Large micromirror array for Multi-Object Spectroscopy in space

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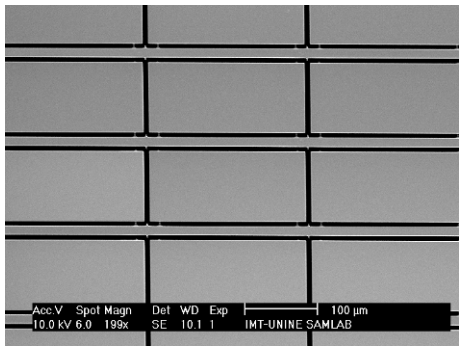
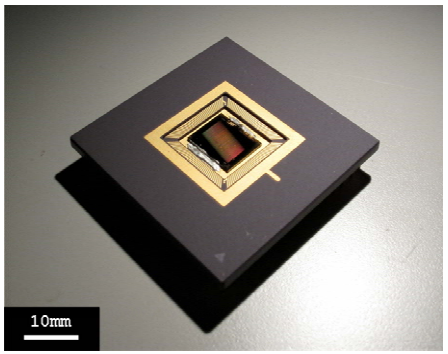
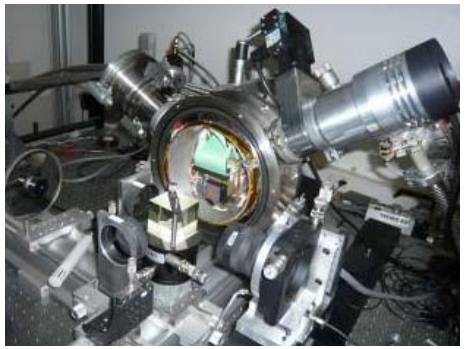
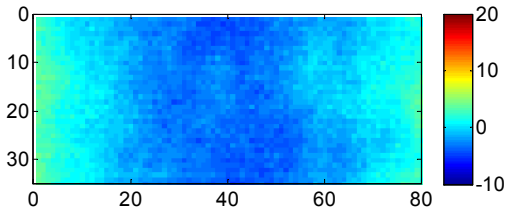






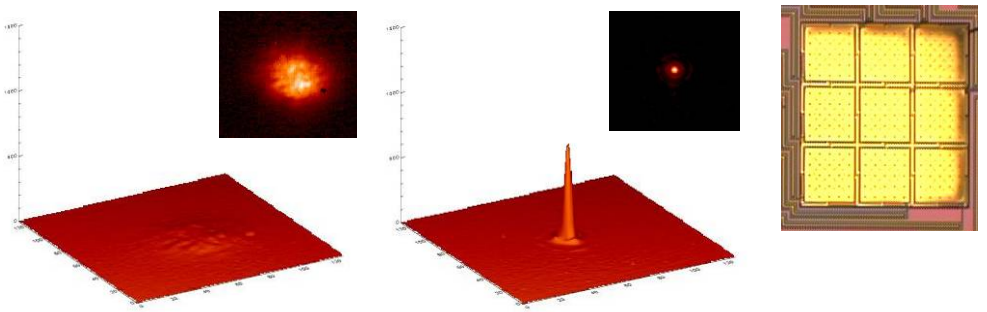


Instrumental needs

- Instrumental needs using micro-opto-electro-mechanical systems (MOEMS)

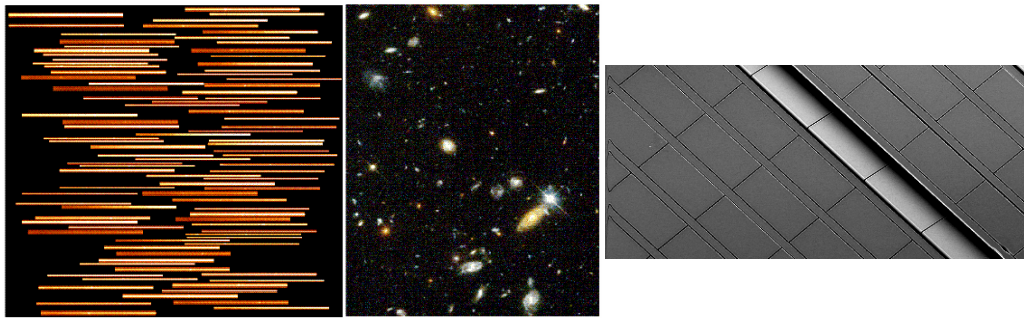
Phase

- Wavefront control
  - Deformable mirrors



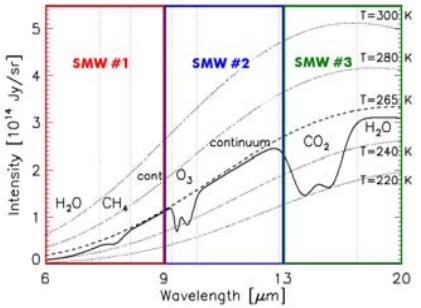
Intensity

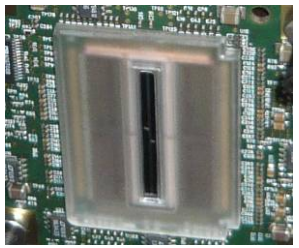
- Object selection
  - Programmable slits



