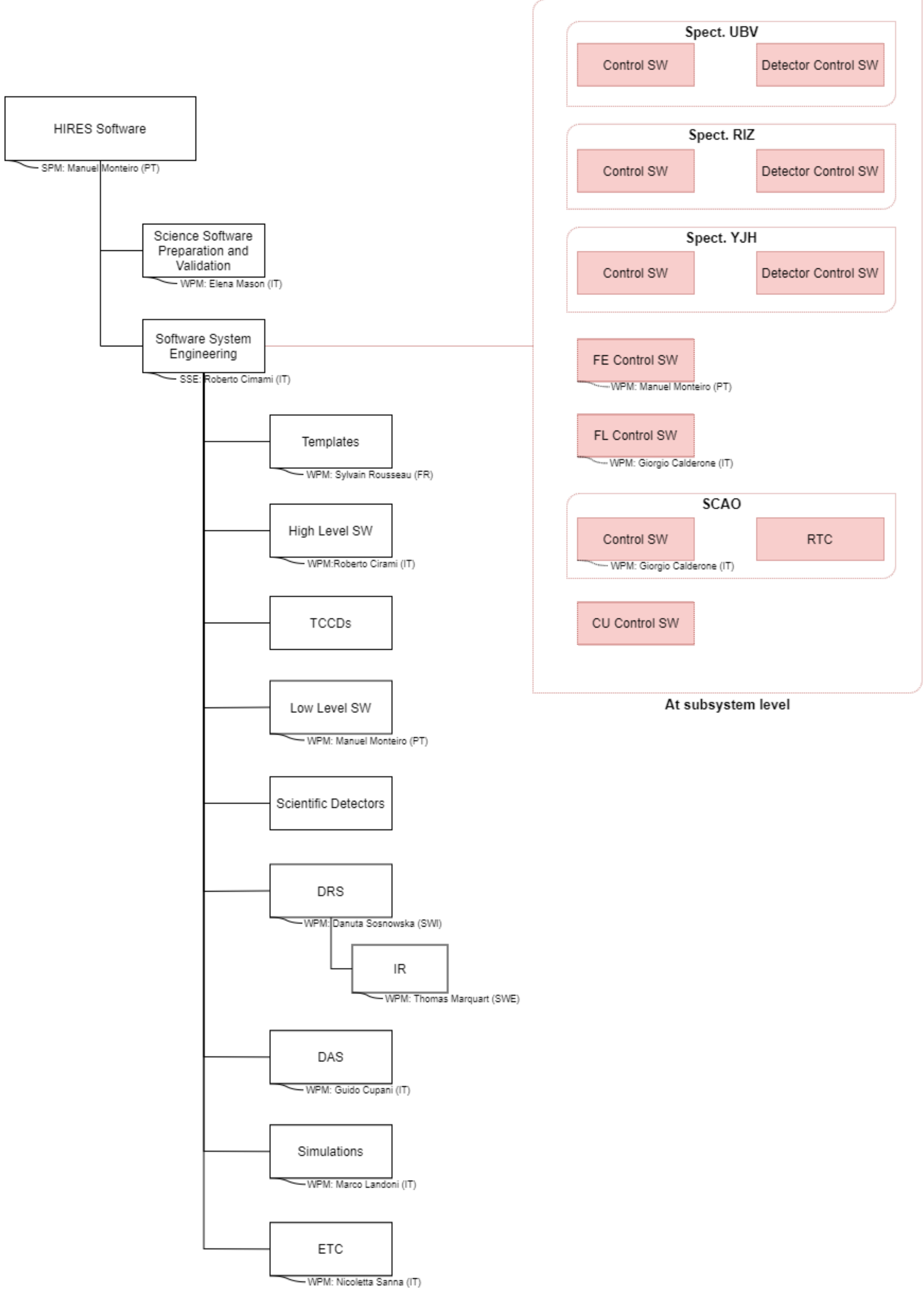
ELT High Resolution Spectrograph

SOFTWARE

Manuel Monteiro (IA / U.Porto)
Software Project Manager
on behalf of the software team

WBS Phase B

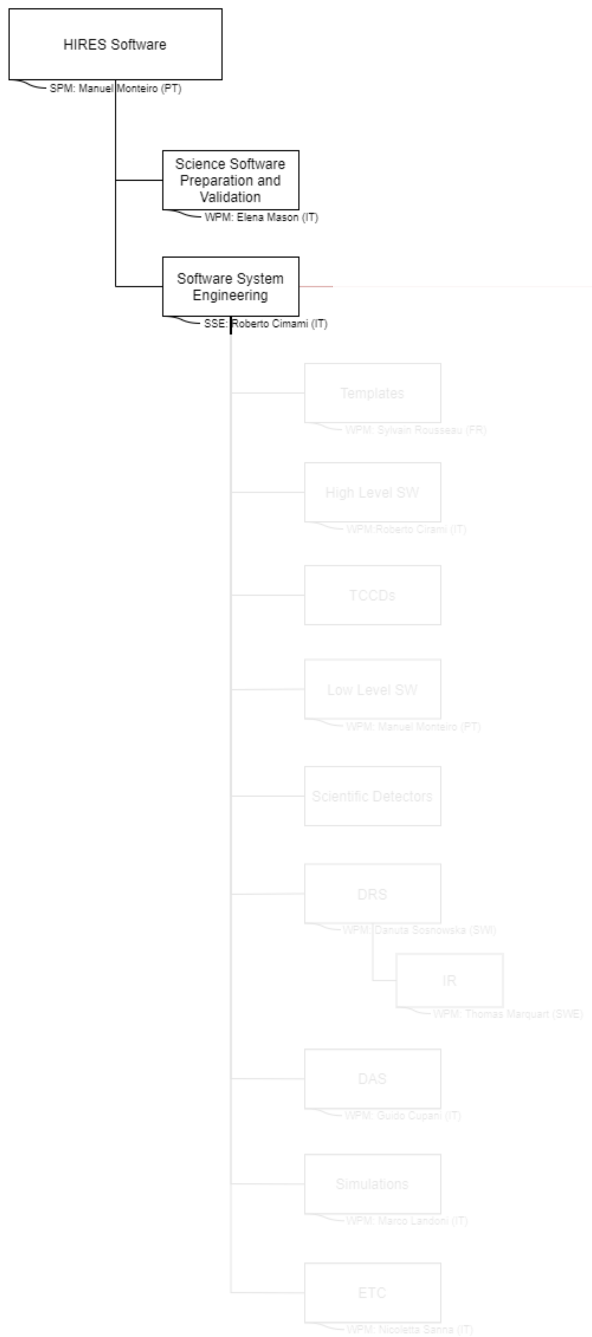


- we have a highly distributed system

- each subsystem will handle its own (local) software

- managed at high level by Roberto Cirami, as a Software Architect, to ensure coherence at project level and fulfillment of ESO standards

