4MOST – 4m Multi-Object Spectroscopic Telescope

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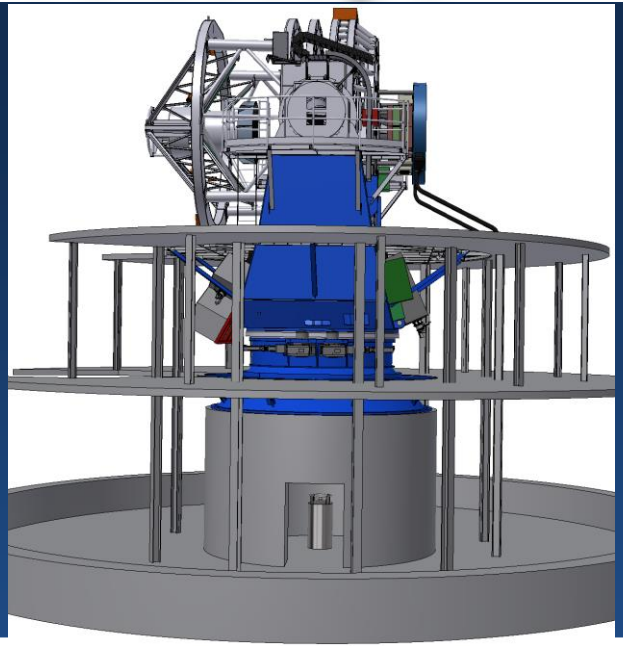
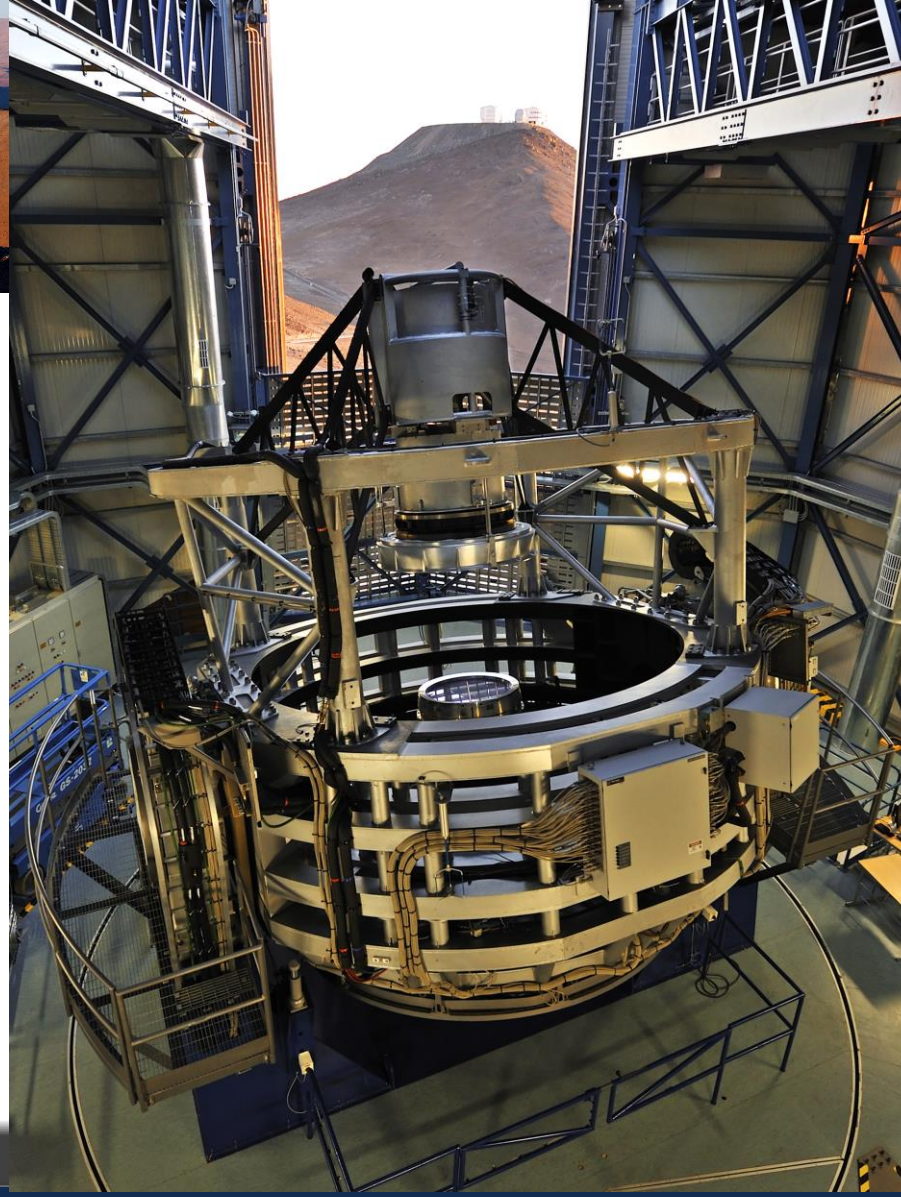
AstroTechTalk 4MOST
29 May 2015



