LATT:
Large Aperture Telescope Technology

from ground adaptive secondaries

to a space active primary

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The LATT Team

CGS S.p.A.: *coordinator*

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ADS International: *mech. System*

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MICROGATE: *electr.+control systems+testing*

R. Biasi, C.Patauner

CNR-INO Italian Optics Inst.: *shell*

F. D’Amato, M. Pucci

INAF-Italian Astrophysics Inst.:

AO expertise+optical testing

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,

ESA

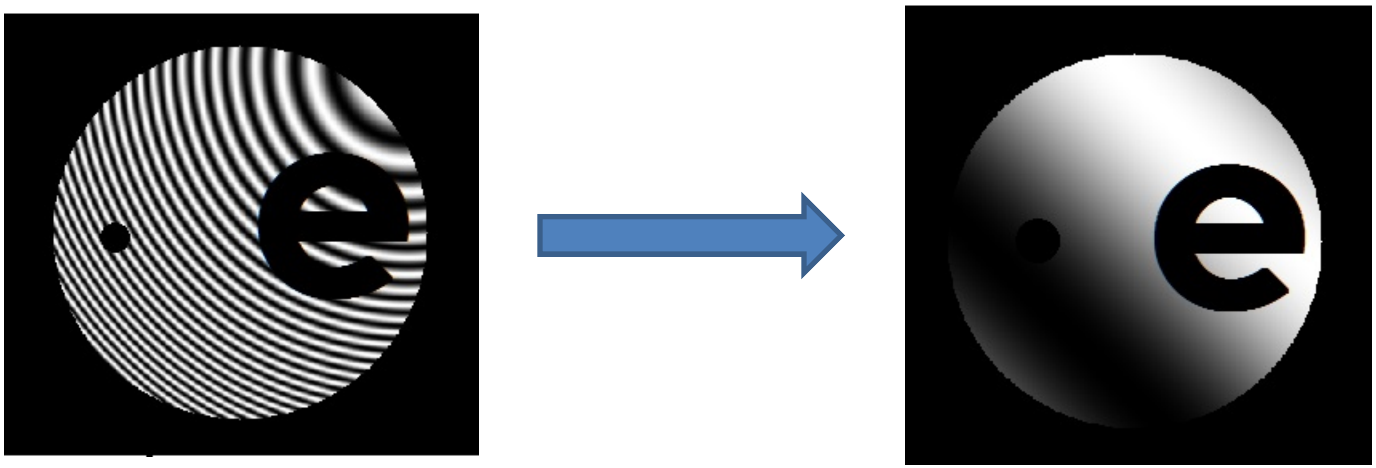
L. Maresi, A. Zuccaro Marchi, J. Pereira do Carmo

LATT?
Concept and demonstrator

- Is our response to the needs of space mirrors:
  - Large format
  - Possibly deployable/segmented
  - Lightweighted
  - Actively shaped
- Scientific cases
  - Astronomical telescope
  - LIDAR
  - Earth monitoring
  - Telecommunications

Preliminary study:
* ALC project in 2007
LATT prototyping:
* ESTEC/Contract No. 22321/09/NL/RA
Expertise from LBT672, DSM, M4DP:
Technologies, strategies, procedures

Actually our secret goal was to fix the ESA logo!!!

