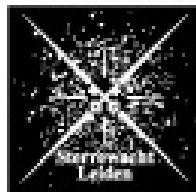# MUSE
Optical wide-field IFU spectroscopy with full wavelength coverage

Thomas Martinsson
Leiden Observatory
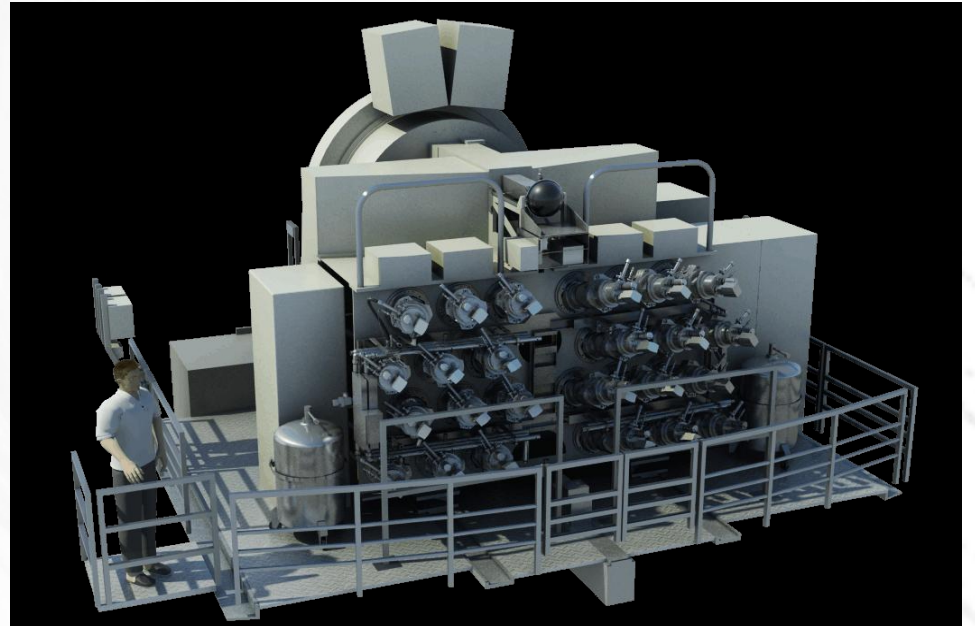martinsson@strw.leidenuniv.nl

MUSE
Multi Unit Spectroscopic Explorer

P.I. Roland Bacon (Lyon)

Outline

- Introduction of MUSE

  - Instrument specifics

  - Science cases

- Data products

  - data (cubes, images, …)

  - metadata

- Data management (of GTO data)

- MUSE data at VO

- Summary

General desciption of MUSE (1)

- Optical IFU at the VLT

  - A powerful tool for discovering objects that cannot be found in imaging surveys

- Assisted by an AO system

  - Improves the spatial resolution by (partially) removing in real time the distortion due to the atmosphere

- 24 IFUs. 1'x1' FOV. Sampled at 0.2''.

  – Splits the (AO corrected) FOV in 24 sub-fields

- Wavelength range: 4650-9300Å (R=3000)

General desciption of MUSE (2)

- Optical IFU at the VLT

- Assisted by an AO system

- 24 IFUs. 1'x1' FOV. Sampled at 0.2''.

- Wavelength range: 4650-9300Å (R=3000)

- Two different modes (WFM, NFM)

  - NFM: 7.5"x7.5" (pixel scale ~ 0.025")