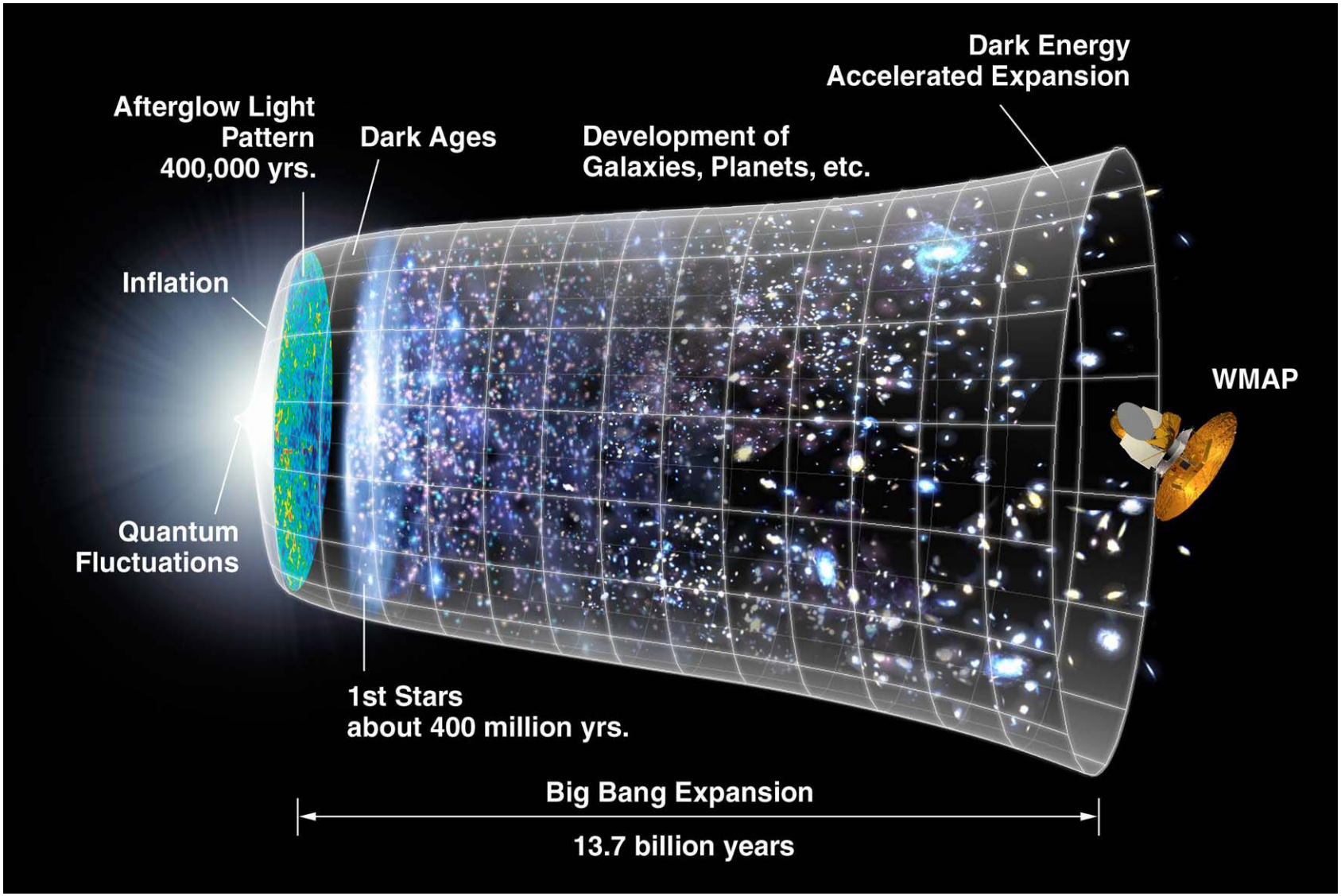
Wavelength

- Spectral domain application
  - Programmable gratings

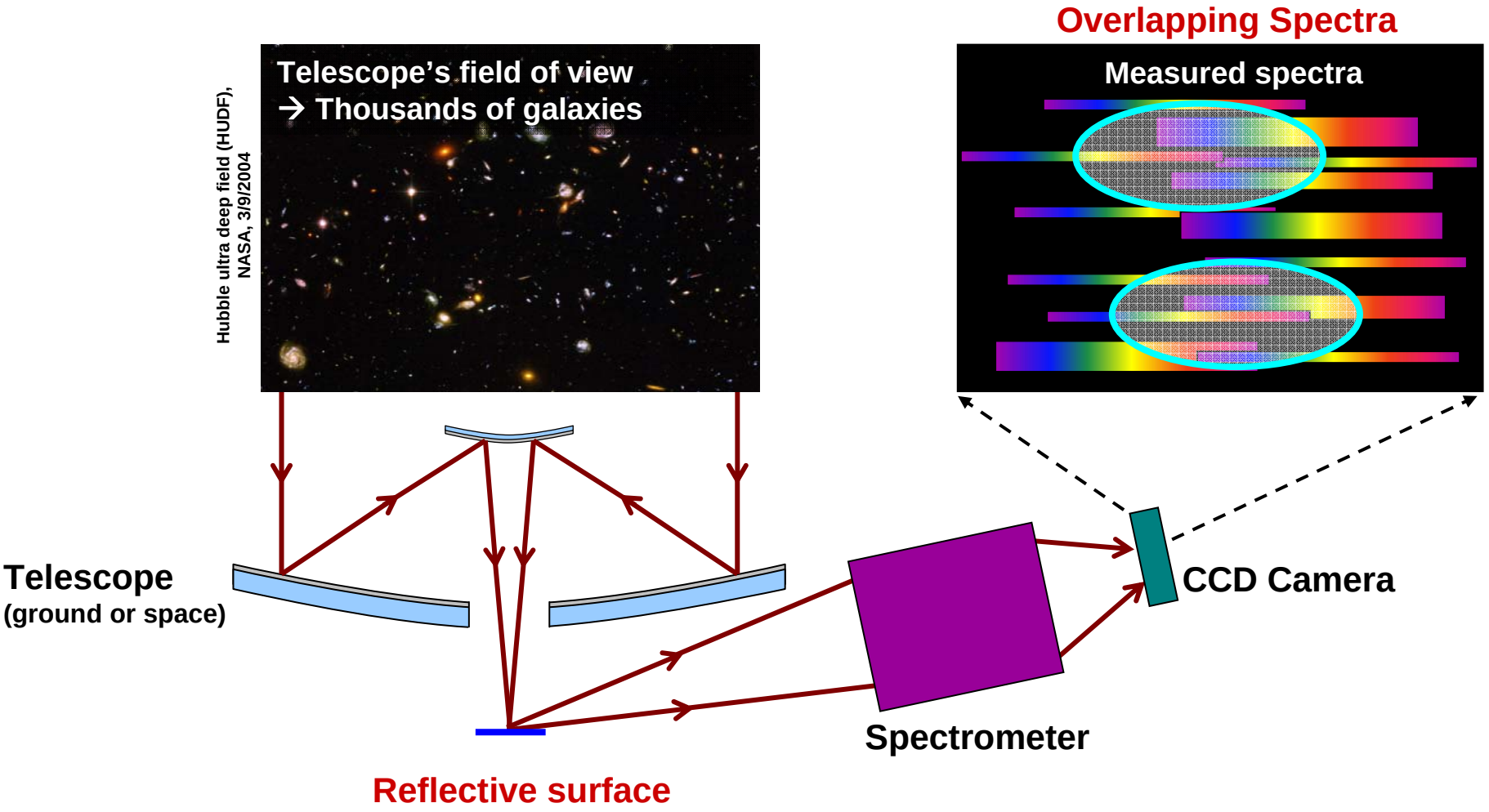




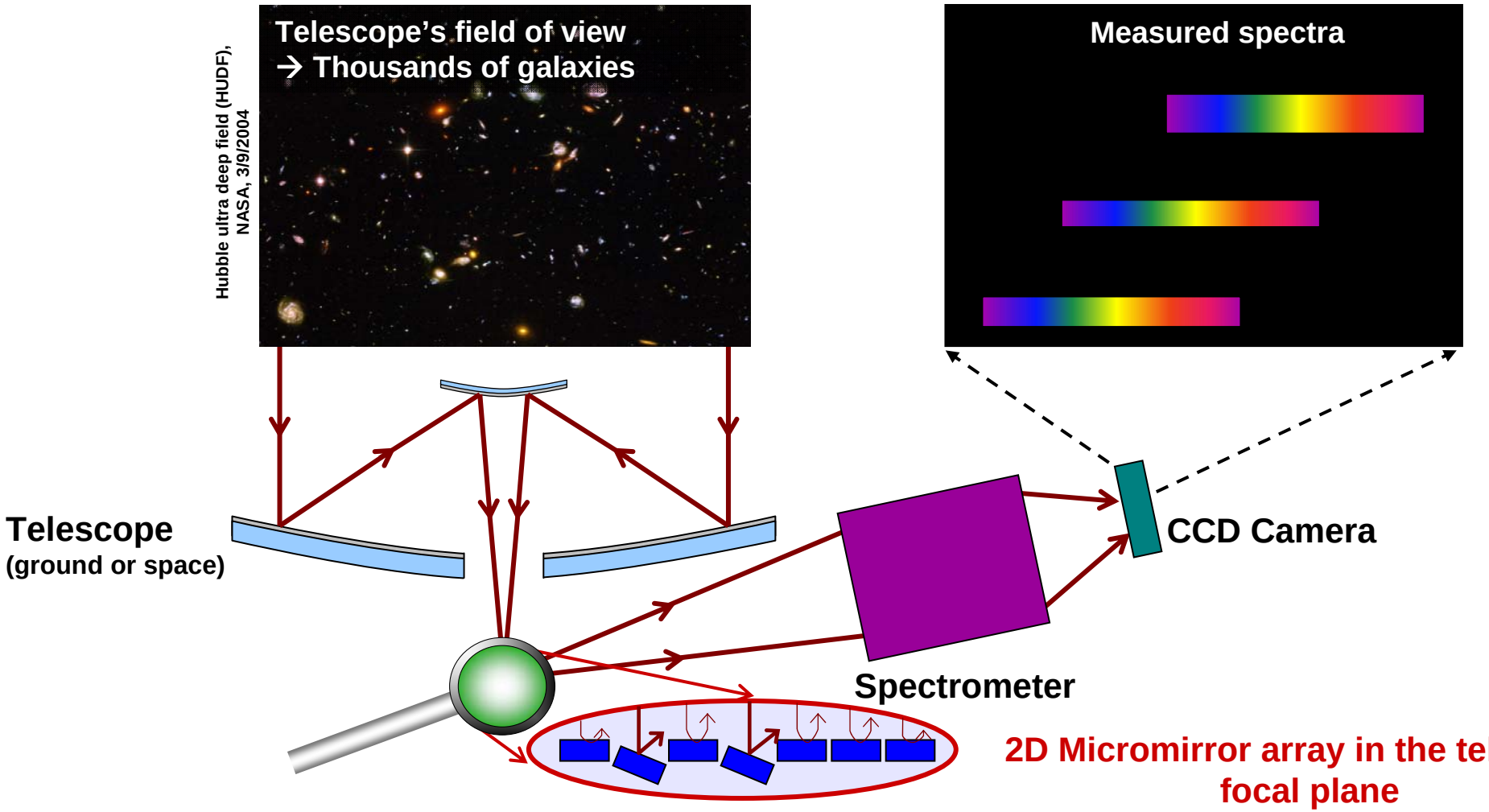
Universe expansion



Multi-Object Spectroscopy (MOS)



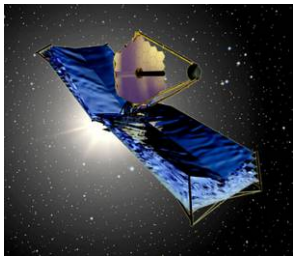
Multi-Object Spectroscopy (MOS)

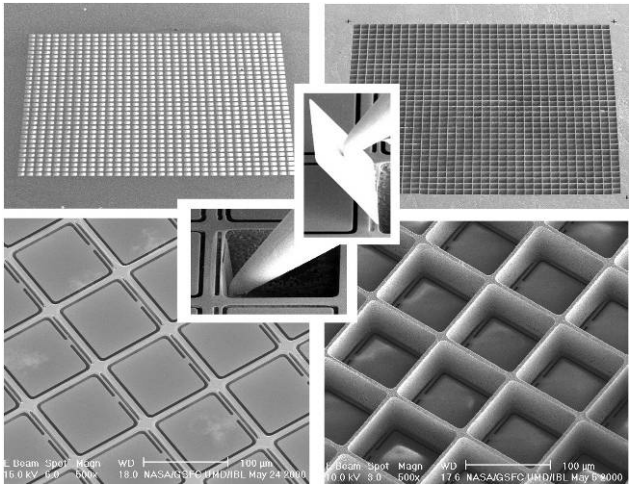


MOEMS developments

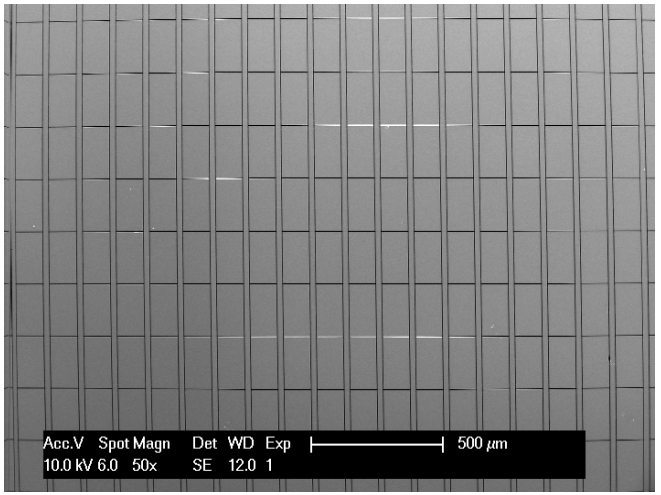
- NASA-GSFC Micro-shutters (USA)

Selected for JWST NIRSpec





- LAM-IMT Micro-mirrors (Europe)

