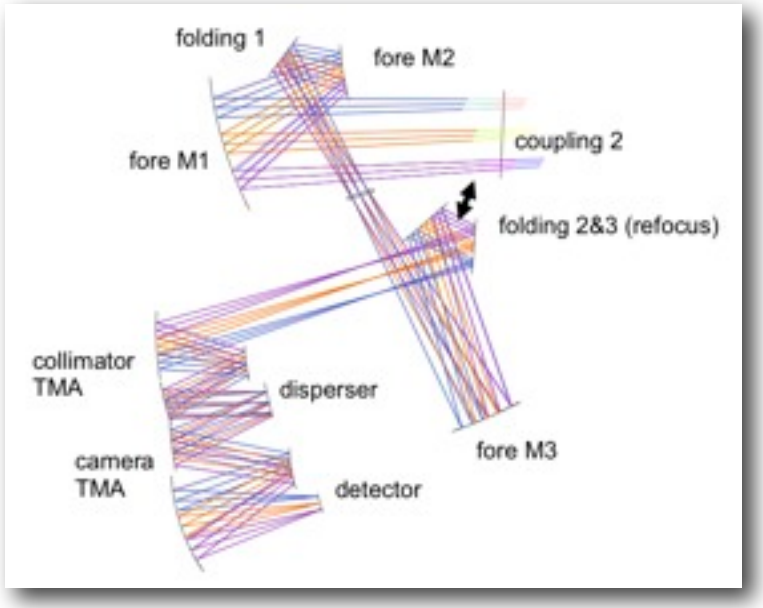
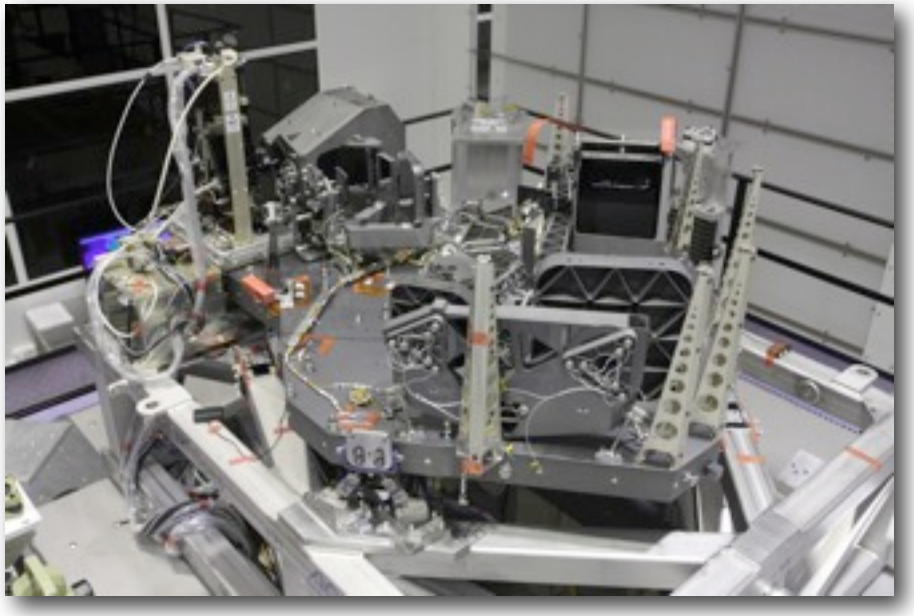




NIRSpec Through The Ages

A Brief Selective History

Peter Jakobsen
ESA JWST Project Scientist

In the Beginning..

- *HST and Beyond* 1996
- *Next Generation Space Telescope* 1997
- Report of the ESA *NGST Task Group* 1997
- ESA and CSA invited to join project 1997

Primeval NIRSpec History

ESA NGST Task Group (1997)

esa

Next Generation Space Telescope
(NGST)