- Commissioning late 2013

- Adaptive Optics ~1 year later

Specifications

| Observational Parameters	
Spectral range (simultaneous)	0.465-0.93 μm
Resolving power	2000@0.46 μm
	4000@0.93 μm
Wide Field Mode (WFM)	
Field of view	1x1 arcmin^2
Spatial sampling	0.2x0.2 arcsec^2
Spatial resolution (FWHM)	0.3-0.4 arcsec
Gain in ensquared energy within one pixel with respect to seeing	2
Condition of operation with AO	70%-ile
Sky coverage with AO	70% at Galactic Pole
Limiting magnitude in 80h	I_{AB} = 25.0 (R=3500)
	I_{AB} = 26.7 (R=180)
Limiting Flux in 80h	3.9 10^{-19} erg.s^{-1}.cm^{-2}
Narrow Field Mode (NFM)	
Field of view	7.5x7.5 arcsec^2
Spatial sampling	0.025x0.025 arcsec^2
Spatial resolution (FWHM)	0.030-0.050 arcsec
Strehl ratio	10-30%
Limiting Flux in 1h	2.3 10^{-18} erg.s^{-1}.cm^{-2}
Limiting magnitude in 1h	R_{AB} = 22.3
Limiting surface brightness in 1h	R_{AB} = 17.3 arcsec^{-2}

