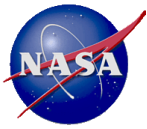
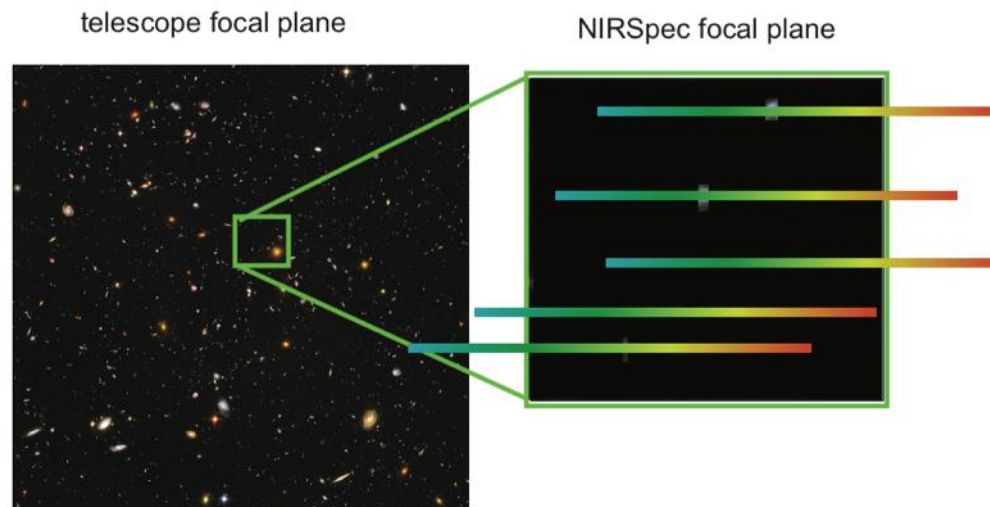


Next generation microshutters – MEMS 2D programmable field masks

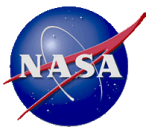


A. Kuttyrev for the microshutter team, NASA GSFC

- Microshutter arrays are programmable 2D field selector masks for optical spectroscopy based on MEMS technology. They are followed the original device that was developed as part of the NIRSpec (Near Infrared Spectrometer) instrument for JWST (James Webb Space Telescope). The NGMSA devices are:
- Random access to individual pixels in large format single module
- High contrast optical blocking $> 10^4$ (to 10^6)
- Operate in UV, visible and infrared
- Long life time for the operation of 20,000 cycles or more
- Fully electrostatic (no macro mechanical components)



Microshutter arrays development



- **Microshutter arrays in several formats (from left to right): pilot array -128 x 64, JWST- 365 x 171 and first large format array 840 x 420 and current SAT development 736x384 with support ribs.**

Primary areas of the NGMSA development

- - Fully electrostatic actuation
- - Modularity of the integrated array unit
- - Thinner microshutter blades
- - Improved antistiction
- - Larger format arrays
- - Simplified electronics design

Latest development:

- Actuation FEA model and analysis
- Shutter format modification
- 6" fabrication process
- 3D printing
- Ceramic carrier fabrication
- Large format arrays PC driver boards
- Next generation suborbital collaboration

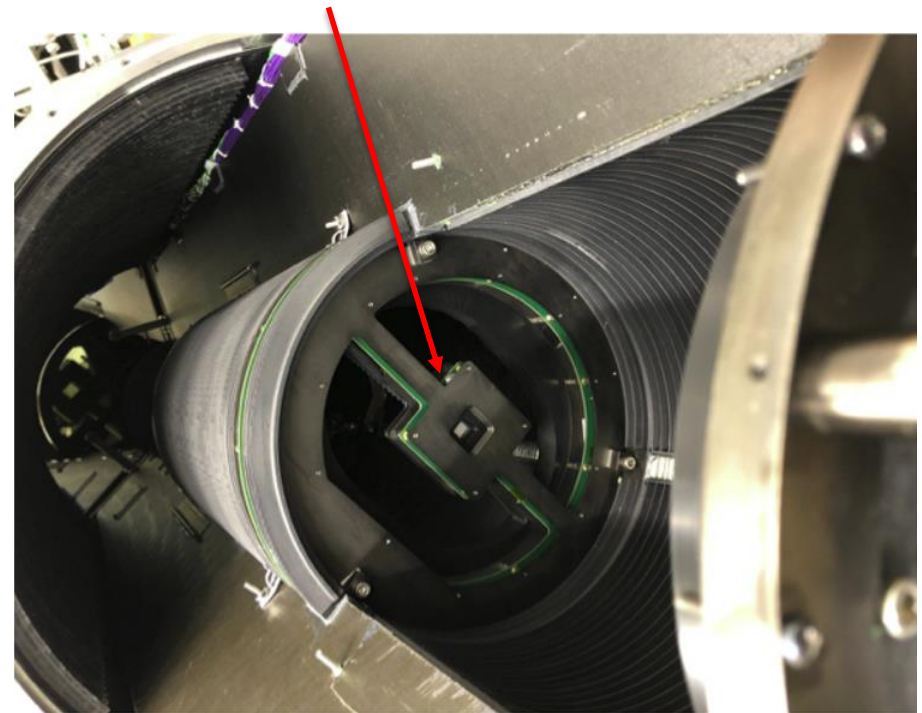
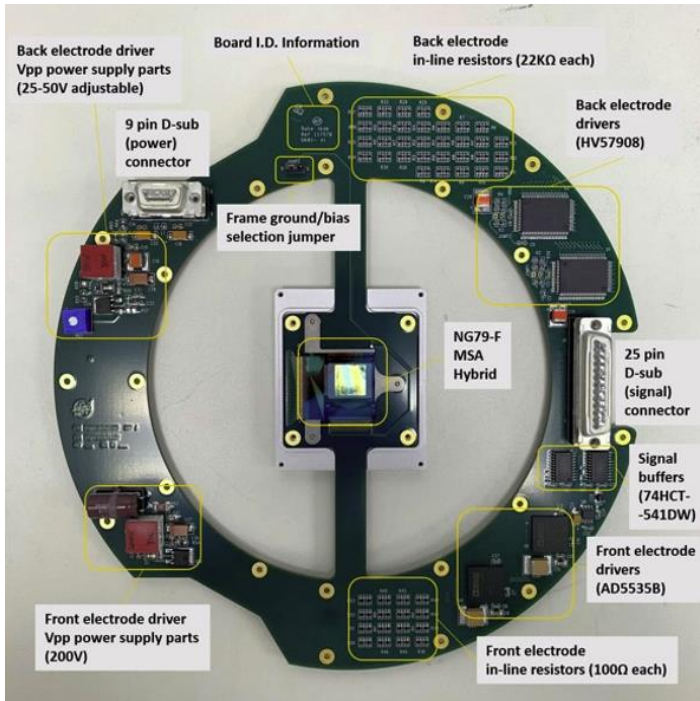
<http://microshutter.gsfc.nasa.gov>



