The Phasing and Diagnostic Station in the ELT

29th October 2019

WFS in the VLT/ELT era, 4th edition in Florence

T.Pfrommer (on behalf of the PDS team)

Agenda

Phasing and Diagnostic Station – Introduction

User Requirements

Architectural Study

Concept Design

Location and Design Volume

PDS in PD phase

Schedule

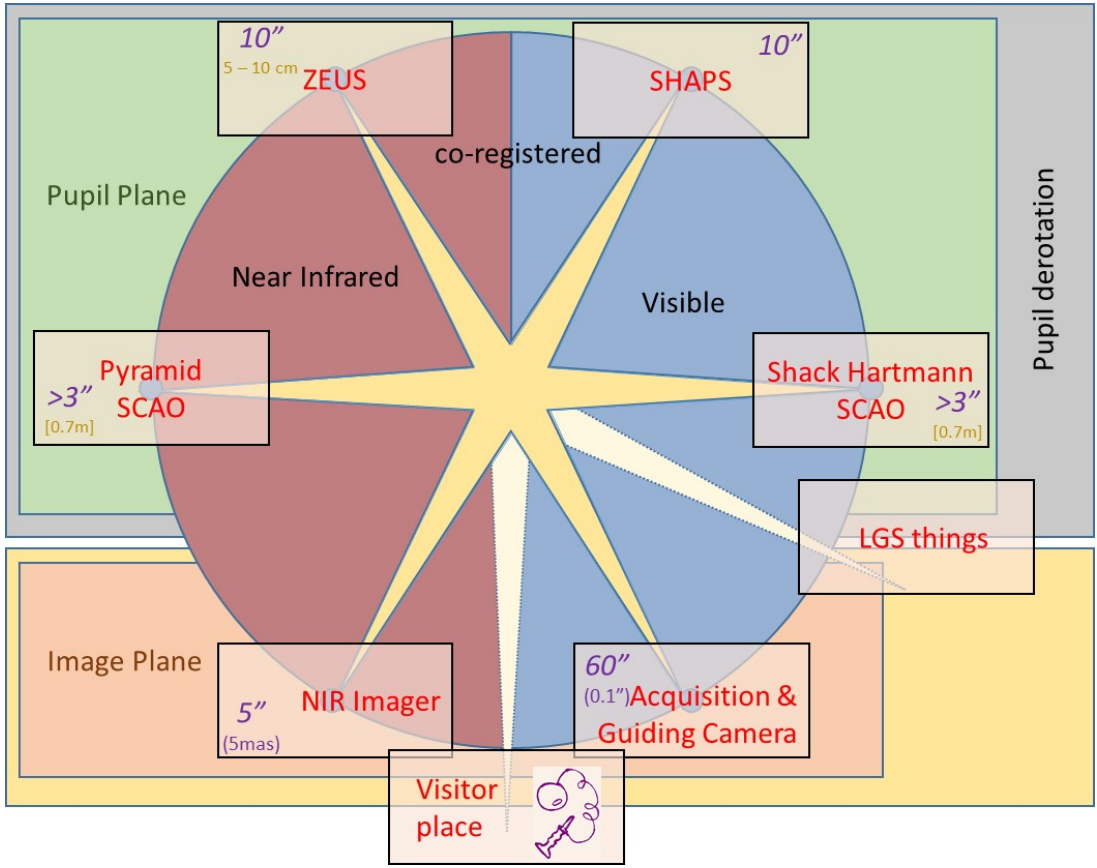
Conclusion

PDS Introduction

- Use Cases
  - Wavefront Control Commissioning (AIV)
  - Characterisation/Verification by Test
    - Level 1 Requirements
    - Instrument <-> CCS Interfaces
  - Regular Phasing of Primary Mirror During Operation
  - Diagnostics and Troubleshooting During Operation
  - Recommissioning after Maintenance
- Key Stakeholders
  - AIV Manager/Telescope Scientist/Wavefront Control Architect
  - Programme and Systems Engineering
  - Programme Scientist
  - Head of Paranal Engineering and ELT Science Ops

PDS User requirements

- M1 segm. capture
  - VIS img. 1'FoV
  - IR diffr.-limt. img. 7"
  - SH phasing
  - Zernike phase contr
- M1 phasing
  - SH phasing
  - Zernike phase contr
  - SCAO SH sensor
- SCAO AO (high Strehl)
  - Pyramid WFS 3" / IR diffr.-limt. imag 7"