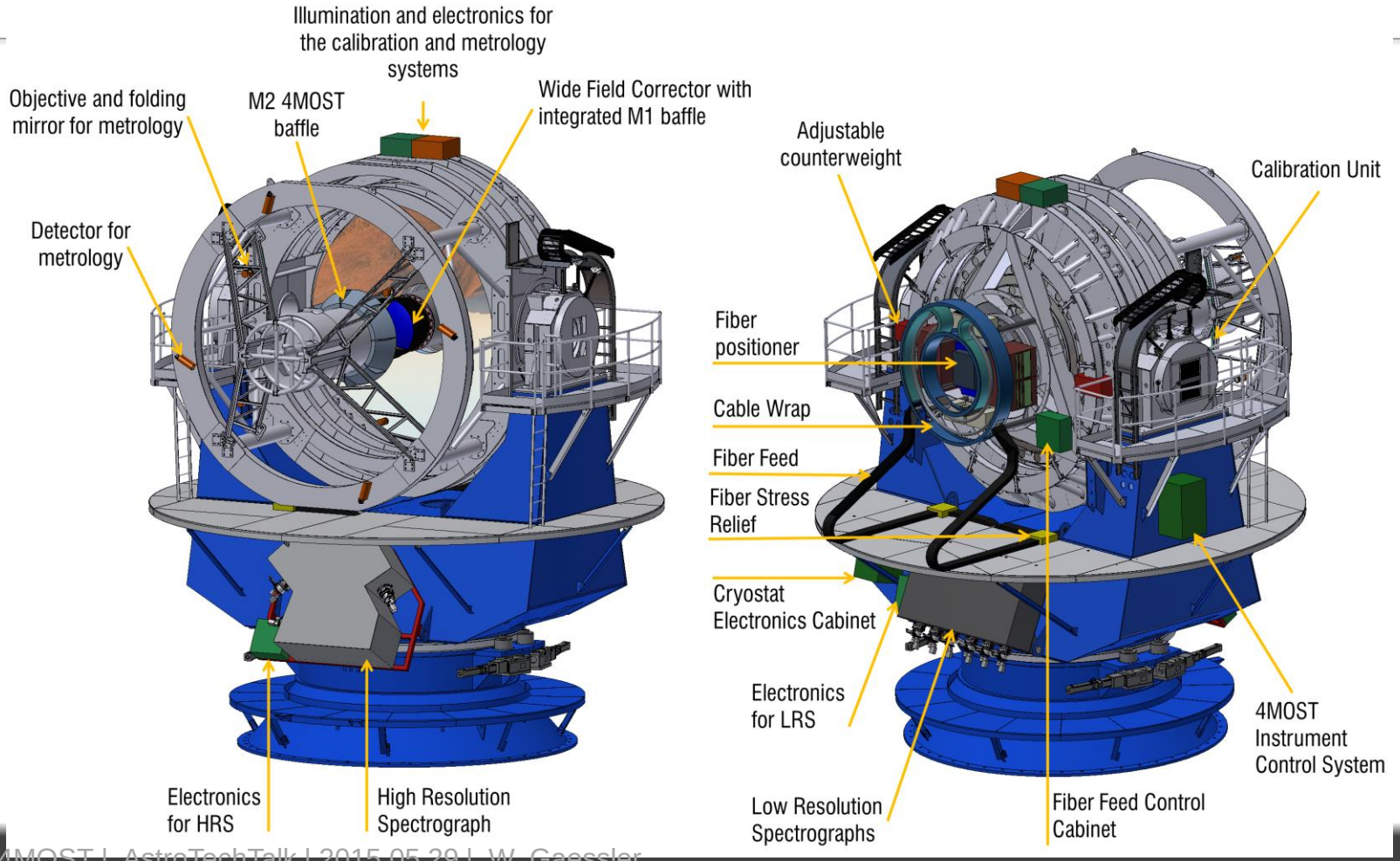
www.4MOST.eu *consortium of 15+ institutes*

4MOST on VISTA Telescope

- 3.7 meter aperture
- 2400 fibers
  - 1600 Low Resolution (5000 λ/Δλ)
    - 395-895 nm coverage
  - 800 High Resolution (18000 λ/Δλ)
    - 395-440, 500-555, 605-675 nm windows
- ~1.45” fiber apertures
- 2.5° linear field diameter (4 square degrees)



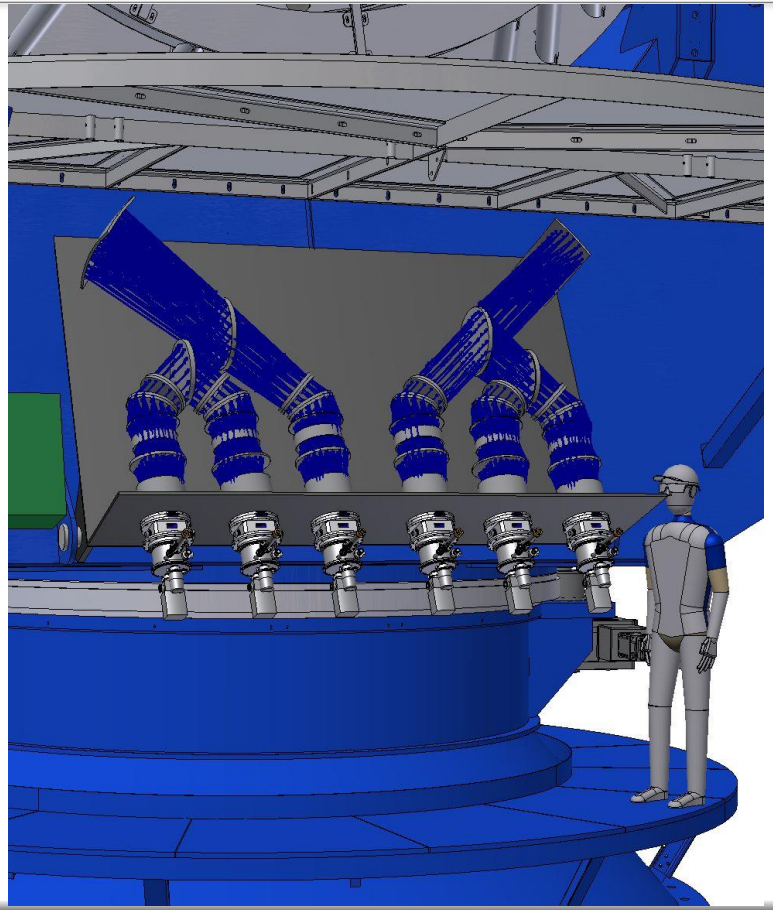
4MOST System



4MOST Low Resolution Spectrographs

- LRS Concept (5000 min resolution)
- 3-channel
- Off-axis Schmidt Collimator
- Dioptric Cameras
- 6k x 6k detectors
- Standard cryostat
- May achieve extended wavelength coverage
  - 390-950 nm