MUSE in Lyon
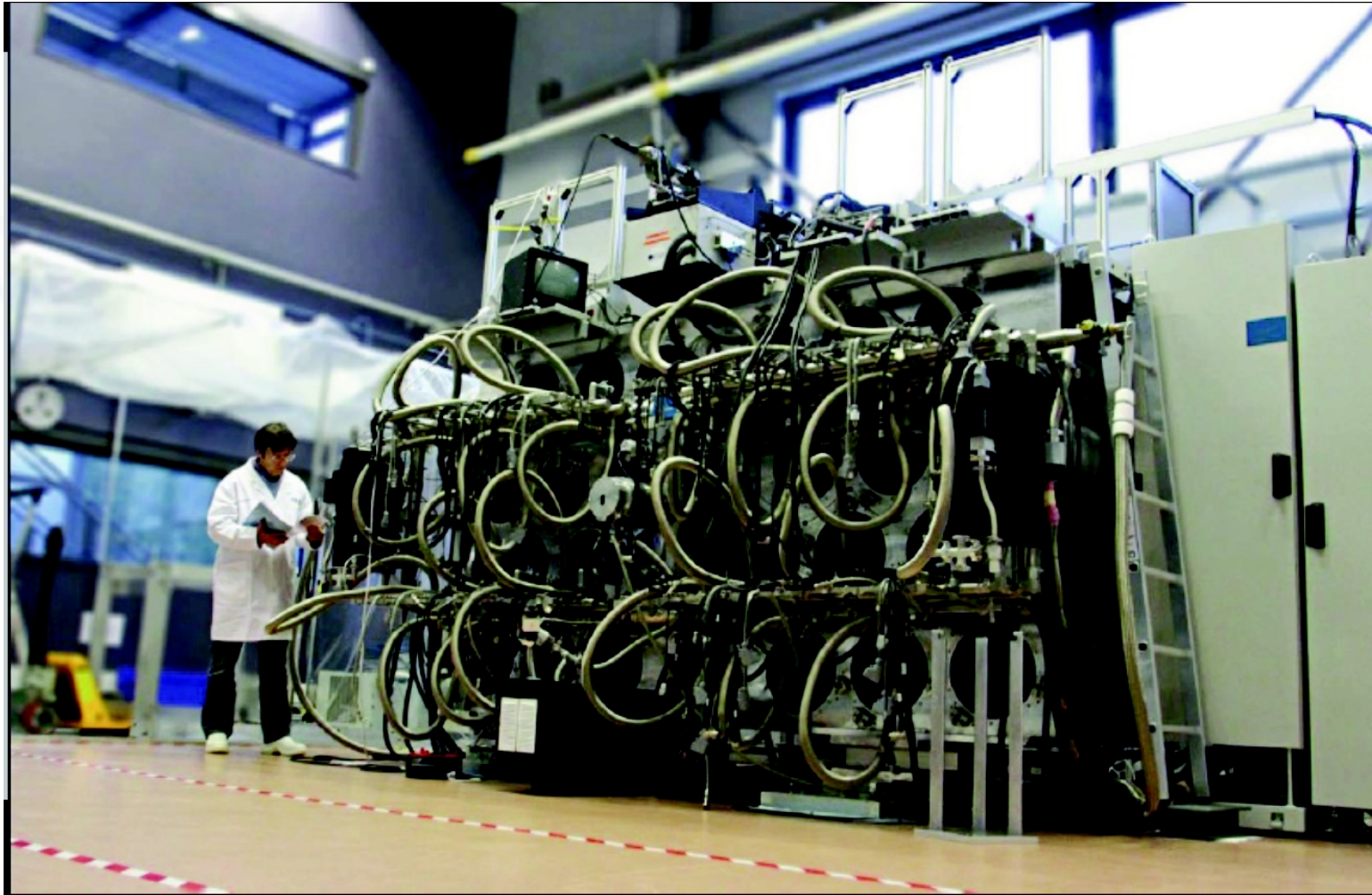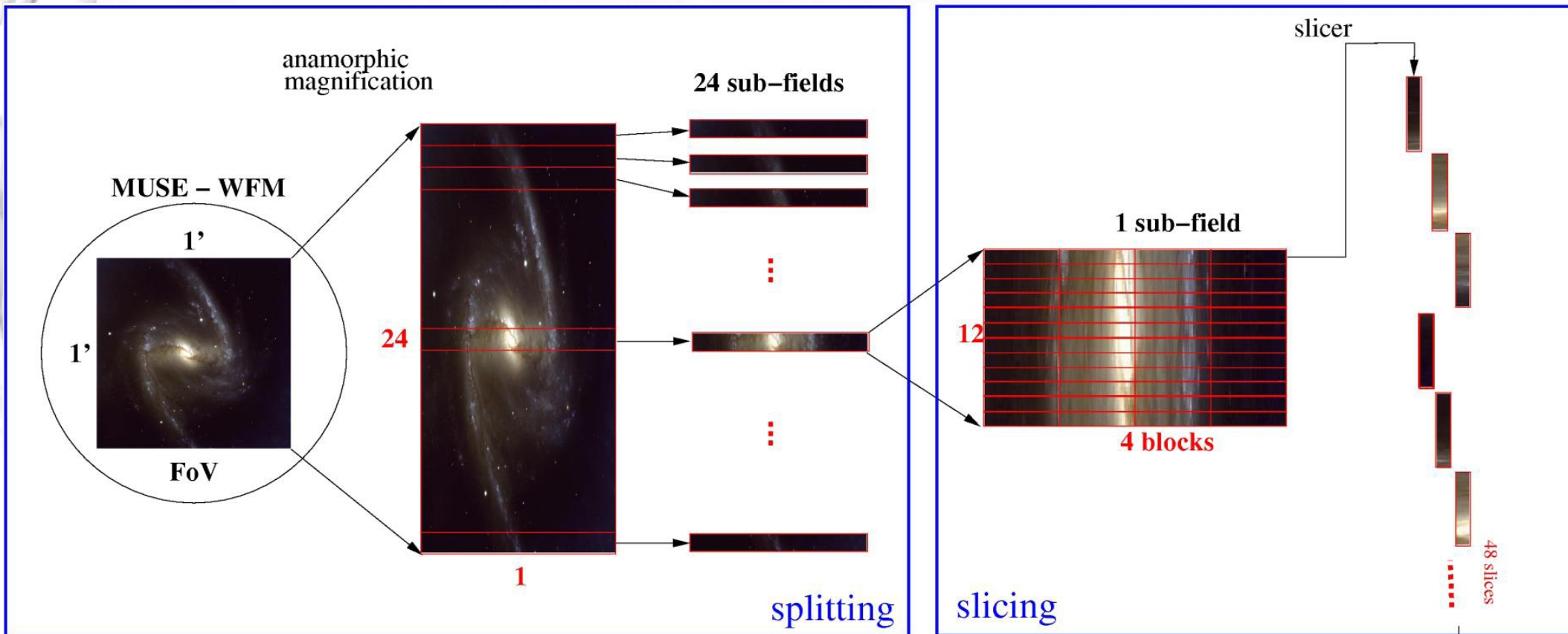
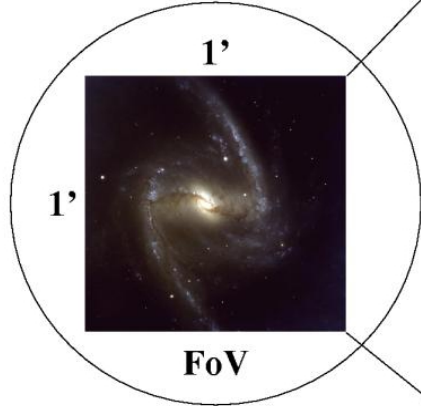# MUSE: An image slicer with 24 IFUs