WBS Phase B



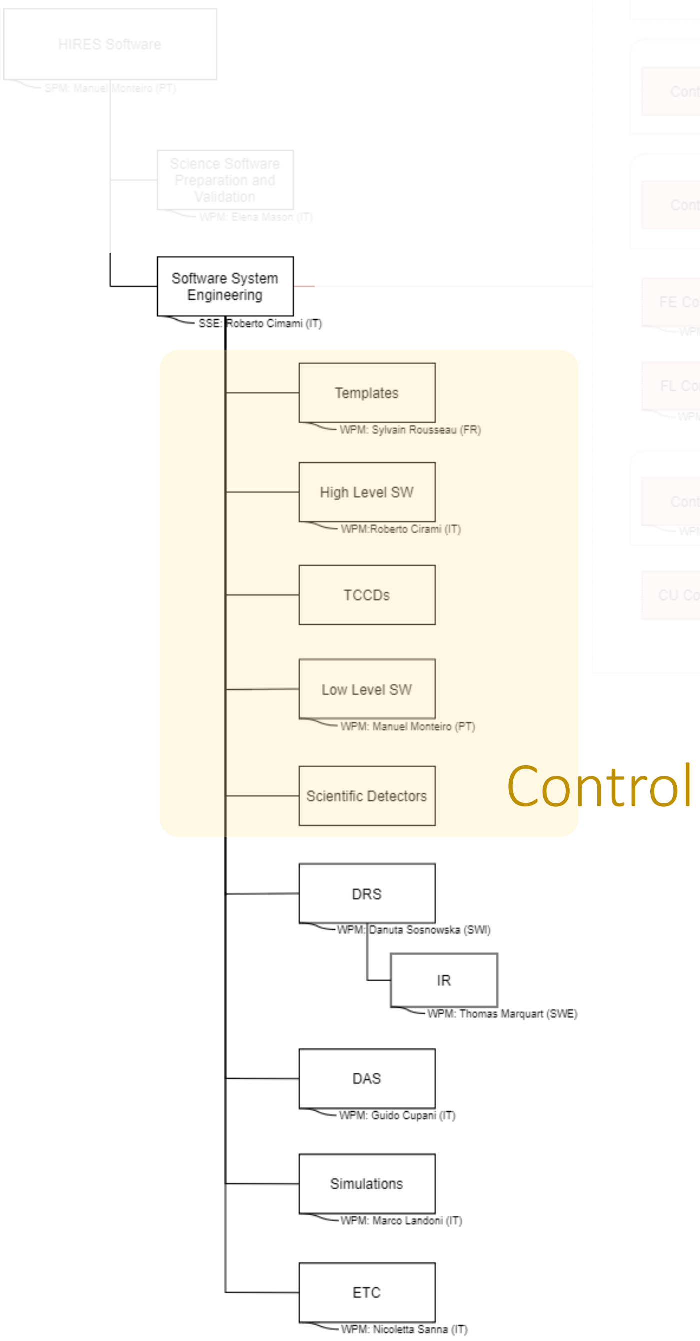
Science Software Preparation and Validation

- definition of science software requirements and flow down to science software work packages
- validation of science software products

Software System Engineeging

- define and verify software interfaces
- system design description
- supervise software packages

WBS Phase B



Templates

- instrument Templates (acquisition, observation, calibration and maintenance templates)

High Level Control Software

- coordination of scientific exposures (data acquisition, managing the data products creation and archiving)

TCCDs

- DCS in the context of instrument control (field stabilization, field curvature compensation, etc.)

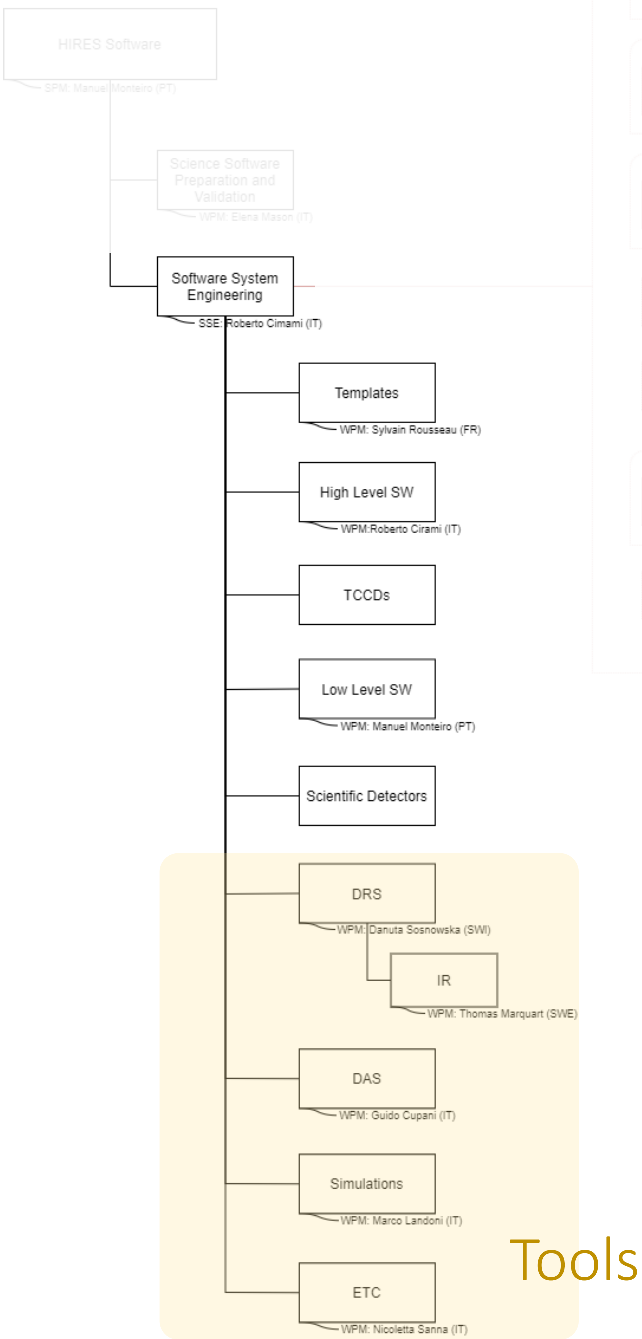
Low Level Control Software

- common needs, e.g., global engineering GUI, etc.

Scientific Detectors

- may not be necessary since it will be handled at subsystem level

WBS Phase B



DRS
- definition and design of the Data Reduction Software (visible and IR)

DAS
- design of the Data Analysis Software

Simulations
- simulation tools, namely the End-to-End simulator

ETC
- design and development of the Exposure Time Calculator

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Science Software Preparation and Validation

Elena Mason (INAF – OATs)

EXPERIENCE/BACKGROUND:

_ science on (galactic) transients using HR spectrographs (FEROS,UVES,STIS,FIES)

_ former support astronomer and instrument responsible at the VLT (ISAAC and XShooter)

TASKS:

_ define requirements for the science software (Template, ETC, DRS, DAS, Simulator, …) *

_ identify need of dedicated tools (e.g. observing) *

_ verify and validate science products **

* expect participation to Science Team and Software System Engineer Team meetings
** needs help for the tests (e.g. internship students and alike)

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Control Software
&
Software Phase B deliverables