PDS User requirements

- Characterization
  - Seeing Limited Perf., Pointing, Offsetting, Nodding
    - Visible Imager, Low Order SH Wavefront Sensor
  - Active Optics (LOO)
    - Visible Imager and Low Order SH Wavefront Sensor
  - SCAO/M4/M5
    - Pyramid WFS and Infra-Red Imager
  - Instrument CCS Interfaces
    - Specific features in CCS/PDS control
- Visitor Optical Port for Risk Mitigation
- PDS will also receive inputs/feedback from MELT test bench

PDS Architectural Study

Three candidate architectures

- Wavelength-oriented
- Instrument-oriented
- WFS-oriented

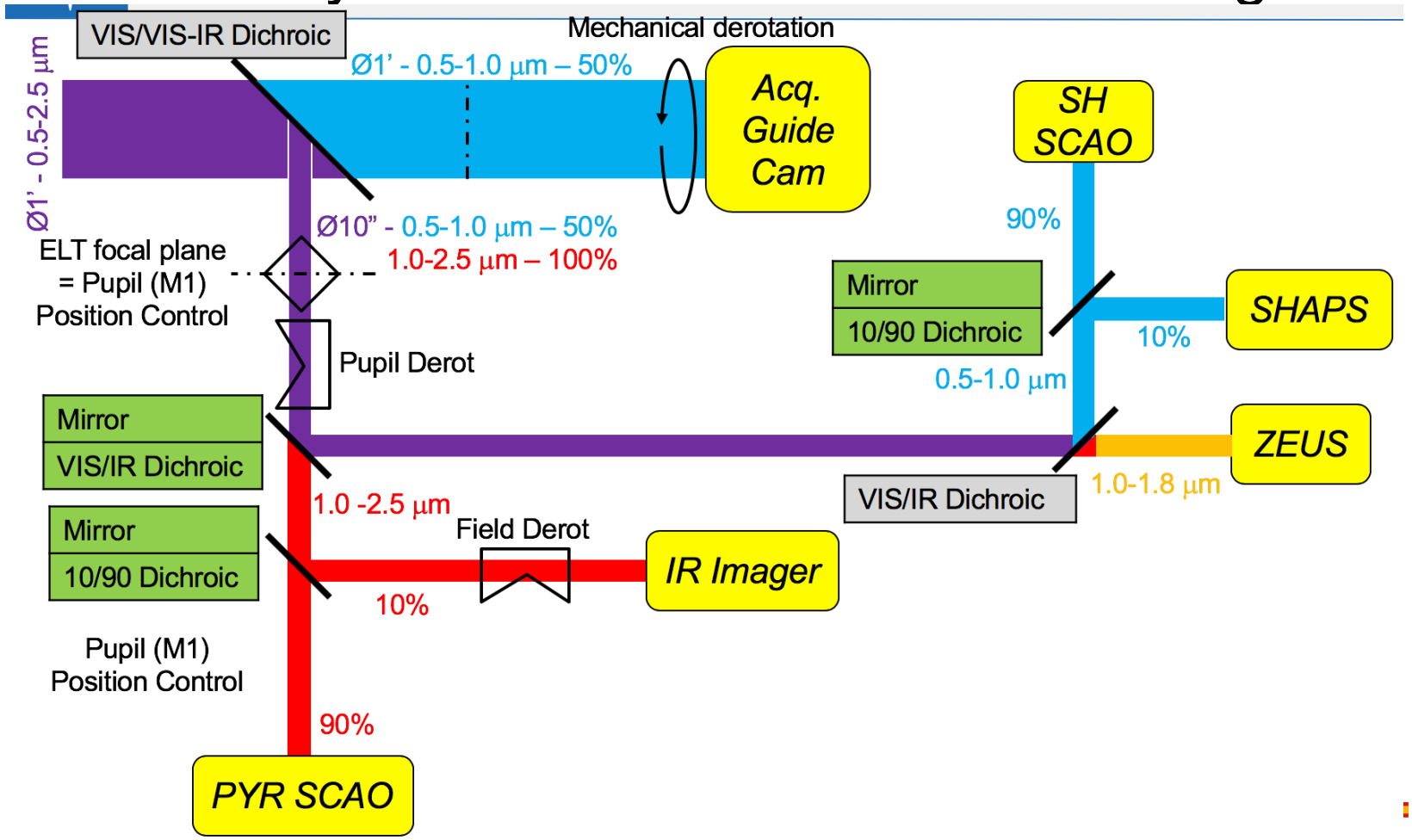
Quite similar (strongly driven by user requirements)