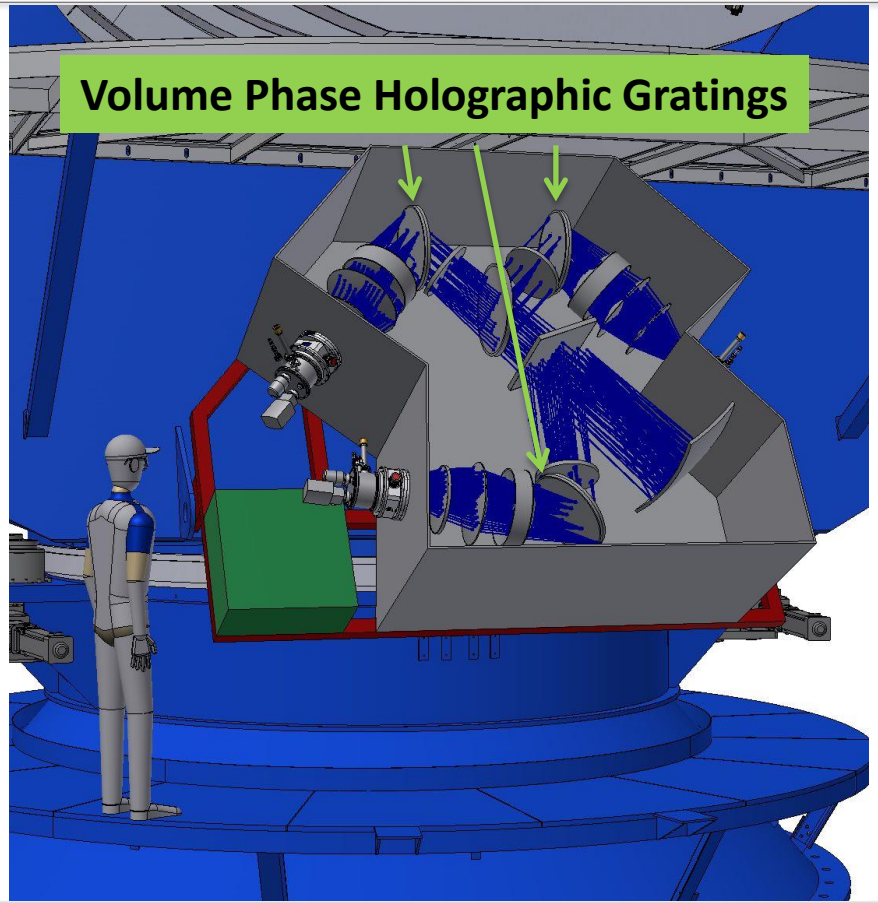
CRAL now exploring and advancing designs



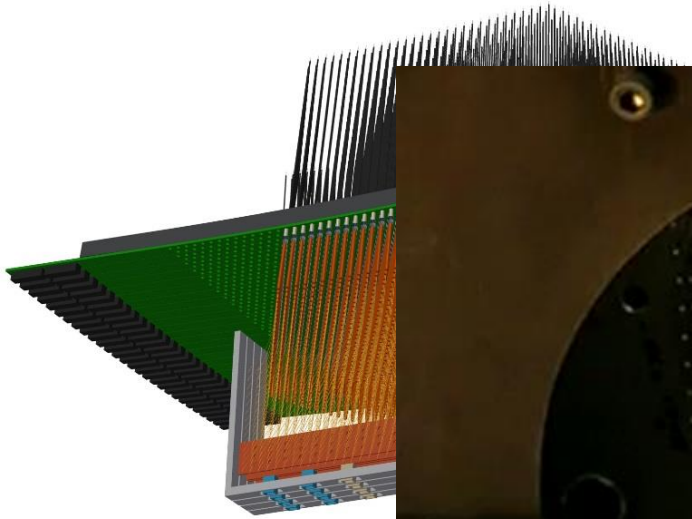
4MOST High Resolution Spectrographs

- HRS Concept
- 3-channel
- Off-axis Schmidt Collimator
- Dioptric Cameras
- 6k x 6k detectors
- Standard cryostat

