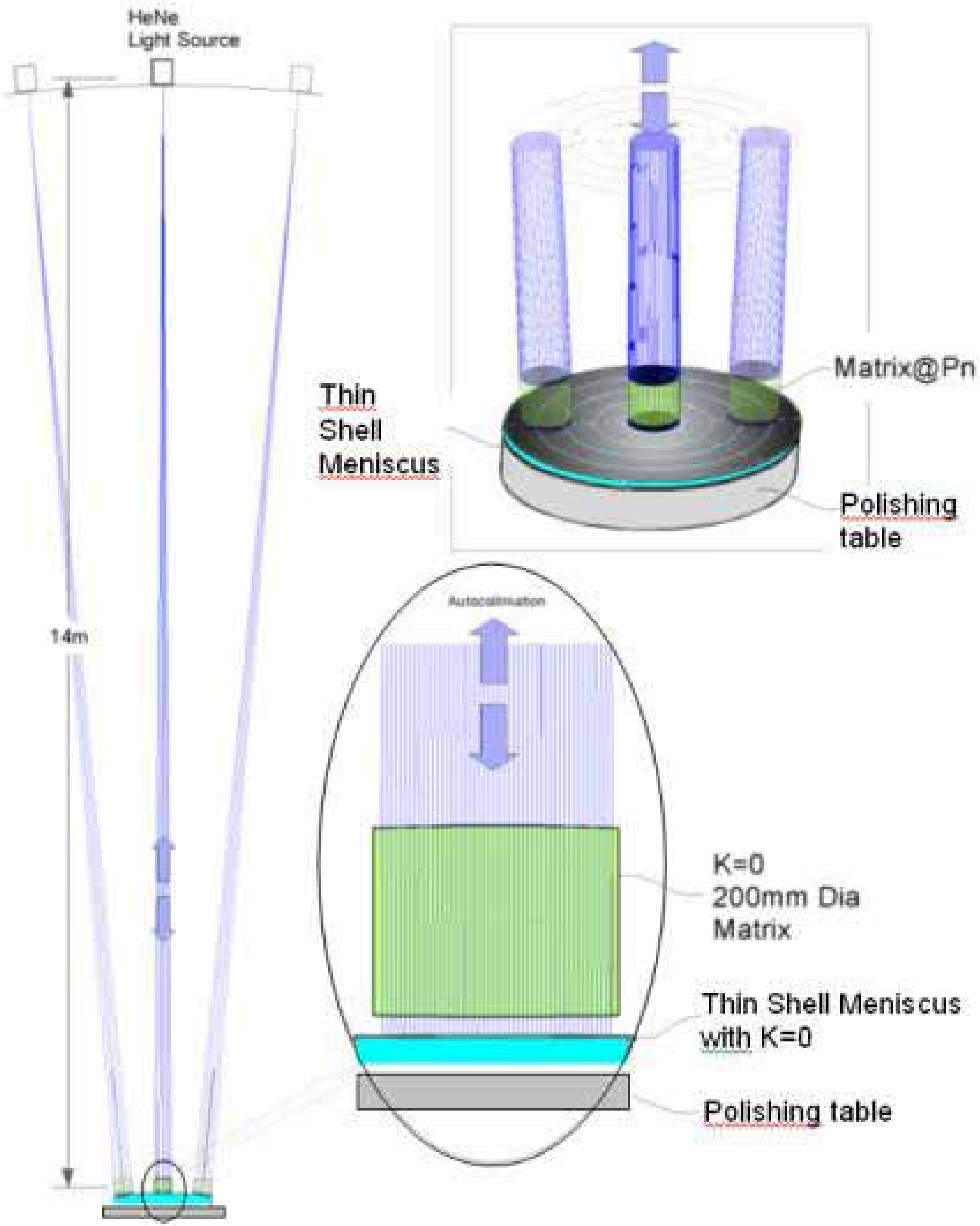
Using special high quality spherical matrix 200mm Ø

Active system : ON
Spherical surface

Control after final active polishing (meniscus)

No new control after thinning

21-22 Novembre 2007



Polishing operations

Thanks!