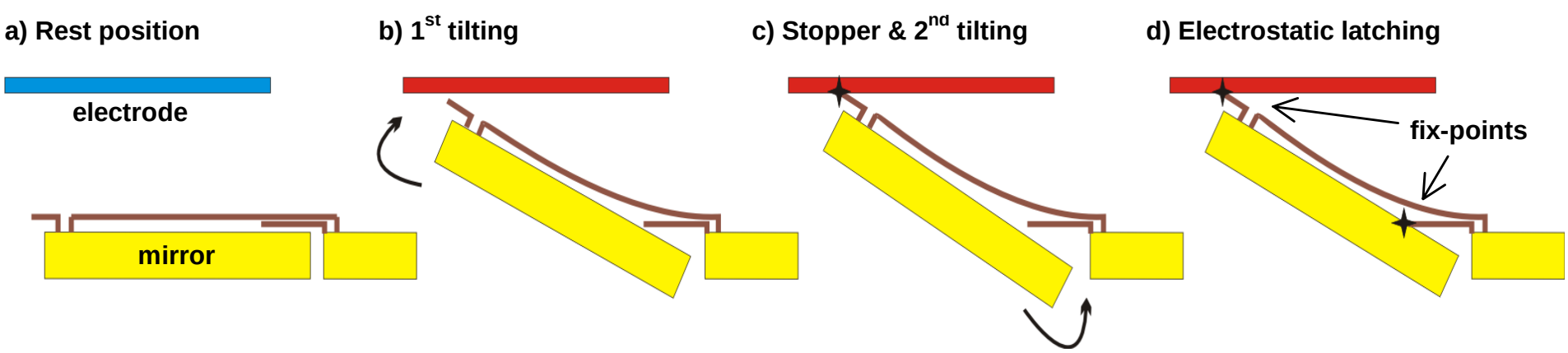


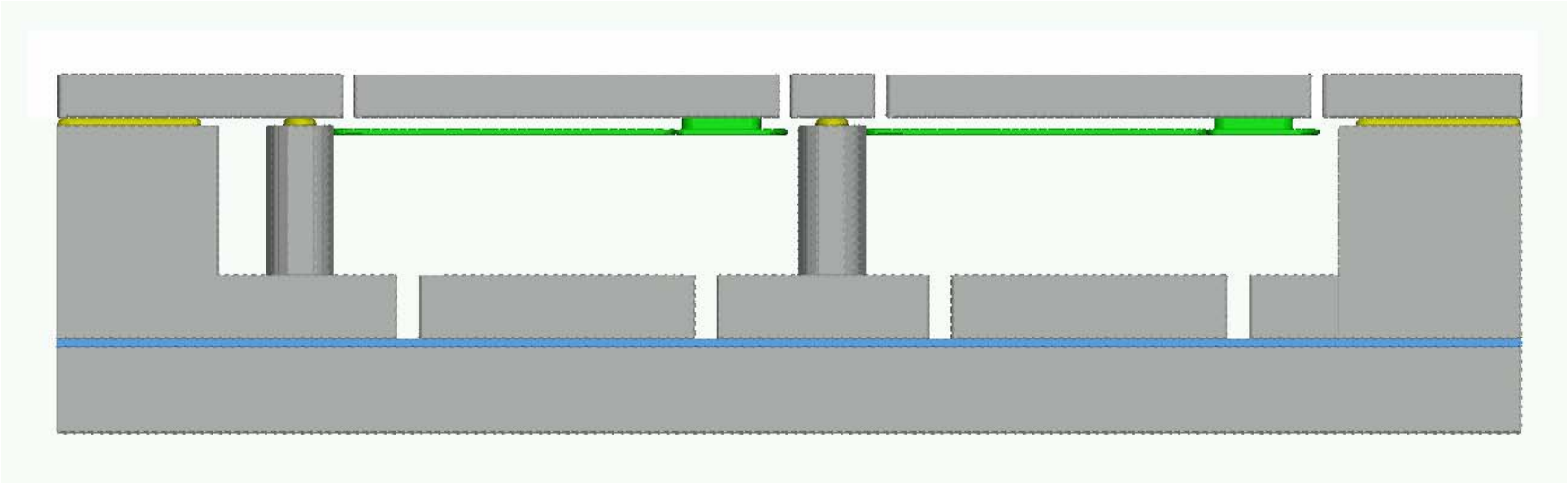
MIRA: the requirements

- Initial list of requirements
  - Mirror size of 100 x 200 μm^2
  - Individual addressing of the micromirrors
  - High contrast of at least 1000:1
  - 20° mechanical tilt angle
  - Uniform tilt angle over the whole array
  - Fill factor of more than 90% (if possible >95% in one direction
  - Wavelength range from visible to infrared
  - Optically flat mirrors in operation $< \lambda/20$ with $\lambda = 1$ µm
  - Cryogenic operating temperature (<100K, 30K goal)