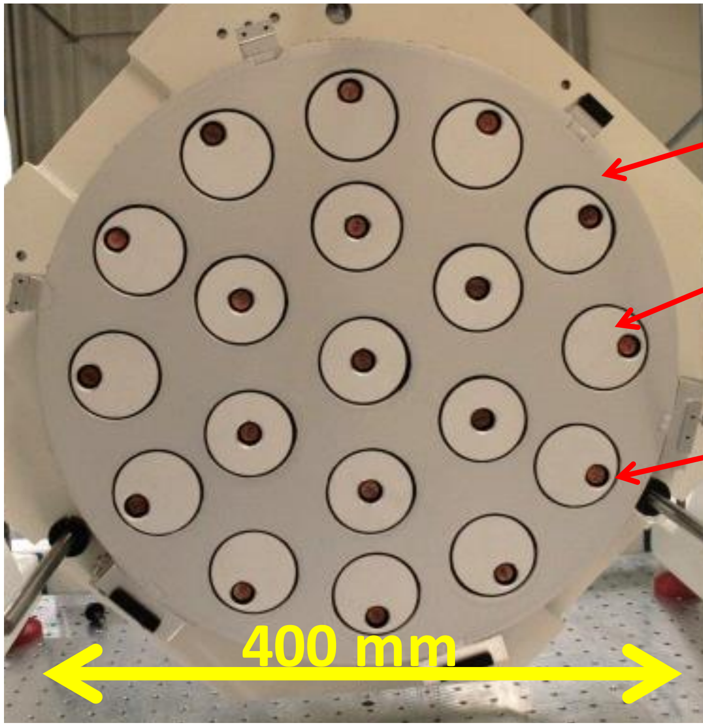


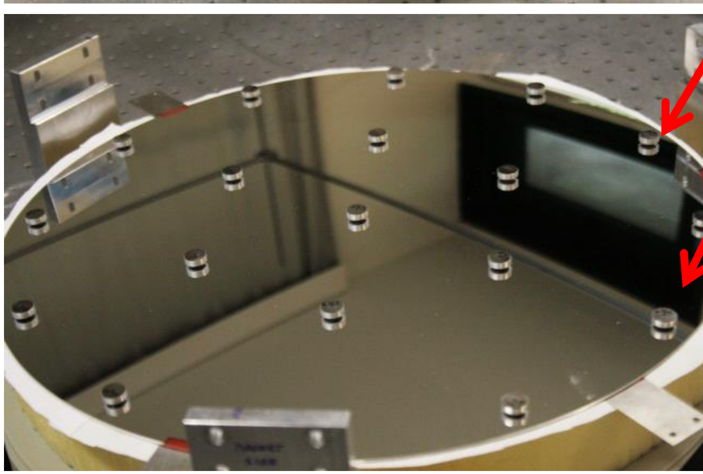
LATT can handle it!

Project status

- Ended in october 2015 with final review @ESA-ESTEC:
  - Lightweigth: better than JWST
  - Actuator stroke >> competitors
  - Power consumption: almost negligible
  - Concept: very attractive for future developments
- Presented at Space Active Optics @ESTEC (nov.2015)
  - Unique of large format, deformable
  - Unique concept addressing segmentation
  - Unique applicable to primary mirror concept

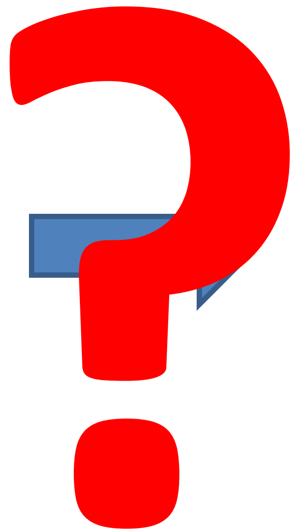
LATT: 400mm, F/6 sphere, 19 acts

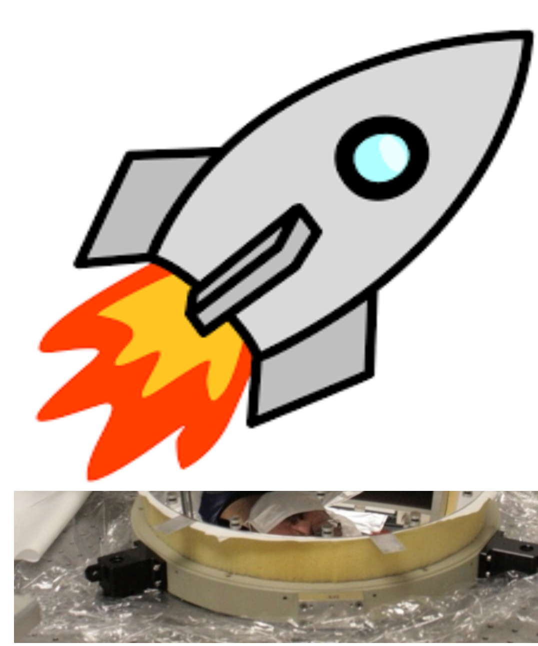




- CFRP+Al honeycomb Reference Body (<9 kg/m2)
- Co-located, contactless, position capacitive sensors (8 nm precision)
- Contactless, voice-coil motors (<55mW, 1mm stroke, , ± 0.24 N and 0.08N for flat)
- Low print-through glued magnet (19 acts)
- Thin glass shell (400mm diam x 1 mm th., F/6)
- 1 single cable, 1 small electronics box (15W) *(providing local control loop and launch safety mechanism for the thin shell)*