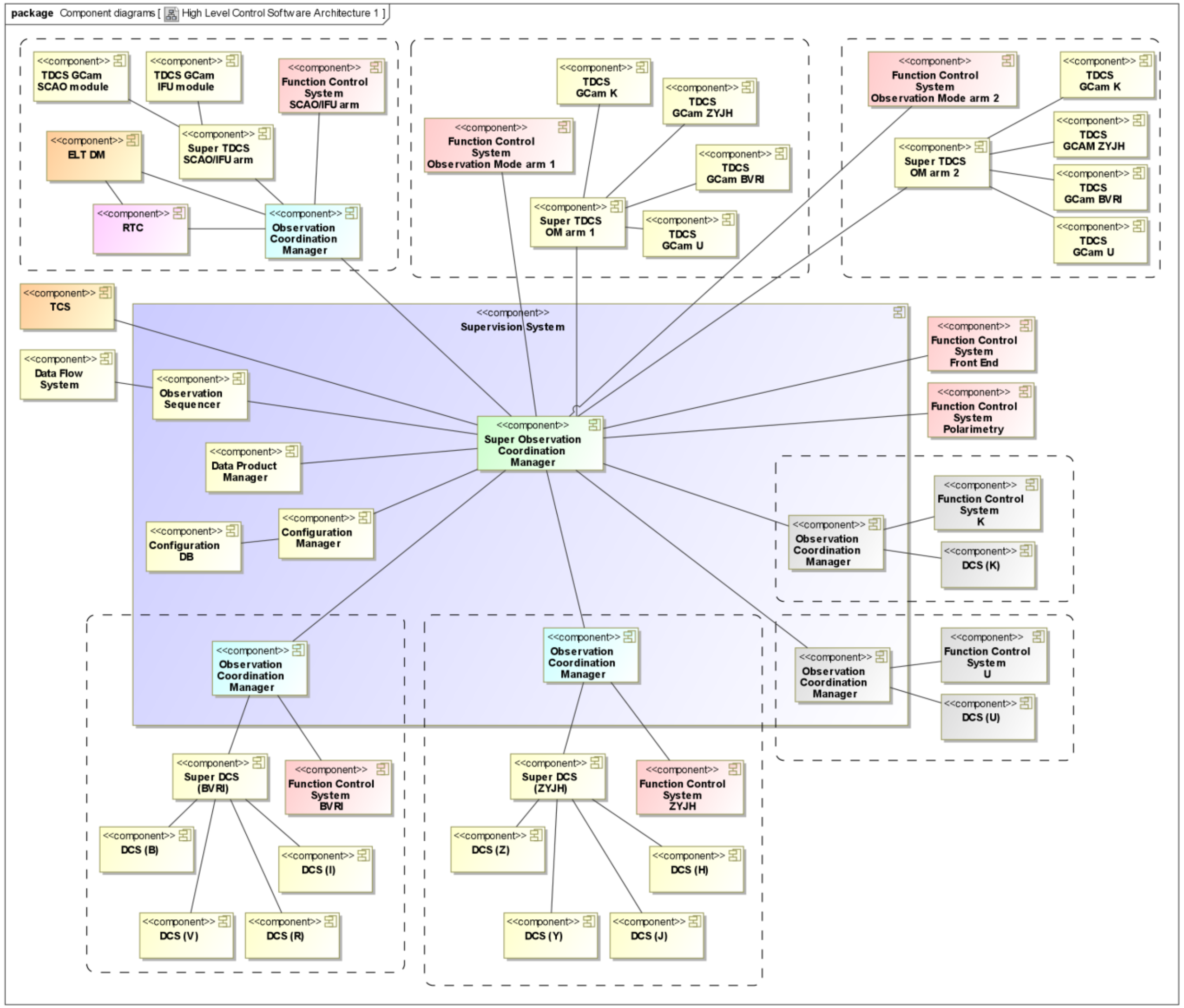
Roberto Cirami – INAF - Astronomical Observatory of Trieste

Software System Engineer / Software Architect

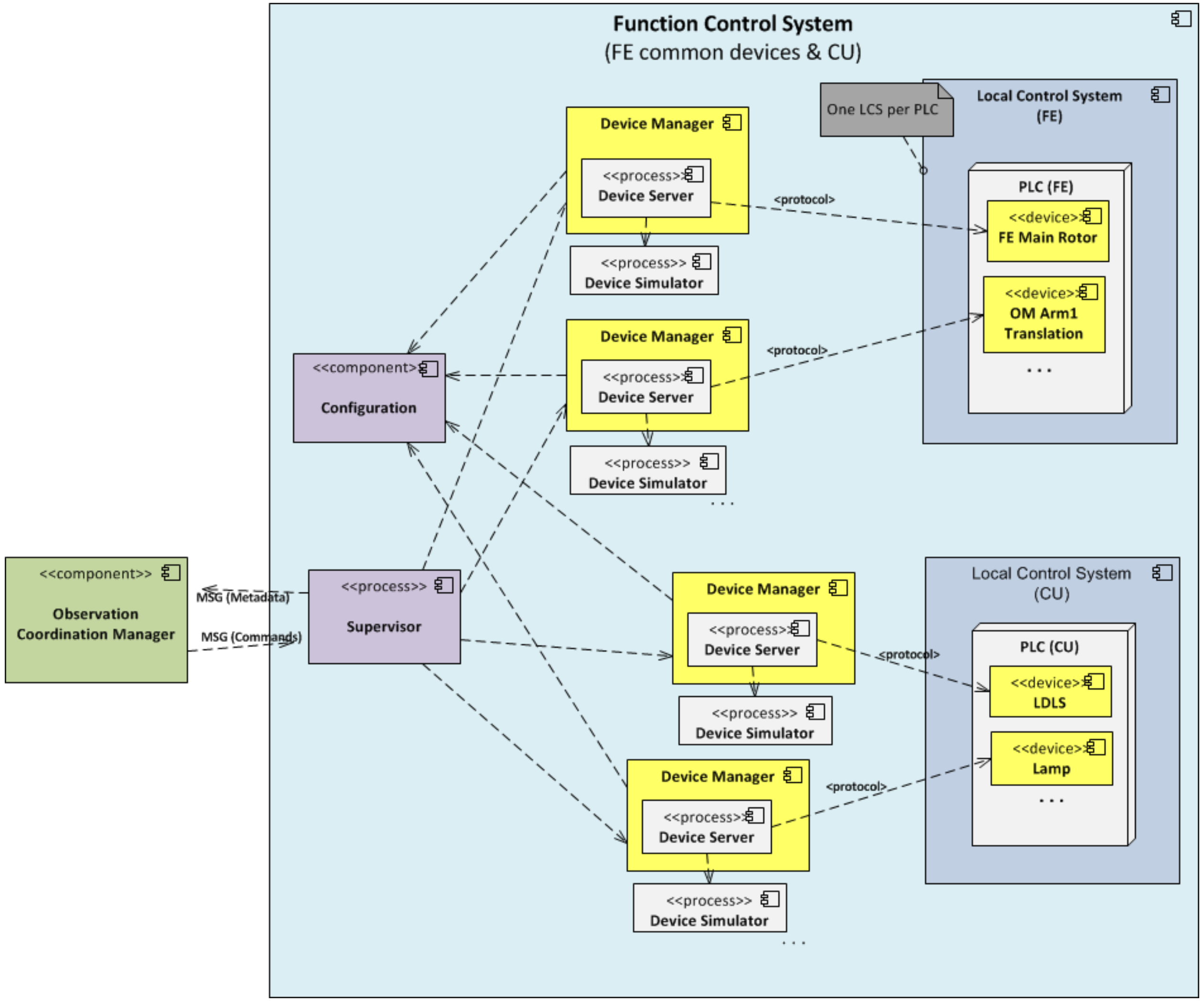
Instrument Control Software

- Based on ELT Instrument Control Software Framework
- Standard Instrumentation Software subsystems:
  - Function Control System (FCS): controls and monitors instrument hardware functions
  - Observation Control System (OCS): coordinates the execution of an exposure
  - Detector Control System (DCS): carries out all the tasks to control the detectors subsystems
  - Maintenance Software (MS): used for instrument configuration and maintenance procedures

Phase A – control software architecture



Phase A – Function Control System architecture



Phase B – software deliverables

- List of software deliverables specified in the following ESO documents:

  - E-ELT Instrument Control System Development Process Requirements (ESO-267497, v. 1)
    - Instrument Software User Requirement Specifications
    - Instrument Software Functional Specifications
    - Instrument Software Management Plan

  - Dataflow for ESO Observatories Deliverables Specifications (ESO-037611, v. 4)
    - Data Reduction Library Specifications
    - Exposure Time Calculator Specifications
    - Observation Preparation Tool Specifications (if needed)

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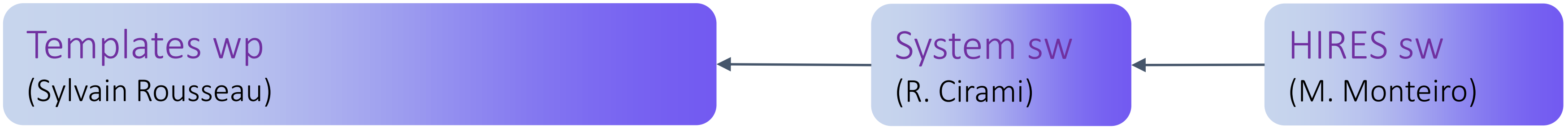
Templates

Sylvain Rousseau (Lagrange Lab / EDISOFT)



- Acquisition templates
  - Set up the telescope, point the target, close image stabilization loops, ensure spectro light feeding
- Observation templates
  - Handle scientific exposures and monitor the image stability loops
- Calibration templates
  - Related to the calibration unit, it aims at calibrate the calibration sources and the scientific detectors
- Technical templates
  - Perform maintenance and testing operations in an automatic way

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DRS

Danuta Sosnowska (Obs. Genève)
on behalf of the DRS team

DRS work package

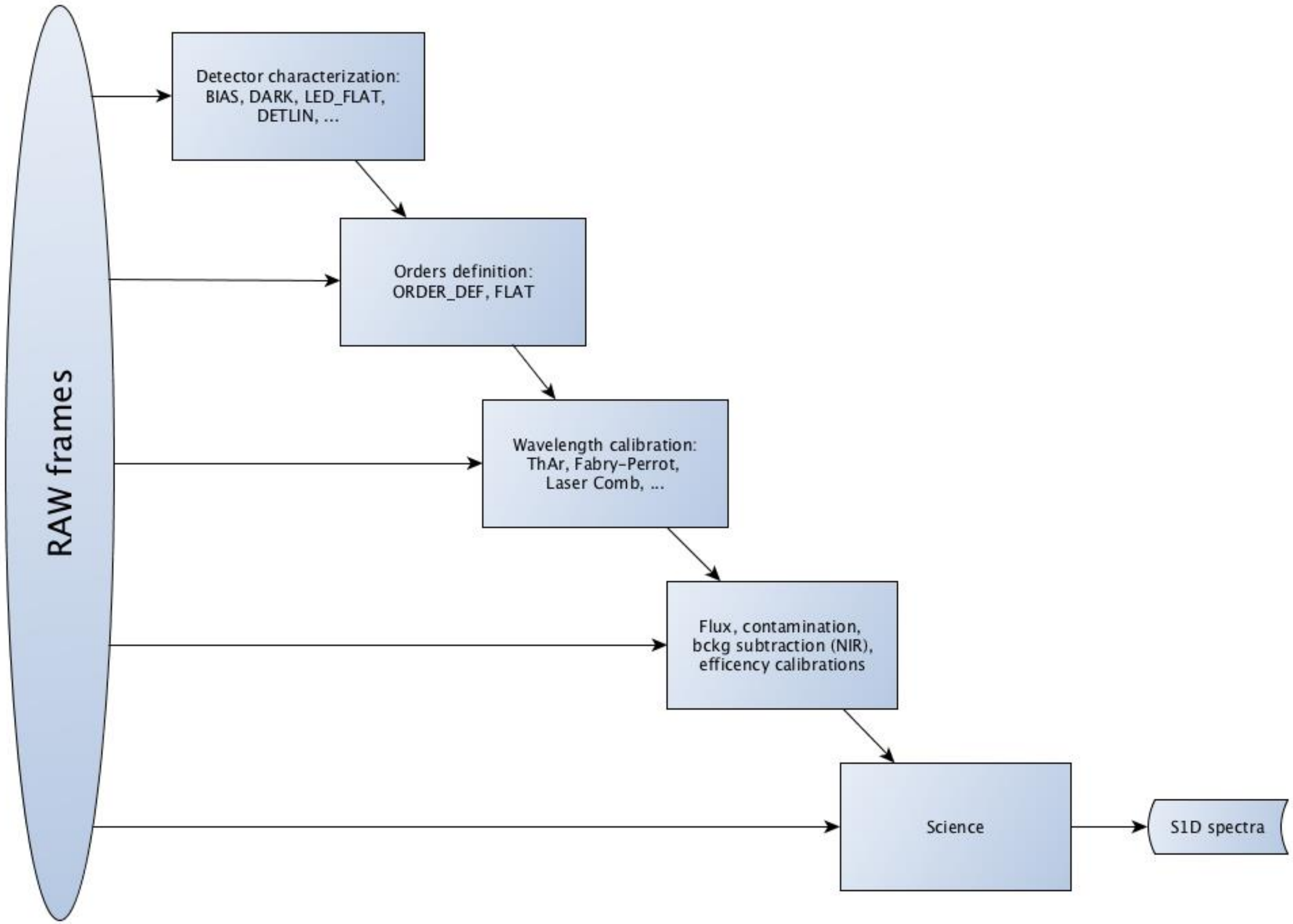
- Data Reduction Software:
  For phase B – prepare the specifications and the required documentation, identify the critical algorithms

- DRS WP structure:
  - Managed by Danuta Sosnowska
  - IR DRS part managed by Thomas Marquart
  - A lot of overlapping between VIS & IR parts

Phase A summary

- Identification of the recipes steps:
  - Detector characterization
  - Orders definition
  - Wavelength calibration
  - High level calibrations
  - Science reduction