Evaluated and compared based on defined criteria

- Technical complexity
- Integration/assembly/Calibration
- Reliability/robustness in operation
- Performance optimization (just enough to meet performance requirements)
- Cost/schedule

PDS Concept Architecture

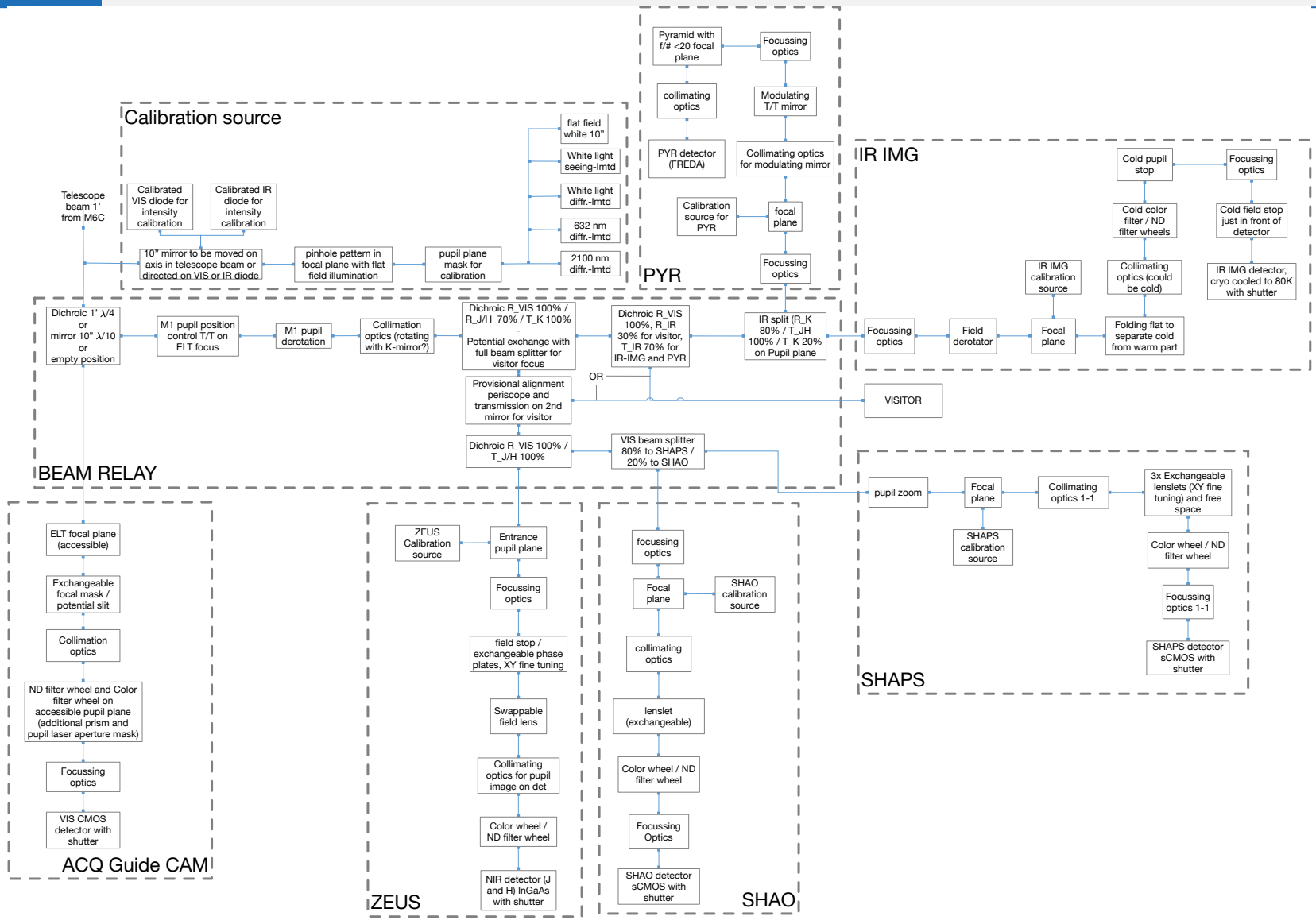
- Instrument oriented architecture selected
- Modularity / clear interfaces / ease of integration/test



