

Adaptive Optics Tip-Tilt Mirror developments at LESIA

D. Perret, M. Marteau, F. Chapron

P. Gigan

and P. Jagourel (GEPI)

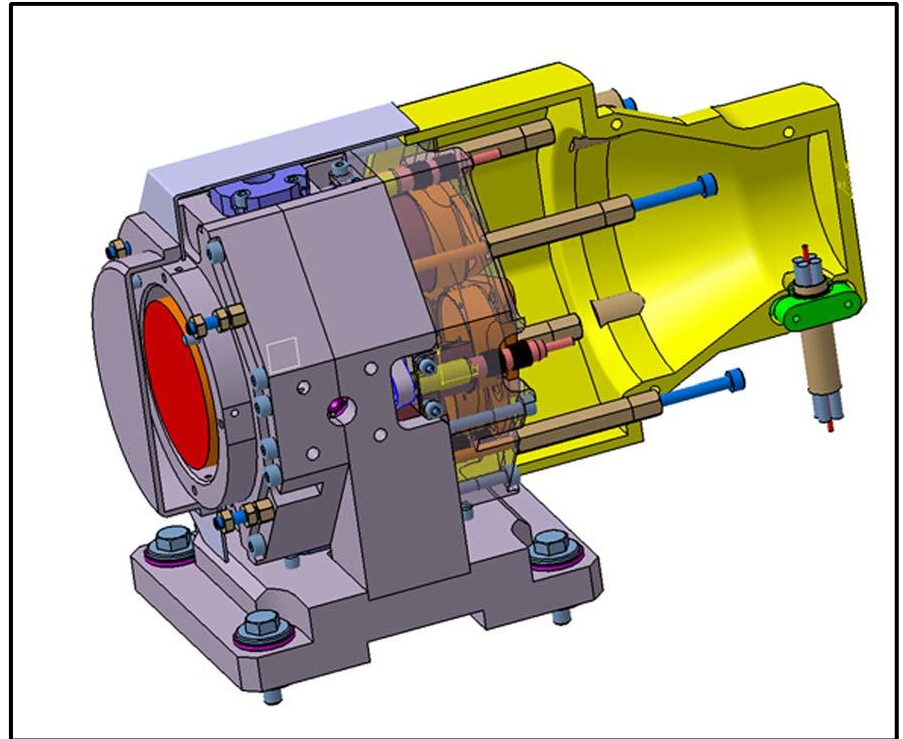
Accumulated experience in AO

- Starting with COME-ON: Tip Tilt Mirror (TTM) and On-Off modulation mirror for the IR camera
- TTM of PUEO CFHT
- TTM of NAOS VLT, ALTAIR Gemini
- TT mount of the MACAO bimorph DM (VLT)
- TT mount of SUBARU, CFHT (Megacam, Wircam)
- TT stage for the TMT AO system
- Image TTM of SPHERE + Differential TT mount
- TTM of CANARY

