Data model as agile basis for evolving calibration software

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OmegaCEN family business

- **Astro-IT expertise center**
- **WISE information systems**
- **Data center (Petabyte scale, with CIT)**

Instrument	**1st light**	**-> System**	**1st light**
OCAM@VST	2011	-> AstroWISE	2006
MUSE@VLT	2014	-> MuseWISE	2013
Euclid	2022	-> EuclidDPS	2018
MICADO	2025	-> MicadoWISE	2022

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Calibration scientist: gaining insight by trend analysis over years of observations

Glue for evolving system [instrument hardware,calibration software]

Basic reqs:	FIXED FOREVER (MICADO: 50uas, 20mmag)	
Phase:	design & implementation	operations
instrument hardware:	evolving detailed specs	degradation, unpredicted behavior
instrument calib plan:	**evolving calibration reqs**	**update**
calibration software:	adapt recipes and pipeline	commissioning -> major update early operations -> adapt all routine -> refine all based on insight from years-of-data

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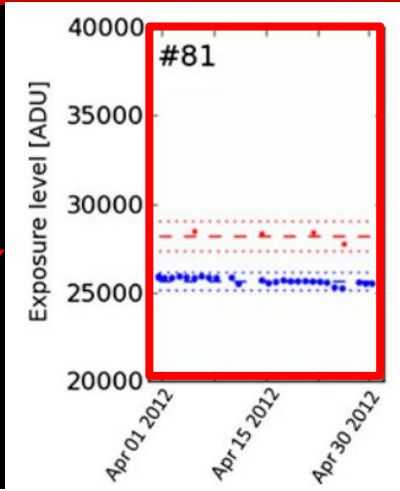

OCAM@VST with AstroWISE, early operations 2011-2012

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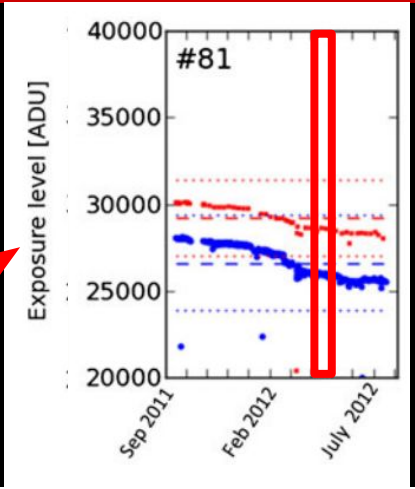


OCAM@VST with AstroWISE, early operations 2011-2012

"Calibrate instrument, not data"

Solution: link it all in a data model centric digital framework

Data Model in machine readable framework

Instrument team readable!

Calibration reqs (accuracy & precision data item,...)

⇓

Calibration Plan (procedure, duration, prerequisites,...)

⇓

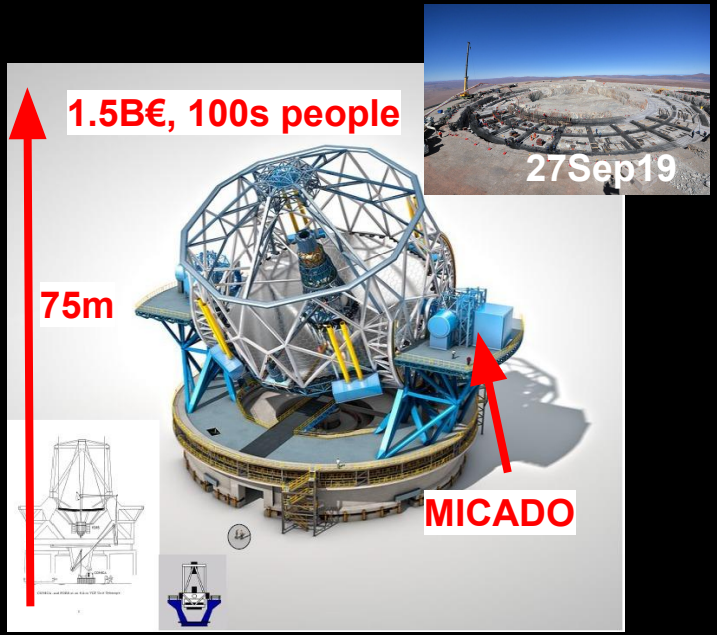
data items (data classes & dependencies,...)