From adaptive secondaries to a space active primary





LBT: **ellipt.**1 m, 672 acts, kW, 1kHz
VLT: **asph**. 1.2 m, 1170 acts, kW, 1kHz

LATT: **spher**. 0.4 m, 19 acts, 1W, 1Hz
& new hair cap, *ton sur ton*

Solutions validated, towards TRL 5

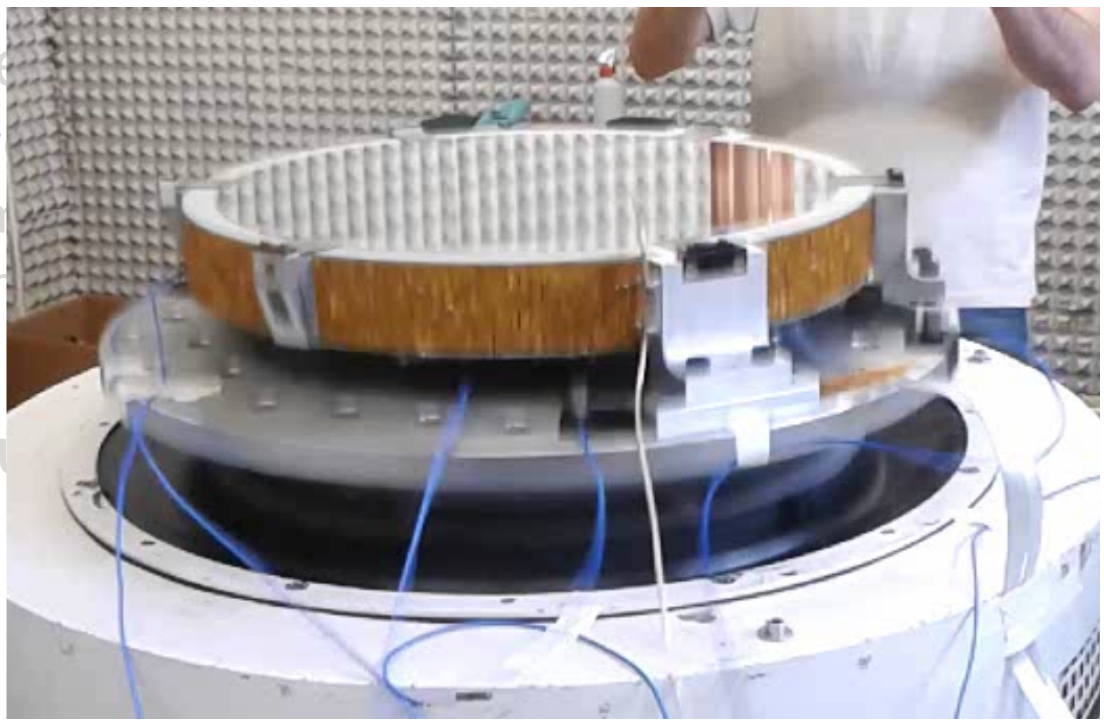
- Shell electrostatic locking:

  The shell is electrically ‘glued’
  on the RefBody during launch

- Reduced powe

  Contactless, v
  (<55mW, 1mm
  Low bandwith

- Goal optical qu



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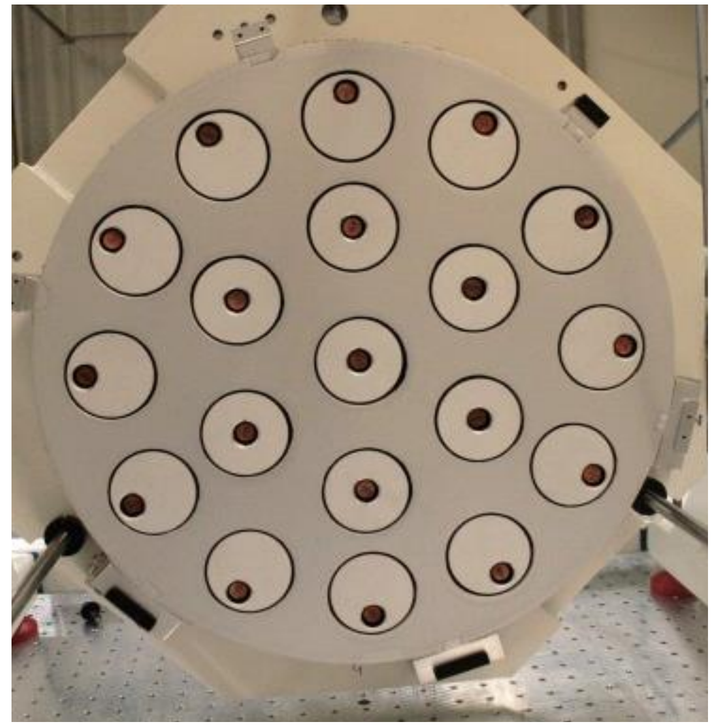

- Reduced power consumption
  Contactless, voice-coil motors
  (<55mW, 1mm stroke)
  Low bandwith smart actuators

- Goal optical quality

Solutions validated, towards TRL 5

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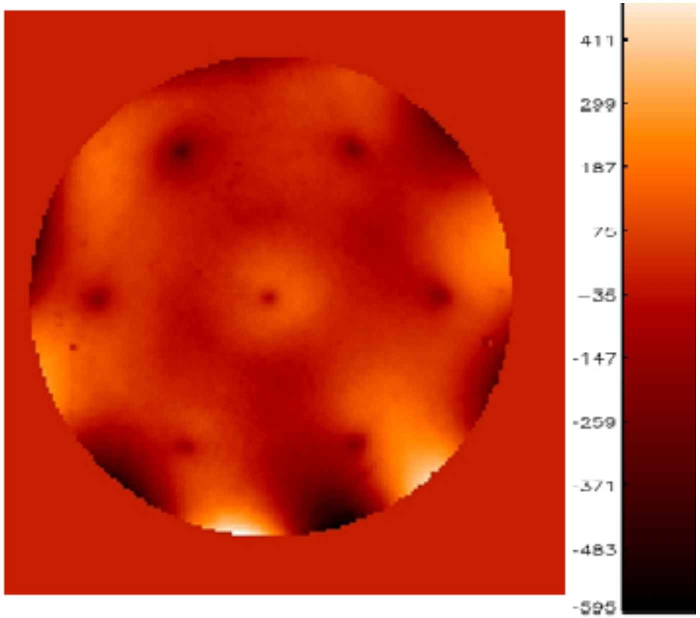
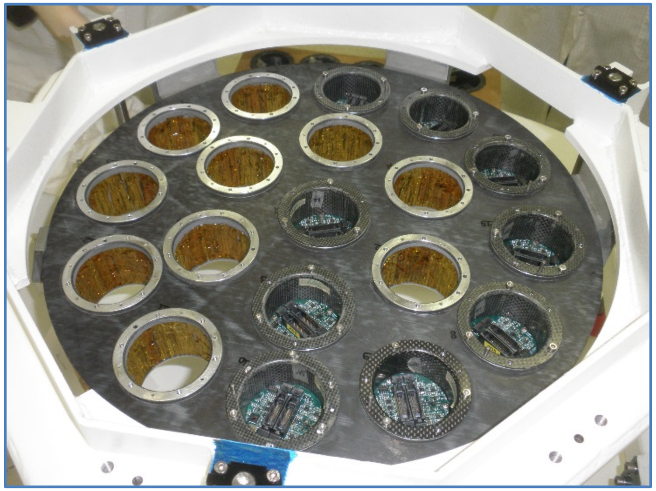
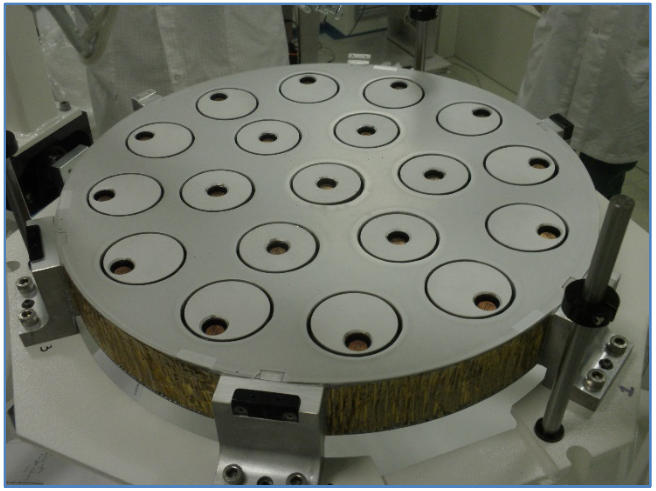