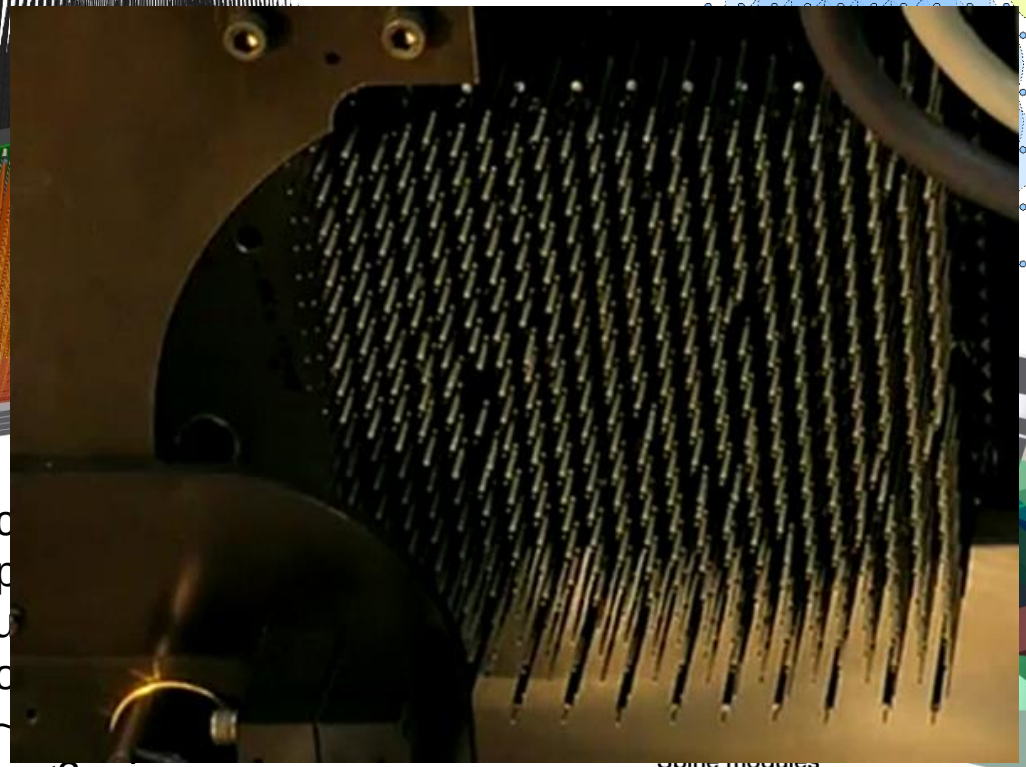
- LSW advancing design

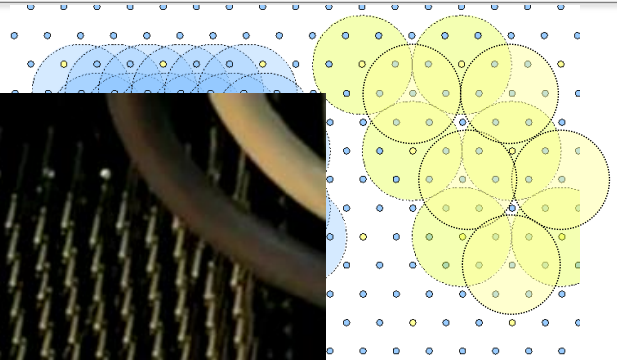


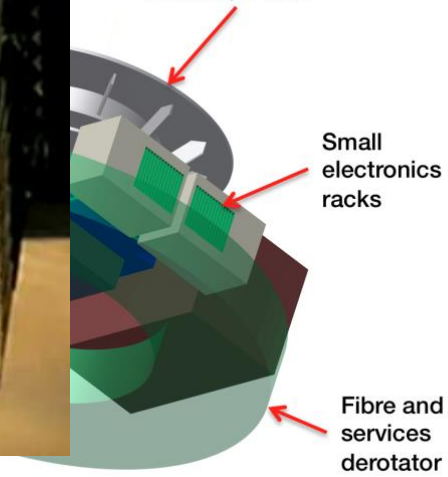
4MOST Fiber Positioner (AESOP)