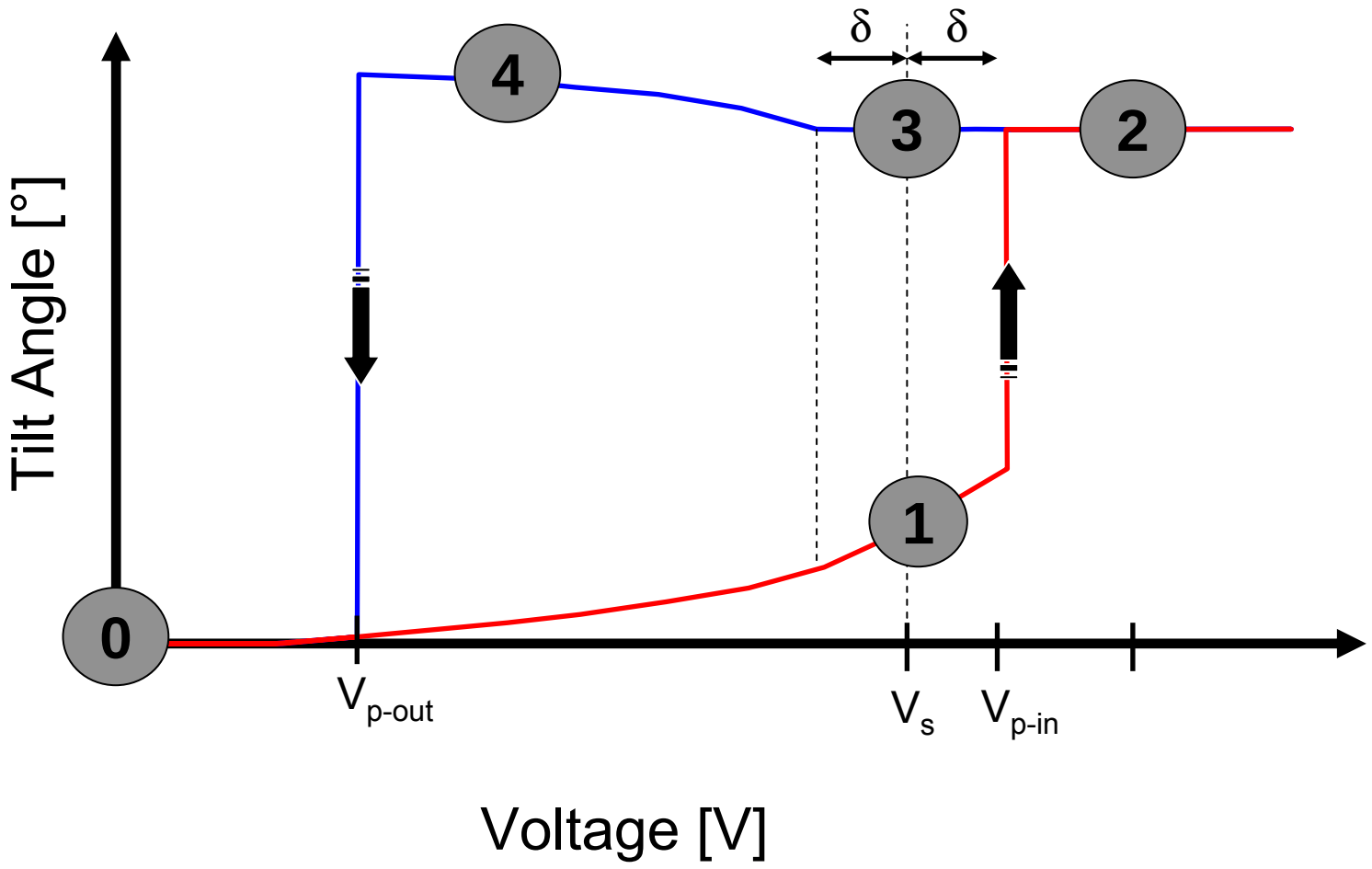
MIRA: the principle

- Concept and design

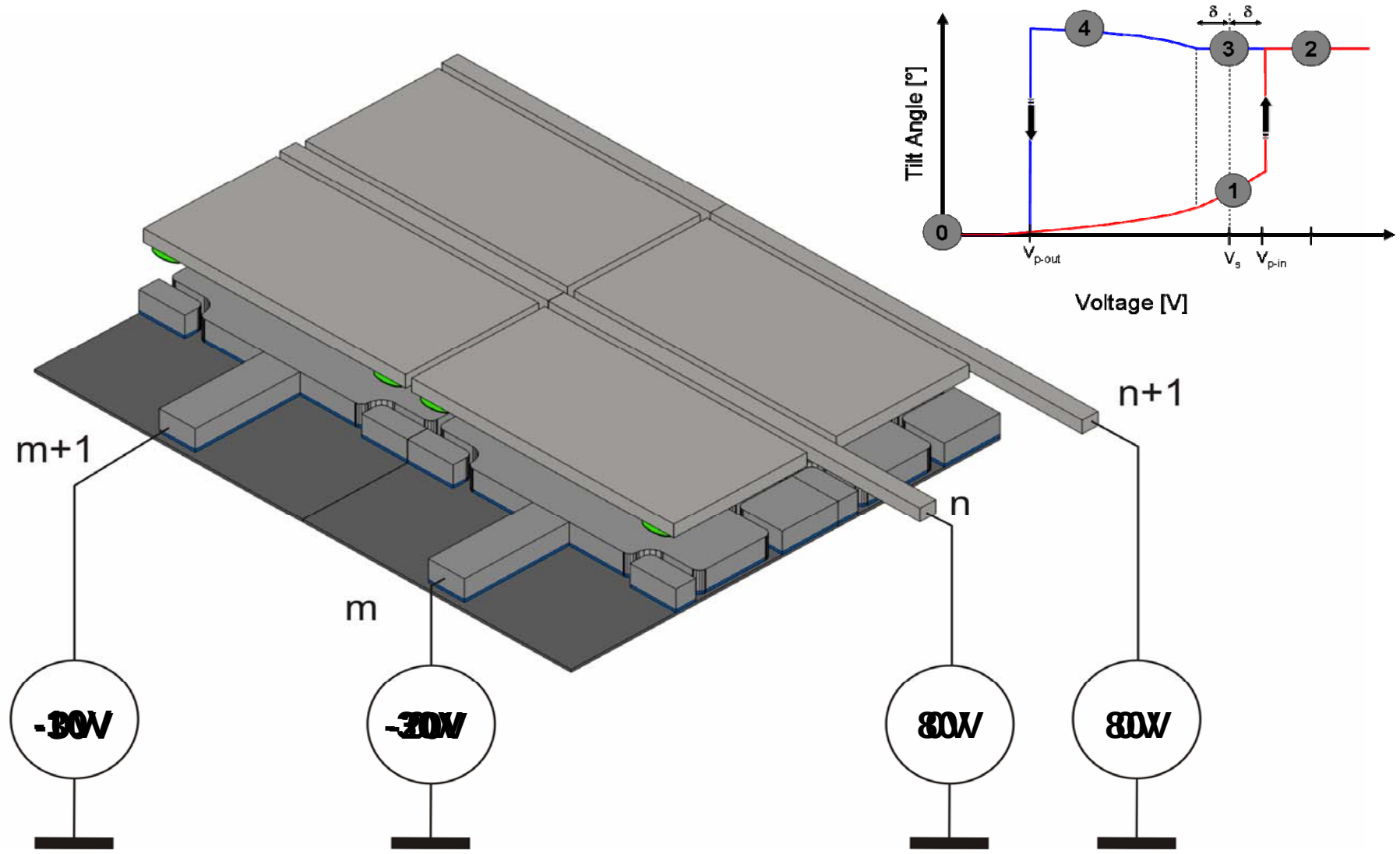




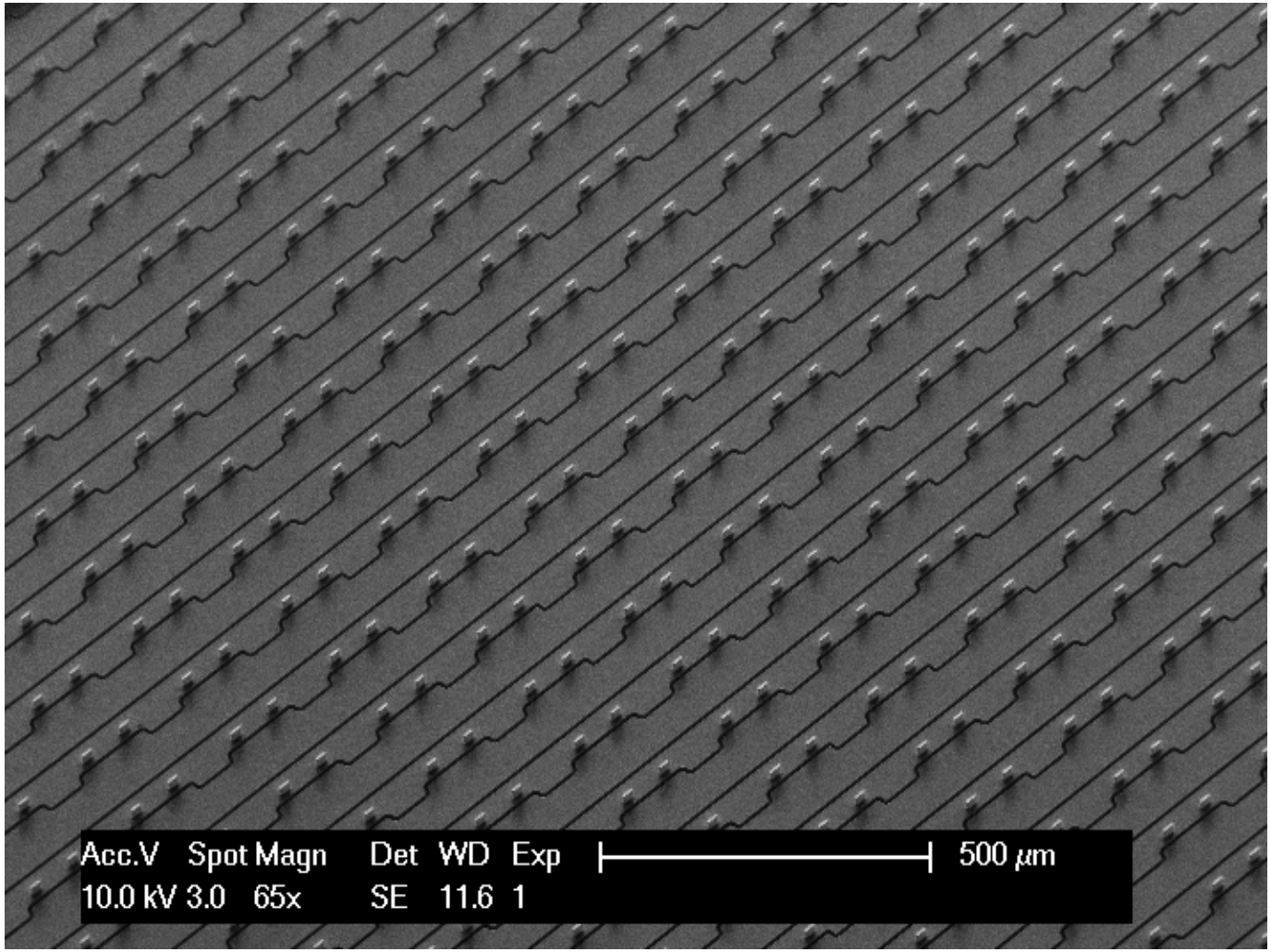
Line-column addressing concept



Line-column addressing concept



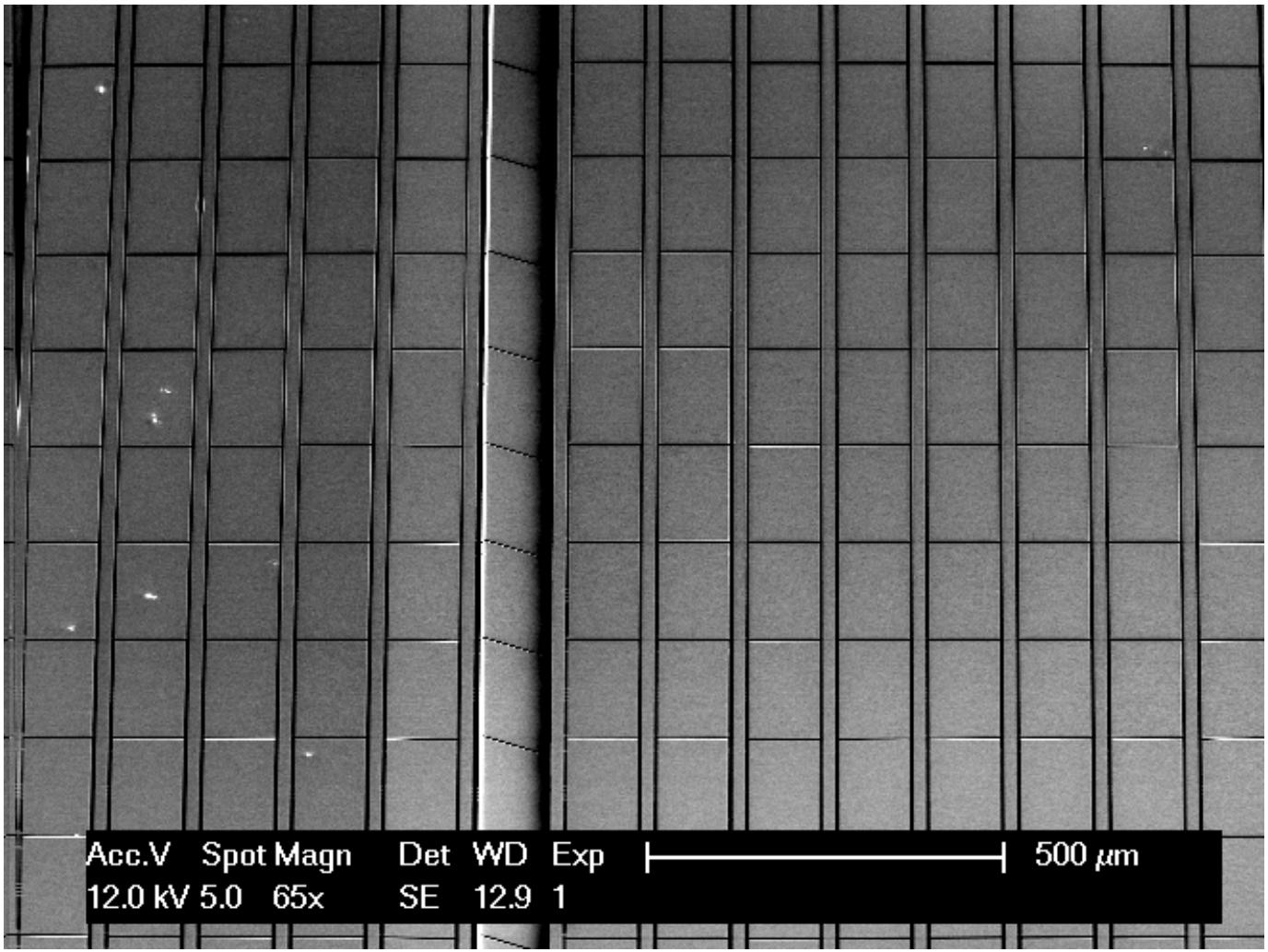
MIRA: the realization



