MUSE-WISE

Managing Massive IFU Data Sets from the MUSE Instrument on VLT

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MUSE data management team:
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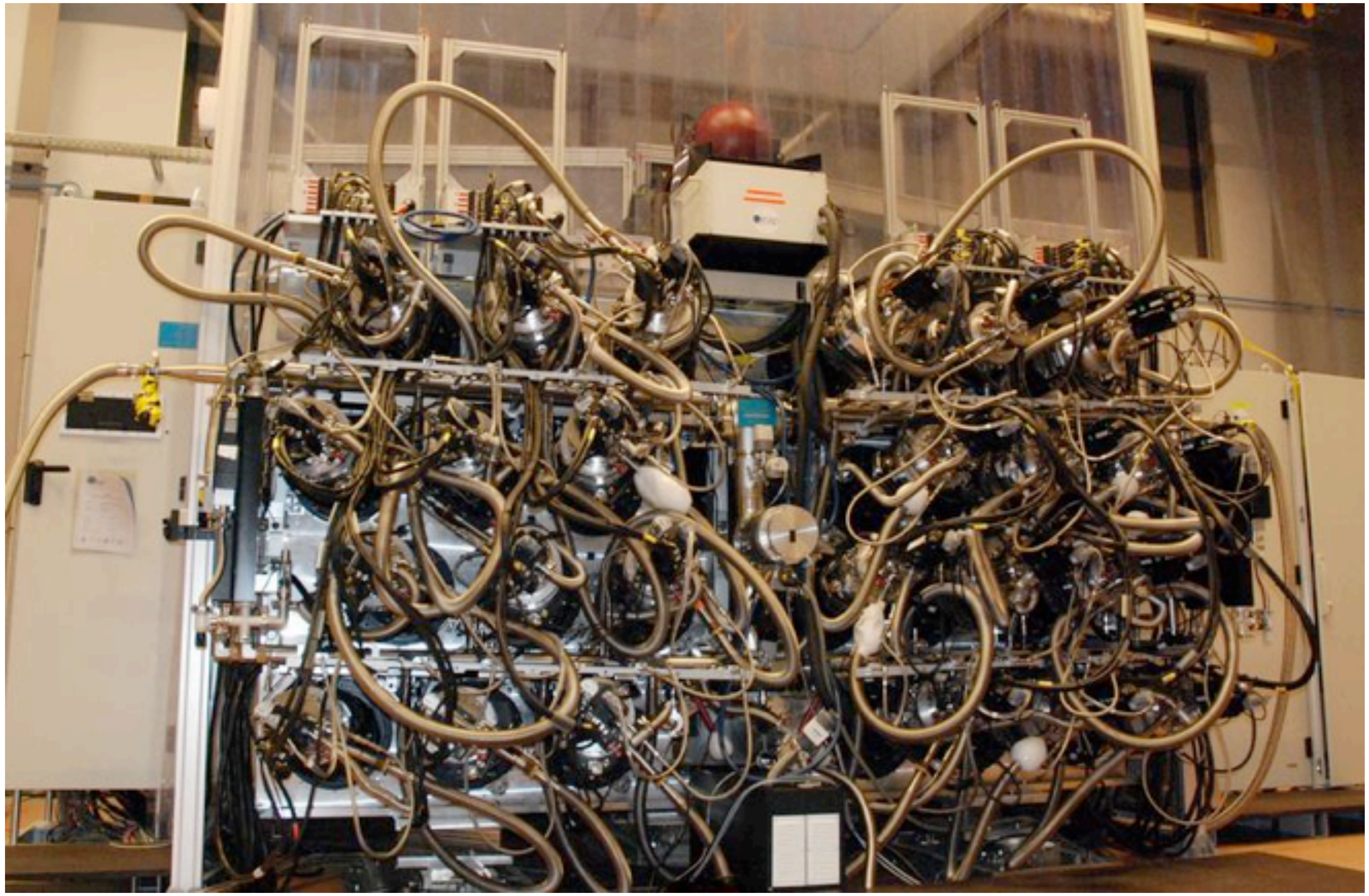
Nicolas Bouche, Genevieve Soucail, Marie Larrieu (Toulouse),
Rees Williams, Willem-Jan Vriend (Groningen)
Thomas Martinsson (Leiden)

The MUSE instrument



Optical (4650Å-9300Å) IFS consisting of 24 IFUs.

FoV: 1'x1' sampled at 0.2", spec R ~ 2000-3000.

Primary Acceptance Europe: Granted September 10.

Commissioning: Feb & Apr 2014, GTO start Oct 2014

The MUSE consortium

PI, Roland Bacon

MUSE-WISE, DRS

MUSE-WISE

MUSE-WISE

GTO

Total award: 250 nights
Duration: 2014-2019

The time is planned as a coherent whole by the entire consortium.

Testing and evaluation of strategies and software is done using a sophisticated instrument numerical model and simulated observations.

Science context (from GTO perspective)

MUSE will be a very stable instrument

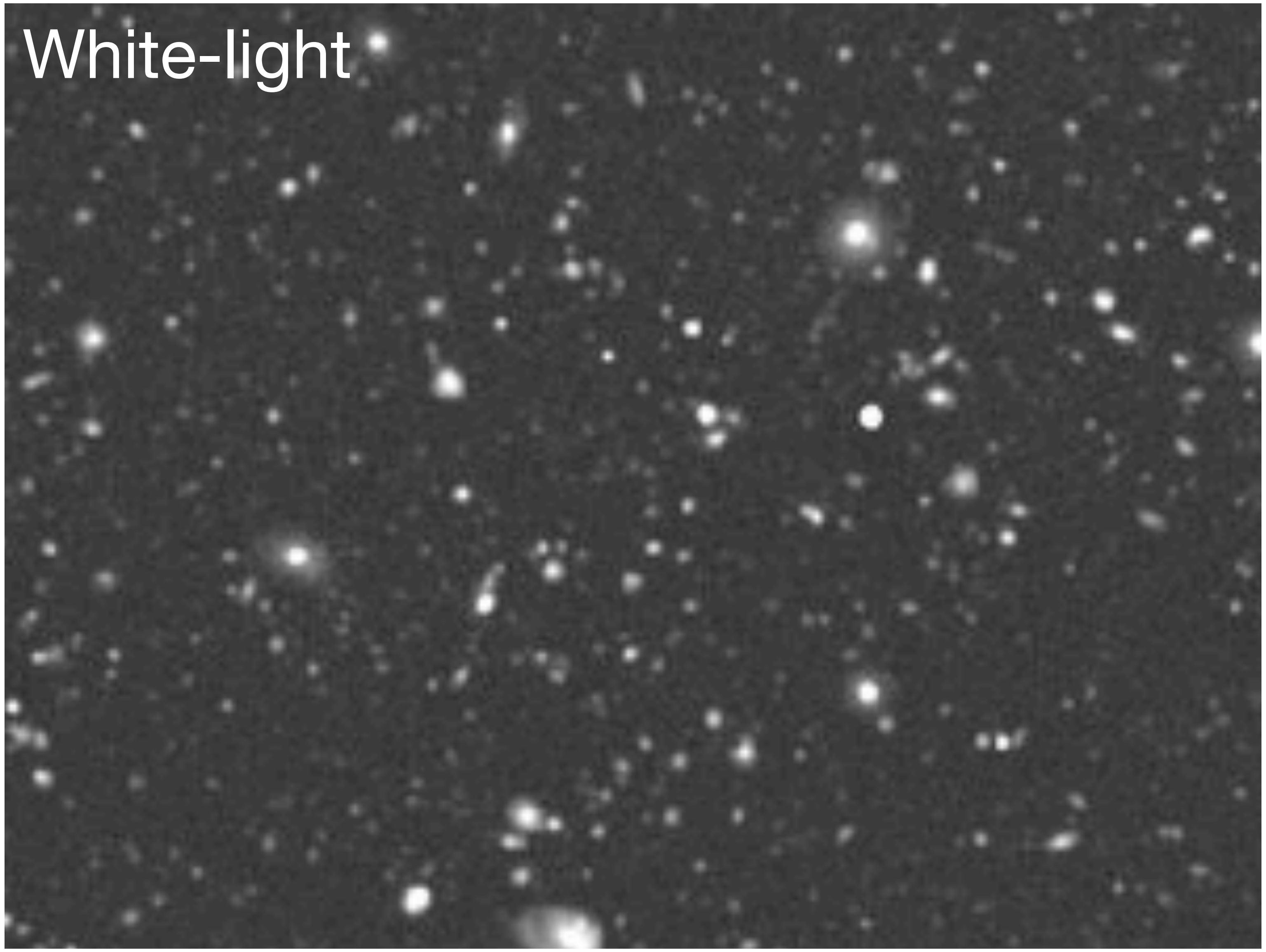
↓

Long integrations possible

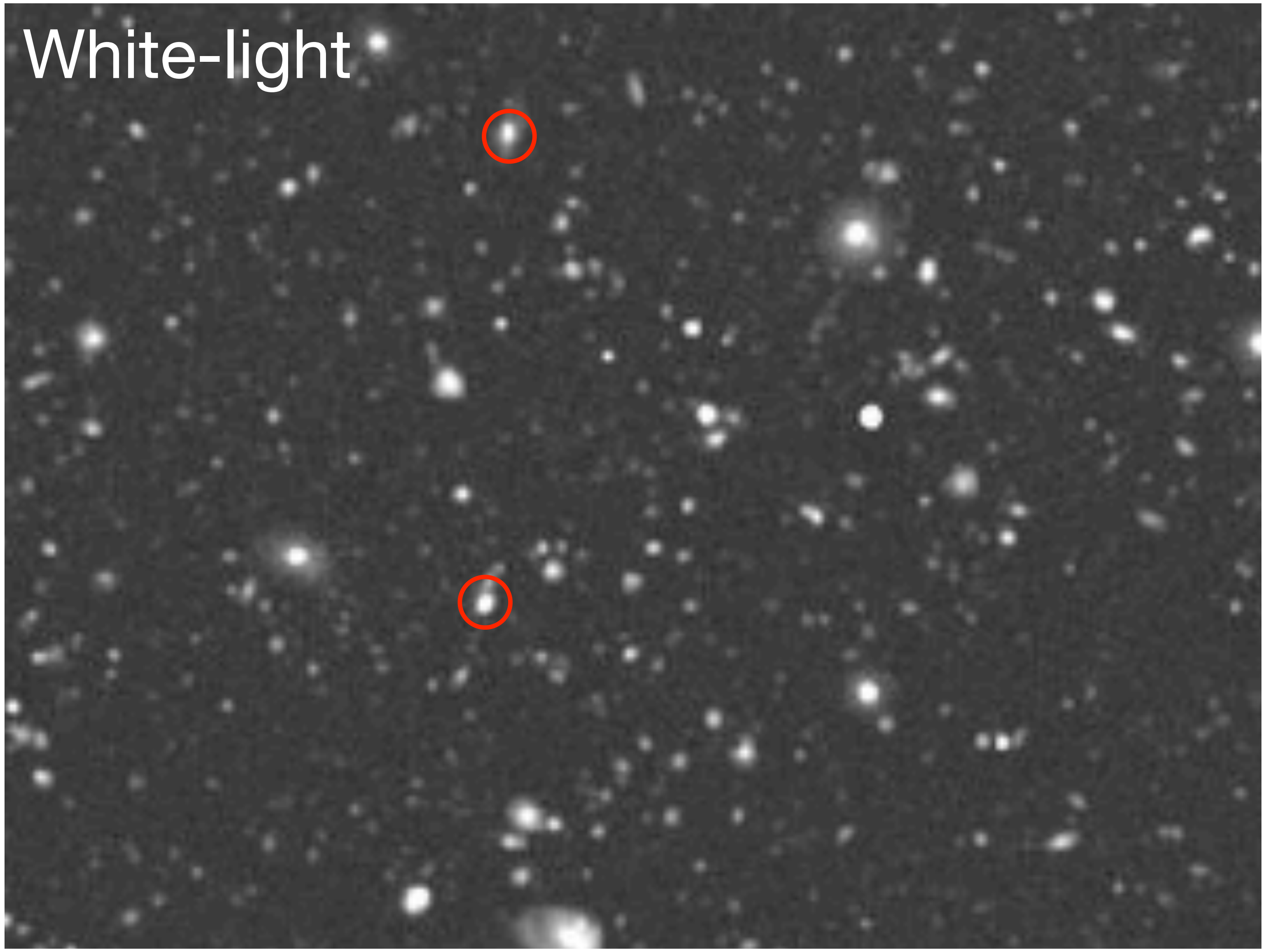
Some example science:

- Detect “fluorescence” and diffuse emission from the intergalactic medium at $z>3$ through Ly-α emission.
- Study gas flows around galaxies through a combination of Ly-α emission and absorption (from UVES/COS).
- Metallicity and dynamical maps of galaxies with $0.1<z<1.0$ - a poorly studied regime thus far.
- Stellar populations in globular clusters and nearby galaxies.