Echidna

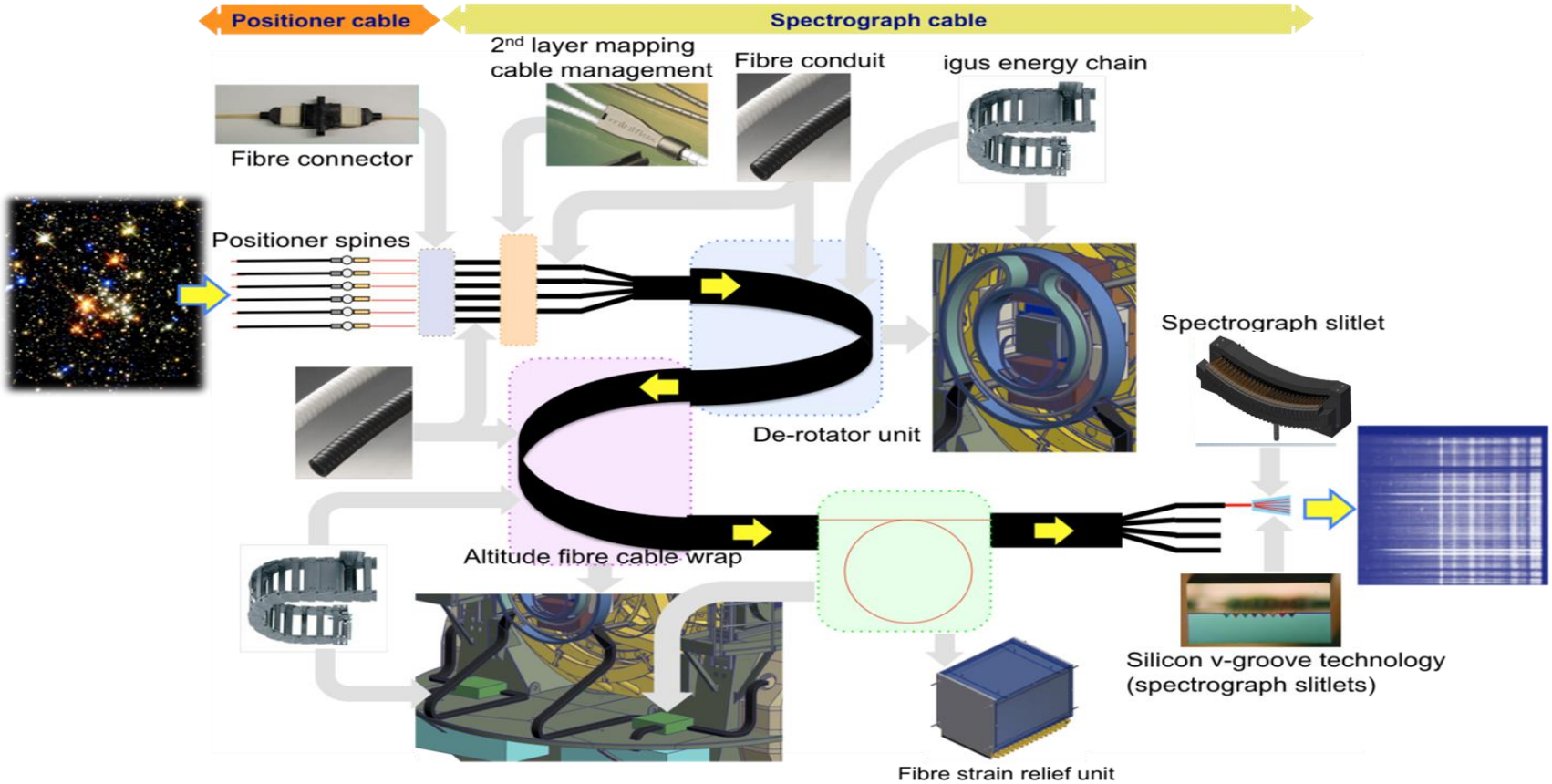


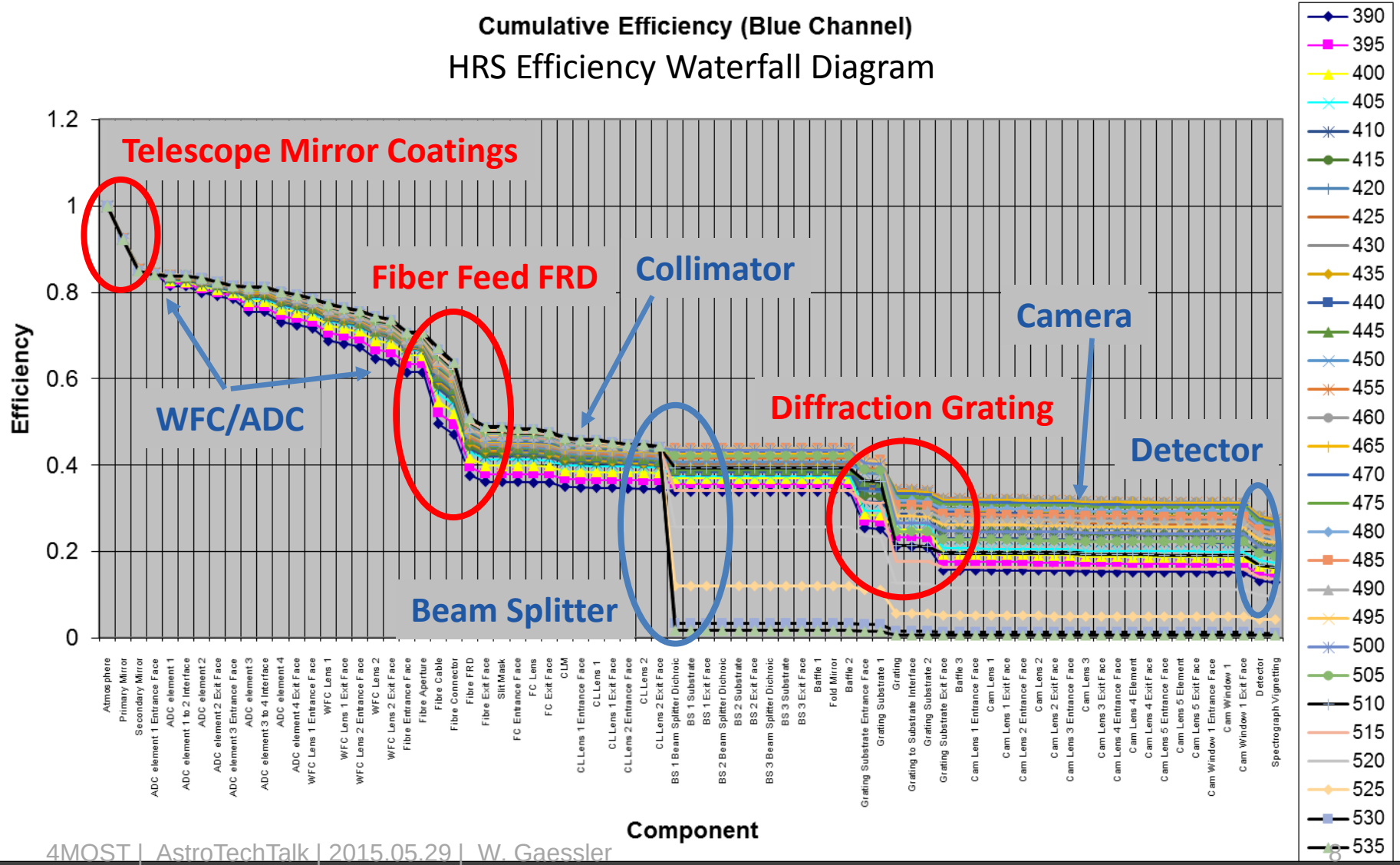




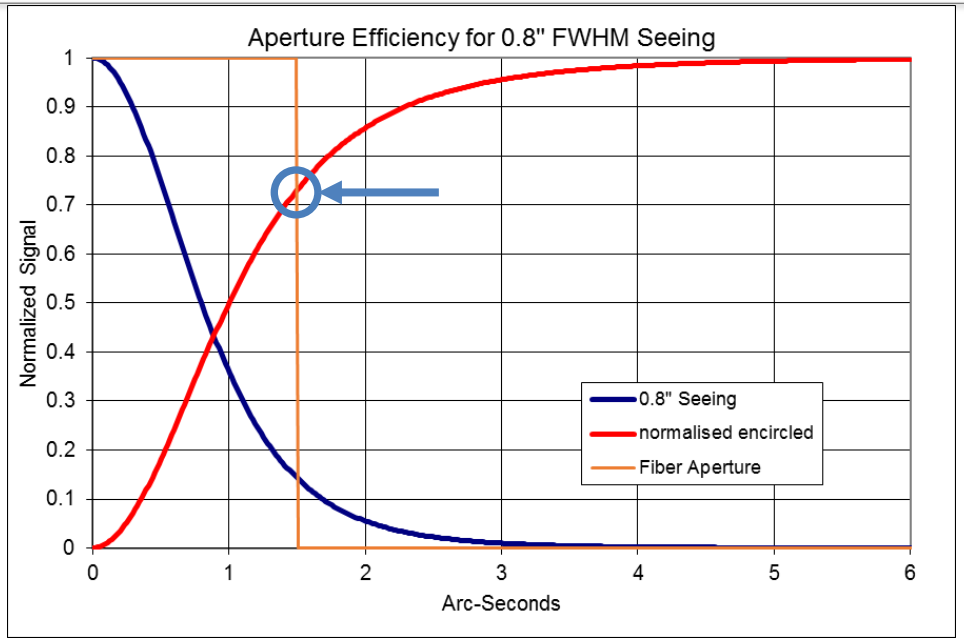
- 2400 fibers using Ec
- Large, overlapping p fibers for high resolu
- Pitch ~10 mm, Patro
- Closest separation ~
- Reconfiguration time <2 min

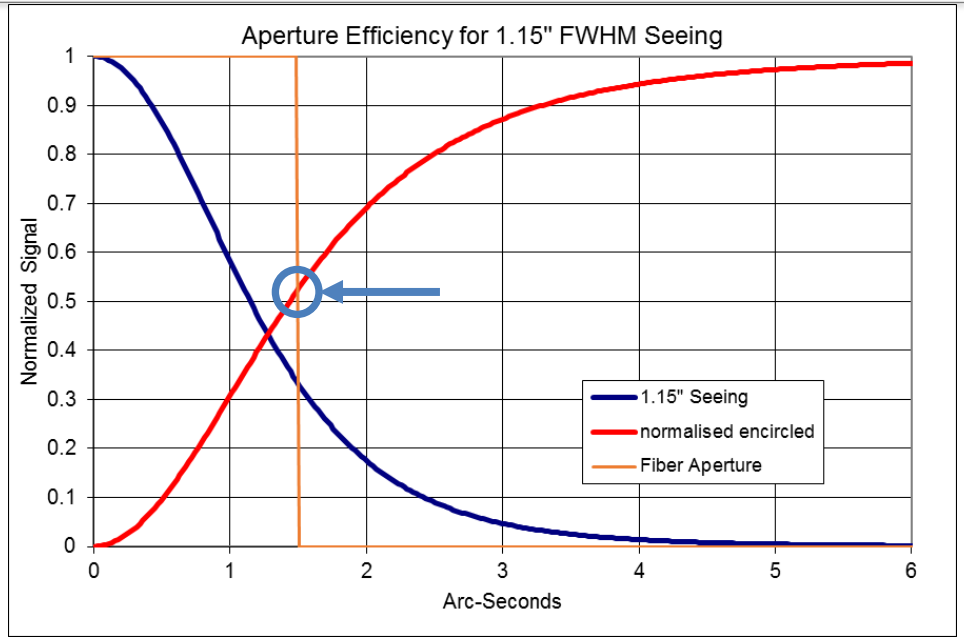
4MOST Fibre Feed




Cumulative Efficiency (Blue Channel)
HRS Efficiency Waterfall Diagram
Telescope Mirror Coatings
Fiber Feed FRD
Collimator
Camera
Diffraction Grating
Detector
WFC/ADC
Beam Splitter
Efficiency
Component
1.2
1
0.8
0.6
0.4
0.2
0
Atmosphere
Primary Mirror
Secondary Mirror
ADC element 1 Entrance Face
ADC element 1
ADC element 1 to 2 Interface
ADC element 2
ADC element 2 Exit Face
ADC element 3 Entrance Face
ADC element 3
ADC element 3 to 4 Interface
ADC element 4
ADC element 4 Exit Face
WFC Lens 1 Entrance Face
WFC Lens 1
WFC Lens 1 Exit Face
WFC Lens 2 Entrance Face
WFC Lens 2
WFC Lens 2 Exit Face
Fibre Entrance Face
Fibre Aperture
Fibre Cable
Fibre Connector
Fibre FRD
Fibre Exit Face
Slit Mask
FC Entrance Face
FC Lens
FC Exit Face
CLM
CL Lens 1 Entrance Face
