

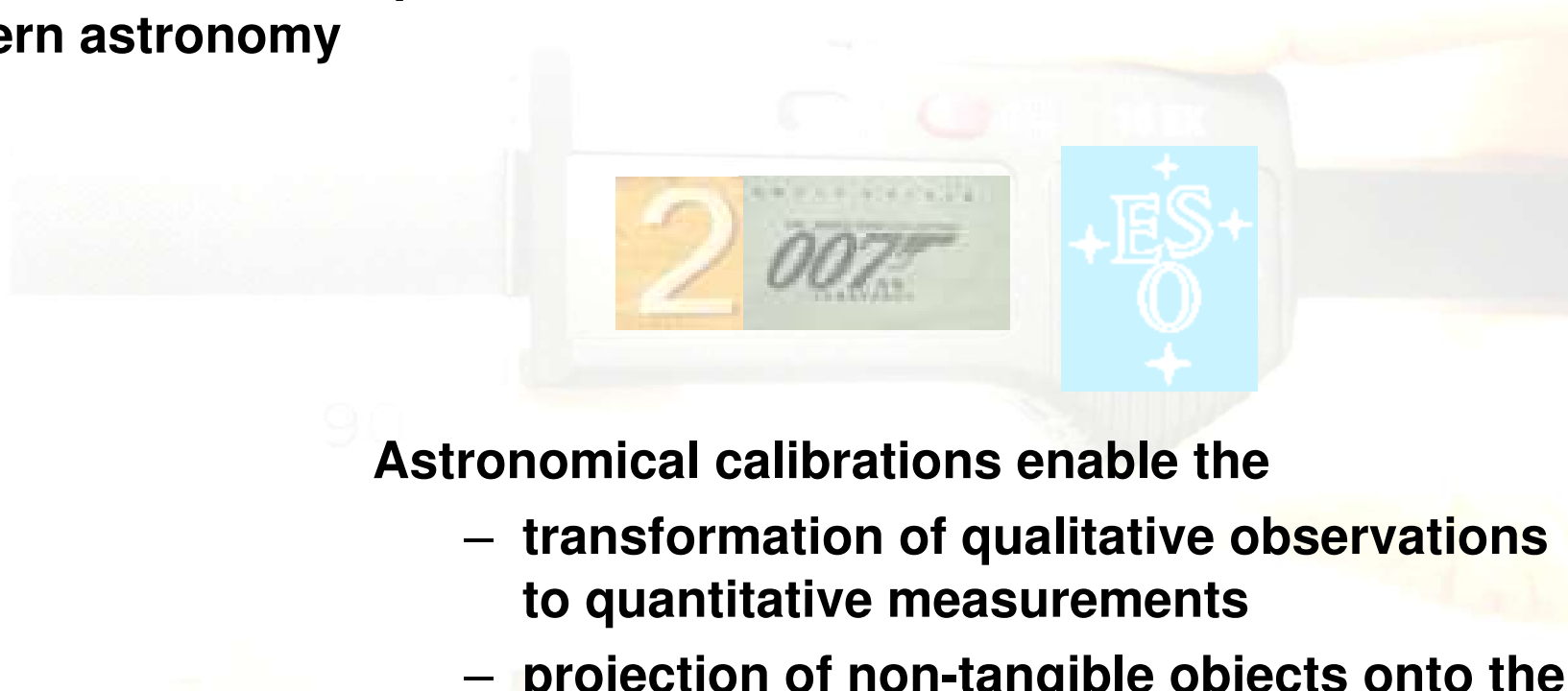
The 2007 ESO Instrument Calibration Workshop