Report of the NGST Task Group

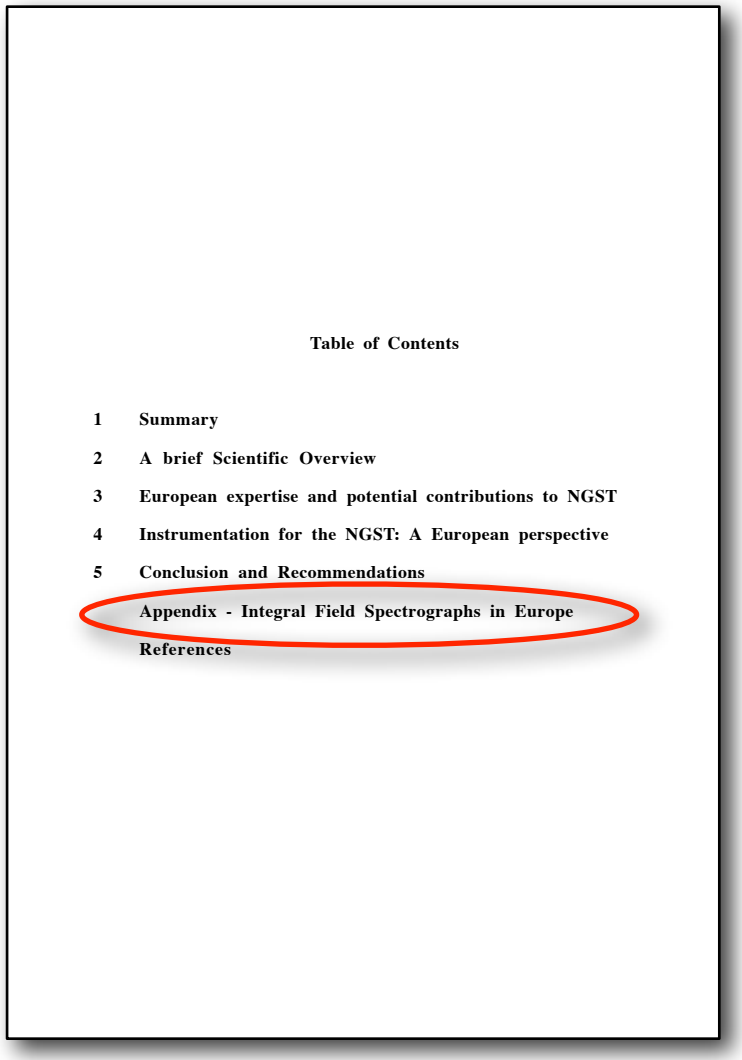
October 1997

Solicited by ESA to gauge interest in community and possibilities for participation

Clear European interest in near-IR Spectroscopy from the start

Primeval NIRSpec History

ESA NGST Task Group (1997)



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Clear European interest in near-IR Spectroscopy from the start

Primeval NIRSpec History

Early ESA Activities (1997-1999)

- ESA Study Scientist and Manager Appointed
  - Sponsored 34th Liège Conference
  - Participated in NASA Ad Hoc SWG
  - Sponsored range of concept studies with industry and science community
  - Instruments (visible Camera, near-IR Camera, near-IR Spectrograph, mid-IR instrument)
  - Telescope Segment

NGST

- Similar competing instrument concept studies sponsored by NASA and CSA

Let a thousand blossoms bloom era

Primeval NIRSpec History

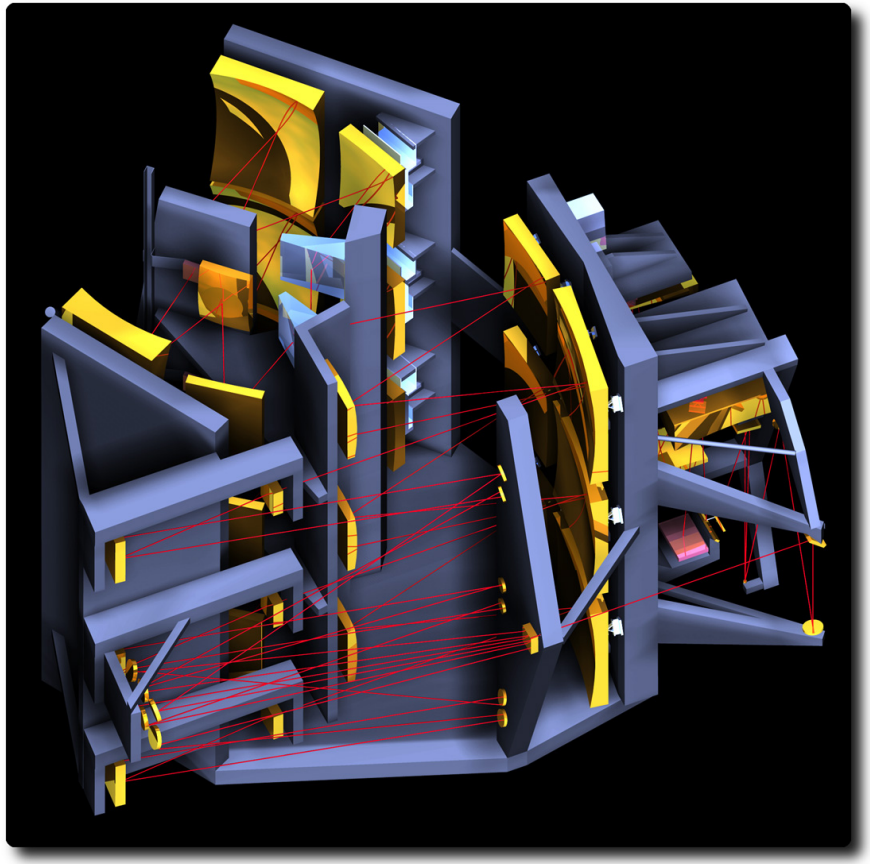
Early All-IFU Concept (circa 1999)