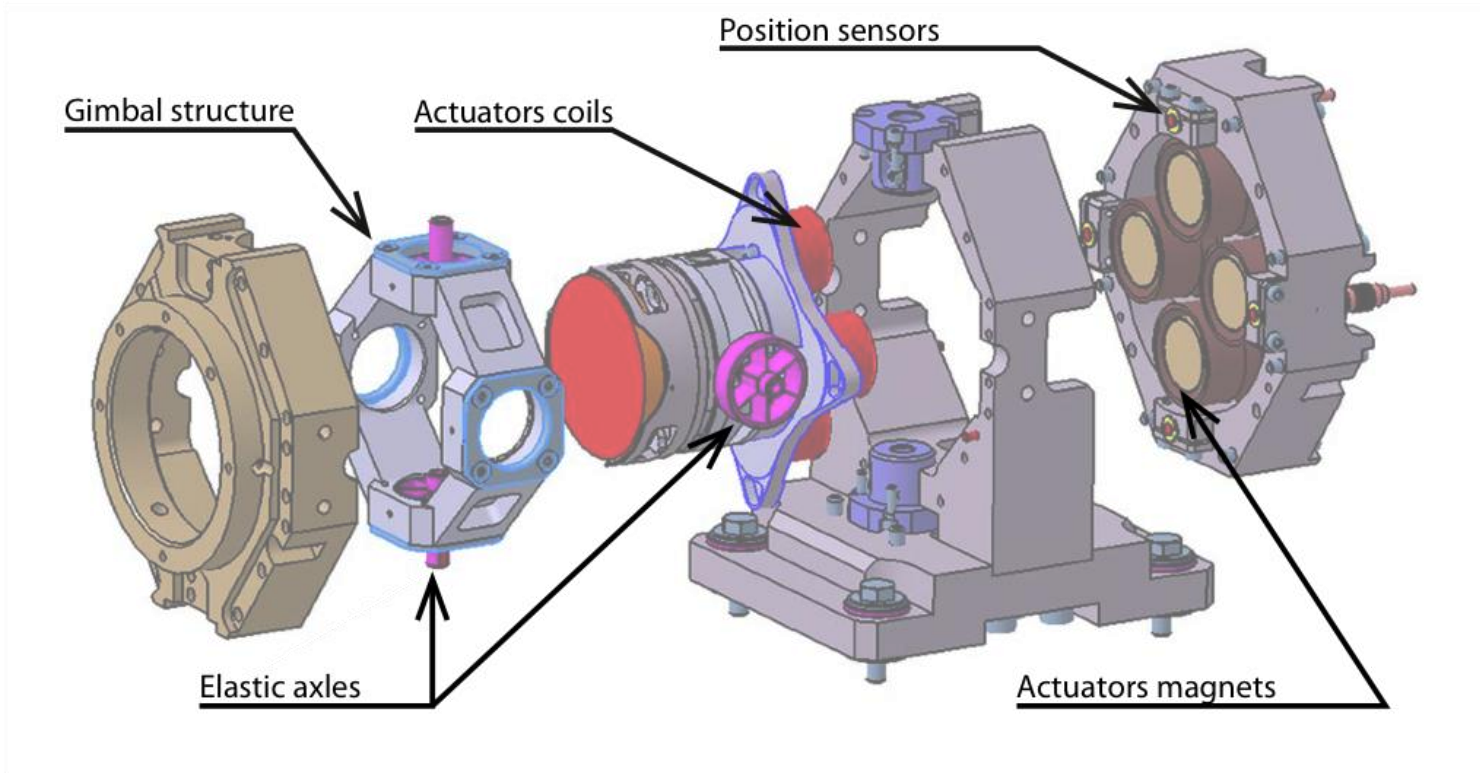
SPHERE IMAGE TTM

Specifications:

- Diameter: 56mm
- Clear aperture: 52.5mm
- Mech. stroke: 1.939mrad (pv)
- Slow resolution: 0.19 μ rad
- Fast resolution: 1.16 μ rad
- Bandwidth(-3dB): 1kHz
- Phase shift (@ 80Hz): 5°
- No resonance in the bandwidth



SPHERE IMAGE TIP TILT MIRROR



Two axes, gimbal mount, light-weighted mirror
Voice coil actuators, position sensors, closed loop control

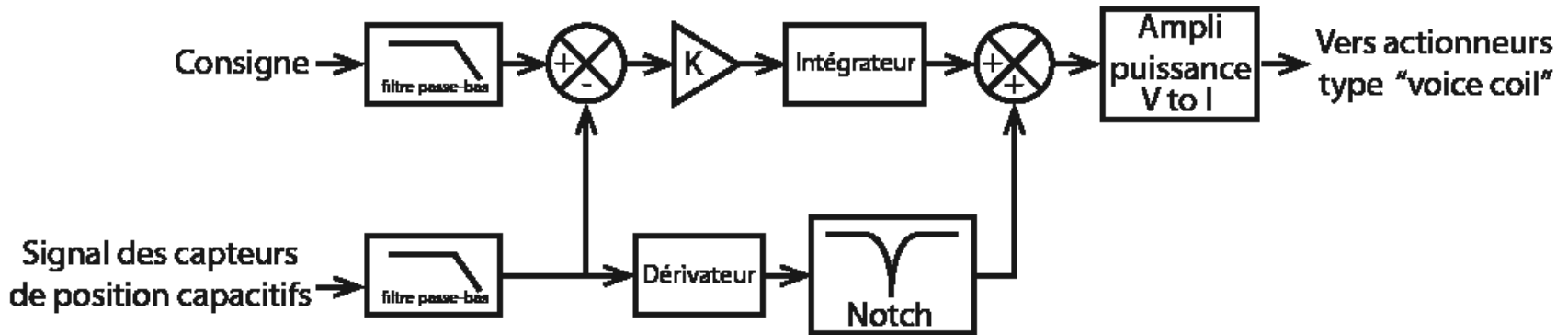
SPHERE IMAGE TTM

- Voice coil actuators from Bei Kimco Magnetics
- Home-made titanium axle: designed by LESIA, optimized with finite elements method
- Capacitive position sensors from Fogale Nanotech
 - Bandwidth: 3kHz
 - Noise: $0.12\mu\text{m}$ (pV)
 - Linearity: better than 0.1% of measurement range (1mm)