Optimising science



Optimising science



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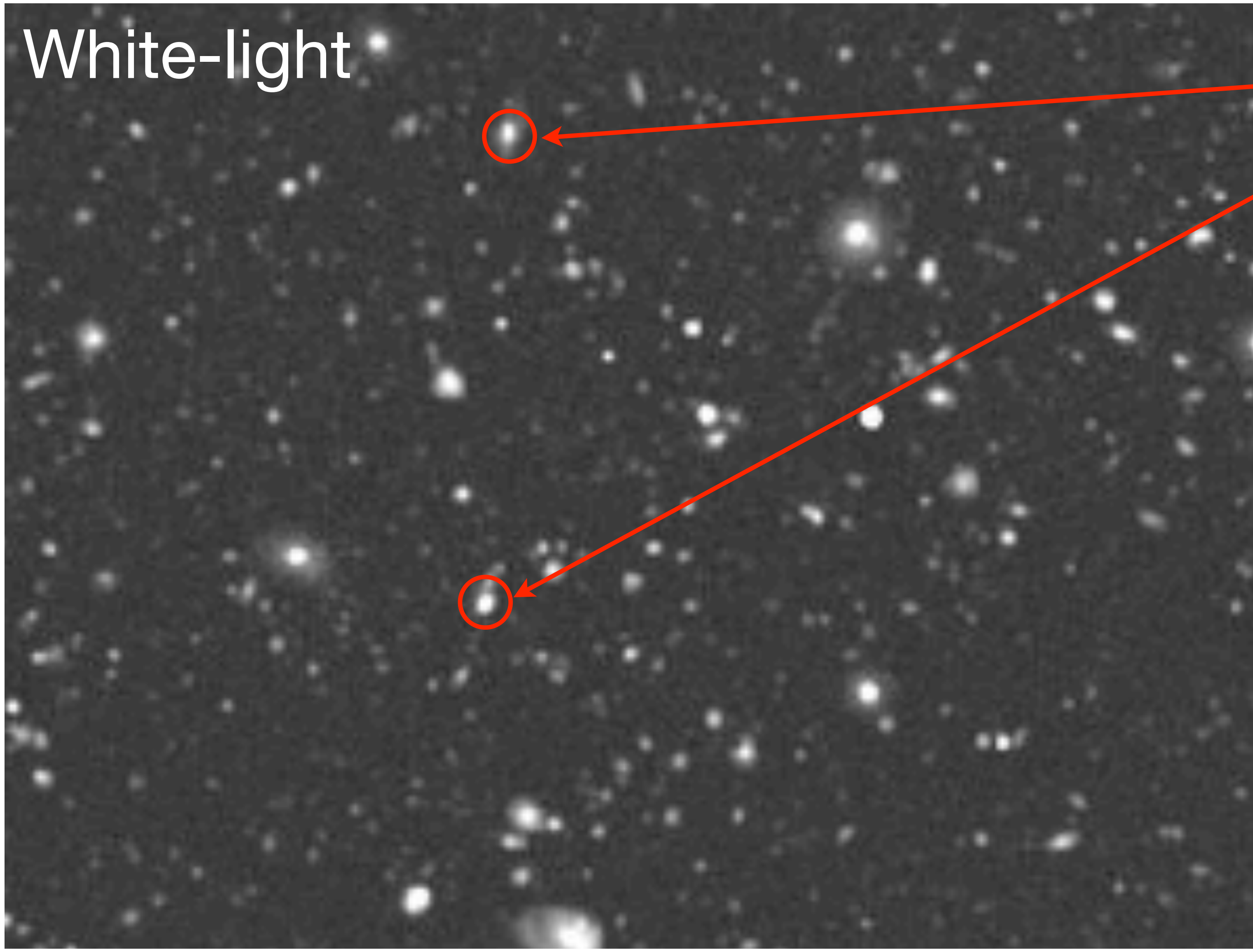
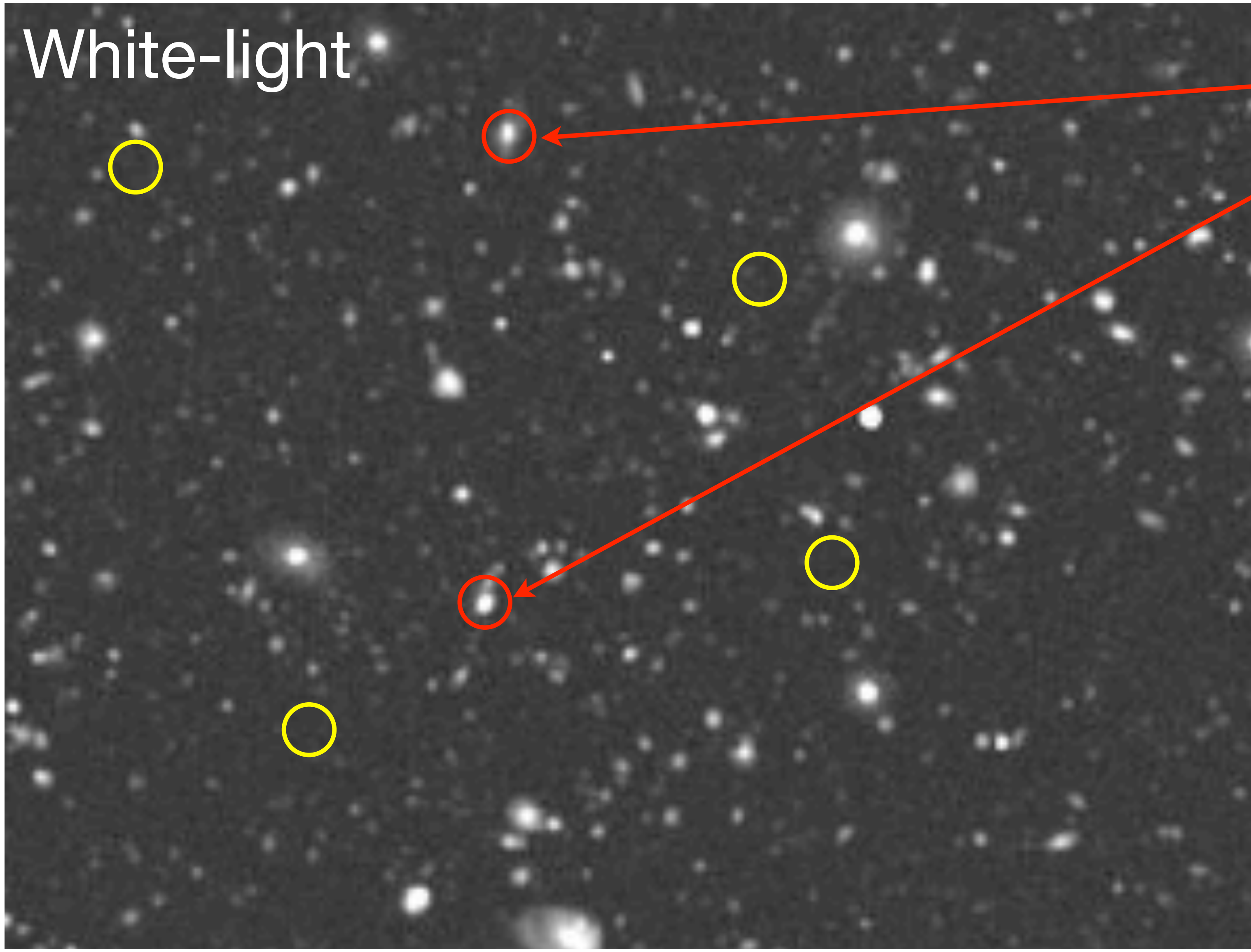