James Webb Space Telescope

esa ASTROPHYSICS

NIR Spectrograph Concept

NGST



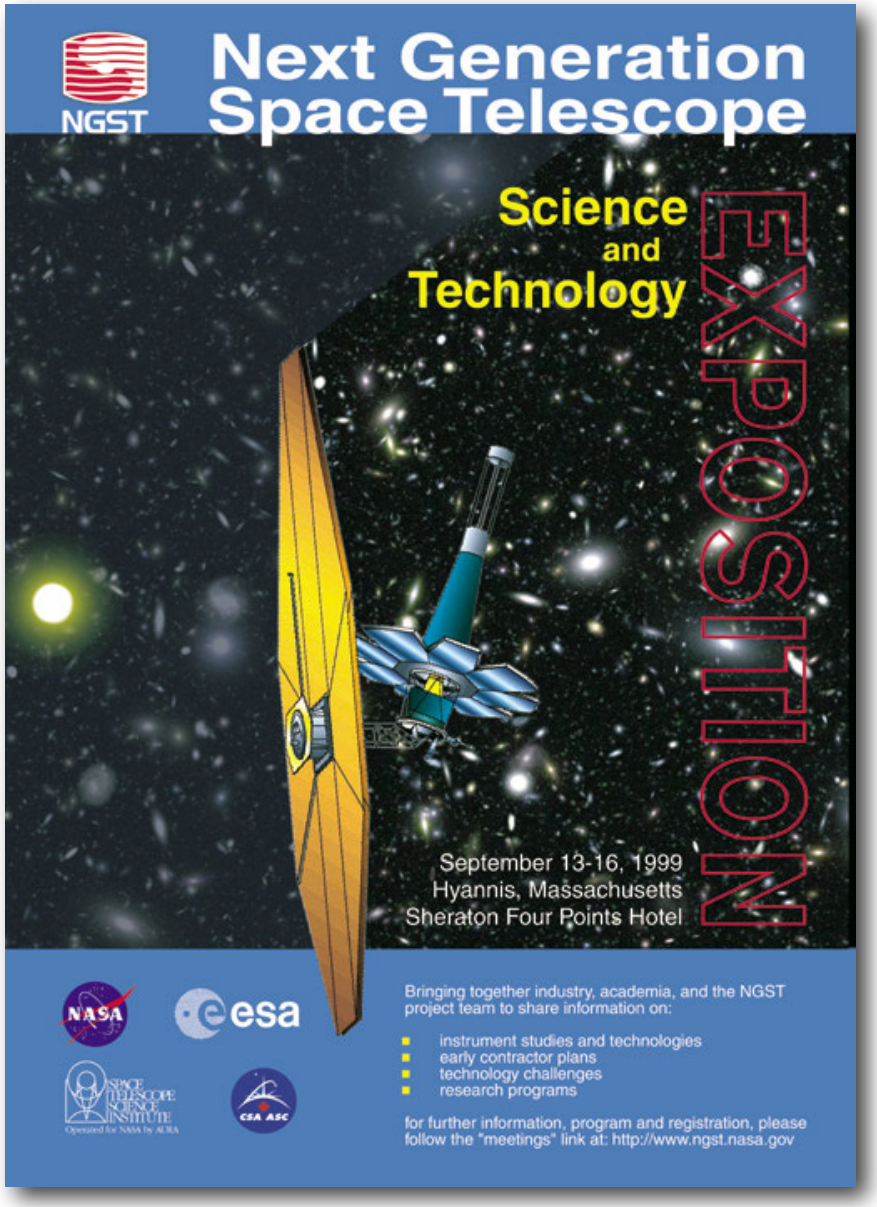
Low Res Channel:	**High Res Channel:**
R=150	R=3000
1.25-2.5 +2.5-5.0 μm	1.25-2.5/2.5-5.0 μm
(two octaves)	(one octave)
46 x 40 arcsec FOV	3.2 x 3.2 arcsec FOV
0.18 arcsec/pixel	0.05 arcsec/pixel
Six 2k x 2k detectors	Four 2k x 2k detectors