CL Lens 1
CL Lens 1 Exit Face
CL Lens 2 Entrance Face
CL Lens 2
CL Lens 2 Exit Face
BS 1 Beam Splitter Dichroic
BS 1 Substrate
BS 1 Exit Face
BS 2 Beam Splitter Dichroic
BS 2 Substrate
BS 2 Exit Face
BS 3 Beam Splitter Dichroic
BS 3 Substrate
BS 3 Exit Face
Baffle 1
Fold Mirror
Baffle 2
Grating Substrate Entrance Face
Grating Substrate 1
Grating
Grating to Substrate Interface
Grating Substrate 2
Grating Substrate Exit Face
Baffle 3
Cam Lens 1 Entrance Face
Cam Lens 1
Cam Lens 1 Exit Face
Cam Lens 2 Entrance Face
Cam Lens 2
Cam Lens 2 Exit Face
Cam Lens 3 Entrance Face
Cam Lens 3
Cam Lens 3 Exit Face
Cam Lens 4 Entrance Face
Cam Lens 4 Element
Cam Lens 4 Exit Face
Cam Lens 5 Entrance Face
Cam Lens 5 Element
Cam Lens 5 Exit Face
Cam Window 1 Entrance Face
Cam Window 1
Cam Window 1 Exit Face
Detector
Spectrograph Vignetting
390
395
400
405
410
415
420
425
430
435
440
445
450
455
460
465
470
475
480
485
490
495
500
505
510
515
520
525
530
535

4MOST Sensitivity – Seeing





<u>1.5” fiber aperture coupling efficiency with seeing.</u>

Left is for median 0.8” seeing – 72% is coupled into fiber aperture.