Metallicity maps

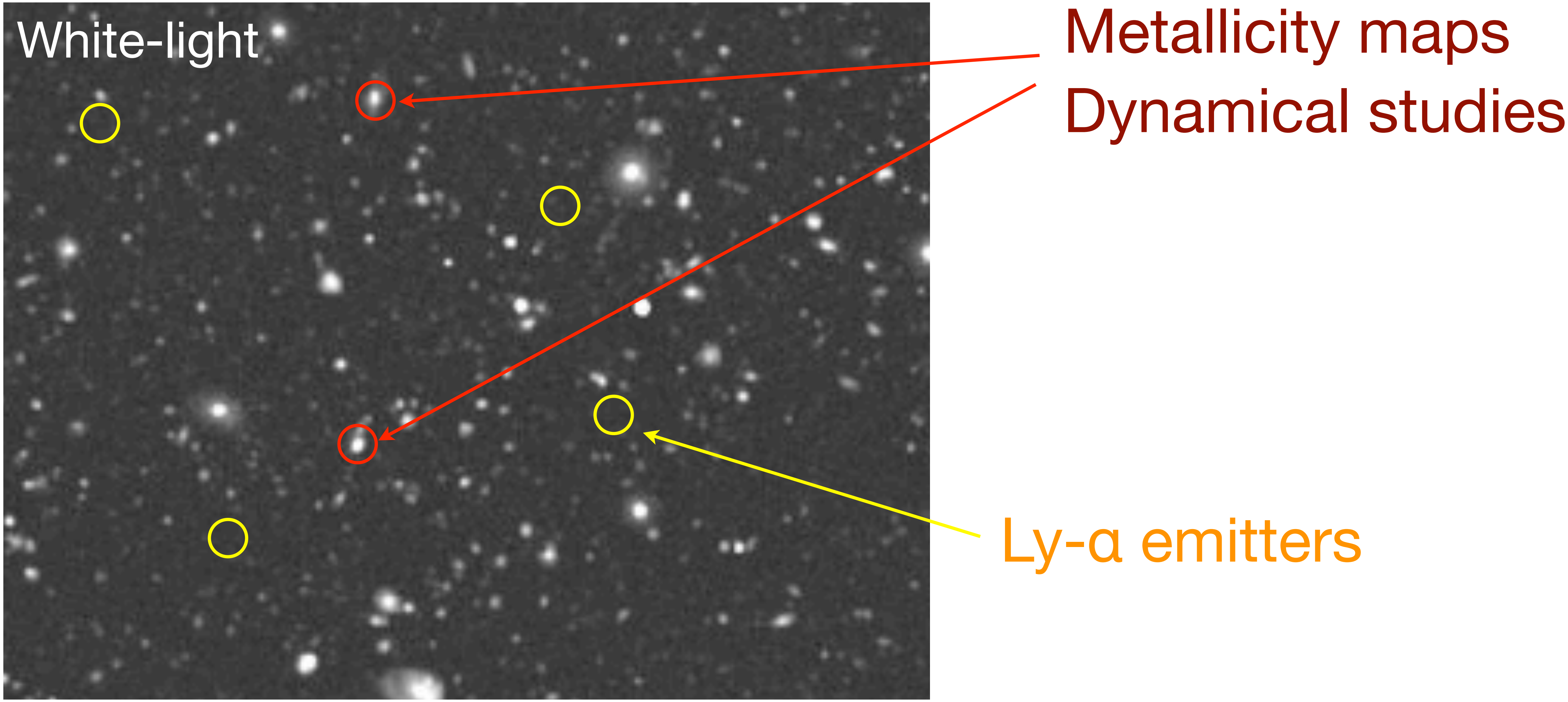
Dynamical studies

Optimising science



Metallicity maps
Dynamical studies

Optimising science



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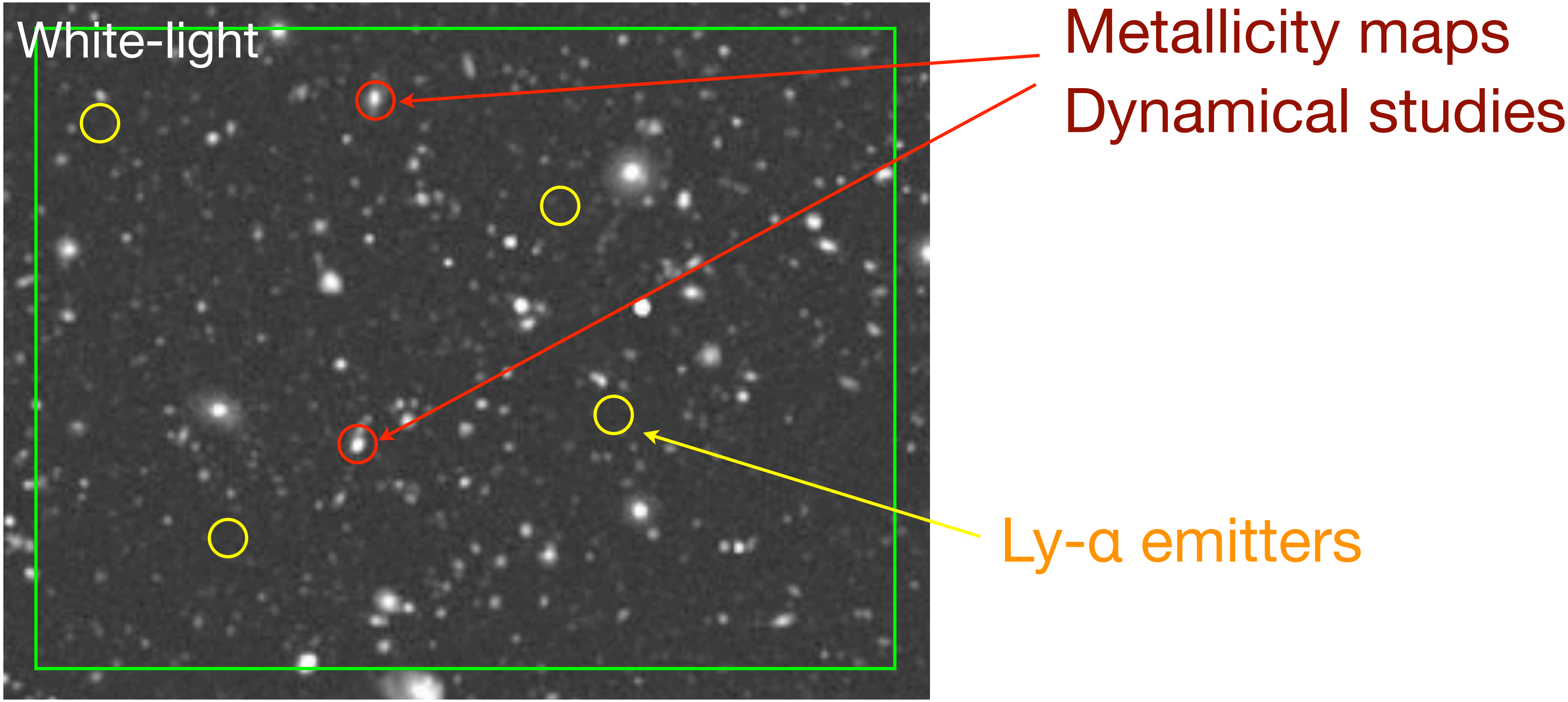

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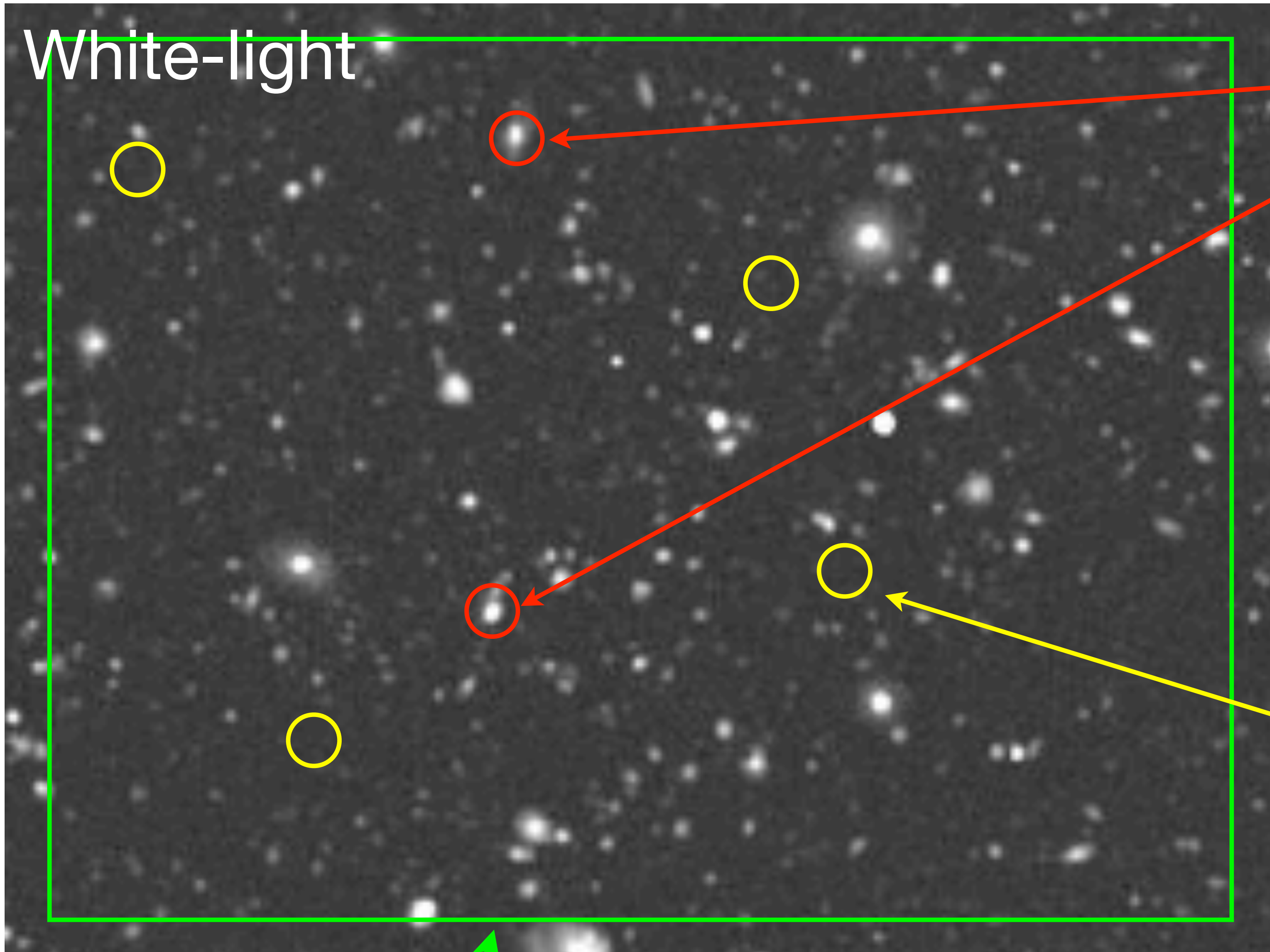