Dimensions: 1.4 x 1.4 x 1.0 m
Total Mass: 143 kg
Power Dissipation at 30 k: 35 mW

– Single mechanism (High Res grating flip)
– Simple “Point and Shoot” operations

Primeval NIRSpec History

Hyannis Conference (1999)



ASWG-spawned *Near-IR Spectrometer Committee*:

Ultimate sensitivity ⇒

Dispersive Approach

Large FOV Multiplexing ⇒

All-IFU too small FOV

High Res Single Object ⇒

IFU attractive

NIRSpec is Born

Thus Spoke ASWG (2000)

10 January, 2000

NGST Science Instrument Recommendations

John Mather (NASA/GSFC), Peter Jakobsen (ESTEC/ESA),
Simon Lilly (CSA/Toronto), and Peter Stockman (STScI)

Summary of Recommendations

The following three-instrument complement provides a minimum for the NGST:

- **A camera with near IR and visible filters, sensitive over 0.6 - 5 μm**
- **A multi-object dispersive spectrograph (MOS) for 1 – 5 μm, with R~1000**
- **A combined camera/slit spectrograph for 5 – 28 μm with R~1500**

At least one of following key capabilities is also highly recommended:

- **An integral field spectrograph (IFS) for 1 – 5 μm**
- **A high-resolution camera, optimized for 0.6-1 μm**
- **An integral field spectrograph (IFS) for 5 – 28 μm**

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Early NIRSpec History

Competitive Definition Phase (2000-2003)

- Wye River ESA/NASA negotiation meeting
  - Ended badly (but eventually kissed and made up)
- ESA participation in NGST approved through competitive ESA “F2/F3” mission selection
- ESA/NASA negotiations successful
  - ESA provides MOS NIRSpec
  - Detectors and MSA from NASA
- Competitive NIRSpec Industrial Studies initiated
  - Two Industrial Consortia