MIRA: the realization

100x200 µm²

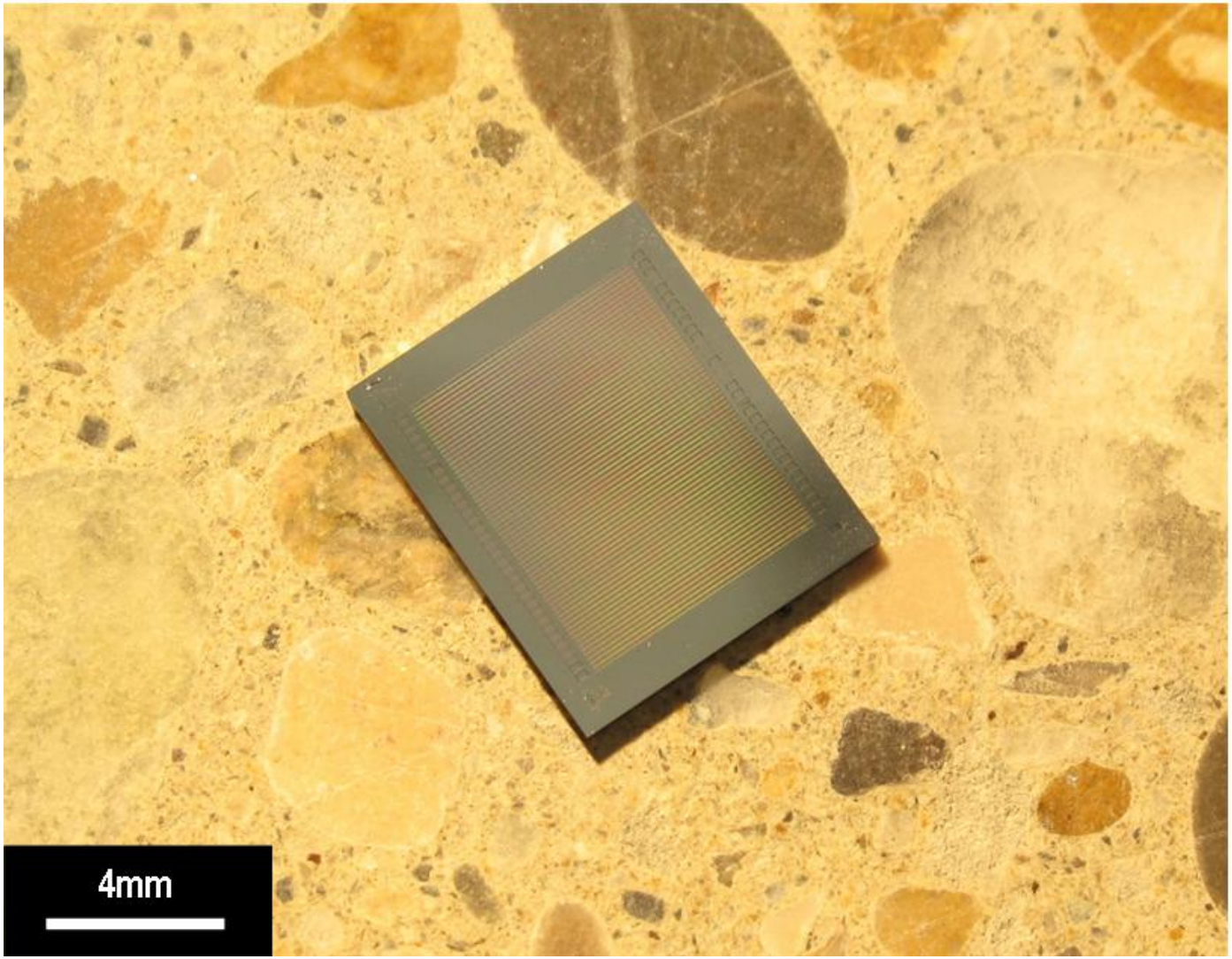
mirrors



MIRA: the realization

2048 mirrors

(64 x 32)



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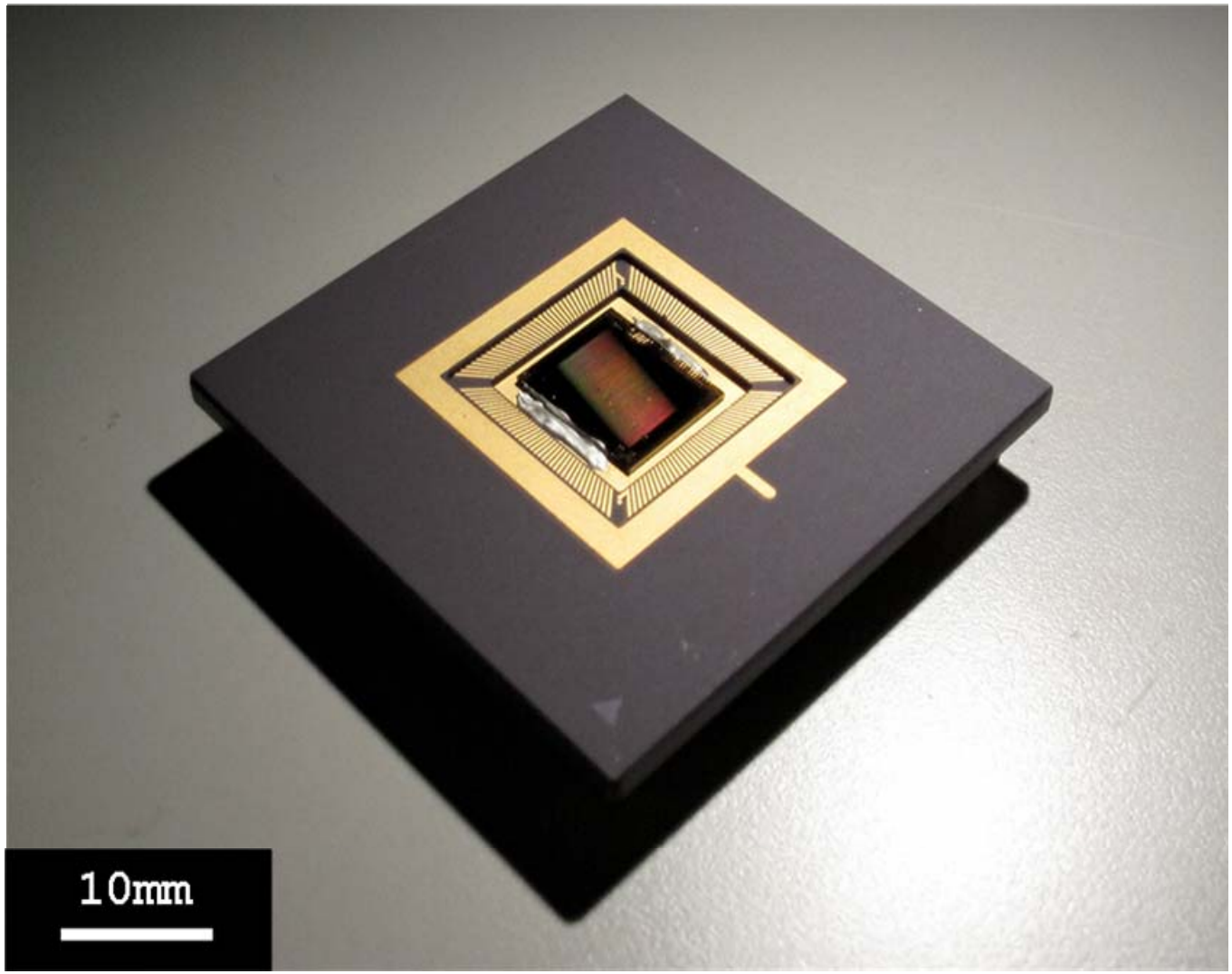
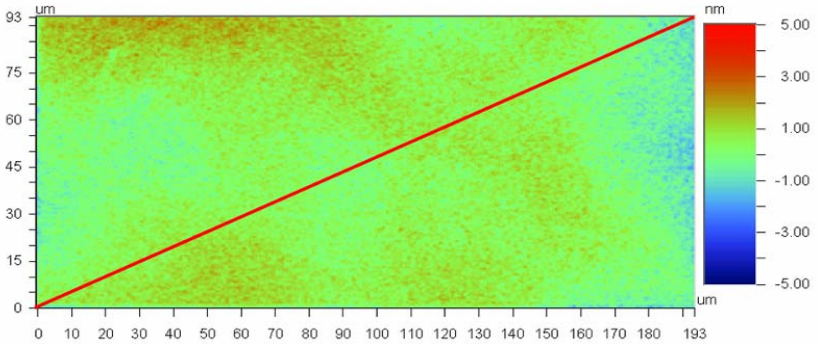
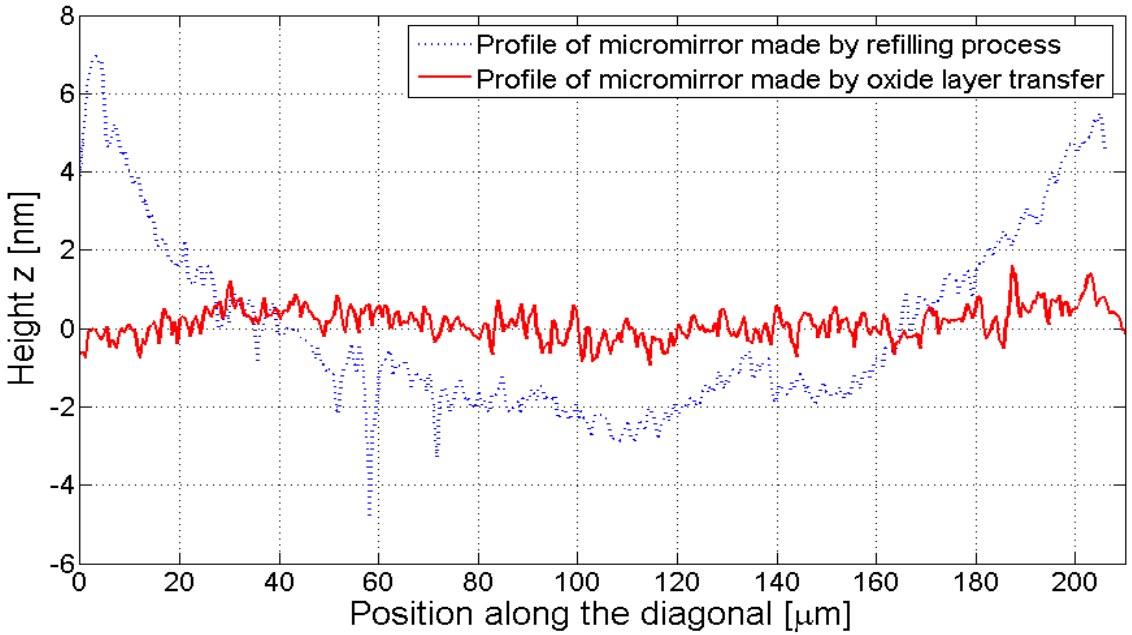