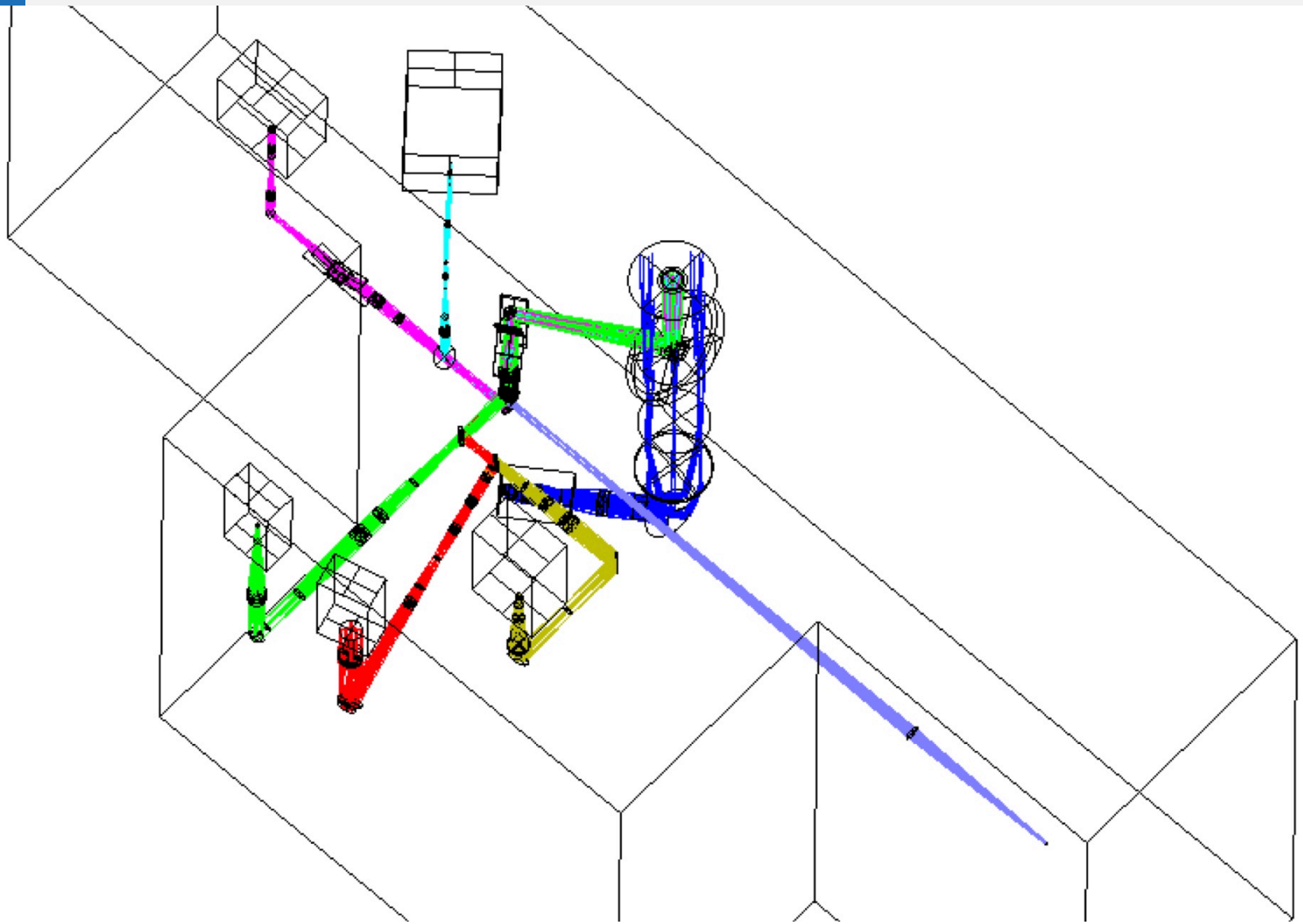
PDS Concept Architecture

- On-axis system, one NGS for all or some sensors
- 1’ FoV only for VIS Aqu/guide Cam (mechanical derotation, no ADC), rest 10”
- Pupil control (common derotation for all sensors)
  - M1 derotation for SHAPS/ZEUS
  - M4 derotation for SH/PYR SCAO
  - M1 position for SHAPS (ZEUS)
  - M4 position for PYR (SH SCAO)
- IR imager and PYR close to reduce NCPA
- Calibration unit, common for all sensors
- Visitor focus