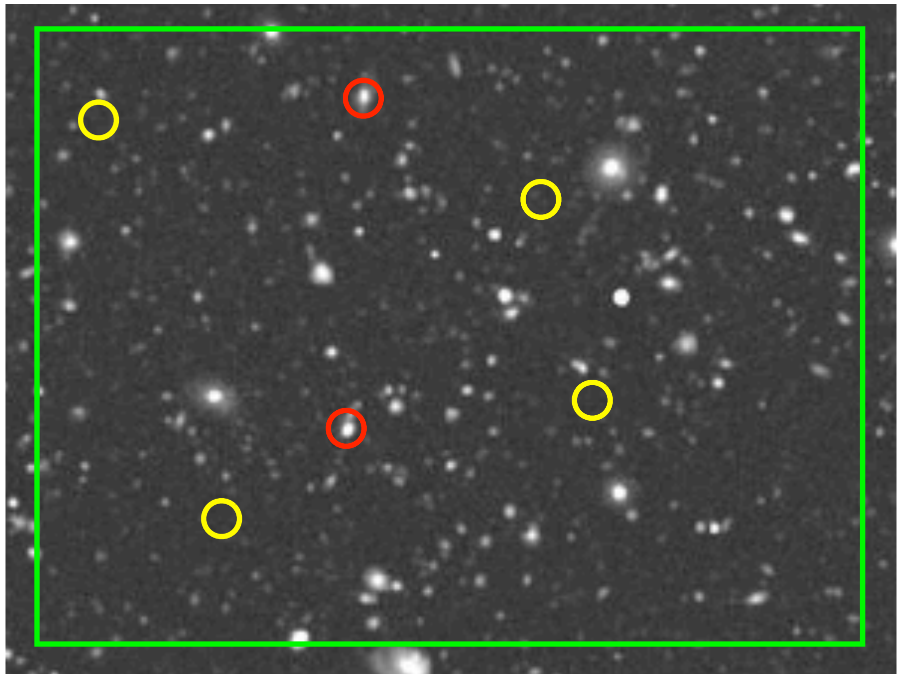
Metallicity maps

Dynamical studies

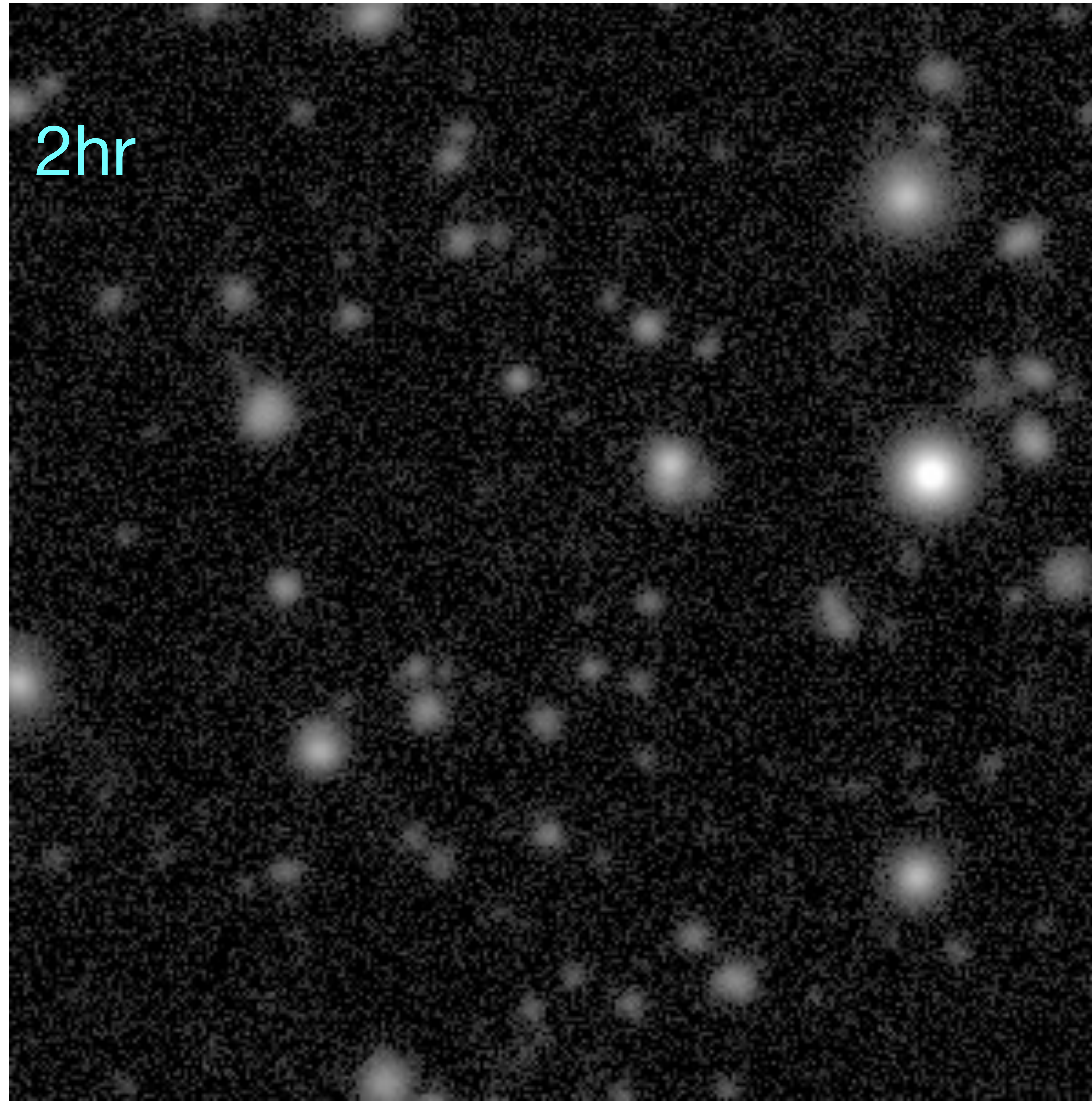
Ly-α emitters

Diffuse Ly-α emission

Optimising science



A range of integration times and observing conditions - want to treat data in a **uniform way**.



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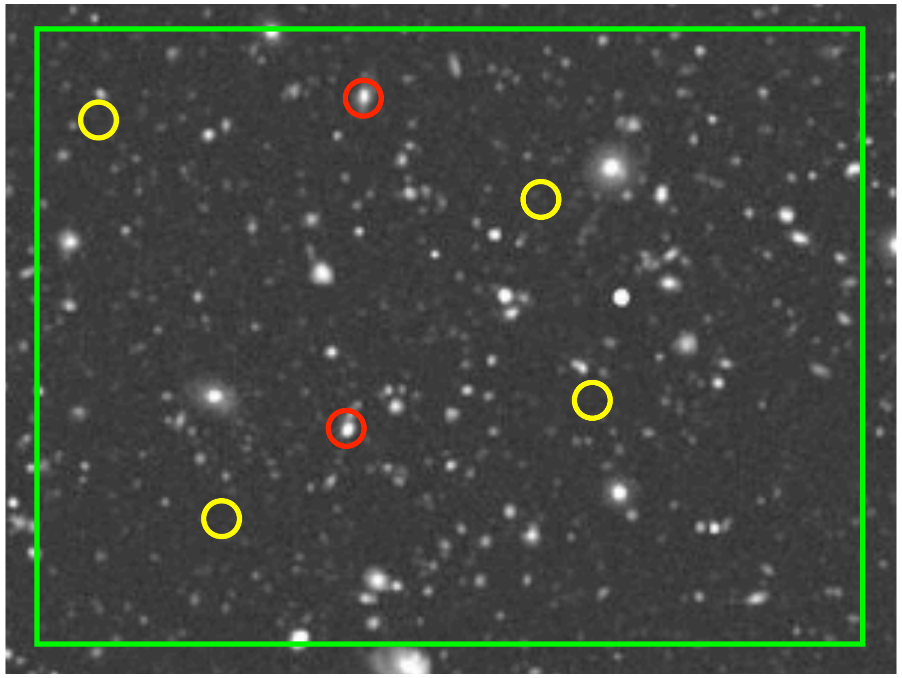

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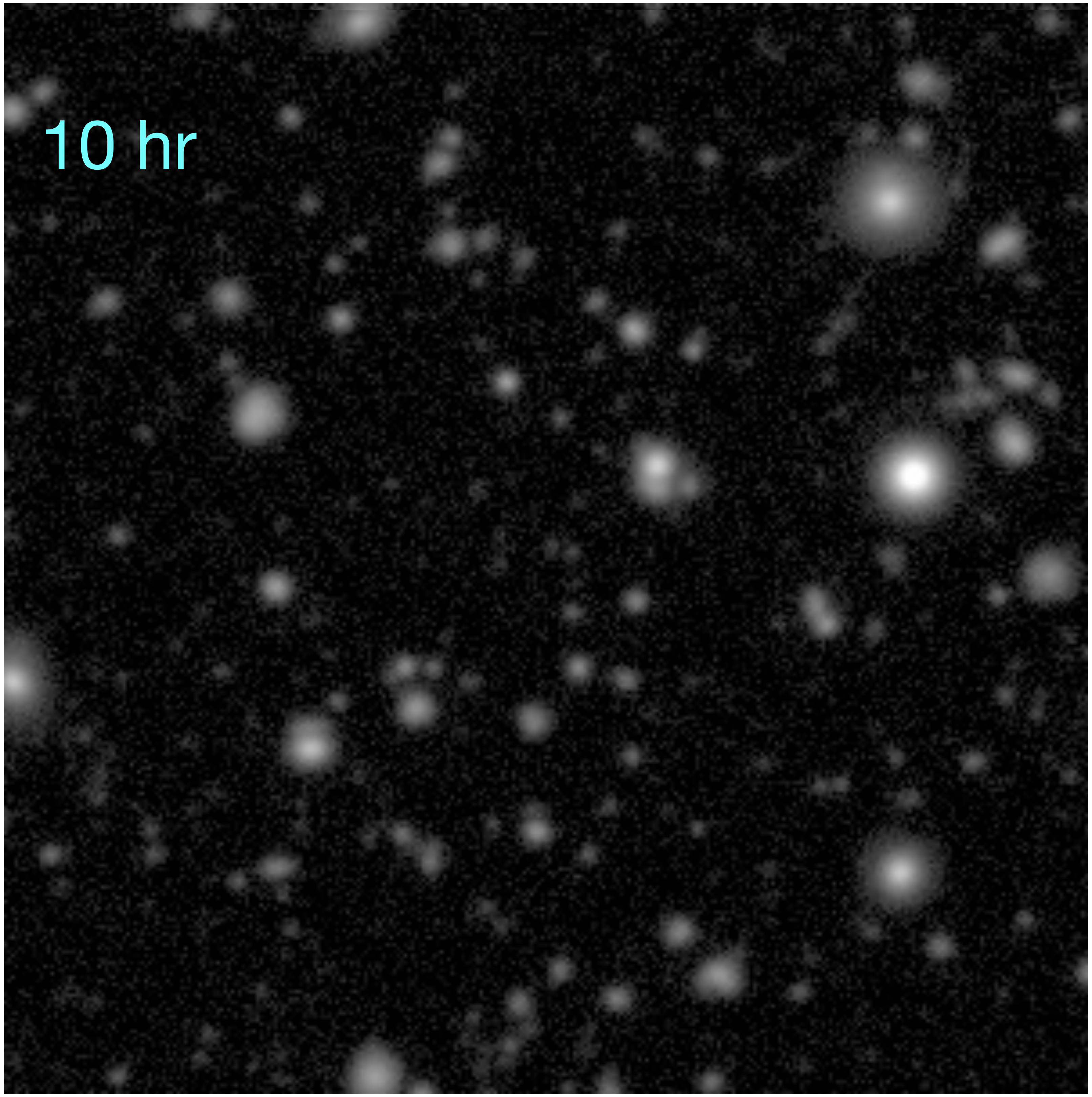

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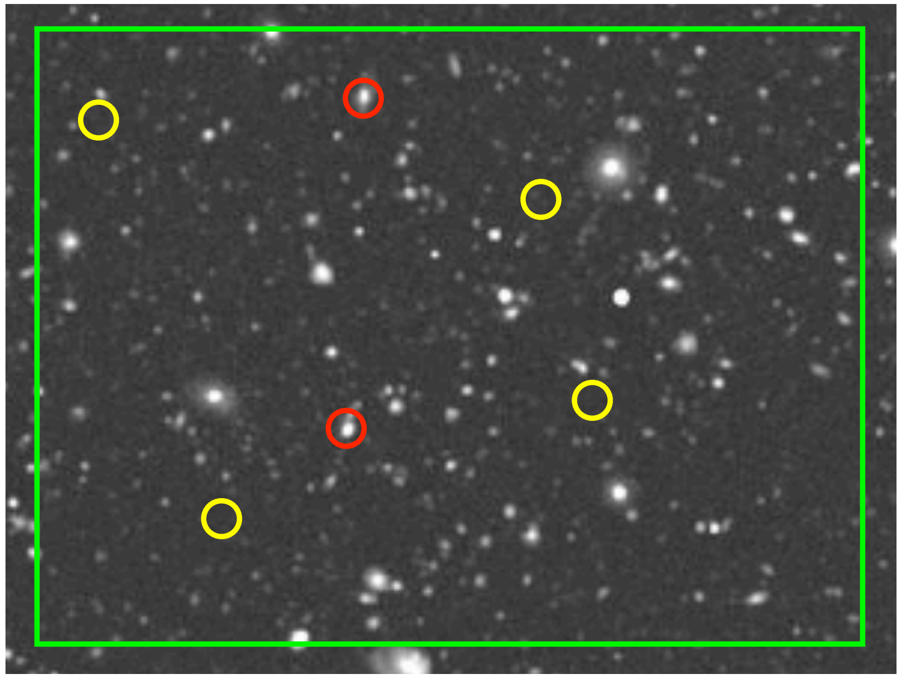