Right is for 90%ile 1.15” seeing – 52% is coupled into fiber.

Moffat function with beta = 3.0 assumed for seeing profile.

<u>≥24% Efficiency required for 90%ile seeing.</u>

4MOST Timeline and Costs

Schedule

- 05/2016 PDR – Preliminary Design Review
- 12/2017 FDR – Final Design Review
- 01/2021 PAE – Preliminary Acceptance Europe
- 06/2021 PAC – Preliminary Acceptance Chile -> Science Operation Phase 1 (5y)
- 06/2023 FAC – Final Acceptance Chile
- 08/2023 – 10/2031 Science Operation Phase 2

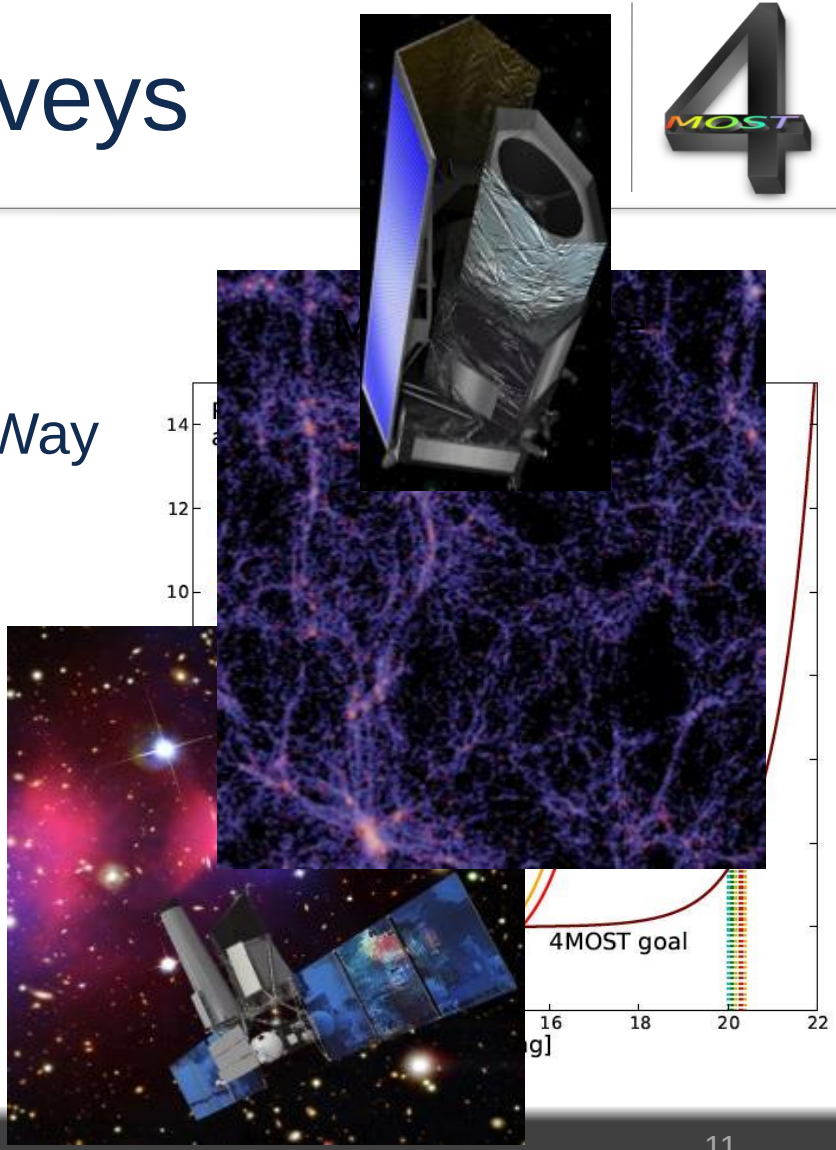
Costs

- ~ 14.5 MEuro (estimated costs) + 2.9 MEuro (20% contingency) = 17.4 MEruo
- ~ 10.5 secured
- De-scope option: Only one 3 channel LRS (Low Resolution Spectrograph)