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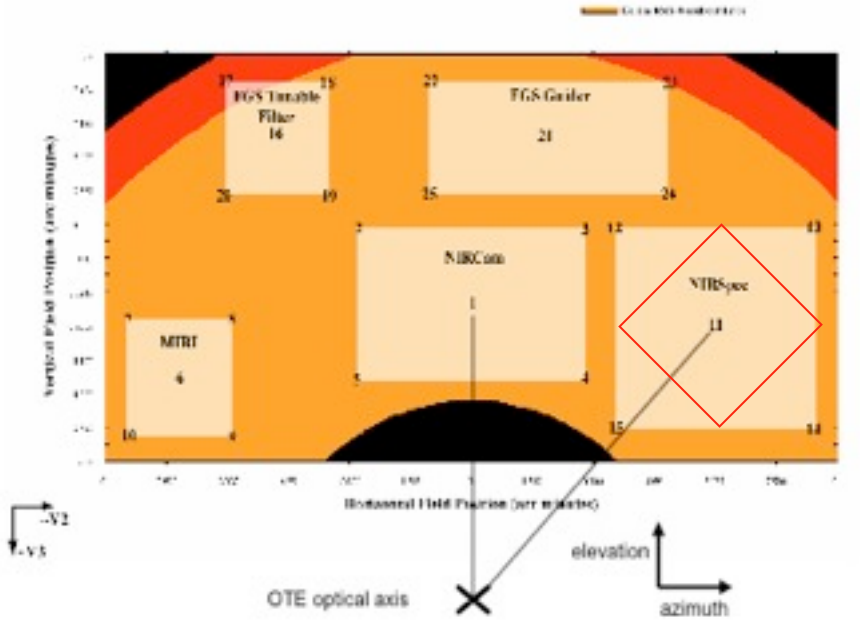
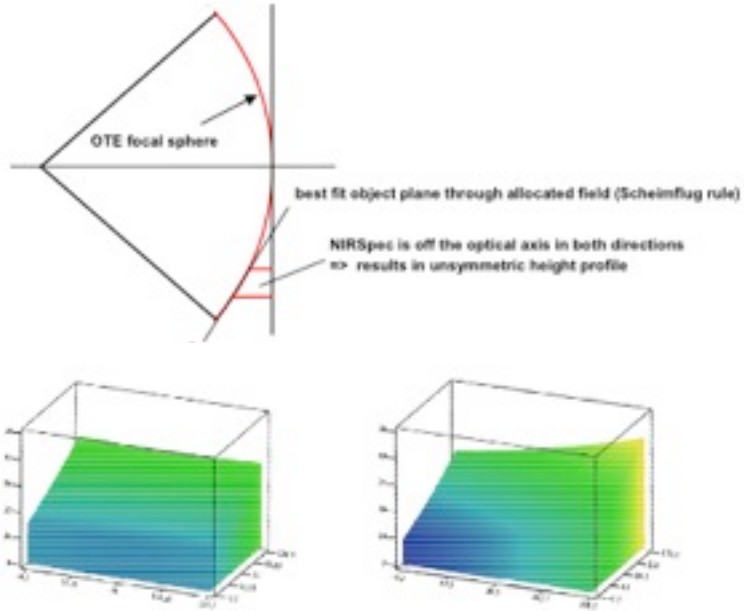
New name too...

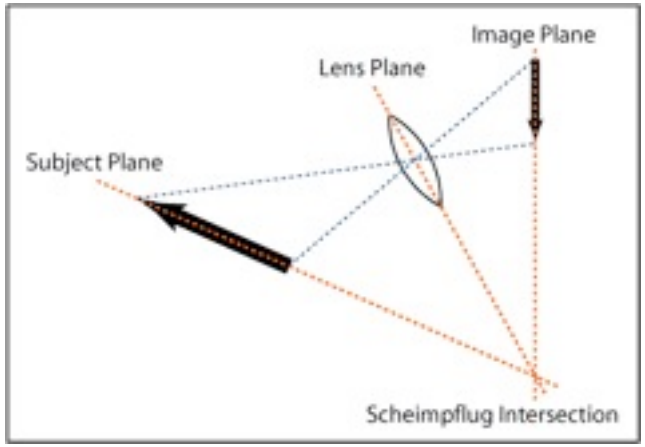
Key Moments in NIRSpec History

Scheimflug (circa 2000)





NIRSpec FOV



Theodor Scheimflug (1865-1911)

NIRSpec Foreoptics needs to image *curved* telescope focal plan to *flat* MSA surface (preferably in a telecentric manner)