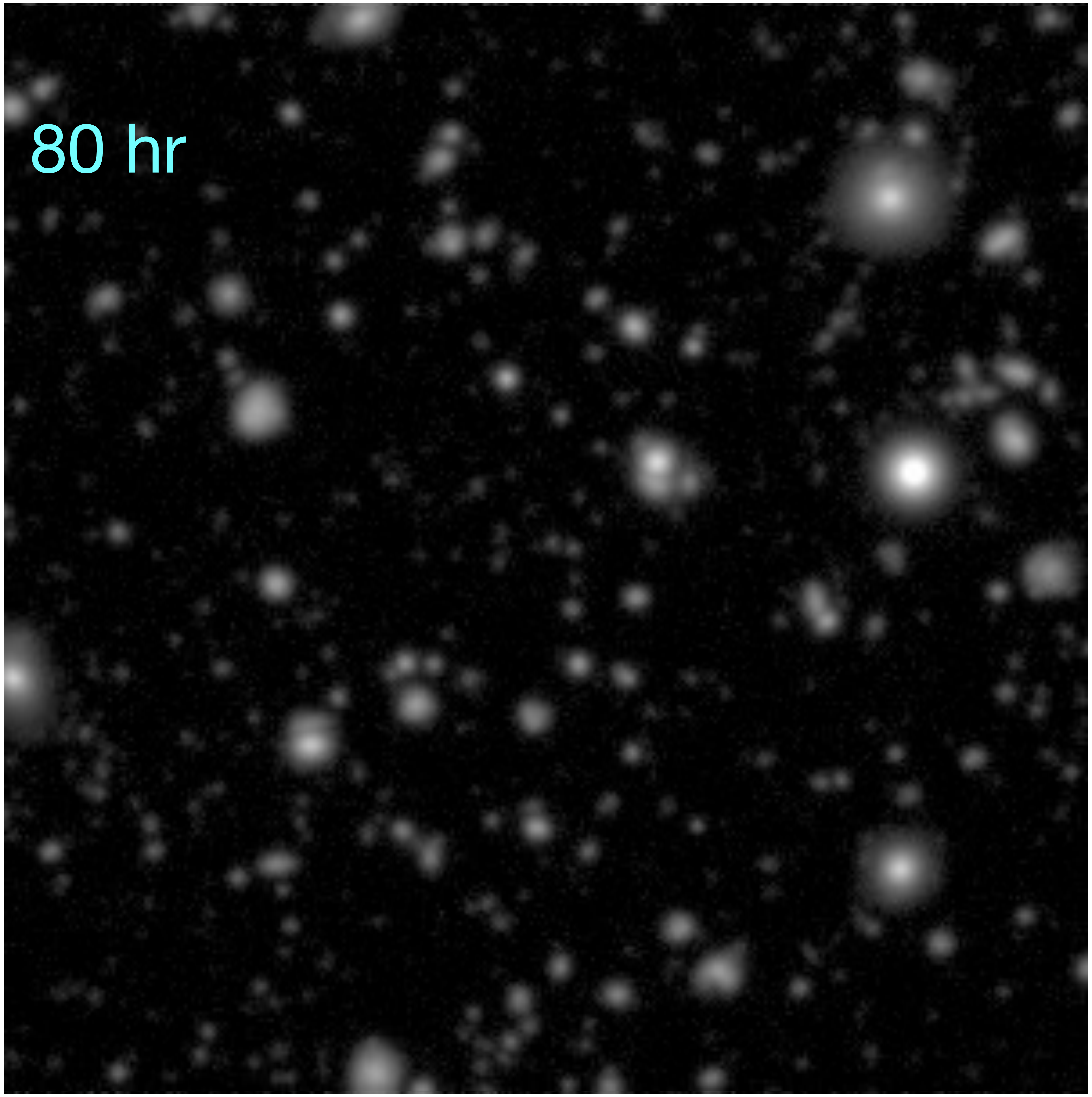

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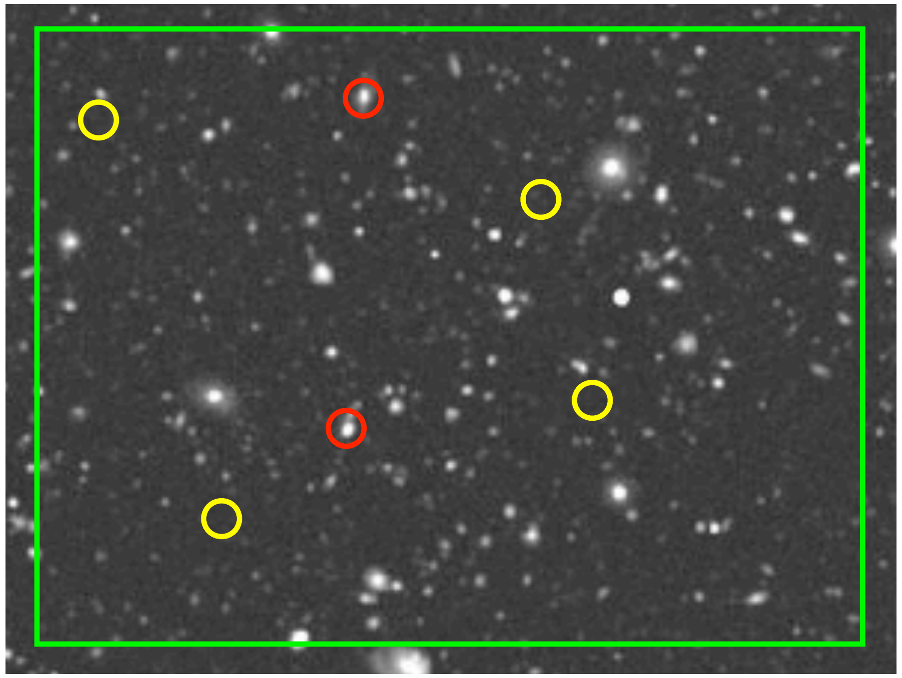

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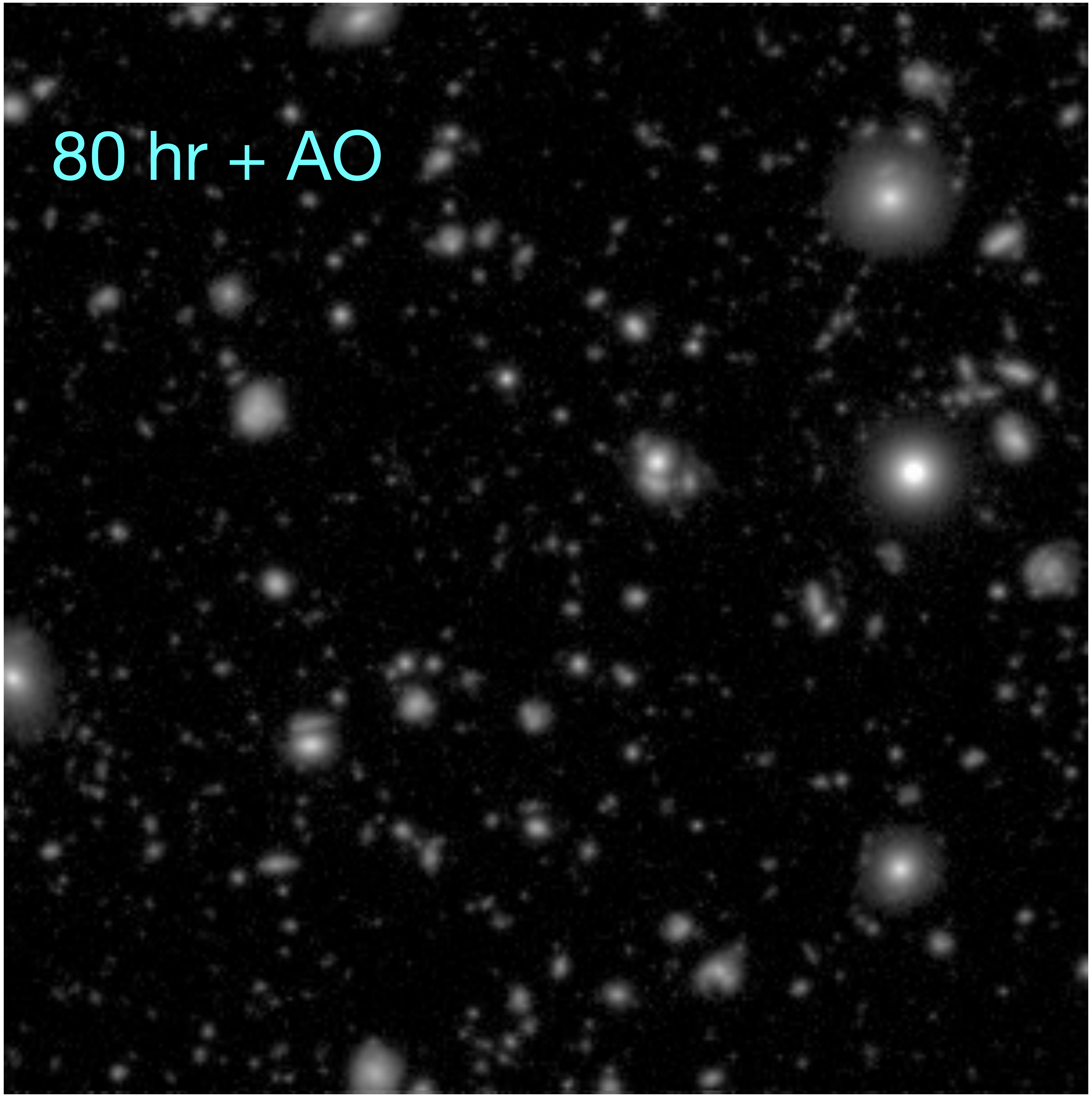


Optimising science & needs - keywords

Multiple uses of the same data ➡ sharing is desirable.

The same data can be used for significantly different science. For consistency within the consortium we would like to be able to work on the same data reduced the same way (but obviously with freedom to do otherwise).

Optimising science & needs - keywords

Multiple uses of the same data ➡ sharing is desirable.

Quality control is complex ➡ Distribute effort.

Verifying the quality of data cubes, particularly after reduction is complex, time-consuming and to some extent science dependent. It is very desirable to be able to distribute this effort.

Optimising science & needs - keywords

Multiple uses of the same data ➡ sharing is desirable.

Quality control is complex ➡ Distribute effort.

Multi-site consortium ➡ reference reduction/analysis needed.

Associated to the first point - by having a reference reduction that all can access in the same way, we will have a backbone for the consortium efforts.

Optimising science & needs - keywords

Multiple uses of the same data ➡ sharing is desirable.

Quality control is complex ➡ Distribute effort.

Multi-site consortium ➡ reference reduction/analysis needed.

Marginal detections important ➡ the reduction history crucial.

Many science goals for MUSE requires work close to the detection limit often where sky lines are strong. Here it is crucial that we know the full history of the data reduction so we can verify controversial, but important, detections.

Optimising science & needs - keywords

Multiple uses of the same data ➡ sharing is desirable.

Quality control is complex ➡ Distribute effort.

Multi-site consortium ➡ reference reduction/analysis needed.

Marginal detections important ➡ the reduction history crucial.

Fundamentally challenging data reduction ➡ software development is ongoing.

MUSE data are irregularly sampled 3D data and the optimal reduction of such data is still not a fully solved problem. We expect on-going improvements to the reduction and analysis pipelines throughout. Thus the system we adopt must be flexible enough to allow this.

Data rates & handling needs

Data rate: Moderate

Raw data cube: 1.5 GB (301x301x3463)
Reduced cube incl. variance map: ~3 GB.

Expected data rate: ~50-100 GB/night incl. calib. data

Data rates & handling needs

Data rate: Moderate

~50-100 GB/night

Data for GTO: Moderate, but complex

For 100 nights: ~10 TB raw data excl. commissioning GO

Reduced data: ~100 TB with multiple versions (TBC)

Data reduction: To combine 10 exposures ~256 GB RAM

Data rates & handling needs

Data rate: Moderate ~50-100 GB/night

Data for GTO: Moderate, but complex ~100 TB

Organisation:

At least 7 sites.

Distributed reduction/quality control: all reduced data must be accessible in a uniform way for all sites.

Know-how must be diffused through the consortium.