HIRES DRS workflow

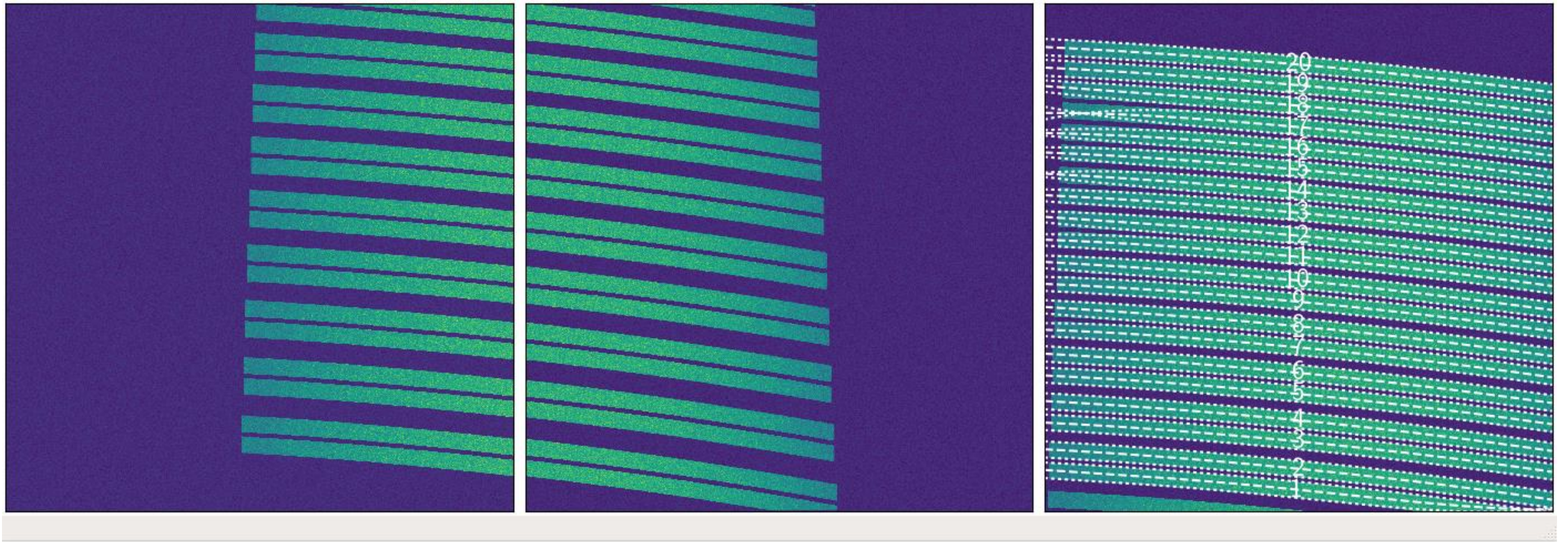


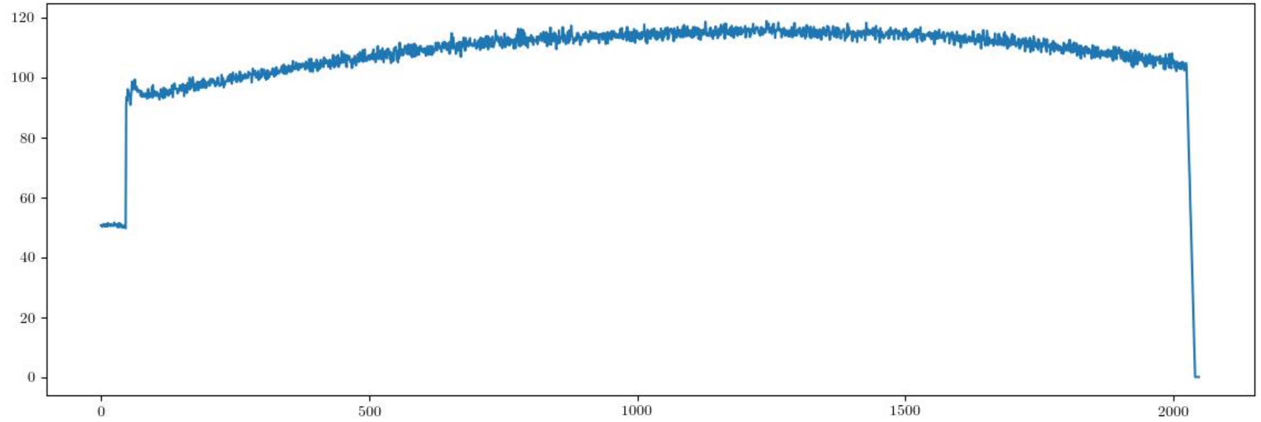
Phase A summary

- Identification of the recipes steps:
  - Detector characterization
  - Orders definition
  - Wavelength calibration
  - High level calibrations
  - Science reduction

- Extraction of the simulated science spectra provided by the E2E team, using the CRIRES+ pipeline by Thomas Marquart

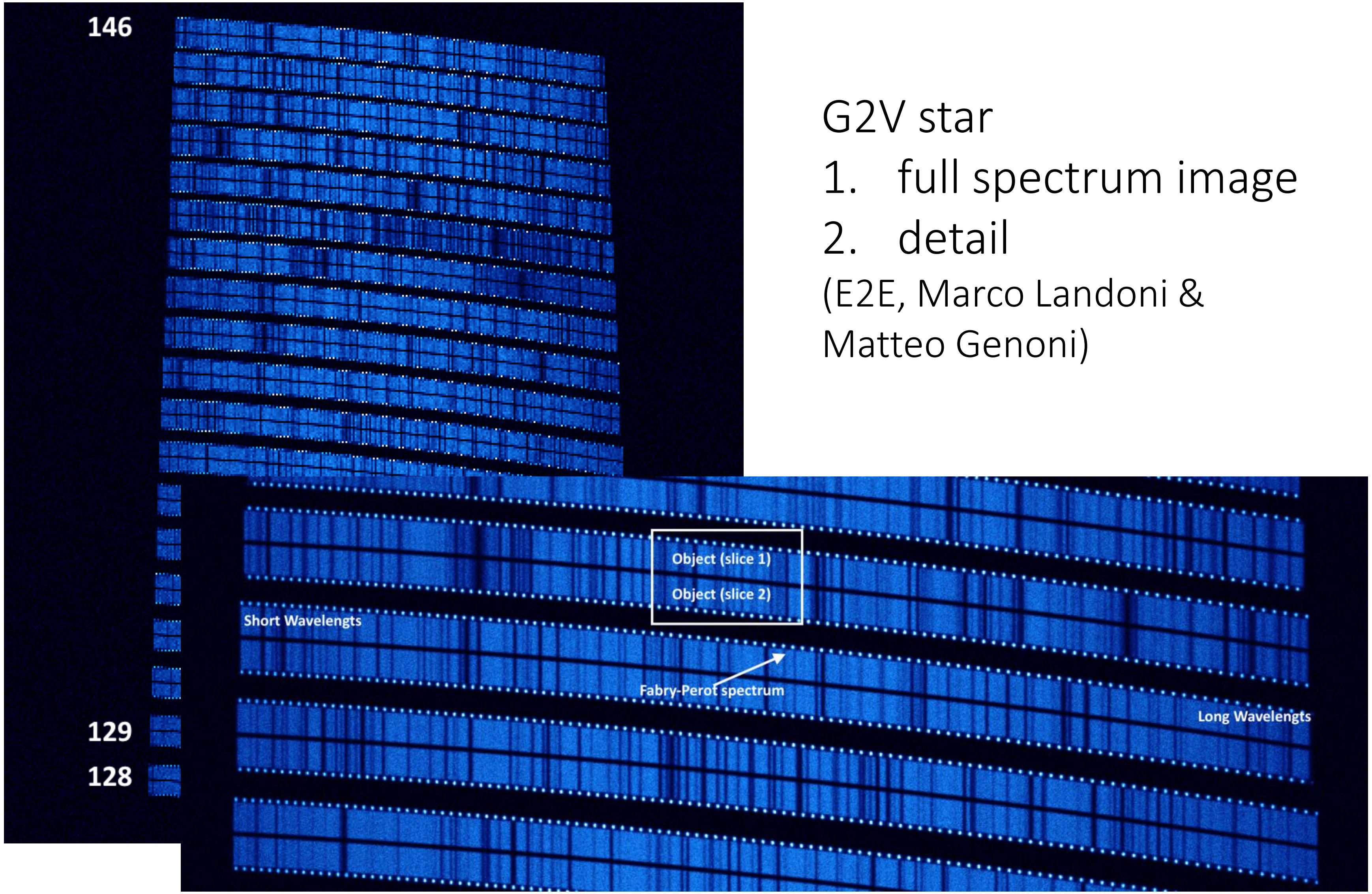
Simulated data – flat spectrum





Orders detection & extraction, using CRIRES+ PPL (Thomas Marquart)