⇓

software recipe specs (algorithm, procedure, validation,....)

	Calib Framework	-> Instrument	-> System
2005	ODOCO: Tex+Python	-> OCAM@VST	-> AstroWISE
2010	NoName: xml+Python	-> MUSE@VLT	-> MuseWISE
2017	Calib Framework: Sphinx	-> Euclid	-> EuclidDPS
2020	**CalibCADO Framework**	**-> MICADO**	**-> MicadoWISE**

Extremely Large Telescope & MICADO Near-IR imager+spectrograph



Extremely Large Telescope & MICADO Near-IR imager+spectrograph

Actively controlled telescope + PSF:

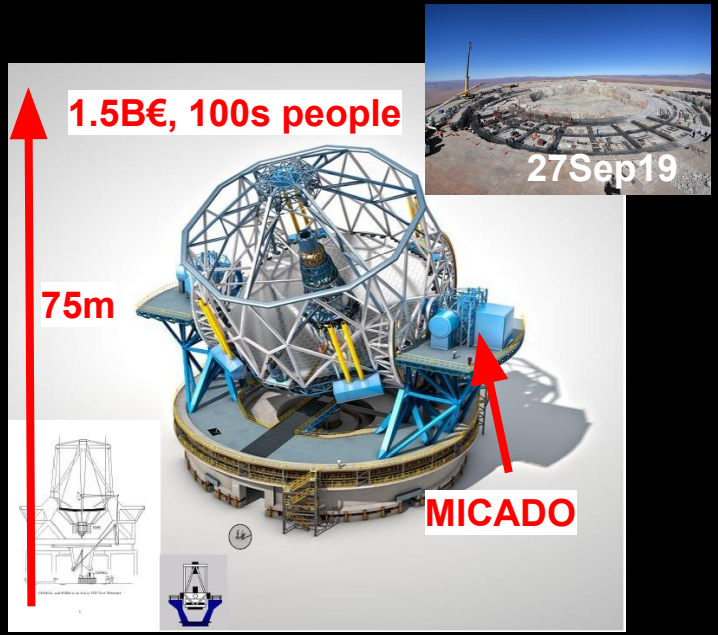
- 40 meter: 1000 alignable segments
- adaptive optics (≥2 deformable mirrors)

Gravity-invariant instrument:

- 3 imaging modes, 1 spectro (slit)
- 5 wheels (incl. 30 filters)
- Atmospheric Dispersion Corrector (moving glass)
- 9 H4RG detectors (1.5 and 4 mas pixels)

Data flow rate / 24hrs:

- ≤ 1E4 raw exposures
- ≤ 6.7 Tbyte



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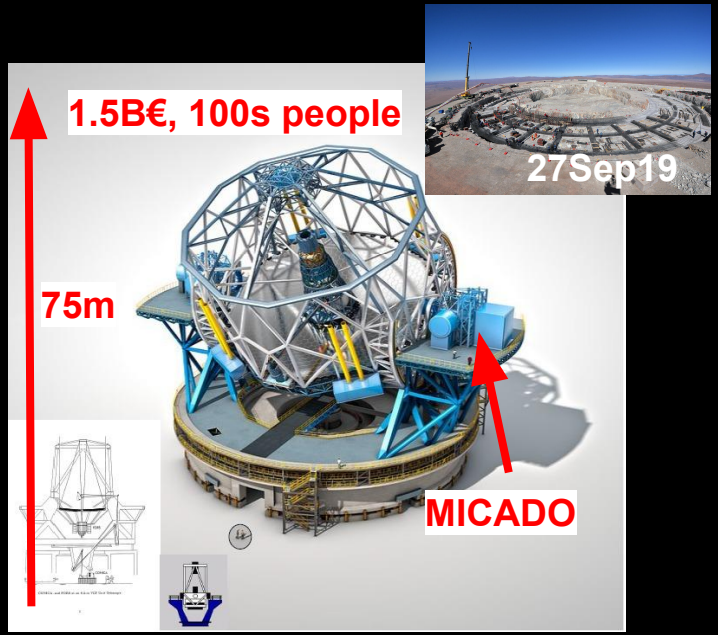
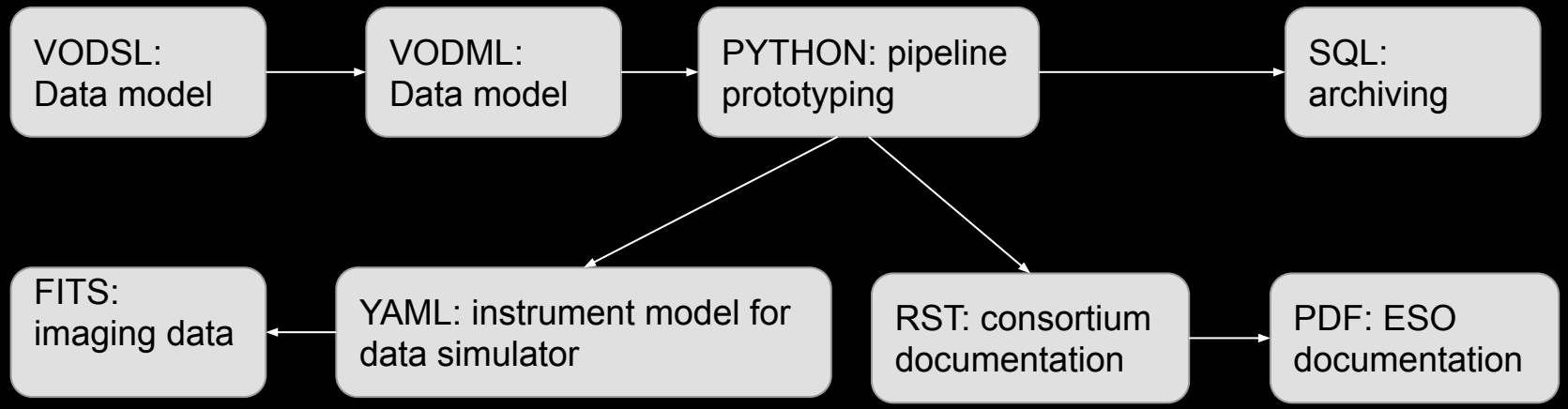


"First ever" versus "minimal calibration time"

⇩

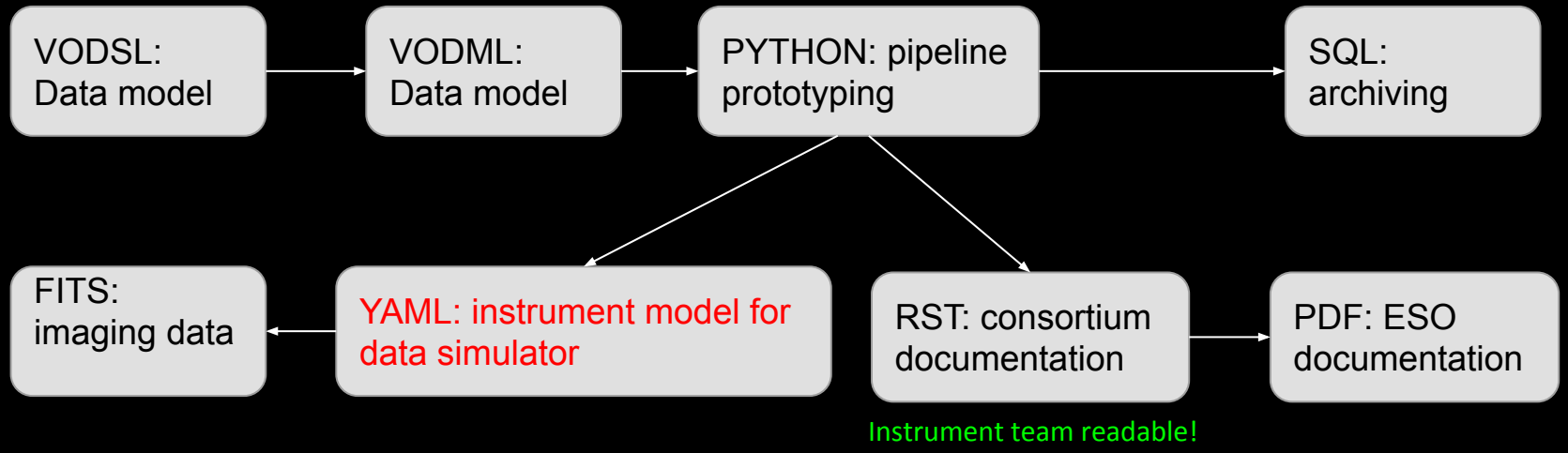
Calibrate instrument with maximum use science data