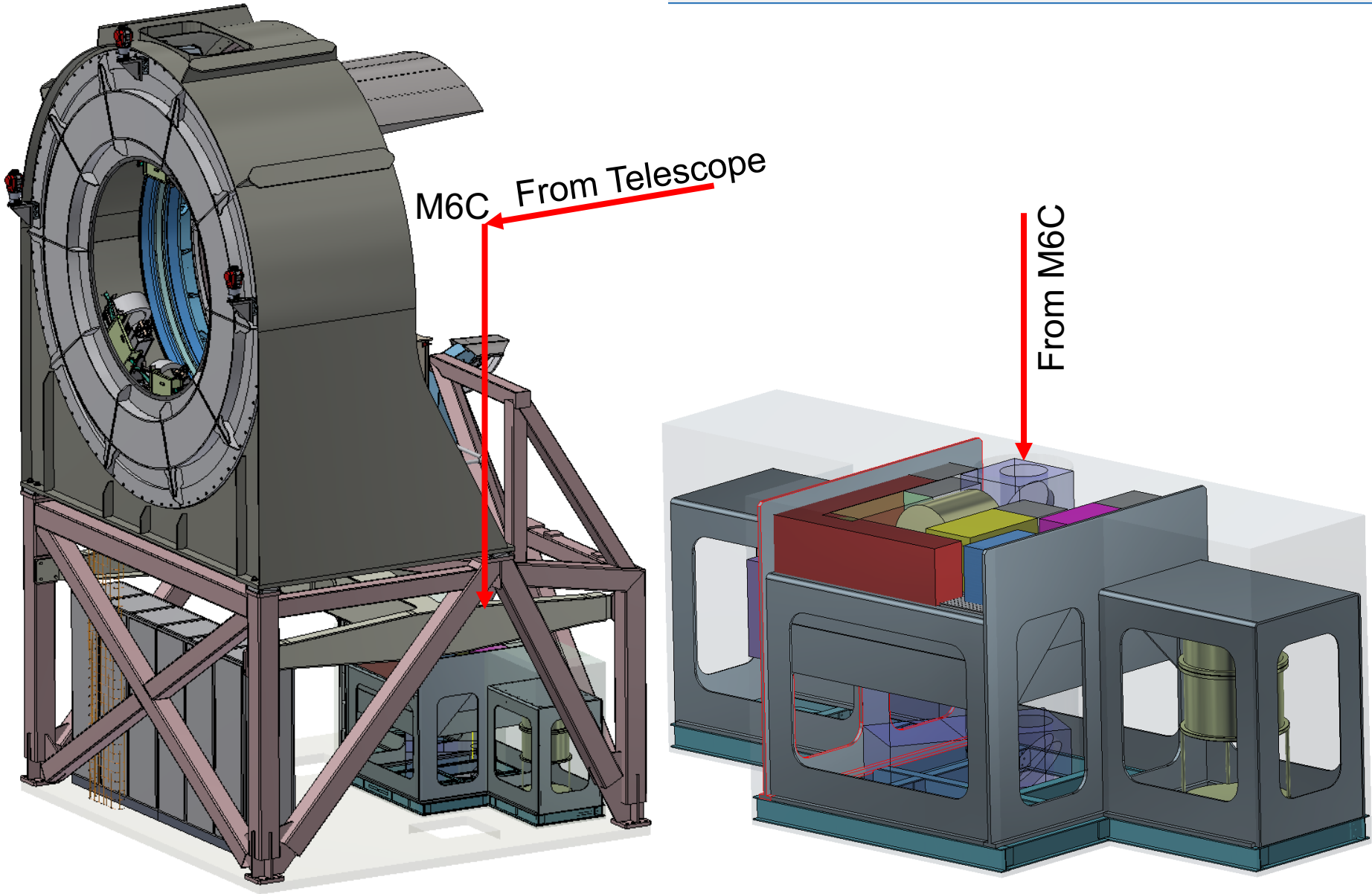
PDS Block diagram



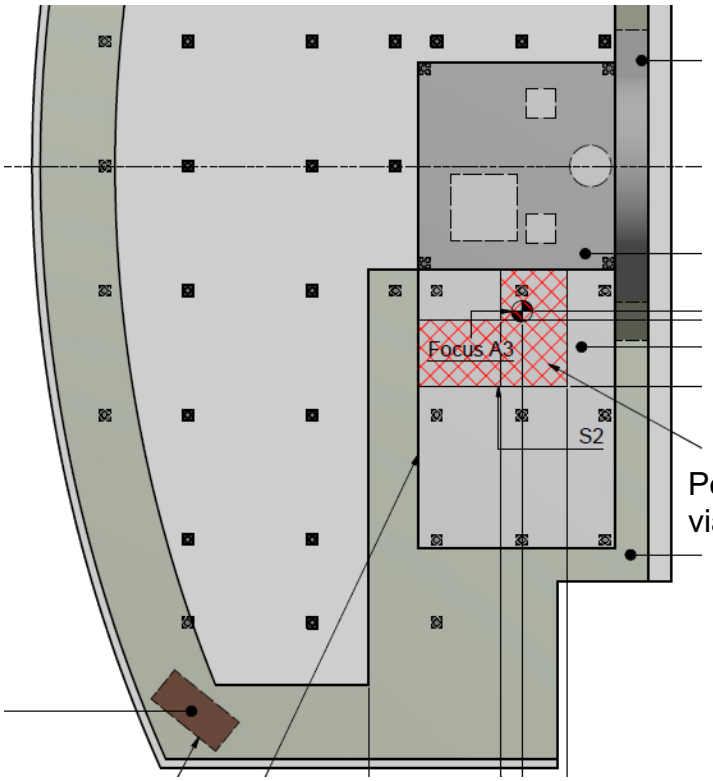
PDS Concept Design



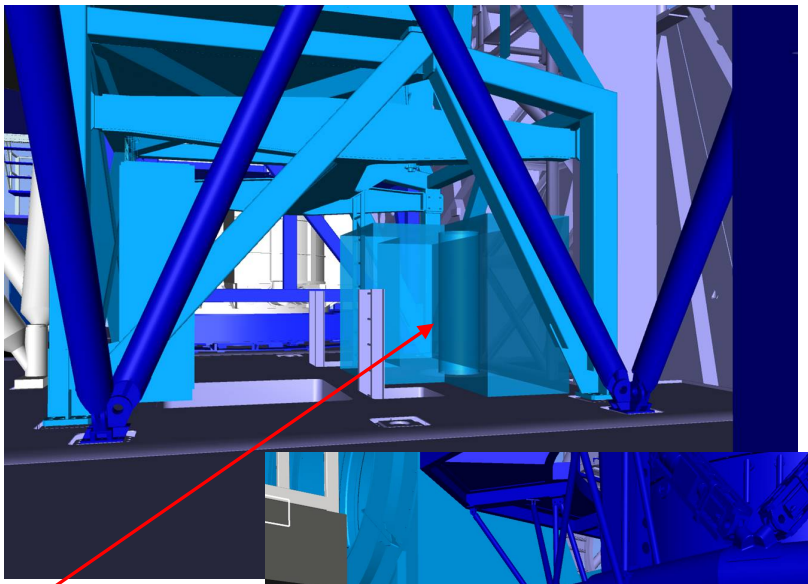
Location and Design Volume



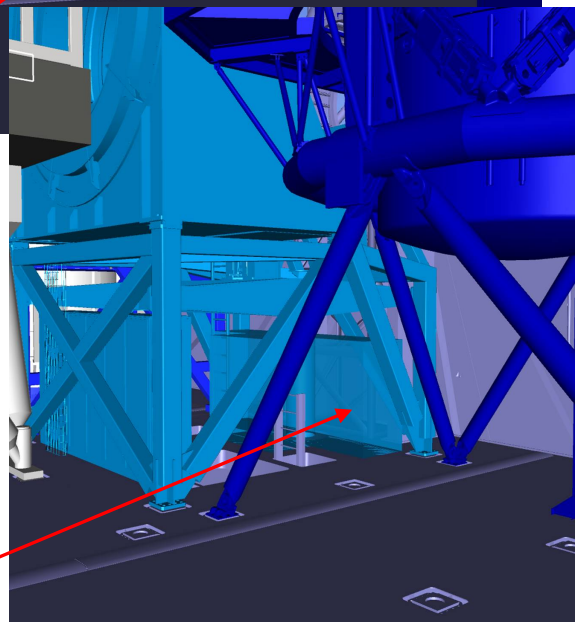
Location and Access



Personnel access via METIS



PDS Volume accessed via METIS across Nasmyth Platform



PDS

PDS Preliminary Design is NOW

System Technical Requirements Specification

Performance Analysis

- SHphasing and Zernike phase contrast studied in detail
- Signal needed to extract phasing information
- Sensitivity Analysis of optomechanics
- Realistic telescope beam with tolerances