Solution: *Scheimflug* Imaging

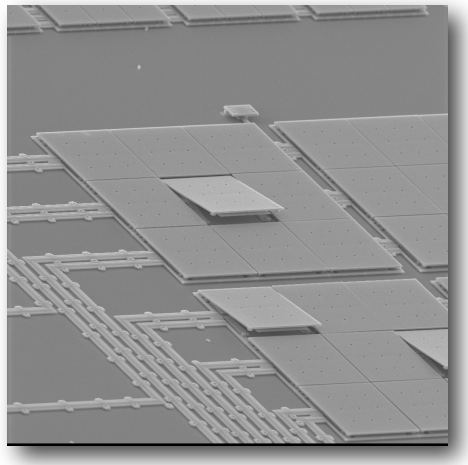
Key Moments in NIRSpec History

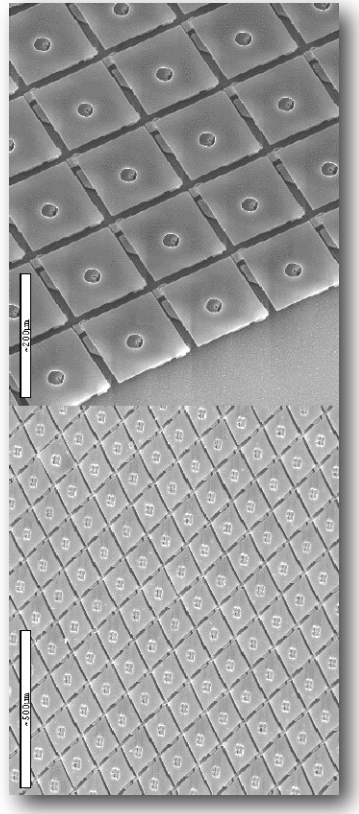
Micro-Shutters over Micro-Mirrors (2001)

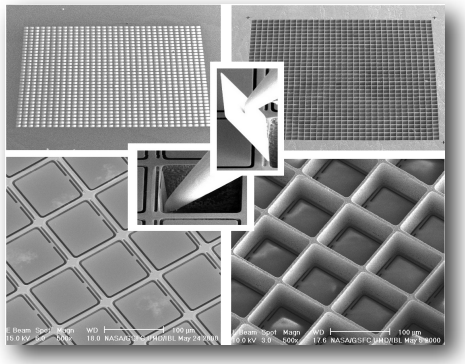
Initially both MEMS-based micro-mirrors and micro-shutters were considered

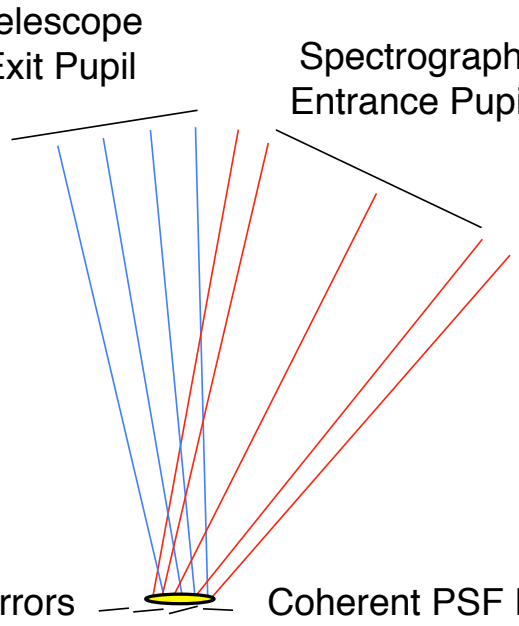
Independent *MEMS Review Board* recommended shutter over mirror technology

One consideration: *Diffraction*







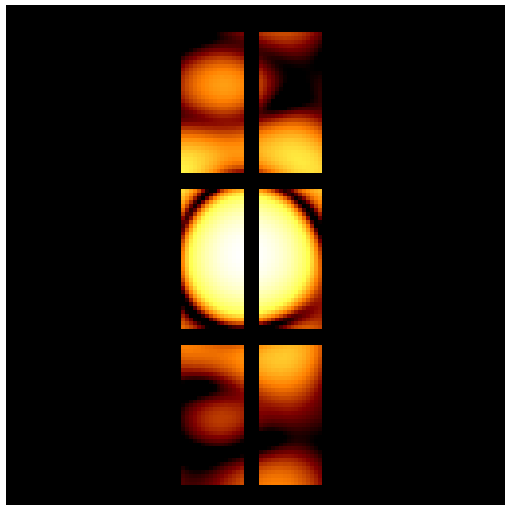


Key Moments in NIRSpec History

'Fat MEMS' (2003)

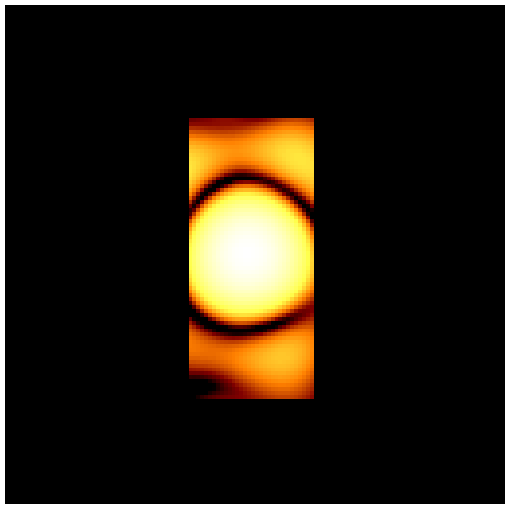
Original MSA: 100 μm x 200 μm pitch with 20 μm bars
(Since changed to 105 μm x 205 μm with 28 μm bars)