CalibCADO Framework: implementation



Details in *"Using VODML with MICADO"*, Buddelmeijer, Sat Oct 12, IVOA DM WG at DOT

New in CalibCADO: integrated specification of data simulator & pipeline protype



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Conclusions

Data-model-centric **Calibration Plan** is agile glue for consistent evolution of instrument & calibration software

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- ELT+MICADO: unprecedented active control, size, cost
  - **Calibration Plan** ever more important
  - Implemented **CP** in software with agile VO data modelling
  - Shared instrument model data simulator and calibration pipeline
    - opens way to bayesian calibration

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@IVOA: 3 Data Model talks: Dabin, Buddelmeijer, Nutma!

kapteyn astronomical institute

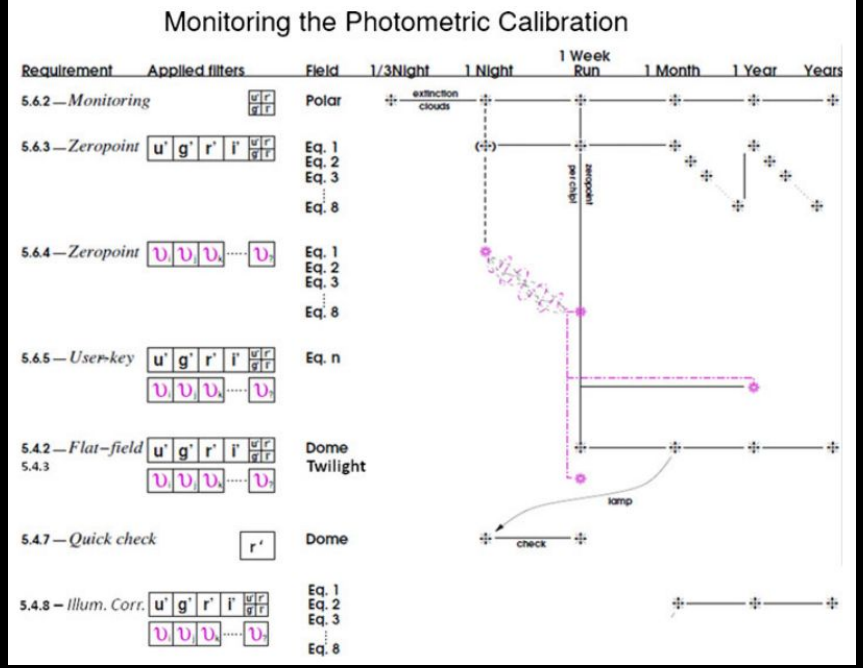
OmegaCEN

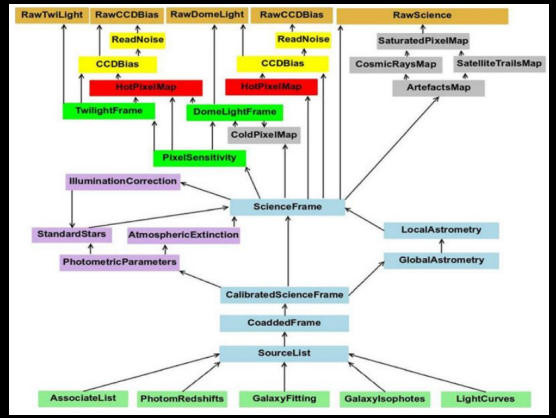
MICADO

END

Example outputs facilitated by data model + framework

ODOCO Calibration Framework for OmegaCAM, 2004





Auto-generated MICADO ESO recipe diagram here

Scratch slides after this one

Outline

1. OmegaCEN family business
2. Evolving instrument systems
3. ELT-MICADO's unprecedented active control & size
4. Approach to evolving calibration software development: framework
5. Framework smaak: MICADO
6. Hugo's add to family business: integrated detailed design of simulator & pipeline
7. Closing punch

Pipeline and data simulator share instrument model