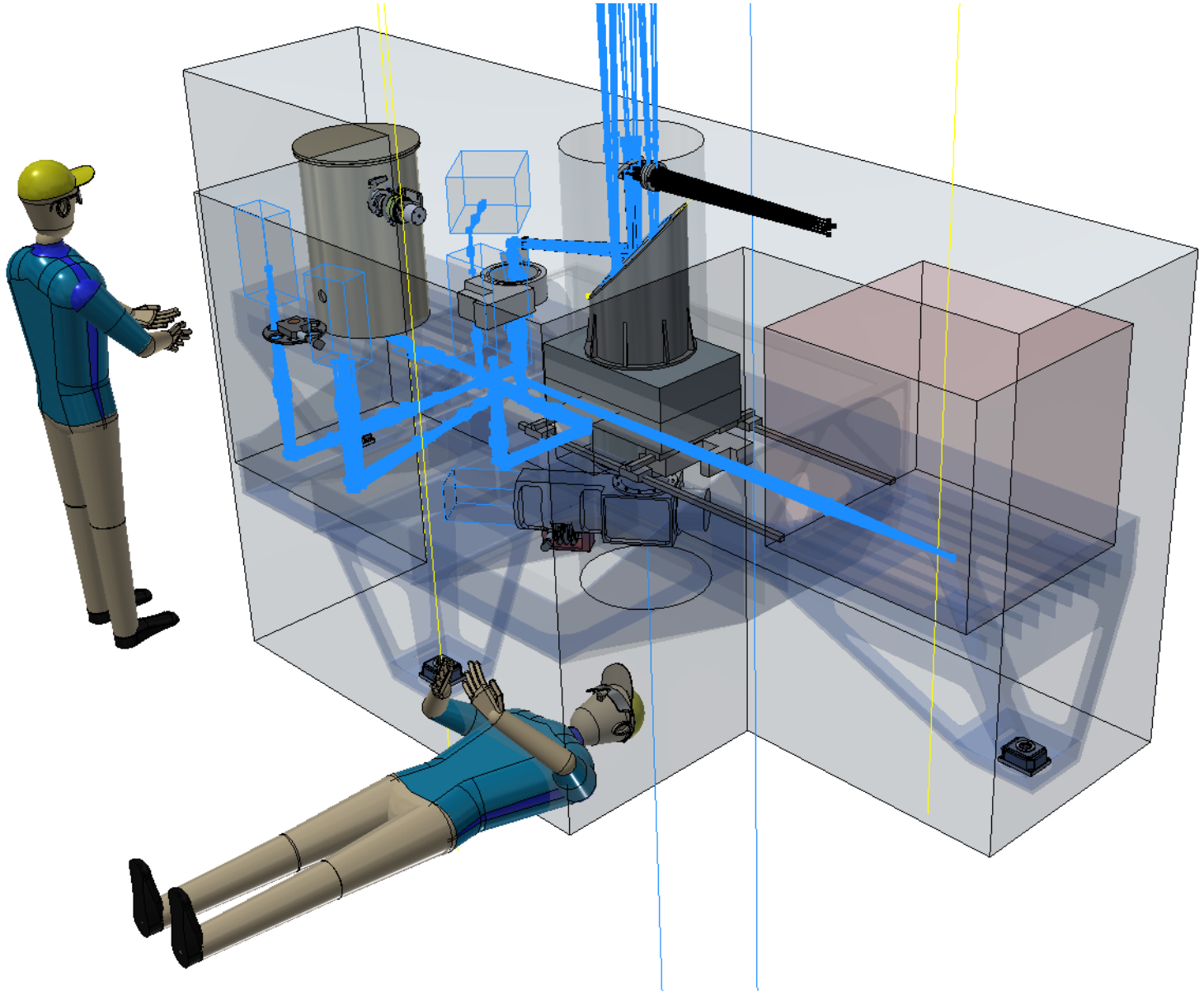
Input for optomechanical design

SH experience on-sky (community and inside ESO)