NGMSA for FORTIS sounding rocket

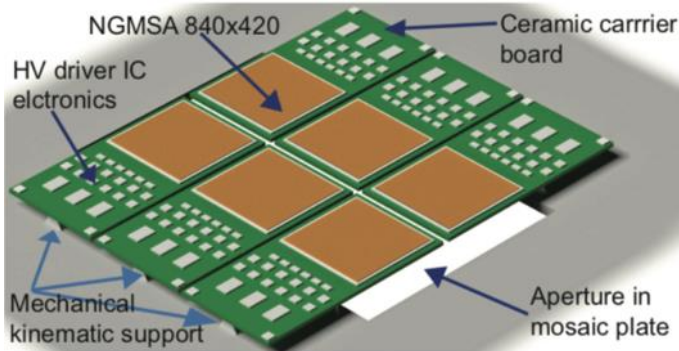
- The NGMSA system as the multi-object selector in FORTIS, a wide angular field telescope for far-UV imaging and spectroscopy project lead by S. McCandliss (JHU). Microshutter array assemblies have successfully flown with this telescope in May 2013, November 2015, and most recently in October 2019 with the latest electrostatic NGMSA technology.

NGMSA assembly mounted in the primary focal plane of the FORTIS telescope.

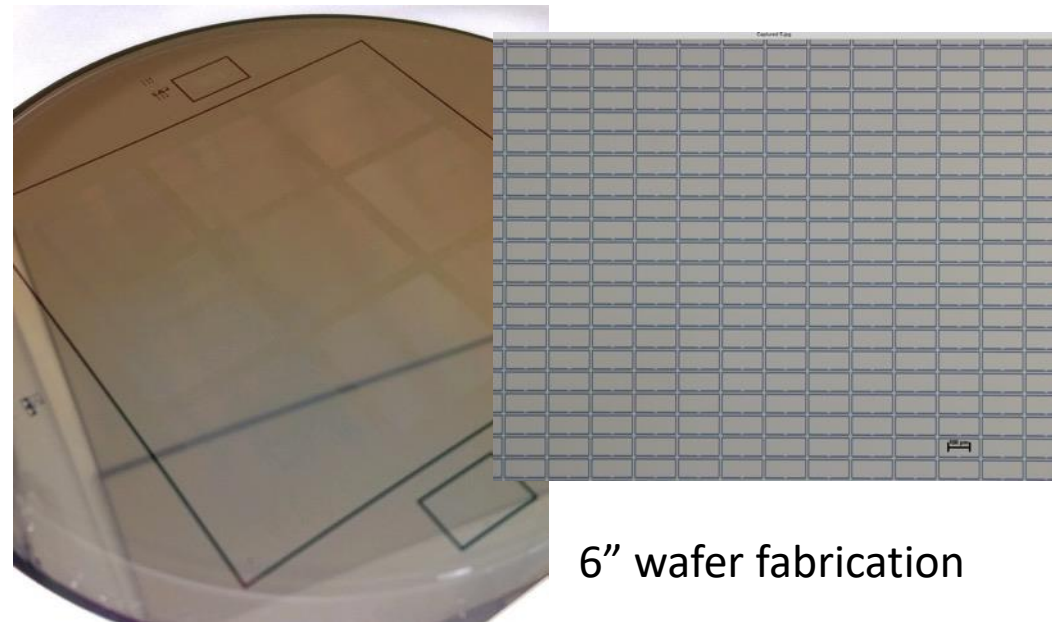


Summary

- NGMSA is a key element for Multi-Object Spectroscopy on sparse fields.
- Microshutter arrays has been identified so far by flight missions studies as needed Multi-Object-Selectors (MOS) in Astrophysics and in Heliophysics:
 - ✓ NG-FORTIS – Next Generation Far-UV Off-circle Roland Telescope for Imaging and Spectroscopy (128x64 arrays, Sounding Rocket Mission, launched in October 2019)
 - ✓ CETUS - Cosmic Evolution through UV Spectroscopy
 - ✓ LUVOIR - Large UV/Optical/IR telescope
 - ✓ HabEx - - Habitable Exoplanet surveyor
 - ✓ AERIE - Atmospheric Expansion Response and Interaction Explorer (128x64 arrays)
- NGMSA is a Micro-Optical-Electro-Mechanical-Systems (MOEMS) being developed at GSFC, inherited from JWST microshutter technology. JWST MSA are operated using magnetic actuation mechanism, while NGMSA utilizing electrostatic actuation mechanism.



NGMSA modules assembly concept.



6" wafer fabrication