Micromirror surface quality

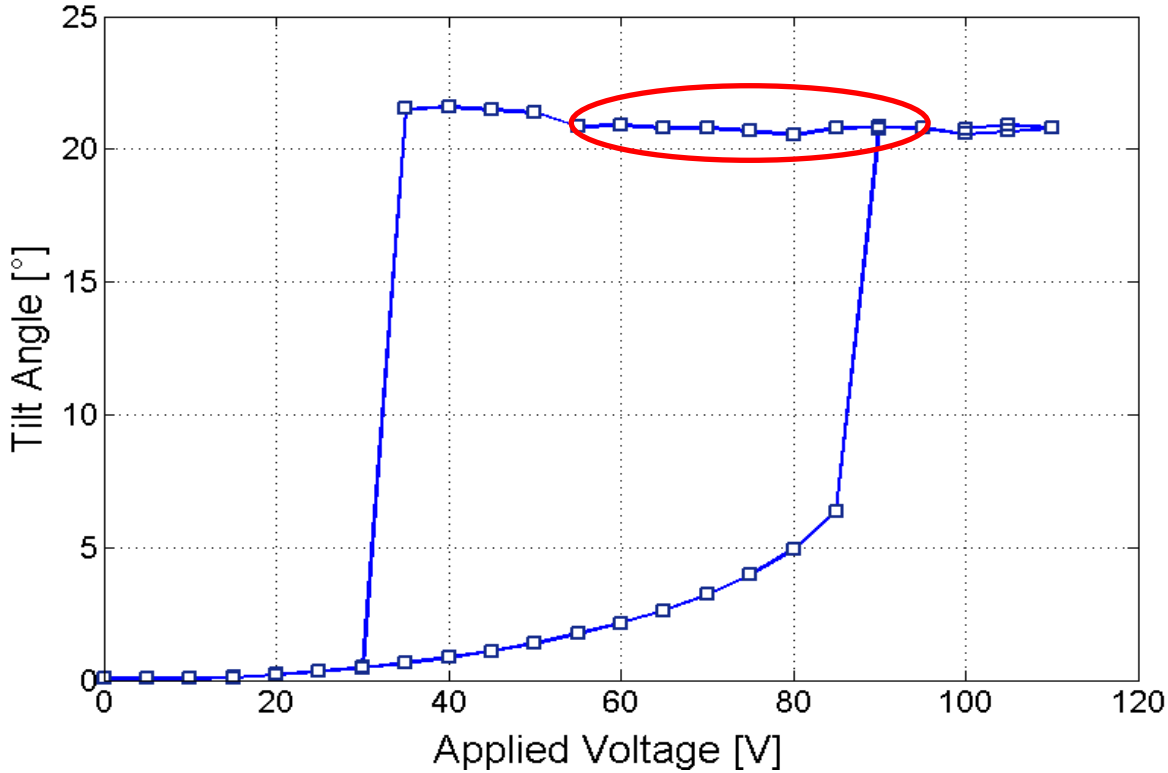


Mirror size 100 x 200 µm²



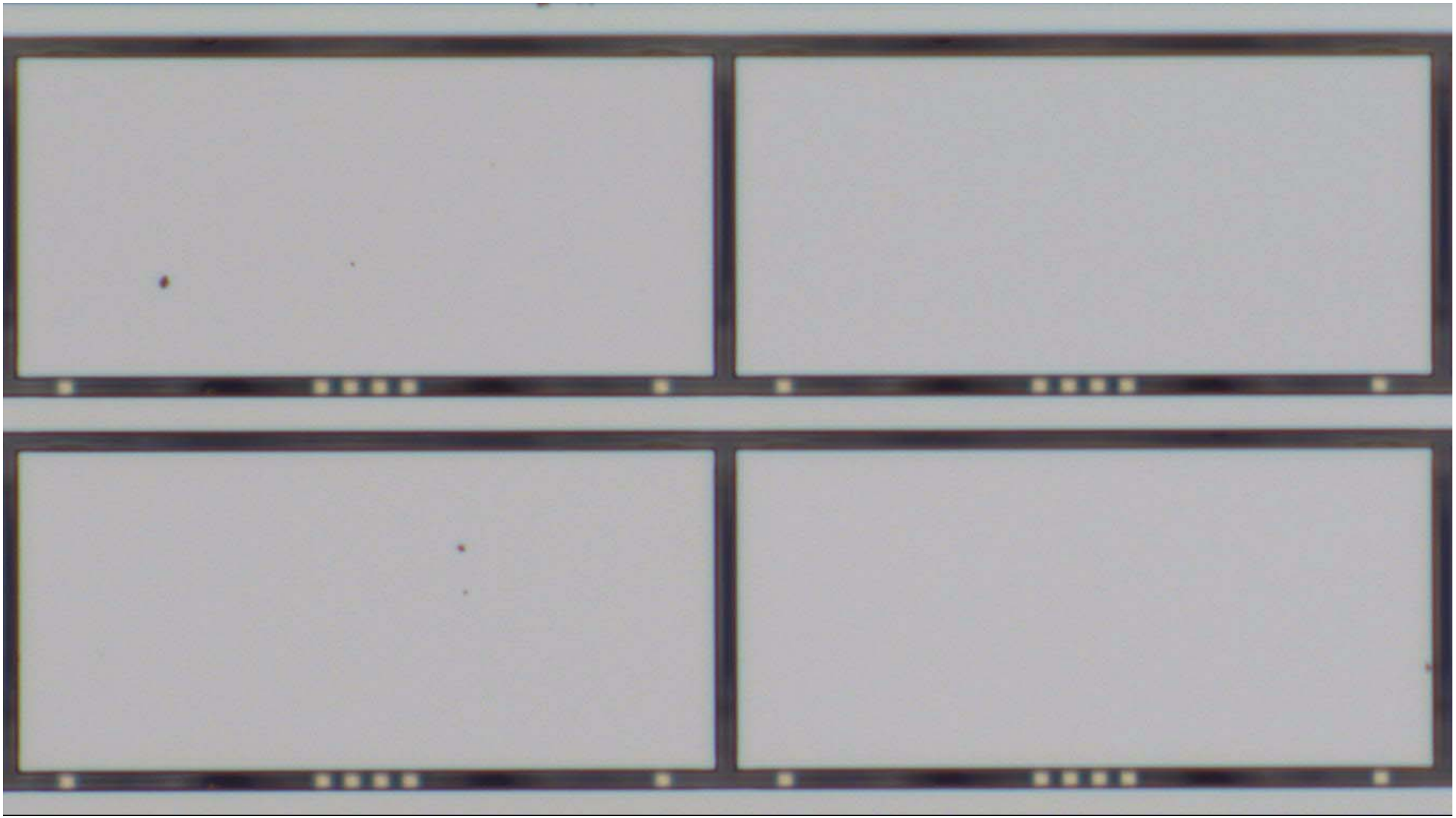
Micromirror deformation better than 10 nm Peak-to-Valley

Characterization Voltage – Tilt angle



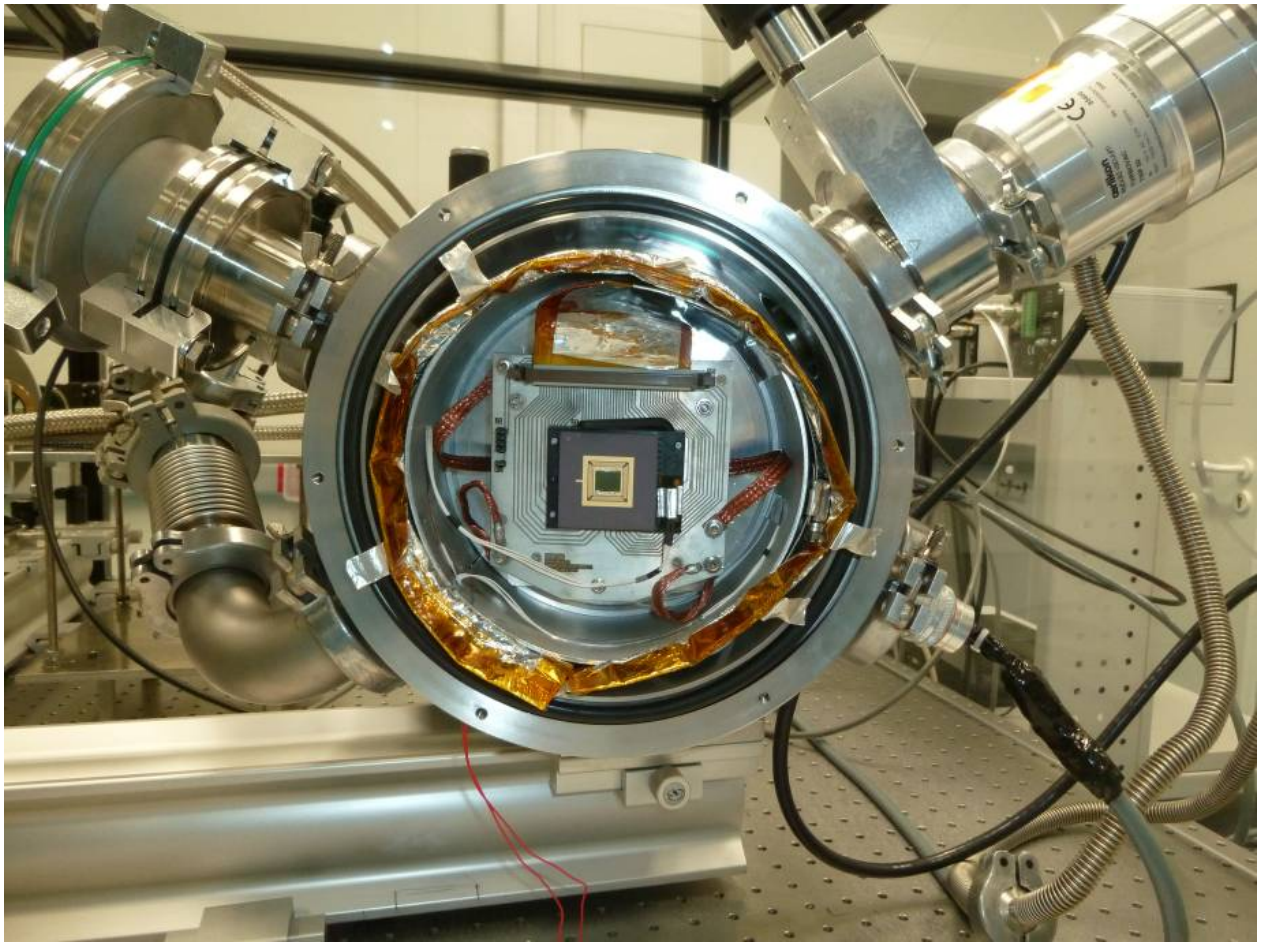
- White light interferometer measurement
- Pull-in at around 90V
- Tilt angle constant for > 90V ⇨ Beams play their role
- Tilt angle constant between 90 to 55 V
- Pull-out at around 35V