MUSE: An image slicer with 24 IFUs
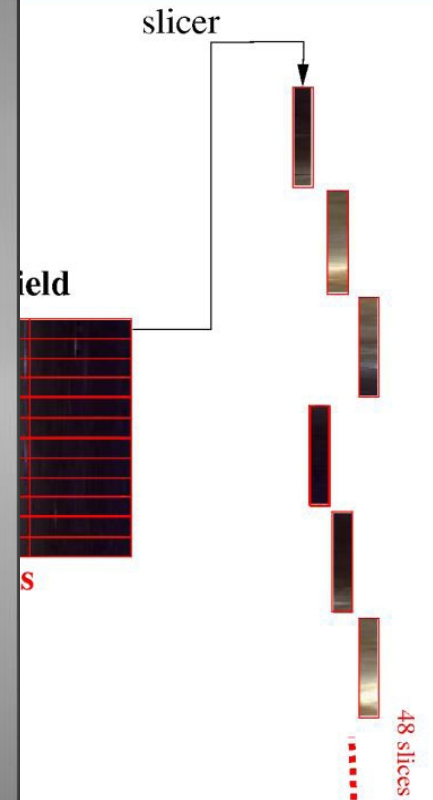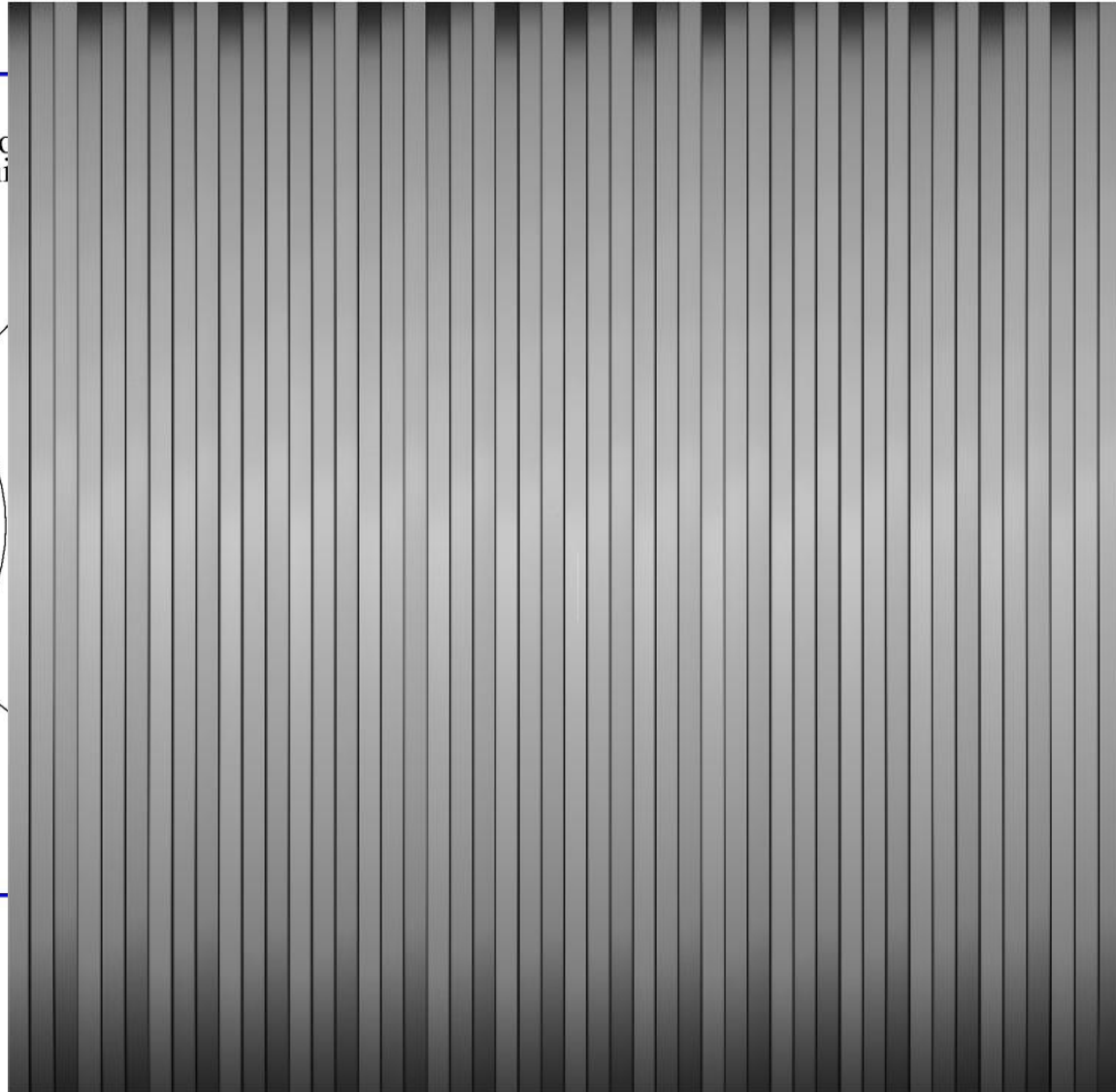
Science cases (1)