SPHERE IMAGE TIP TILT MIRROR

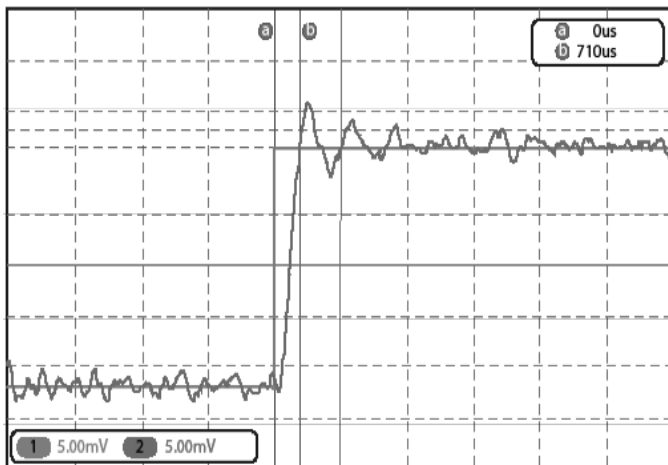
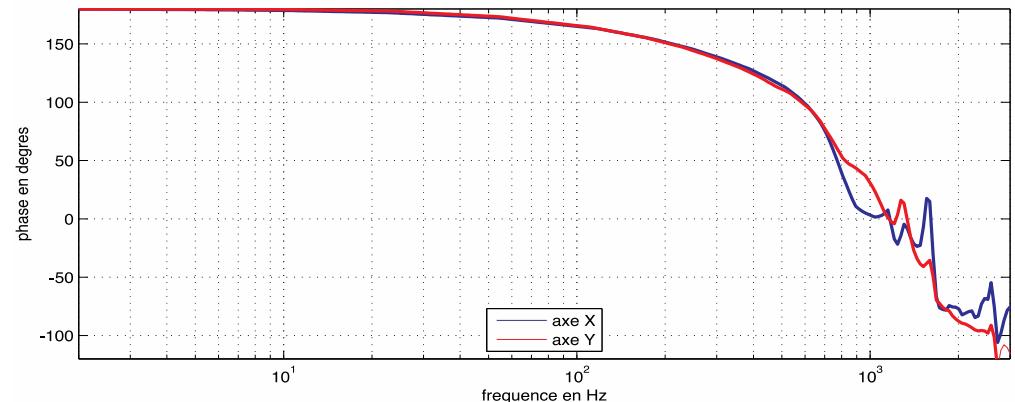
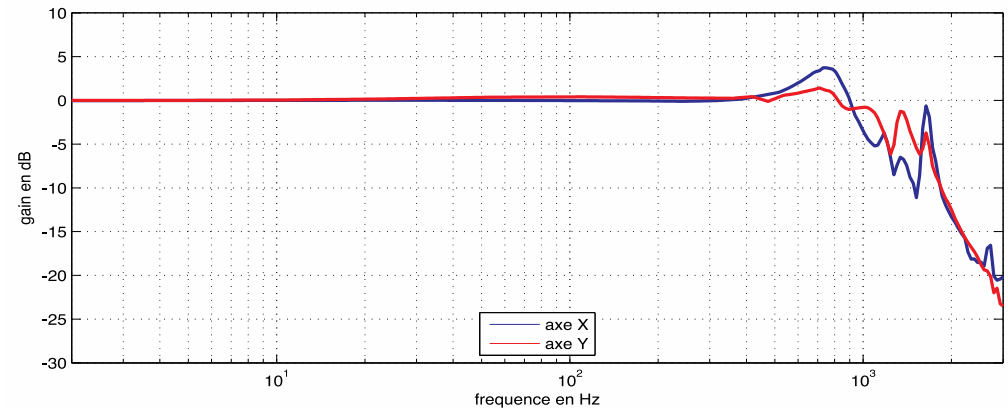
Home-made servo-control electronics:
Analog PID + notch filter to kill the first resonance



SPHERE IMAGE TIP TILT MIRROR

Measured performances:

- Rising time : $590\mu\text{s}$ on one axis, $710\mu\text{s}$ on the other
- Bandwidth: 1.1kHz on one axis, 870Hz on the other
- Noise: $0.1\mu\text{rad rms}$
- Phase shift: 14° at 80Hz



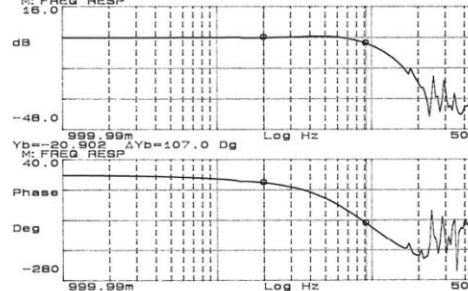
TMT TT stage

- For TMT : 4000-actuator DM (40kg) mounted on a high bandwidth TT stage
- Studies at LESIA and GEPI (Observatoire de Paris) in collaboration with CILAS
- Prototype manufactured and tested by CILAS



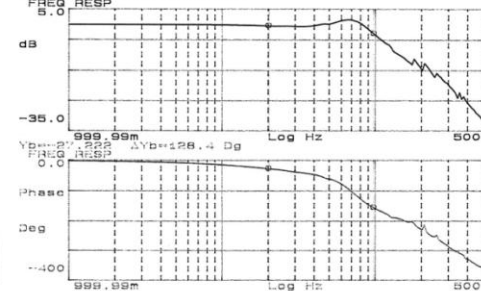
Measurement:

X=20.098 Hz AX=71.88 Hz
Yb=-20.902 AYb=107.0 Dg
M: FREQ RESP



Tilt Y: 92 Hz @ -3 dB (21° phase rotation @ 20 Hz)
55° phase margin & 13 dB gain margin in open loop

X=98.819 Hz AX=77.88 Hz
Yb=-20.902 AYb=128.4 Dg
M: FREQ RESP



Tilt X: 98 Hz @ -3 dB (27° phase rotation @ 20 Hz)
56° phase margin & 9.8 dB gain margin in open loop

Closed Loop responses to swept sine