Line-column addressing demonstration



Cryogenic test

- Specific cryo chamber developped, compatible with our interferometric bench
- Vacuum 10^{-6} mbar
- Cryogenic temperatures



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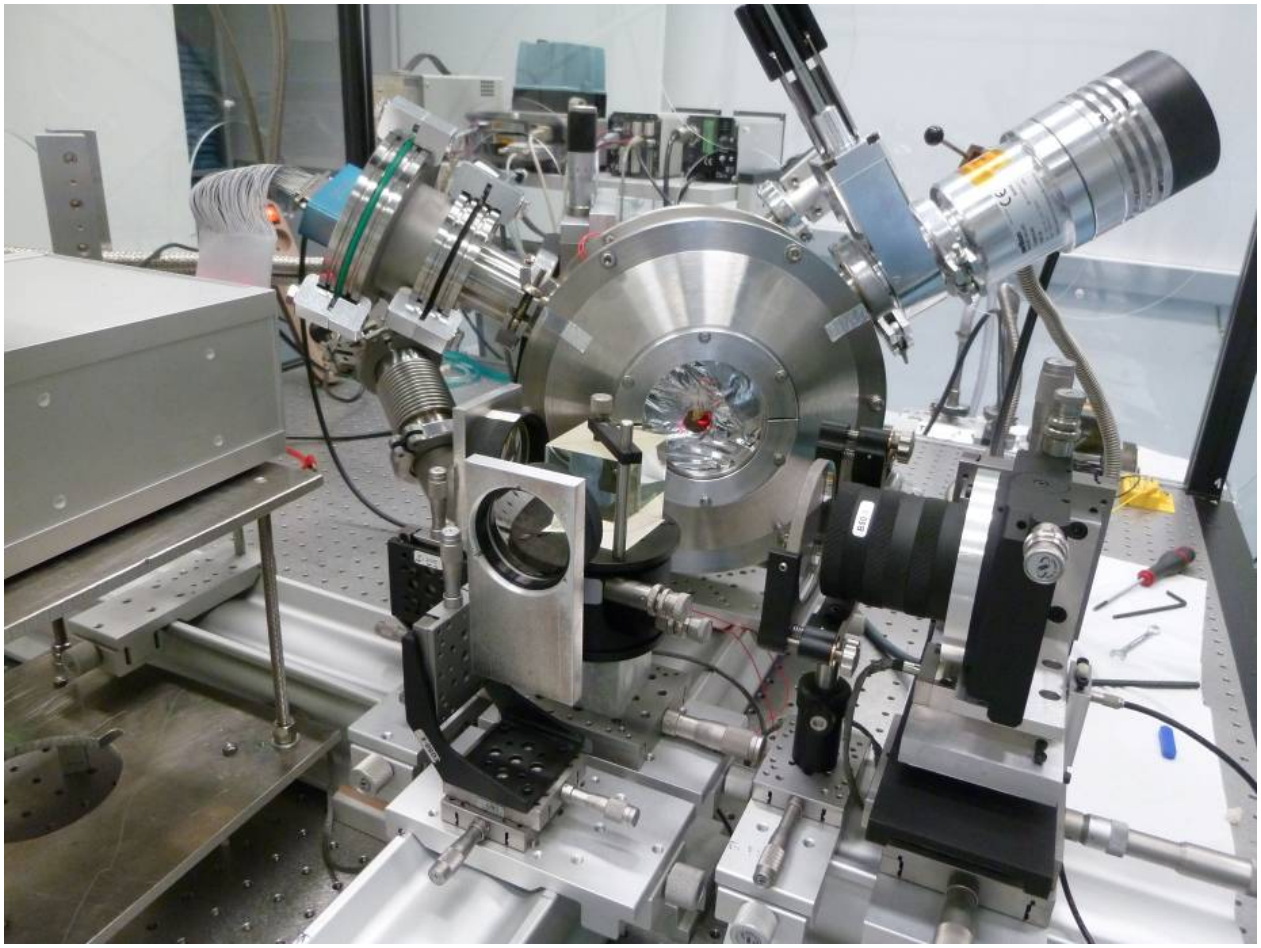