Data rates & handling needs

Data rate: Moderate ~50-100 GB/night

Data for GTO: Moderate, but complex ~100 TB

Organisation: Multi-site

Flexibility:

Allow for improvement in data reduction.
Ease integration of novel analysis methods.
+ +

Data rates & handling needs

Data rate: Moderate ~50-100 GB/night

Data for GTO: Moderate, but complex ~100 TB

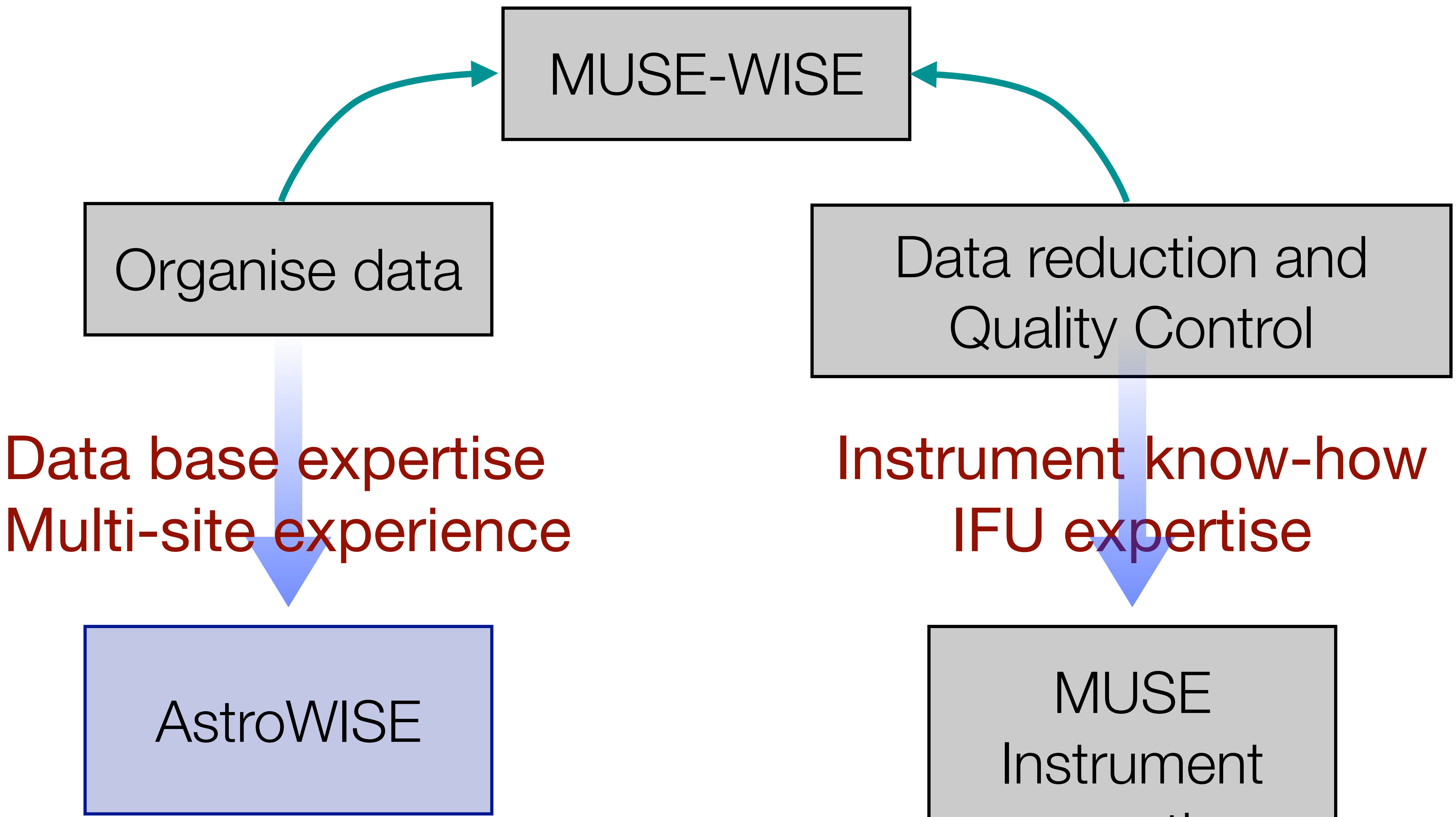
Organisation: Multi-site

Flexibility: Pipeline/analysis changes

Distribution (TBD):

Data releases.
VO functionality/access.

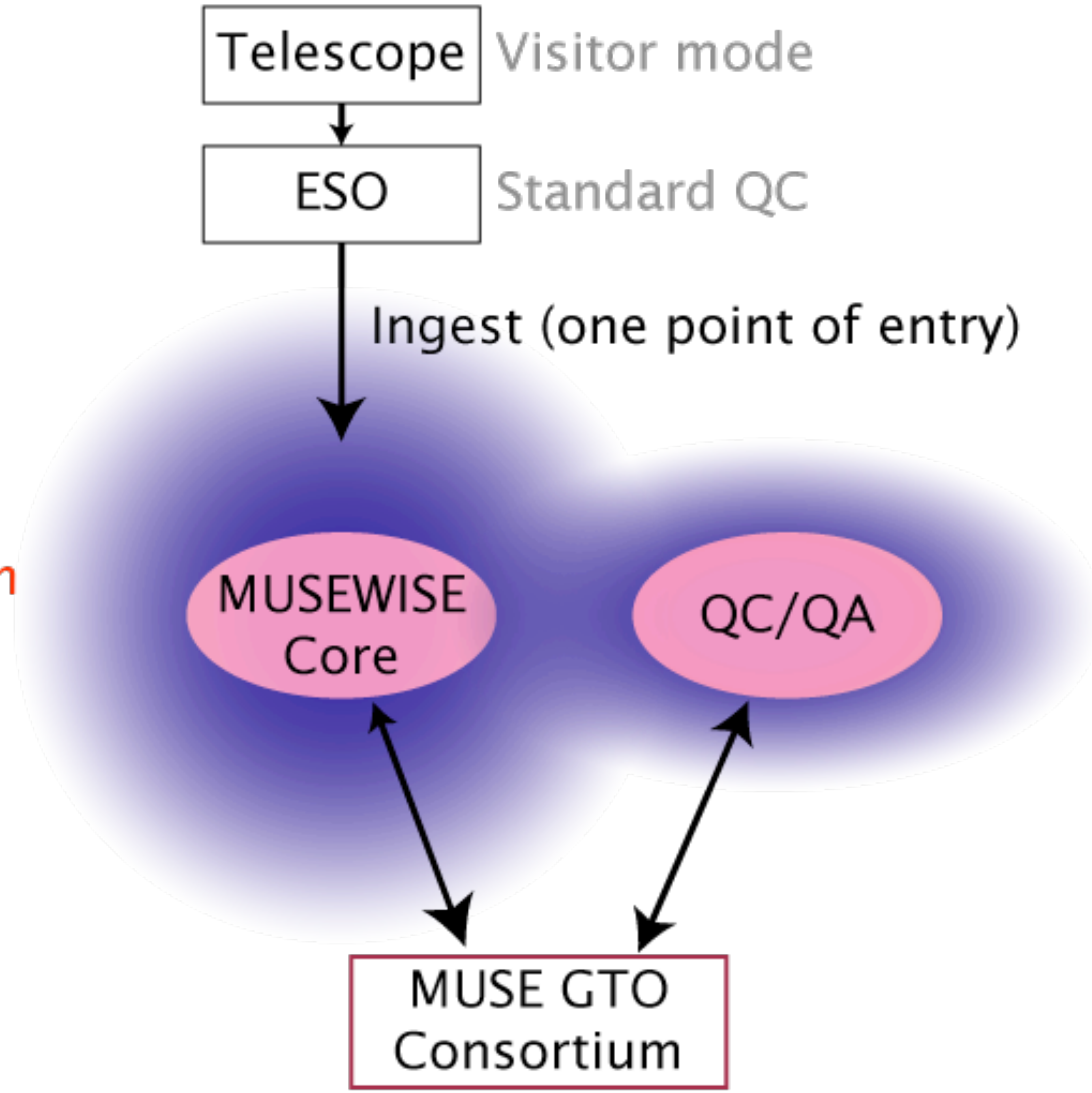
MUSE-WISE - sharing of expertise



First time this is done for IFU data

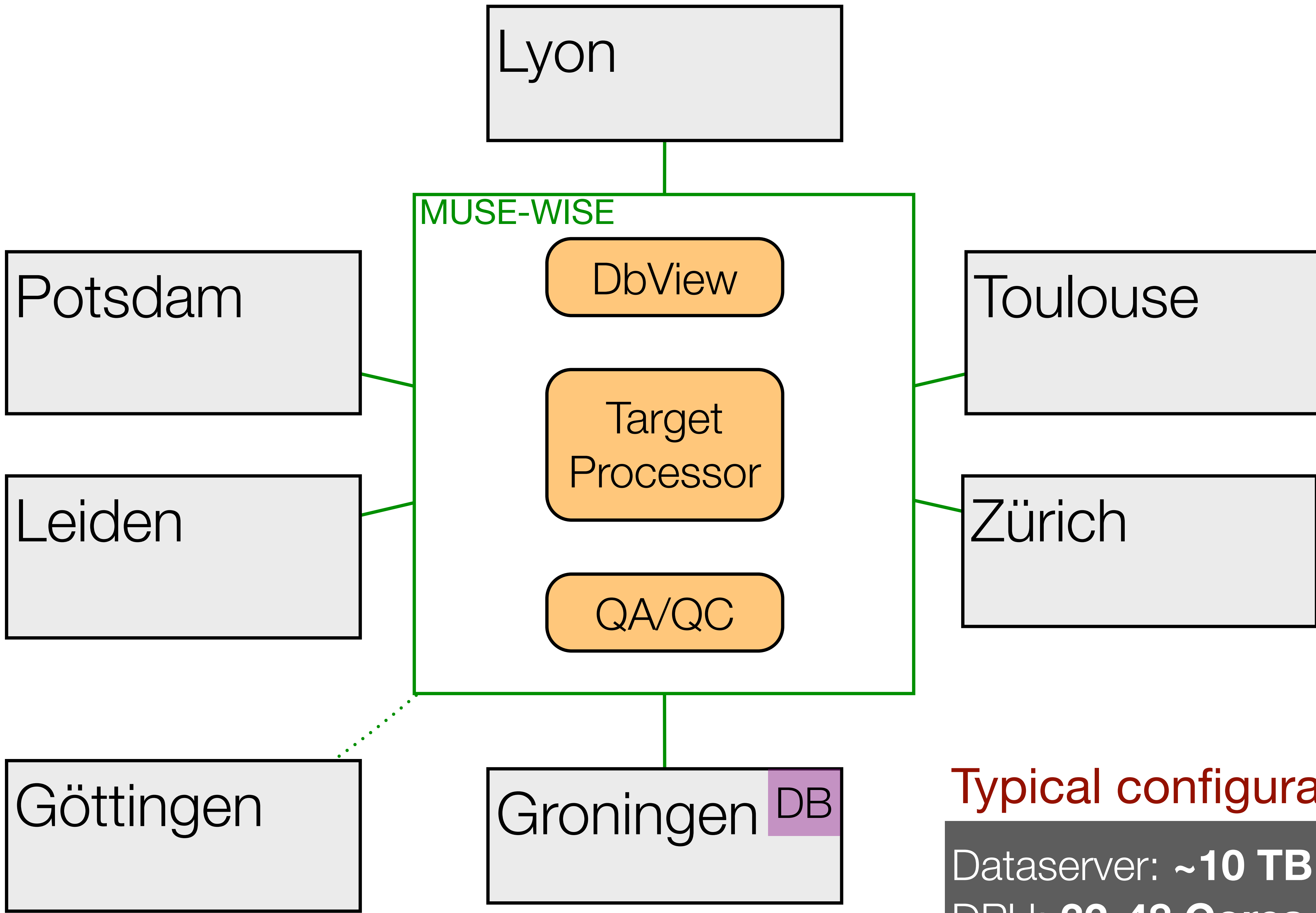
MPDAF developed in Lyon for analysis

Data flow



Operated by
MUSE consortium
+
AstroWISE
redundancy!