- Stability checked
- Comparable with ground based technology: flattened **30 nm RMS WFE**

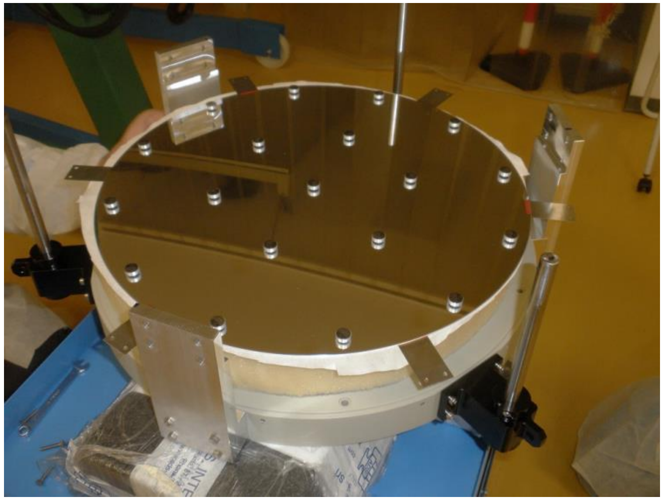
LATT - integration



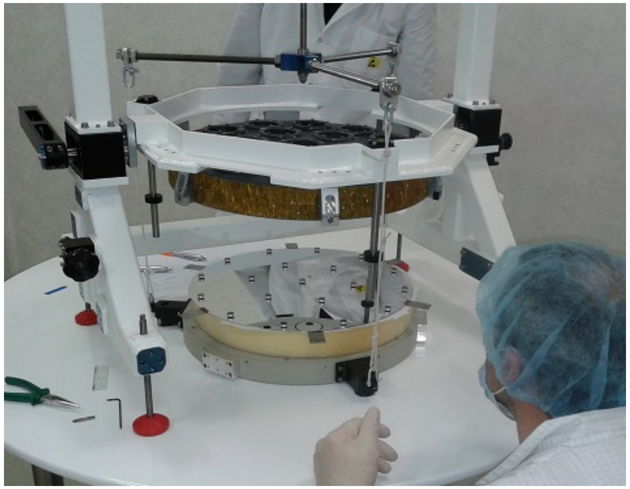
Actuator cups mounted on the aluminum honeycomb