Cryogenic test

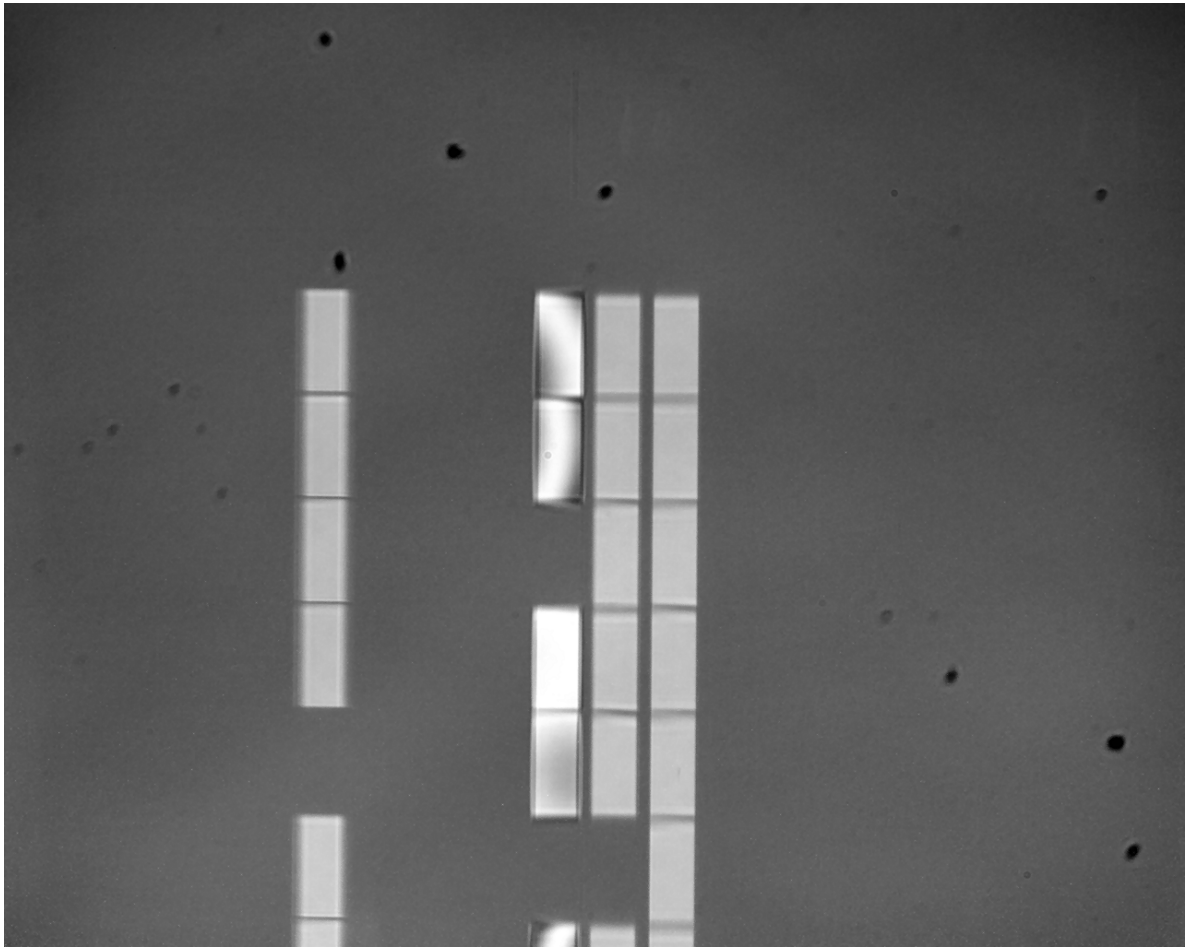
162K

0 V

Cryogenic test

162K

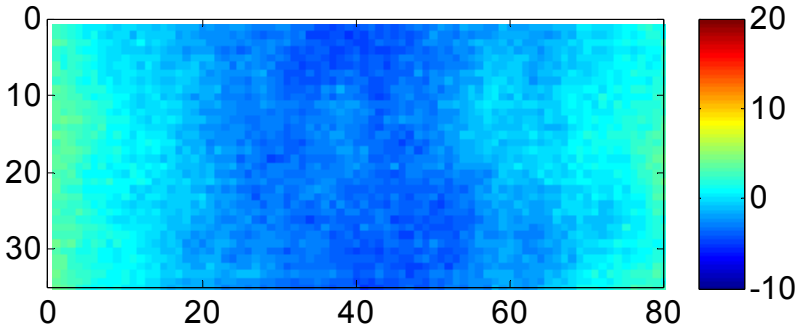
148 V



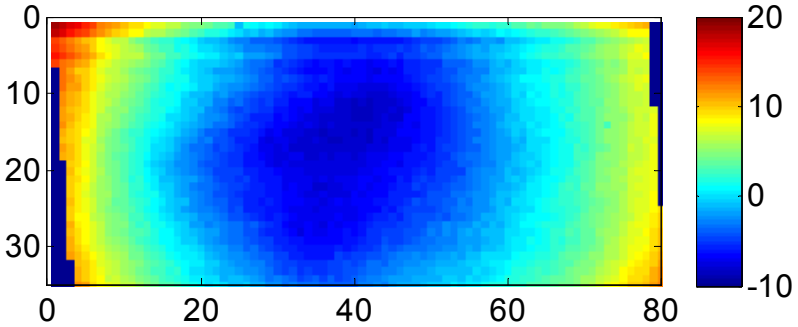
Cryogenic test: mirror surface

Surface quality measurement in the ON position

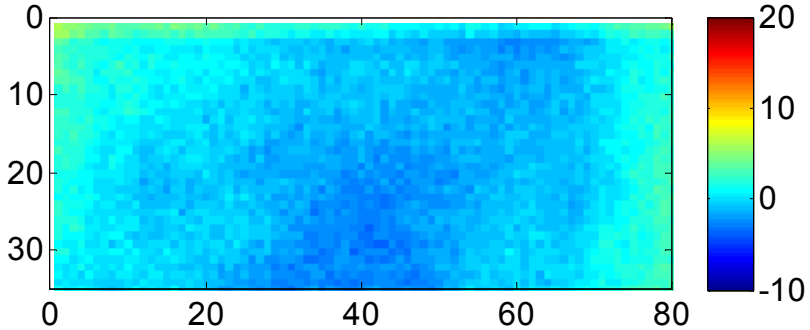
293 K
135 V
9.8 nm PtV



162 K
148 V
27.2 nm PtV

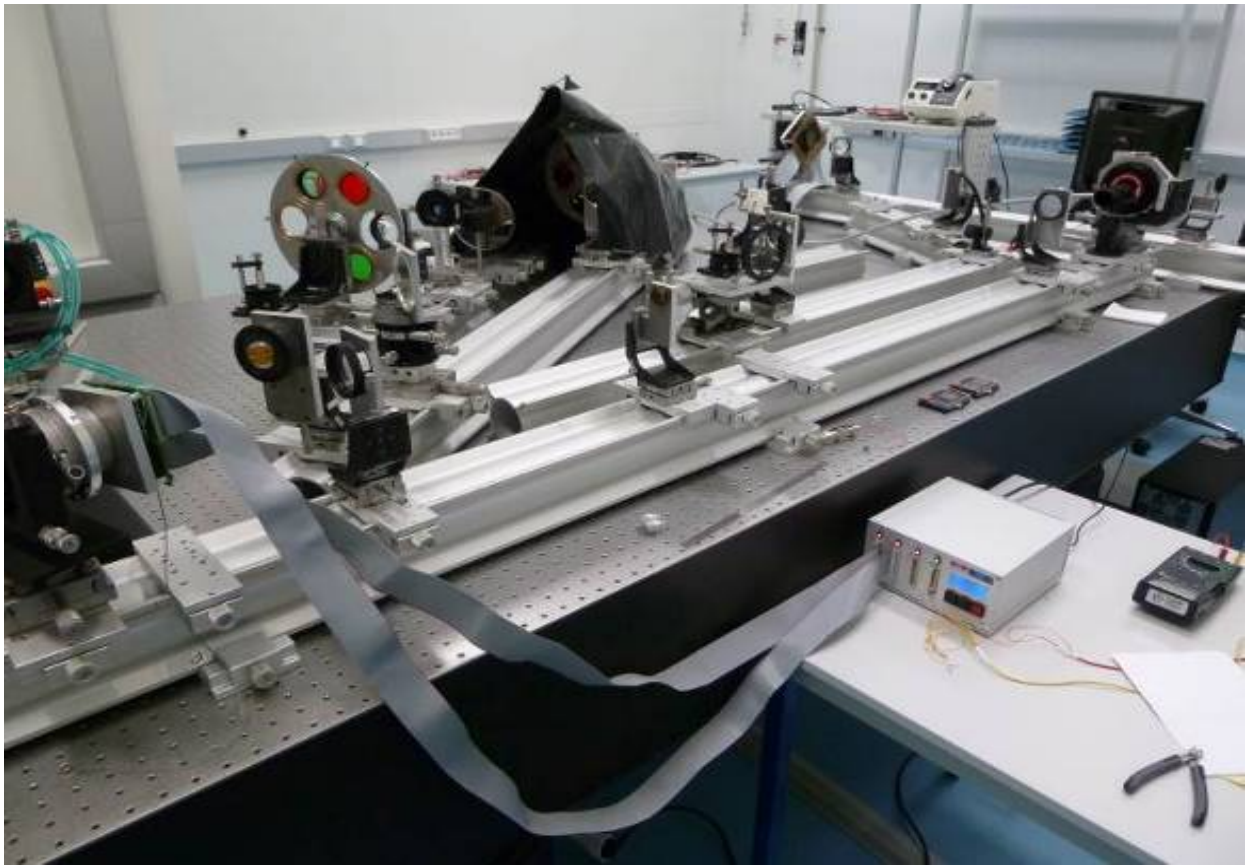


293 K
135 V
9.9 nm PtV

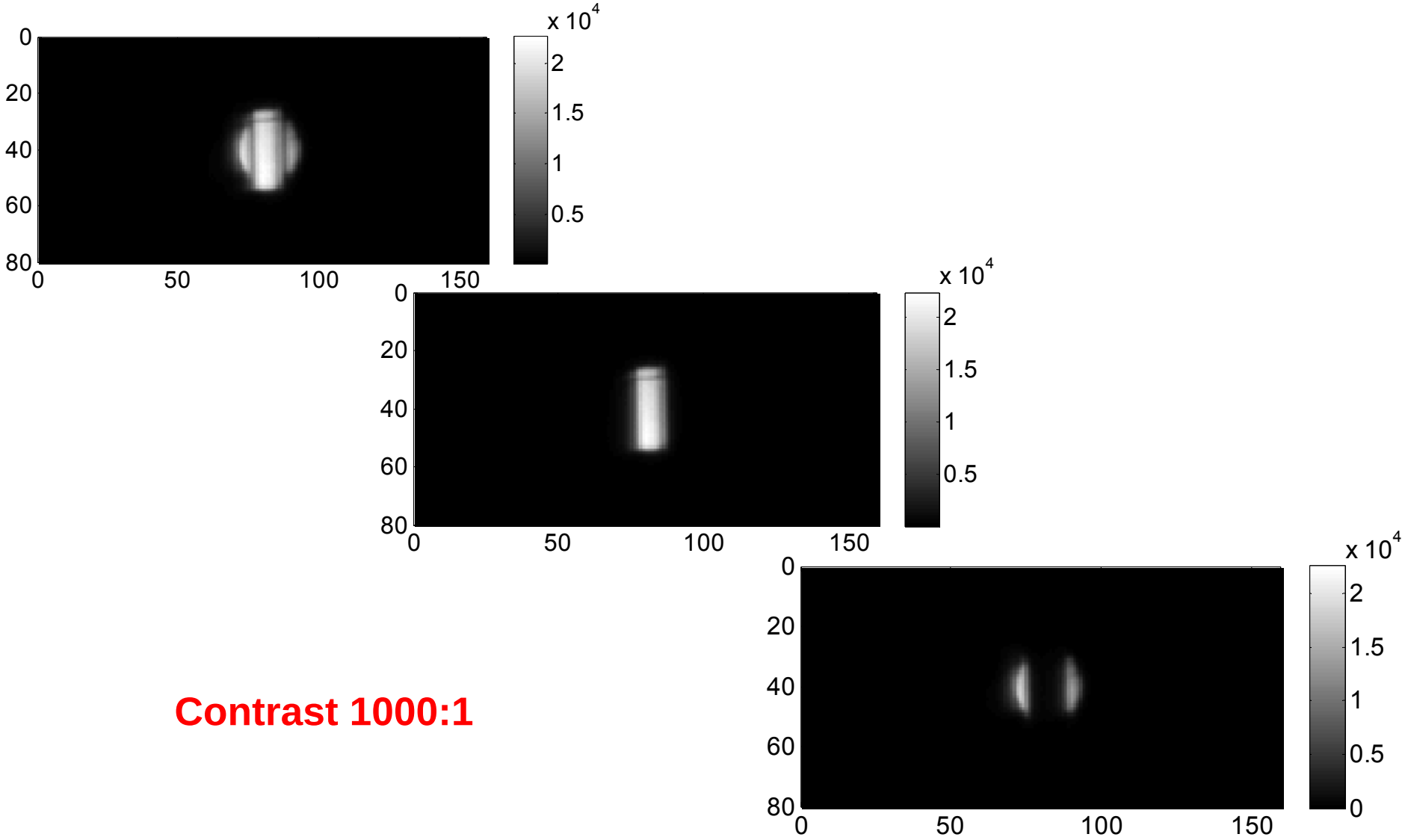


Contrast measurement

- Operational bench simulating astronomical FOV
- Observation in spectrograph direction



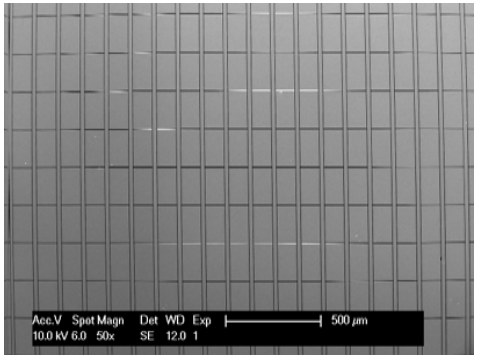
Contrast measurement

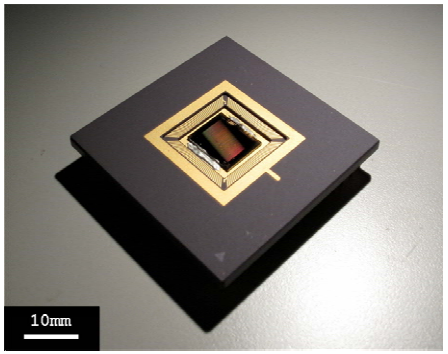


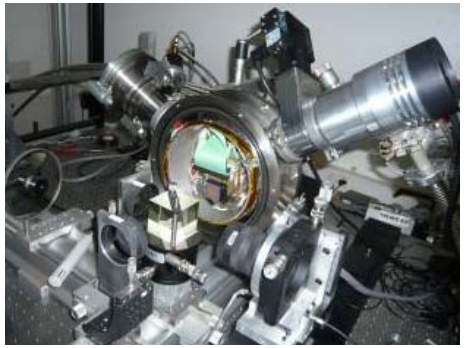
Contrast 1000:1

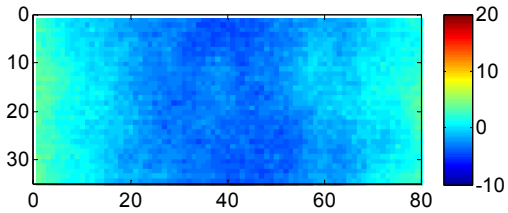
Micromirror arrays for MOS in space

- Large micro-mirror array with large tilt angle, excellent surface quality, operation at cryogenic temperature has been demonstrated
- MIRA project is under way for the realization of large arrays dedicated to MOS applications
- Future work: integration with hardened electronics
- Micromirror arrays are the future slit mask generators for MOS (and other applications, like Earth Observation (Thursday, 9:15, declouding)









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