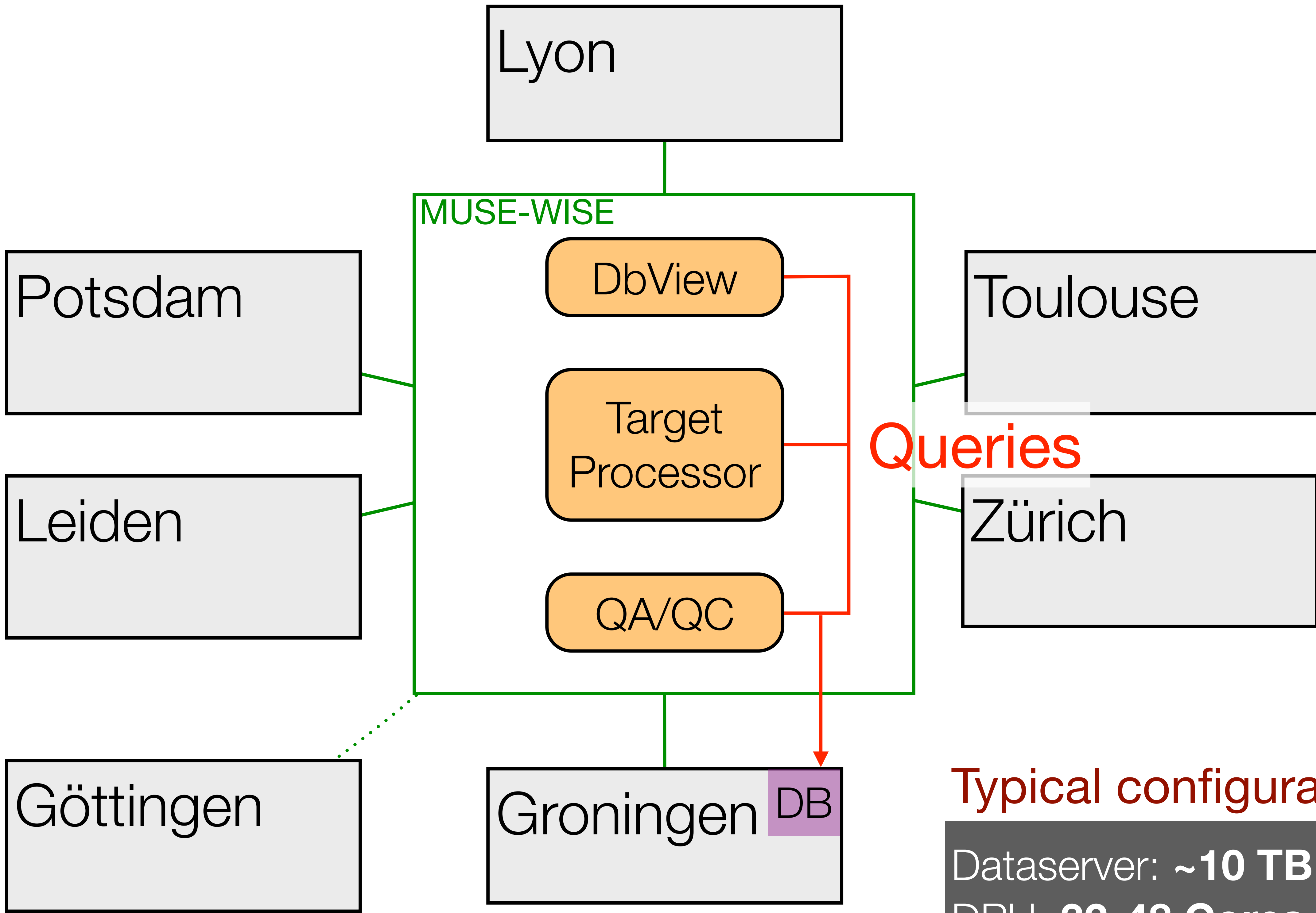
Current setup



Typical configuration

Dataserver: **~10 TB**
DPU: **32-48 Cores**
256 GB Mem

Current setup



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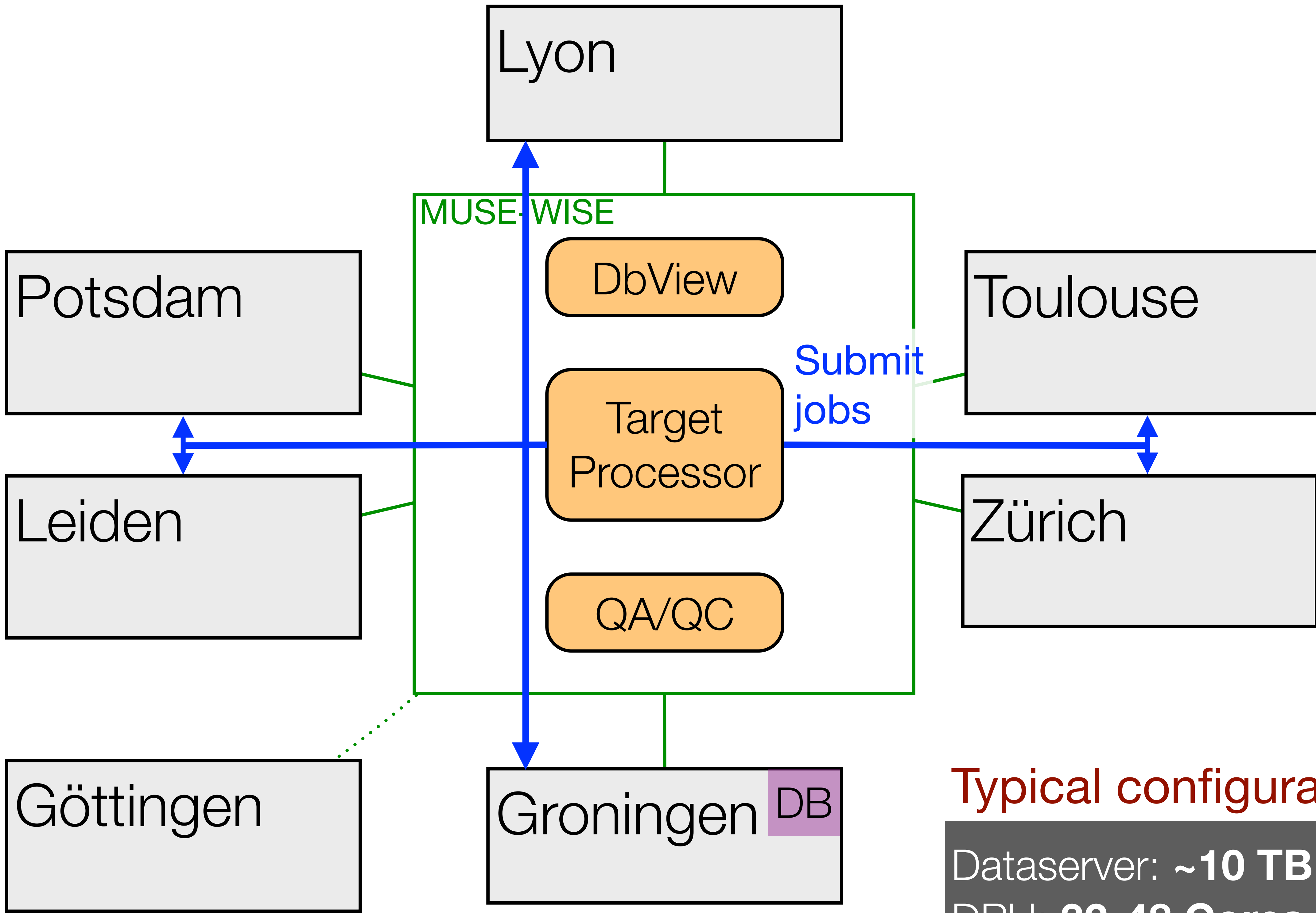

Typical configuration

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Implementation

Data Reduction System

+

XML description files

(almost) Automatic creation of Python wrappers

AstroWISE

MUSE-WISE

Quality control & quality assurance

MUSE consortium

Interface

Python command line

`MasterBias, for IFU #1 & don’t commit:`

```
> date = datetime(2011, 10, 01)
> dpu.run(‘bias’, date=date, ifu=1, commit=False)
```

`Science reduction for all IFUs with commit:`

```
> pars = {‘crtype’: ‘median’, ‘crsigma’: 20, ‘resample’: ‘drizzle’}
> dpu.run(‘scipost’, date=date, commit=True, p=pars)
```

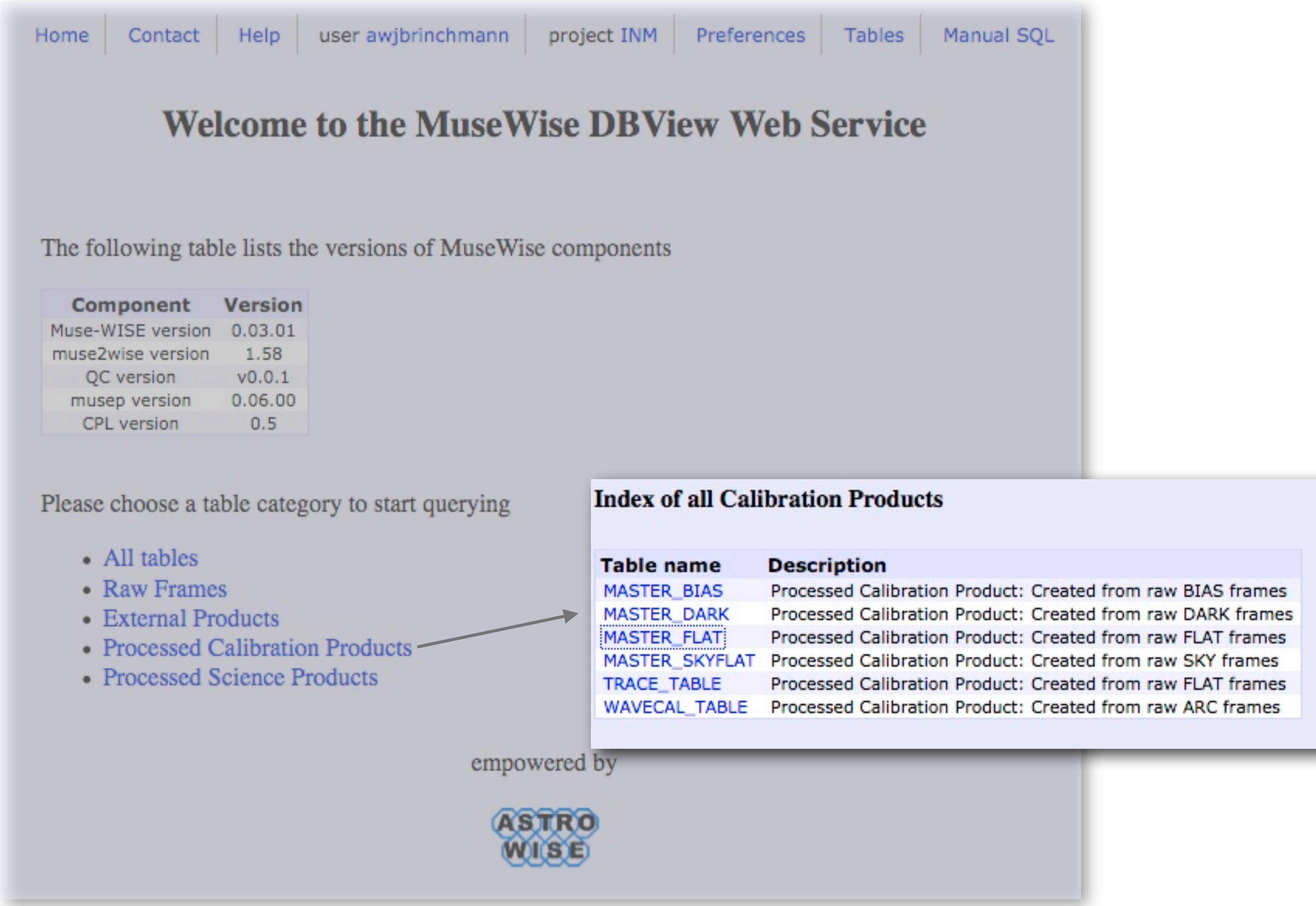
Allows full SQL searches of database, and access to all DRS recipes, but some learning curve.