Simulated data – science



G2V star

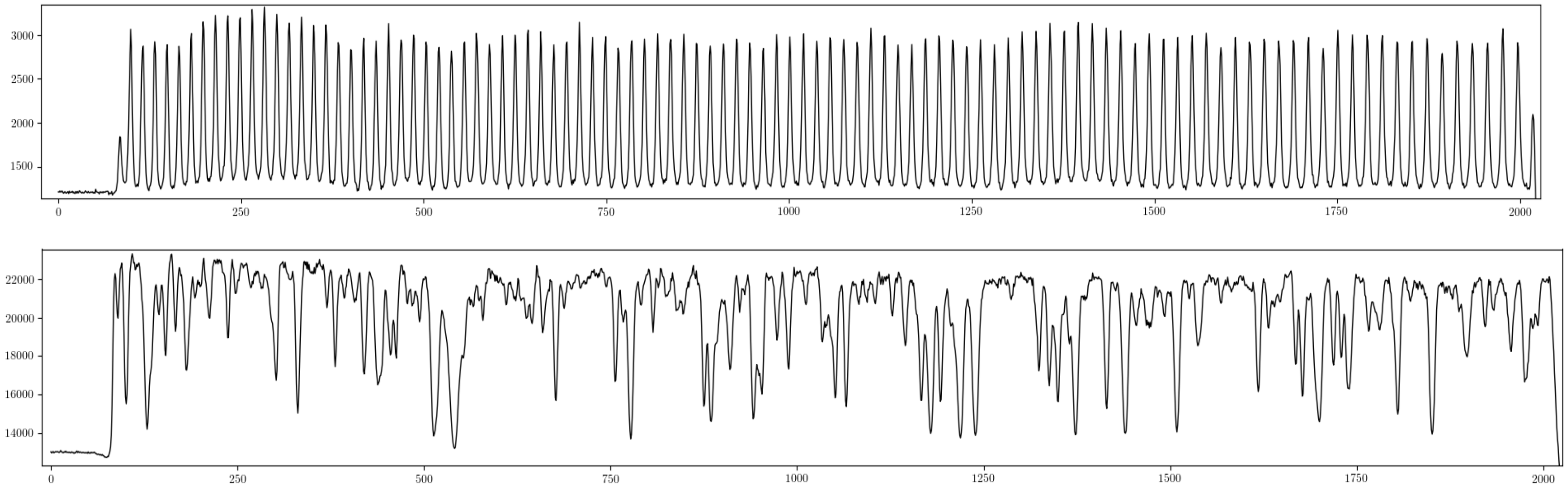
1. full spectrum image
2. detail

(E2E, Marco Landoni & Matteo Genoni)

Science extraction

by Thomas Marquart, CRIRES+ PPL

- One order extraction, no bias, no flat-fielding, along detected order (polynomial), vertical slit
- Slit decomposition extraction (Piskunov & Valenti 2002) independent of the slit illumination function



Extraction: FP (upper), science (lower)

DRS key tasks

- Specification of the reduction steps
- Identification of the critical algorithms
- Definition of the interfaces
  - Calibration WP
  - ICS & templates
  - Science cases

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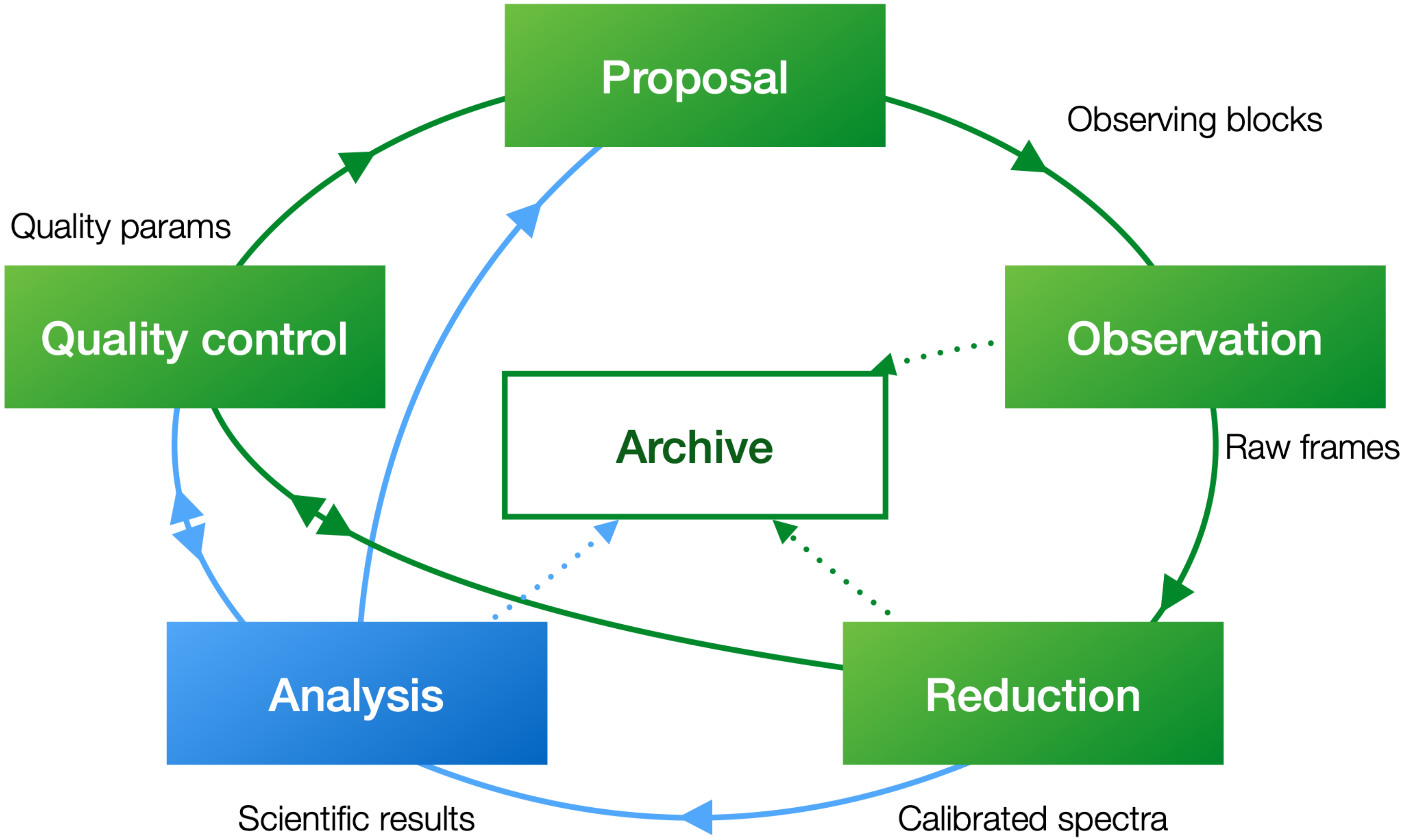
DAS

Guido Cupani (INAF-OATs)