Design Reference Surveys

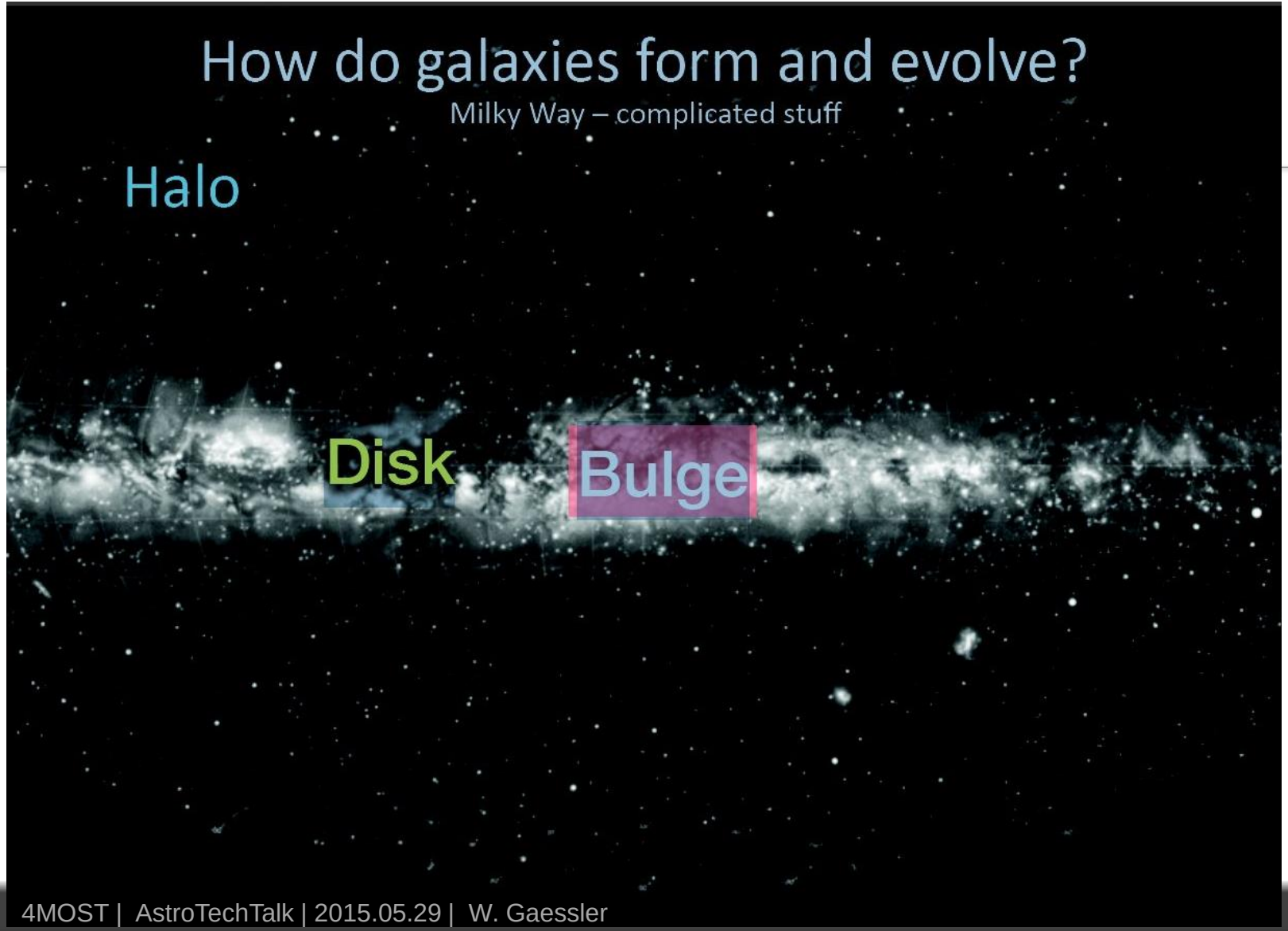
- 4 Galactic Surveys
  - GAIA complements
  - Understand structure of Milky Way
  - Main interest of MPIA

- 4 Extra Galactic Surveys
  - eROSITA complements
  - Understand evolution of active galxies
  - EUCLID complements
  - Constrain dark energy



How do galaxies form and evolve?

Milky Way – complicated stuff

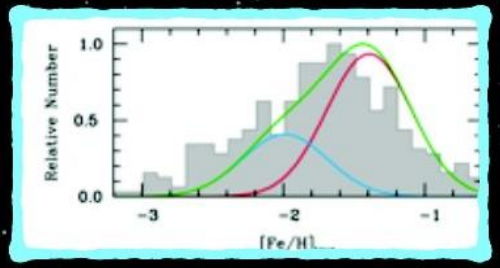


How do galaxies form and evolve?

Milky Way – complicated stuff

Halo Accretion

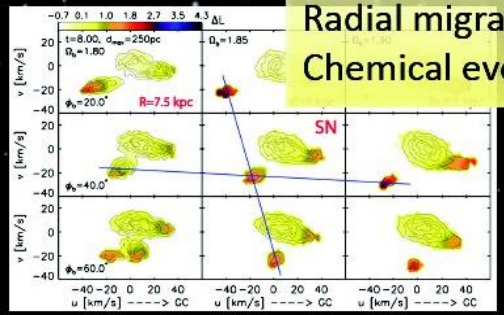
- Streams
- Galactic potential
- Very metal-poo stars

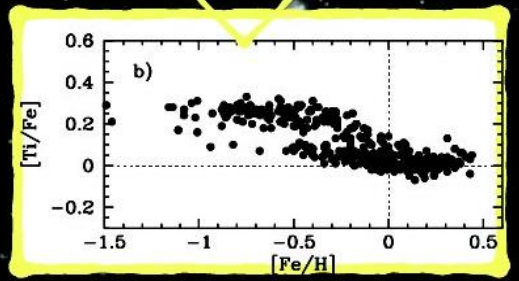


Disk

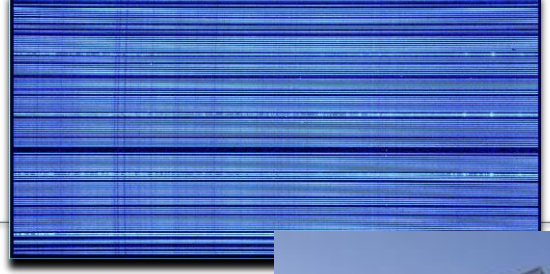
Bulge

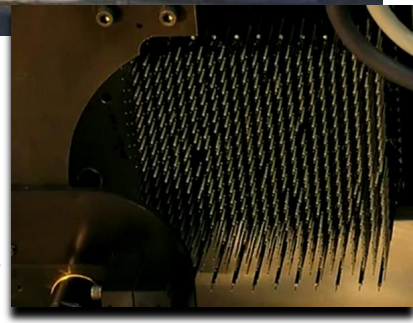
Galactic potential
Arms
Radial migrations
Chemical evolution





Conclusion





- **Multi object spectroscopic telescope**
- **2400 fibers**
- **More than 25 Million objects**
- **8 Design Reference Surveys**
- **Complete GAIA, eROSITA and EUCLID data**
- **Understand the structure of the Milky Way**
- **Understand the evolution of active galaxies**
- **Constrain dark energy properties**

In the end, 4MOST will be a powerful and capable facility!