Interface

Graphical

Interface

Graphical



Home | Contact | Help | user awjbrinchmann | project INM | Preferences | Tables | Manual SQL

Welcome to the MuseWise DBView Web Service

The following table lists the versions of MuseWise components

Component	Version
Muse-WISE version	0.03.01
muse2wise version	1.58
QC version	v0.0.1
musep version	0.06.00
CPL version	0.5

Please choose a table category to start querying

- All tables
- Raw Frames
- External Products
- Processed Calibration Products
- Processed Science Products

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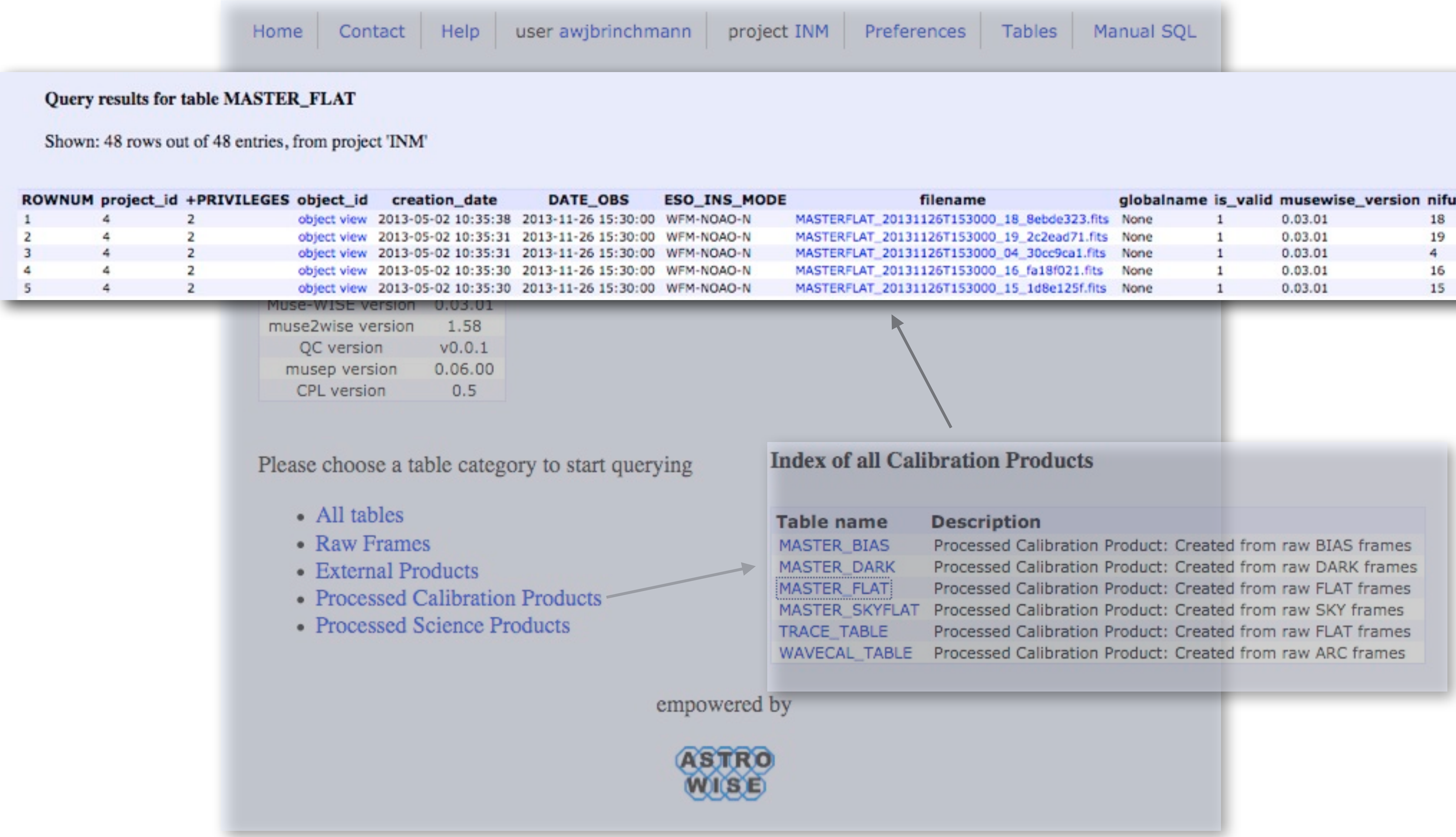
ASTRO WISE

Index of all Calibration Products

Table name	Description
MASTER_BIAS	Processed Calibration Product: Created from raw BIAS frames
MASTER_DARK	Processed Calibration Product: Created from raw DARK frames
MASTER_FLAT	Processed Calibration Product: Created from raw FLAT frames
MASTER_SKYFLAT	Processed Calibration Product: Created from raw SKY frames
TRACE_TABLE	Processed Calibration Product: Created from raw FLAT frames
WAVECAL_TABLE	Processed Calibration Product: Created from raw ARC frames

Interface

Graphical



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Query results for table MASTER_FLAT

Shown: 48 rows out of 48 entries, from project 'INM'

ROWNUM	project_id	+PRIVILEGES	object_id	creation_date	DATE_OBS	ESO_INS_MODE	filename	globalname	is_valid	musewise_version	nifu
1	4	2	object view	2013-05-02 10:35:38	2013-11-26 15:30:00	WFM-NOAO-N	MASTERFLAT_20131126T153000_18_8ebde323.fits	None	1	0.03.01	18
2	4	2	object view	2013-05-02 10:35:31	2013-11-26 15:30:00	WFM-NOAO-N	MASTERFLAT_20131126T153000_19_2c2ead71.fits	None	1	0.03.01	19
3	4	2	object view	2013-05-02 10:35:31	2013-11-26 15:30:00	WFM-NOAO-N	MASTERFLAT_20131126T153000_04_30cc9ca1.fits	None	1	0.03.01	4
4	4	2	object view	2013-05-02 10:35:30	2013-11-26 15:30:00	WFM-NOAO-N	MASTERFLAT_20131126T153000_16_fa18f021.fits	None	1	0.03.01	16
5	4	2	object view	2013-05-02 10:35:30	2013-11-26 15:30:00	WFM-NOAO-N	MASTERFLAT_20131126T153000_15_1d8e125f.fits	None	1	0.03.01	15

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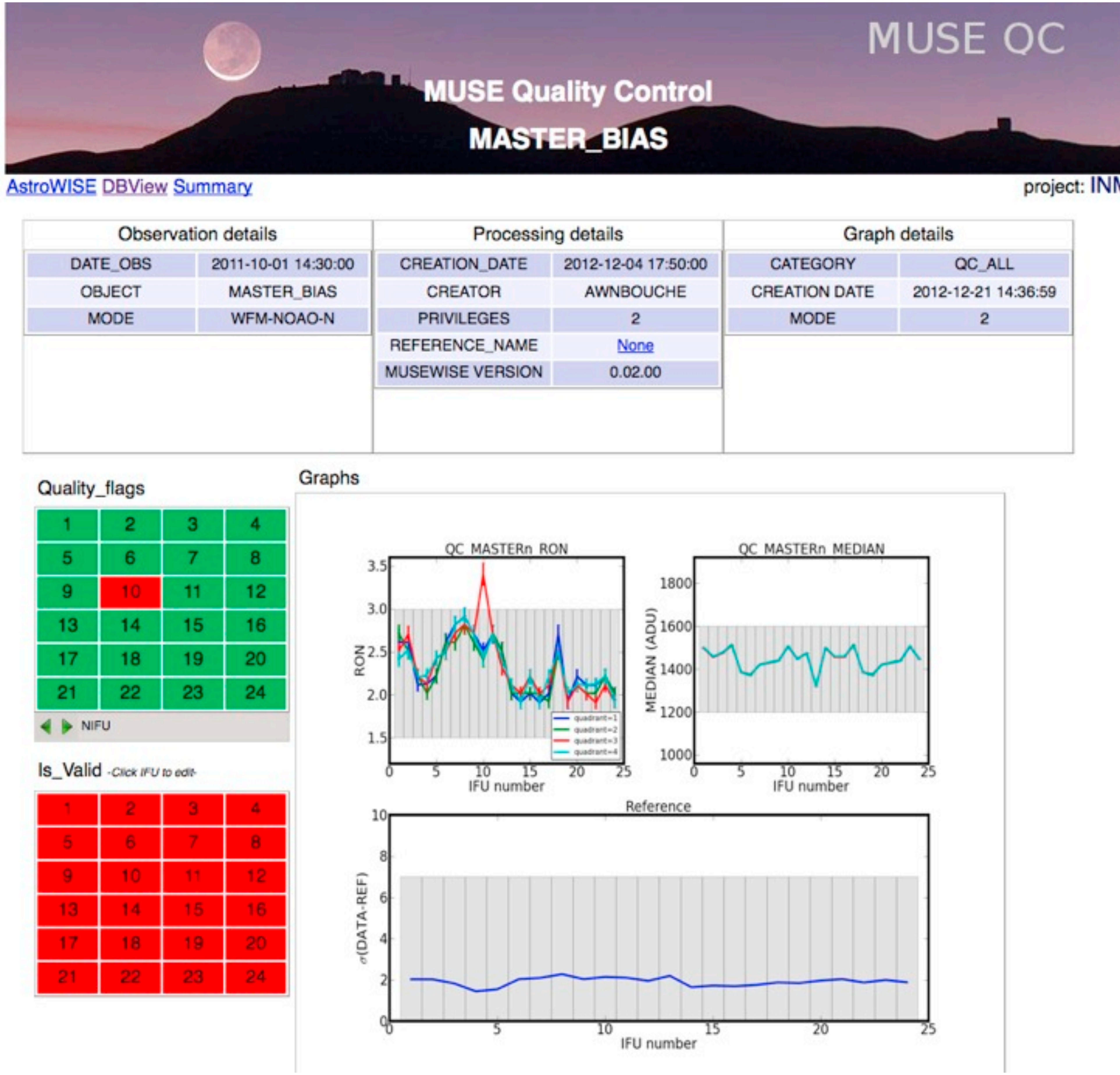
Interface

Quality control

Visual overview for calibration data and scientific data.

Requires IFU expertise and is handled by the consortium.



Management/Organisation - current

- Data management group (Harry Enke, Ole Streicher, Adrian Partl, Thomas Martinsson, Willem-Jan Vriend, Rees Williams, Nicolas Bouché, Genevieve Soucail, Marie Larrieu, Jarle Brinchmann)
  - Monthly telecons, information/discussion of strategy.
- Requirements document(s)
  - Ensures that the final system satisfies what we need and allows us to identify areas that require major effort to resolve.
- Database/MUSE-WISE core: **AstroWISE** + Consortium.
- Quality control/assessment: **Consortium** + AstroWISE.
- Documentation: Consortium/AstroWISE.
- Overall management: **Consortium**

Overall planning for MUSE-WISE

Significant pipeline changes expected

Narrow Field Mode

DRS stabilised in terms of data model?

Integration of non-DRS algorithm into MUSE-WISE

Integrate catalogues into system

2014 2015 2016 2017 2018 2019

Start GTO

End GTO

Relative contribution from MUSE consortium

Summary

- The MUSE GTO science will strongly benefit from a centralised data management system.
- Combining consortium expertise (IFU, data reduction) with OmegaCEN (AstroWISE) ➜ Efficient system construction.
- Integration of IFU data in such a data management structure is a new experience.
- MUSE is not yet in operation ➜ Long-term plan is necessary including knowledge transfer to consortium.
- It is important to ensure that despite differences in project management styles, language use and science focus a common vision emerges.