A Personal Summary

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ESO - Garching

**More than 20 of the top 50
Google hits for
“Calibration Workshop”
concern astronomy**

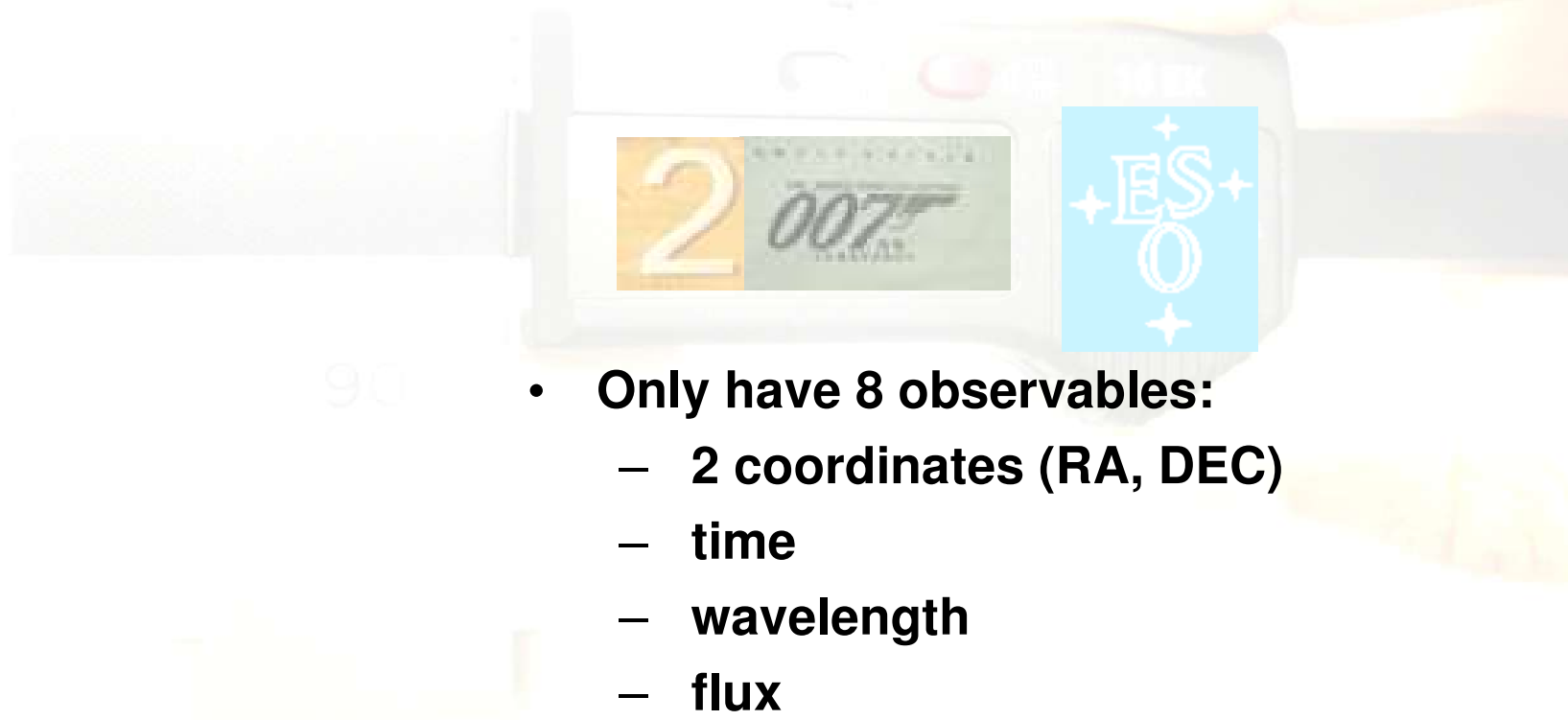


Astronomical calibrations enable the

- transformation of qualitative observations to quantitative measurements**
- projection of non-tangible objects onto the human (and also microphysics) world**

No calibration - no astronomy

Calibrating Astronomical Observations (I)



- **Only have 8 observables:**
 - **2 coordinates (RA, DEC)**
 - **time**
 - **wavelength**
 - **flux**
 - **degree of polarization**
 - **angle of polarization**
 - **phase (differences)**

Calibrating Astronomical Observations (II)

➤ Only need to consider 3 basic types of scientific calibrations:

○ radiometry

- always tough

extinction, sky background, instrumental background, sky concentration, slit losses, slit illumination, PSF, detector linearity, standards, variability, and many more atrocities

○ geometry

- mostly easy

but: flexure (e.g., VIMOS, FORS) requires differential parametric correction (or much time: hysteresis)

but: sensitivity to vibrations (VLT)

but: do HARPS (Lovis), NACO (Seifahrt), VLT et al. show that we have been settling for too little? (Lo Curto)

○ chronometry

- trivial (since introduction of GPS)

amazing – can this be true?