Reference body front surface with capacitive sensor



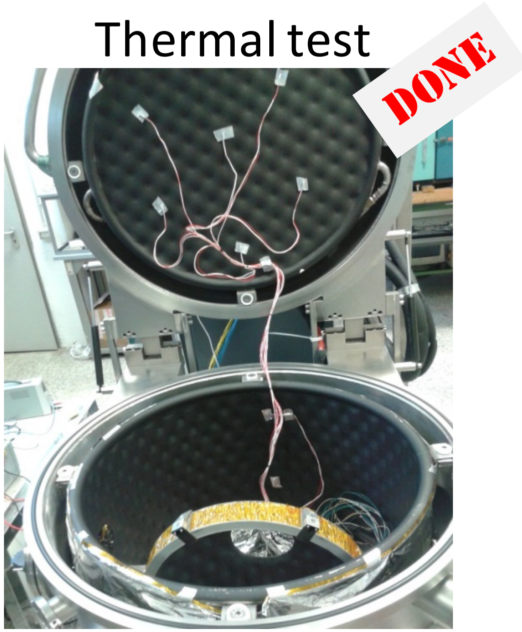
Actuator magnets glued on the shell



Shell mounted on the reference body

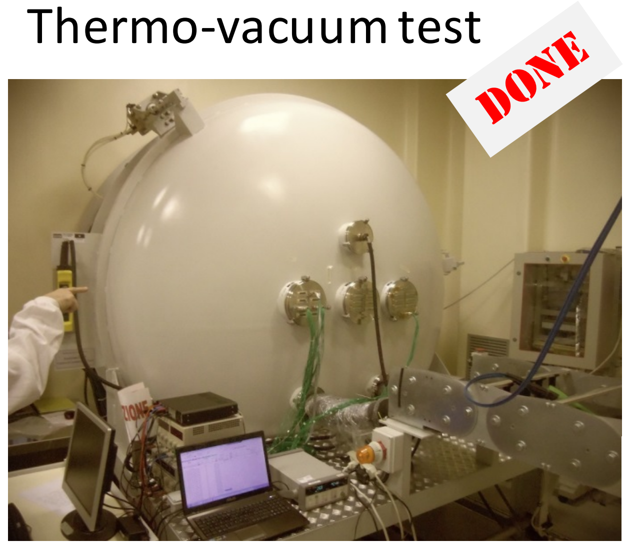
Laboratory test campaign

Thermal test



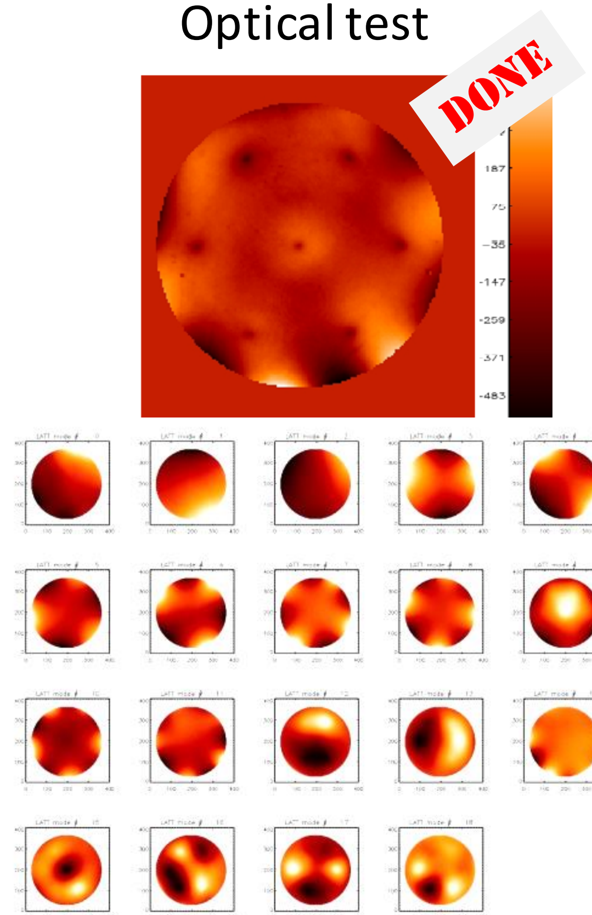
Temperature range: -25°C→55°C

Thermo-vacuum test



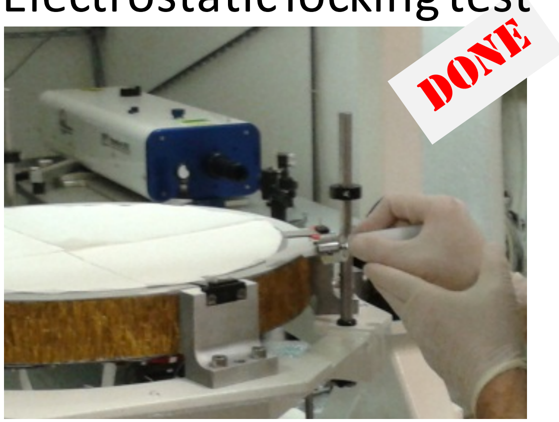
Tested @ 1e-5mbar

Optical test



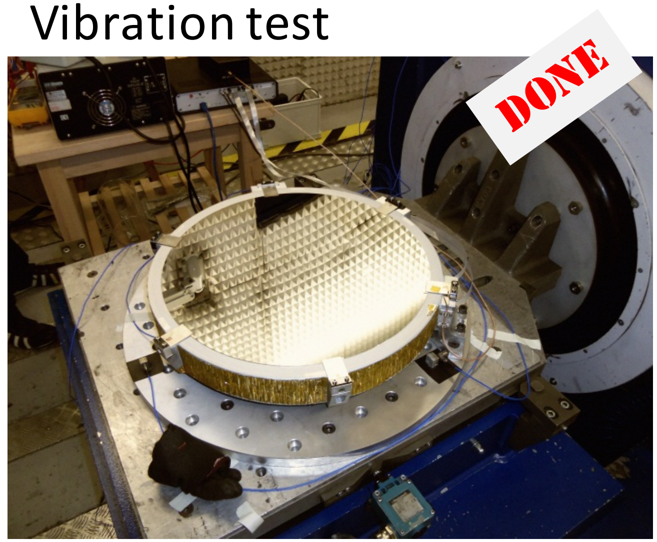
WFE comparable with AO after removing the membranes deformation (λ/6 @UV)

Electrostatic locking test



locking pressure: 600 N/m2

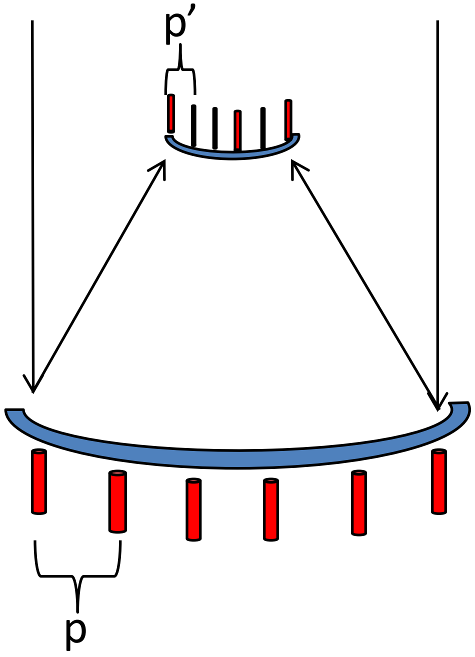
Vibration test



Max acceler.: 10g

LATT scaling: from secondary to primary

- **@same optical area:**
  - Larger actuator density is feasible (no optical compression)
  - Lower print-through (dispersed on larger area)
- **@same actuator density:**
  - Larger correction range (lower local stiffness: p vs p')
  - Lower power-budget (lower local stiffness)
- **Easier manufacturing, no miniaturization**



Why a LATT-like ***primary*** mirror is attractive

- **2 in 1: active element + lightweight < 22kg/m^2**
  - low areal density compared to existing systems
  - no need to develop novel lightweight technologies
  - **No relay, no additional optics, simple design**
- **Very low power consumption**
  - <55mw for each act
  - 15W for control electronics
- **Natural solution for segmented mirrors**
  - Alignment+phasing allocated to active optics
  - Act stroke & accuracy relax deployment tolerances
  - Complex mirror topology: local correction is easier

ESTEC/Contract No. 22321/09/NL/RA

Conclusion

- Thin shell + voice coil acts + capac.sensors: well established technology for AO mirrors

- LATT:
  - Spherical primary mirror, 40cm diam, F/6
  - 19 acts, 55mW/act
  - CFRP+AL honeycomb+ thin zerodur shell: $<22kg/m^2$

- LATT demonstrated its applicability to space:
  - ***lightweight shell*** ↔ ***launch stresses***
  - ***Low power budget*** ↔ ***shell controllability***

- LATT demonstrated the concept of:
  - **Active + lightweight space primary** (2 in 1)
  - Suitable to segmented/deployable systems

LATT: a brick for more complex systems