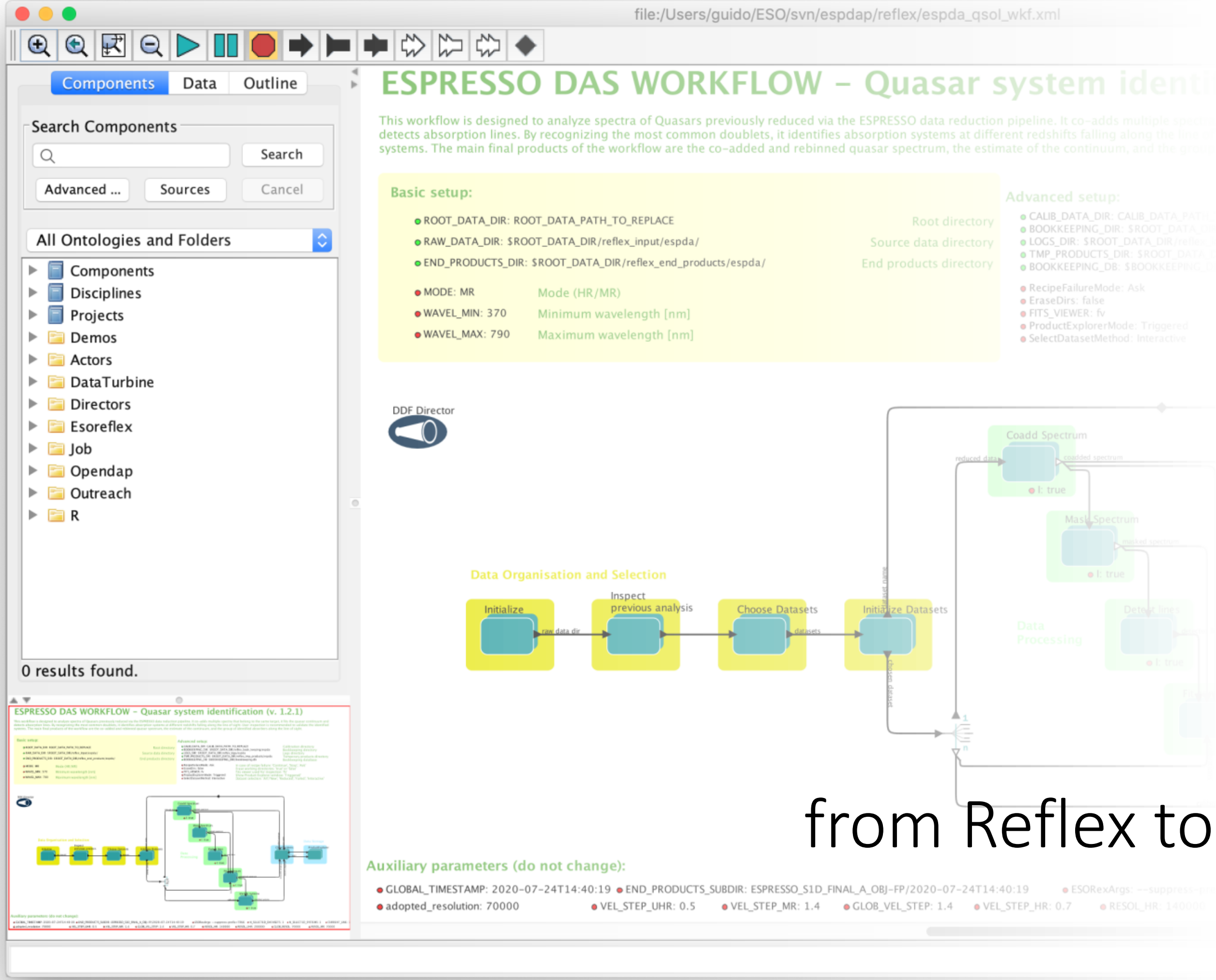
Role of the DAS



Science cases addressed

Exoplanets and circumstellar disks (WG1)	Exoplanet atmospheres in transmission	1	
	Exoplanet atmospheres in reflection	3	
	Characterization of the physics of protoplanetary disks	(~3)	
	Planet formation in protoplanetary disks	(3)	
	Exoplanet mass determination	(4)	
	Radial velocity search for exoplanets around M-dwarfs	(~4)	
	Planetary debris on white dwarfs		
Stars and stellar populations (WG2)	Characterization of cool stars	(1)	✓
	Investigation and characterization of primitive stars	(2)	✓
	Characterization of stellar atmospheres	(3)	✓
Formation and evolution of galaxies and intergalactic medium (WG3)	Detection and investigation of near pristine gas	(~1)	✓
	Reionization of the Universe	(1)	✓
	3D reconstruction of the CGM	(~1)	✓
	Extragalactic transients	(~1)	✓
	Search for low mass black holes	(3)	
	Galaxy evolution		✓
	3D mapping of the IGM and metallicity		✓
Cosmology and fundamental physics (WG4)	Variation of fundamental constants	2	✓
	Variation of CMB temperature	(2)	✓
	Determination of the deuterium abundance	(2)	✓
	Sandage test	4	✓