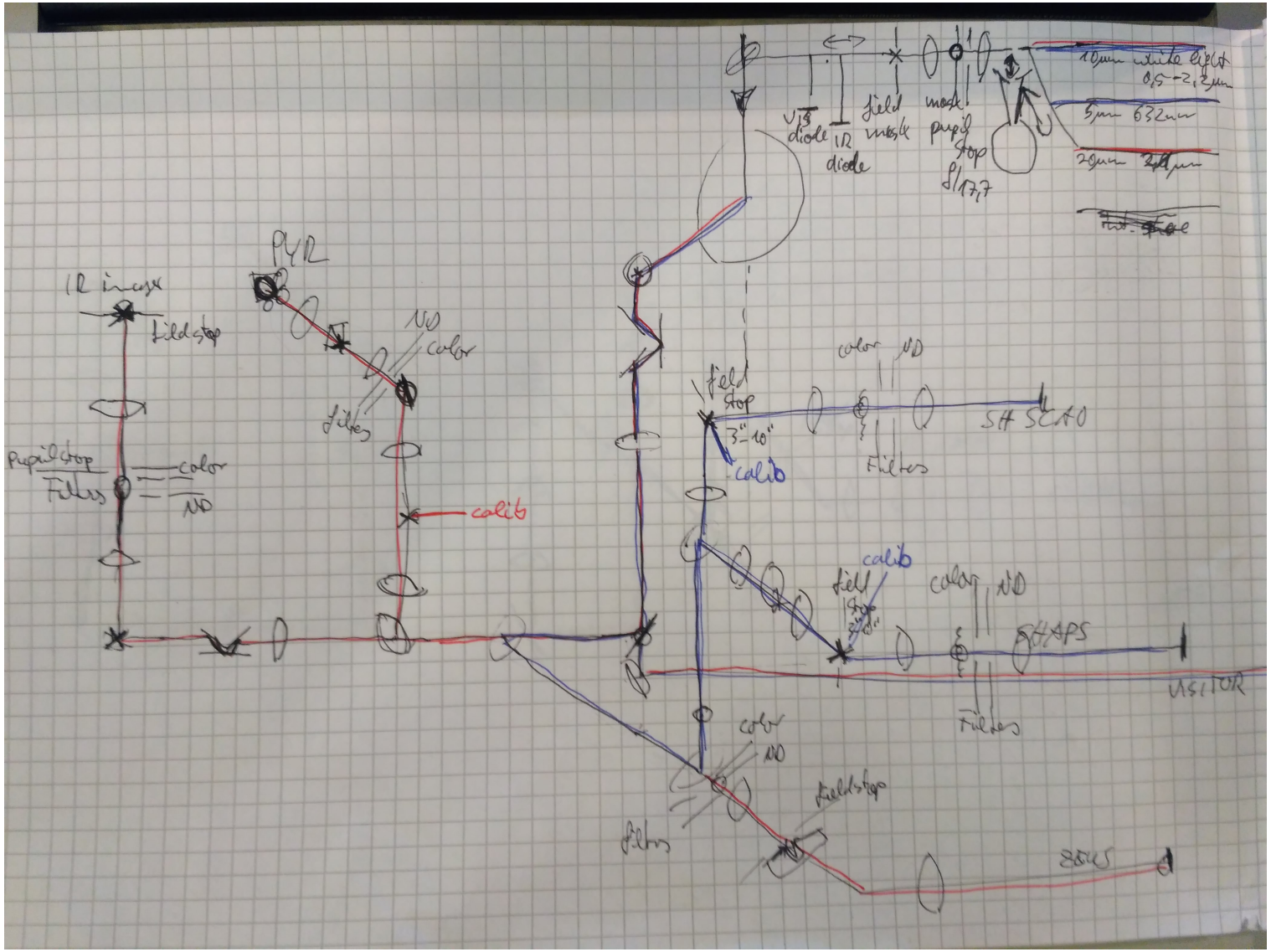
PDS Preliminary Design is NOW

- Iterative phase with optics/mechanics/AIV/SysEng
- Detector control system structure definition
- Overall control system definition
- Design driver
  - Robust, simple
  - From Architecture study:
    Schedule-Cost / Maintainability-Integratability important
  - Not performance driven
    We will meet required needs, and that's enough
  - No Science, not photon starved

PDS Preliminary Design is NOW



PDS Preliminary Design is NOW



PDS Project phases and Timing

- 09/2019 Kick-off preliminary design phase (1 year)
  - 07/2020 end of design, start of documentation
  - 09/2020 review process, early 10/2020 PDR
- 10/2020 Final design phase (1 year)
  - 08/2021 end of design, start of documentation
  - 10/2021 review process, end 10/2021 FDR
- 11/2021-11/2024 MAIT (3 years) – space in LIH
  - 1 year procurement/manufacturing
  - 1 year subsystem assembly and test
  - 1 year system assembly and test
- Shipment 12/2024

Conclusion

PDS supports wavefront commissioning, system verification, diagnostics/troubleshooting during regular operations, recommissioning after maintenance

PDS is THE tool that will bring the ELT to the diffraction limit for the first time

We have a baseline “instrument-oriented” architecture for the ELT Phasing and Diagnostic Station

The architecture will be developed to preliminary design level in the next project phase

PDS system responsibility in-house at ESO. Make/buy decisions on subsystems on a case-by-case basis.

THANK YOU