Original Platescale at MSA: 1.0 "/mm



Slit made of pattern of 80 mas x 180 mas shutters with 20 mas bars in middle

New Platescale at MSA: 2.5 "/mm



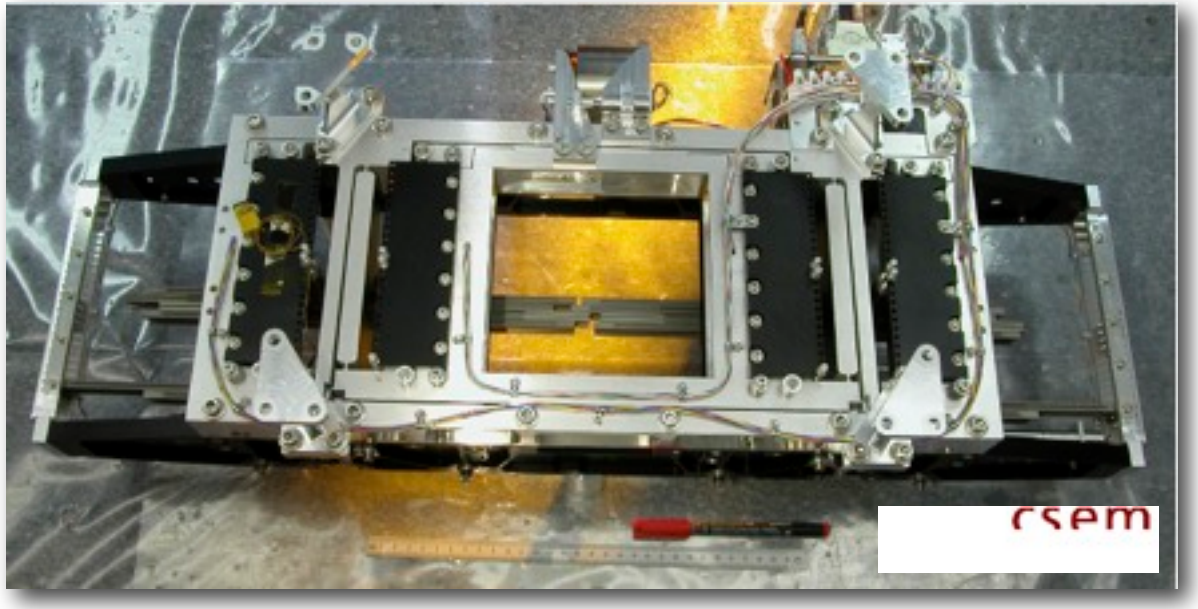
Slit made of single 200 mas x 450 mas shutter (50 mas bars)

Advantages: MSA > 4 times smaller(!) Less Diffraction in Slit
2.5 x Demagnified FOV⇒ More Compact Instrument

Price to Pay: Loss of Multiplexing Capability

Key Moments in NIRSpec History

Exclusion of Mechanical Slit Mask (2003)



Development maintained through early MEMS development
Intended to be 'drop-in' back-up to MEMS-based MSA

Problem: MSM is a *macroscopic* device - the MSA is *microscopic*
⇒ MSM requires larger image magnification than MSA ⇒ Different Foreoptics

Serious accommodation problems to start with

Following 'Fat MEMS' change only 10-15 slitlets possible

More Familiar NIRSpec History

Implementation Phase (2004-Present)

- EADS/Astrium wins NIRSpec Contract
- ESA AO Released
- NIRSpec IST Appointed (ELIXIR created!)
- System Requirements Review (2004)
- Preliminary Design Review (2006)
- R=100 Prism Changed from ZnS to CaF_2
- Critical Design Review (2008)
- 1600 mas Square Aperture Introduced
- Instrument delivery now within sight...

Thirteen Years in the Making..