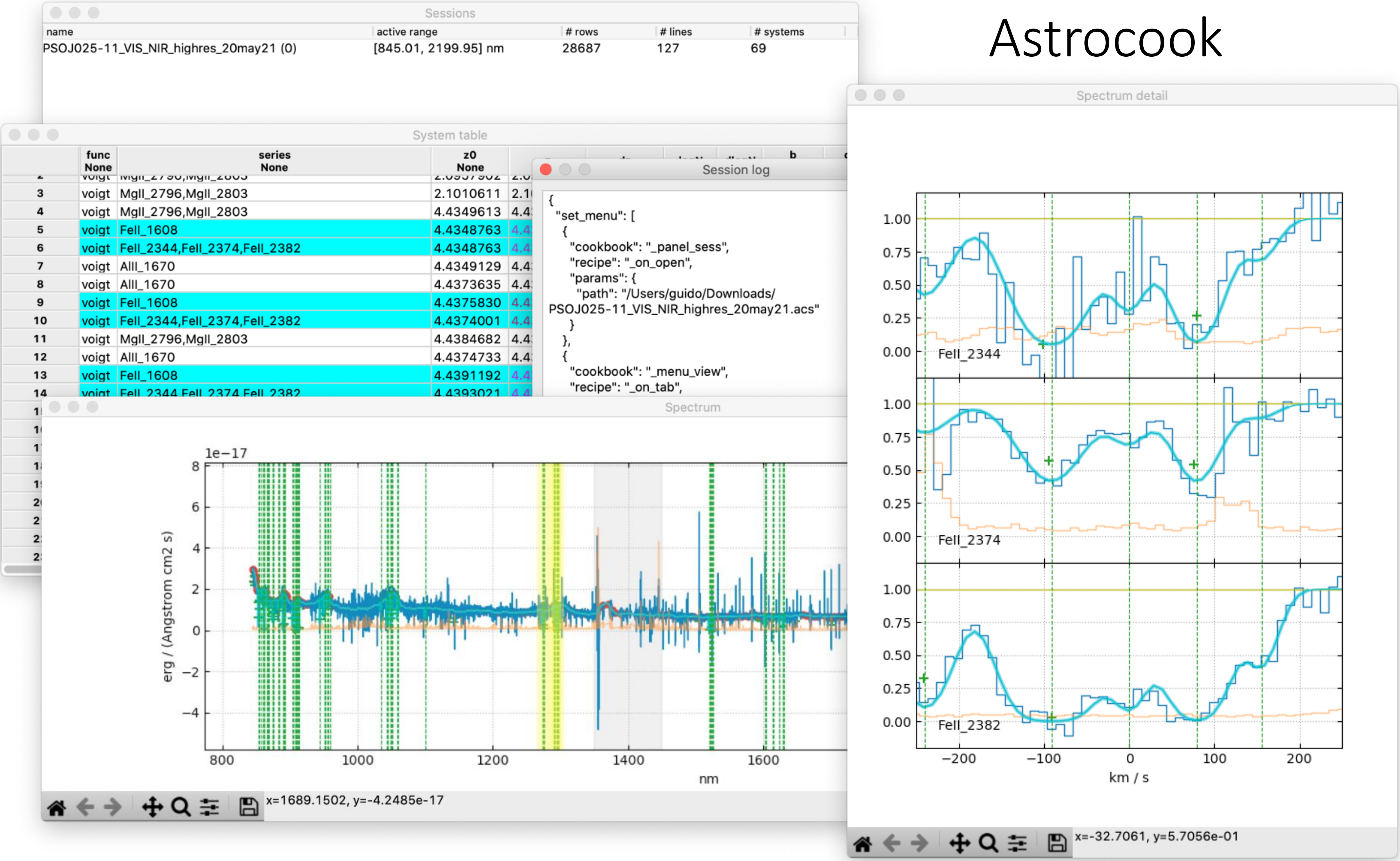
A changing ecosystem



from Reflex to the EDPS…

A changing ecosystem

Astrocook



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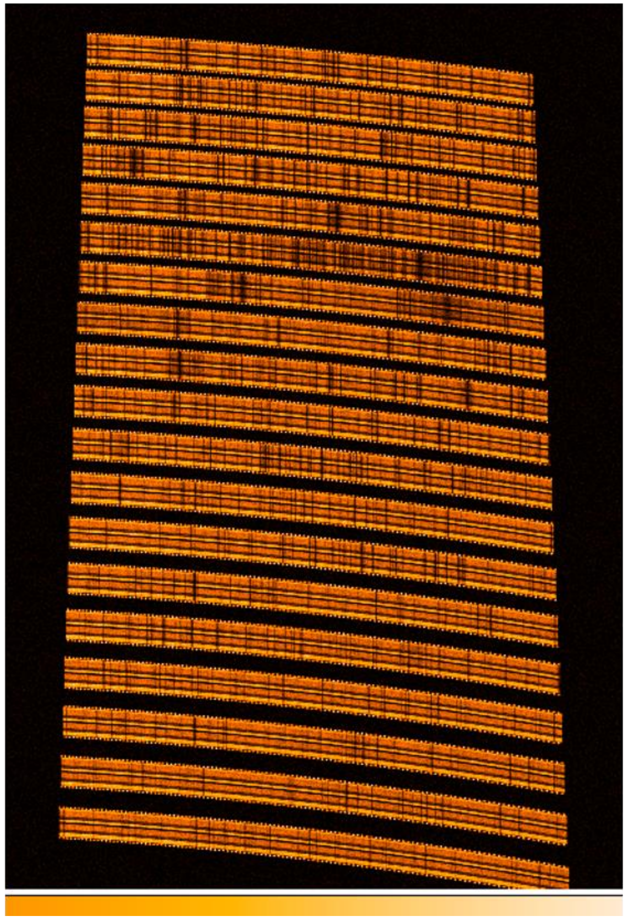
End-to-end

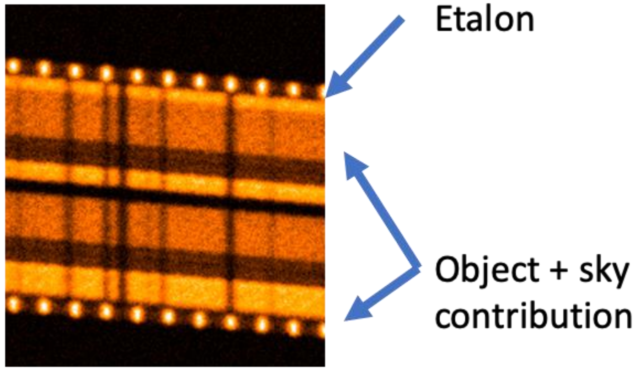
Marco Landoni (INAF-Brera Observatory)

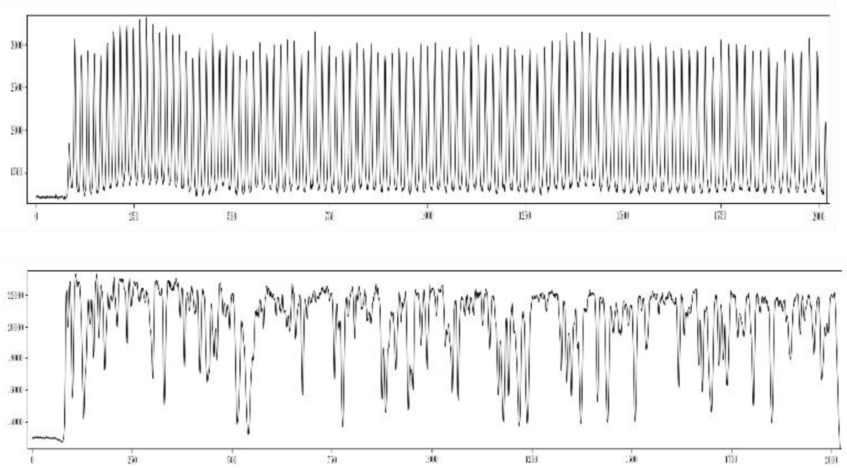
Recap from Phase A

- Definition of the internal interfaces between people involved in this WP. Completed
- Definition of the external interfaces and identification of WPs that will provide inputs to E2E (e.g. detectors, telescope, calibration-unit, etc.) Completed
- Collect the contribution (spectrum, images, …) from the team’s contributor. Completed
- Development of the image simulator module core. Completed
- Feed the DRS with simulated frames closing the loop. Completed

Recap from Phase A







We closed the loop with the CRIRES-2 beta pipeline with Thomas and Danuta.

Next Steps for Phase B and beyond

End-to-end system point of view

- Go back to the source code to re-engineering some part of it, with the aim to improve the stability and usability of E2E in Phase B
- Include effects from high orders aberrations from the Zemax.
- Make the whole system more stable and user friendly (although it cannot be offered at large due to computational complexity of the simulation itself).

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HIRES Consortium point of view

- Define simulation scenarios with the science/tech teams
- Define next steps for DRS interfaces in order to make E2E useful during this and the next phases.
- Improve interfaces in order to simulate as much effects as possible.

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ETC

Nicoletta Sana (INAF-OAA)

HIRES Exposure Time Calculator

The ETC is a tool (Fortran code) to predict the performances of the spectrometer for different parameters and environmental conditions.

Several parameters can be modified to evaluate their effect.

It works wavelength per wavelength: no SED or spectral type.

ETC versions 1.1-1.5 for Phase A design.
ETC seeing-limited mode version 2.0 updated for post-Phase A design (Sept. 2020)

http://hires.inaf.it/etc.html

Nicoletta Sanna – researcher @INAF-OAA and expert on high-resolution spectro-photometry of resolved stellar populations in crowded fields

HIRES Exposure Time Calculator

The ETC computes:

- the limiting magnitude (in AB units) achievable at a given wavelength, in a given exposure time and at a given signal to noise ratio and the limiting surface brightness (in AB mag/arcsec^2) achievable at a given wavelength, in a given exposure time and at a given signal to noise ratio
  http://tirgo.arcetri.inaf.it/nicoletta/etc_hires_mag.html

- the signal to noise ratio achievable for a compact source at a given wavelength, in a given exposure time and at a given AB magnitude
  http://tirgo.arcetri.inaf.it/nicoletta/etc_hires_sn_com.html

- the signal to noise ratio achievable for an extended source at a given wavelength, in a given exposure time and at a given surface brightness
  http://tirgo.arcetri.inaf.it/nicoletta/etc_hires_sn_ext.html

Next steps: writing the code in python and updating it according to the design (if needed)

Next?

- Work with the System and Science Teams for the user requirements
- Continue to follow closely the development of the ELT ICS FW