- Globular Clusters:

  - Simultaneous abundances and radial velocities.

- Nearby galaxies:

  - Kinematics and stellar populations

  - Dynamics at large radii

  - Environmental dependence

- Detailed structure of mergers

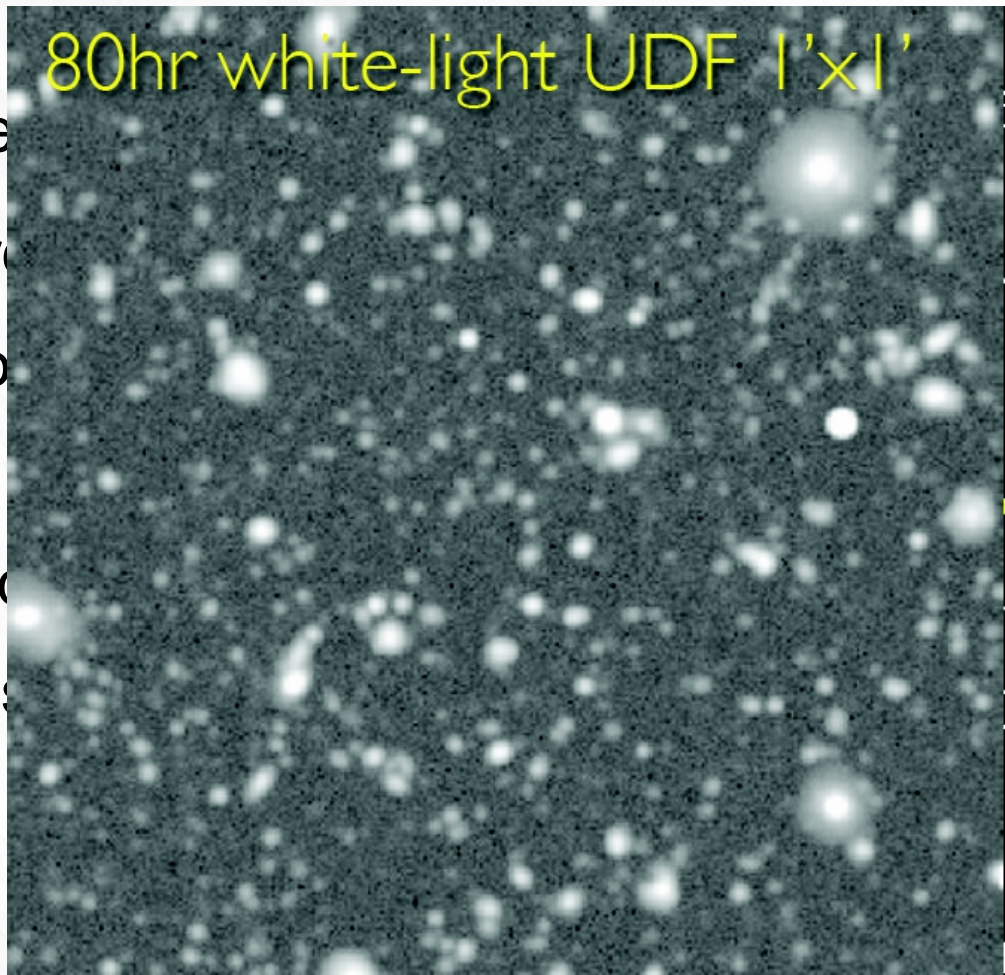- Dynamical M/L of dwarf ellipticals

Science cases (2)

- Galaxy evolution (with resolved spectroscopy) at intermediate redshift:

  - Gas & stellar kinematics and dynamics

  - Metal abundance gradients

  - Environmental dependence

  - SFR at low masses

Science cases (3)

- High redshift Ly-α emitters:

  - Blind Ly-α emitter searches in HST deep fields

- Improve mass distribution models of clusters

- Reionization

- Feedback processes and galaxy formation

- IGM absorption in QSO sight-lines

Science cases (3)

80hr white-light UDF 1'x1'

- High redshift Ly-α emitte

  - Blind Ly-α emitter sear

- Improve mass distributio

- Reionization

- Feedback processes an

- IGM absorption in QSO

Data products (1)

- 3-D data cubes (RA, dec, λ)

  - <u>Format:</u> FITS, Euro-3D

  - <u>Extensions:</u> variance, bad pixels, 2D images

  - <u>Size:</u> ~300x300x4400 = 4×10^8 spaxels ***per exposure***

    ~60''x60''x4500Å

    ~3.2G

Data products (2)

- 3-D data cubes (RA, dec, λ)

- Sub-cubes can be extracted with analysis tool

- Cubes often from combined observations, e.g. a medium-deep field (10h) in a mosaic (3x3)

- Pipeline also creates reconstructed 2D "filter" images (e.g.,B,V,R,I; Hα), which are stored in the data base

Data products: meta data

- The data base contains the full data linage of the data reduction

- It contains all relevant information on the data reduction

- It can also contain results, such as lists of

    - objects, RA, dec, z

    - magnitudes, line fluxes & ratios, SFR, etc

Data management: *MuseWise*

- *MuseWise*: developed for the data management of the GTO - could be used for other observations as well

- It uses parts of the *AstroWise* system

- Contains layers of recipes that control input(s) and output(s)

- Metadata saved in Oracle DB; data files stored on a data server

- Visibility of data objects depends on PROJECTS, CREATOR, PRIVILEGES

- A "Target Processor" will be used to get reduced data products from the most up-to-date data reduction

MUSE data at VO

- In *AstroWise*, data can be published directly to VO

- Can easily be implemented for *MuseWise* as well

- Data products and metadata could then be made available at VO by a simple change of one attribute (privileges) in the *MuseWise* data base

- This would make it possible for anybody to search the MUSE data base for objects of interest

- However, for the MUSE GTO data, no decissions have been made so far regarding when and if these will be available to the community

Summary

- MUSE will produce:

  - Optical, full-wavelength coverage (4650-9300Å), medium spectral resolution (R~3000), high spatial resolution (~0.2"), wide-field (1x1 arcmin) IFU spectroscopy

  - With NFM and AO: 7.5''x7.5'', pixel scale of 0.025''

- Data management for internal GTO observations is handled by the *MuseWise* system:

  - It will keep full track of data linage and store the results in a data base

- Policies for sharing MUSE GTO data still to be discussed