Calibrations at ESO

- Calibrations form the core of the very broad QC process www.eso.org/QC
- Calibration plans – calibrate instruments rather than data sets. In 1995, philosophy received with much skepticism. Seemingly working quite well, but users see complexity. Marconi
- Have calibration plans been optimized for minimum effort? Does ESO over/under-calibrate data? Or is it just about right? Marconi, Scodiggio / Hanuschik, Rosati; Osip, Kaufer, Käufel
- Have calibration plans been adjusted to meet (changing) scientific requirements (expectations)? Kaufer, Rosati
- Physical models: becoming more common; predictive rather than clean-up calibration; add more physics as you learn to understand the instrument Rosa, Bristow, Jung, Walsh; Kaufer

Challenges – from VLT to ELT (I)

Pipelines

- make them modular **Péron (recipes, CPL)**
- make them configurable **Hook & Sampo (ESO Reflex)**
- develop standard modules for standard tasks **Izzo**
- minimal assumptions
- error propagation and estimates **Grado, Horrobin, Roth**
- publication-ready results **Nissen, Møller Larsen**
- robustness (must scale with data volume) **Emsellem, Izzo**

• Archive

- support *in situ* operations on images and parameters
- project log files onto exposures
- pro-active filters for selection of candidate calibration data
- offer also processed data **Nissen; Romaniello**
Rosati (Advanced Data Products),
Hildebrandt

Merksätze (I)

- ***Calibration is a life-long learning process.***
(Marconi)
- ***Equivalence of experience and calibration: They are what we did not have when we needed them the most.***
(Unidentified)
- ***Calibration cannot make up for poorly prepared observations.***
(Bonifacio)
- ***A well calibrated instrument (ETC) is a prerequisite for the successful planning of any observing project.***
(Anonymous)

Challenges (II)

- **Trend analyses**

Part of ESO-standard QC but not used for calibration

- **Atmospheric extinction and background**

- a larger challenge than any decent instrument
- fast and long-term variations
- a 42-cm telescope will do
- feed ASM/LOSSAM data into calibration procedures
- consider autoguider and image analyzer data
- repeatedly observed (standard) fields
- IR transparency from precipitable water vapor
- good IR calibrators from ISO and Spitzer
- interferometry depends on seeing

All

Patat, Riello, Rosa

Bonifacio, Burke

Patat, Freudling

Mason

Smette, Thomas-Osip

Dobrzycka, Pantin

Hummel

(Davies, Clenet)

- **Radiometric calibration of adaptive-optics data**

Merksätze (II)

- ***Calibration cannot subtract noise. But it often adds noise.***
(Bonifacio)
- ***Calibration maps are a strong alternative to re-sampling.***
(Davies, Izzo)
- ***Artifacts are removed most effectively by multiple re-sampling.***
(Emsellem)
- ***Cannot follow two, probably not more than one, slides/minute.***
(Self-cross-calibration with mental model)

Challenges (III)

- Sky subtraction from (MOS, IFU, etc.) spectra **Bonifacio, Monelli**
- Large-scale structure in flat fields **Emerson, Freudling, Rosati, Selman**
- Continuum retification **Nissen**
- Monitoring did not detect WFI contamination **Selman**
- Detector fringing
 - built-in calibration tools not possible
 - rapid non-homologous variability of night-sky lines **Patat**
 - physical model **Walsh**
 - thick deeply or fully depleted CCDs (and CMOS) can eliminate the problem (and increase near-IR sensitivity) **Nissen, Baade**

Merksätze (III)

- ***Software is a pipeline if it can reduce data from several instruments of the same kind.***
(Izzo, Möhler)
- ***Pre-natal modelling is better than post-mortem calibration.***
(Rosa)
- ***We must optimize cost.***
(Nobody)
- ***Involve the end users. Need agency/forum for coordination, and management for prioritization in the case of limited resources.***
(Lindler, Emsellem)

Challenges (IV)

- Instrument design

- stiff mechanics
- very good telescope
- pre-construction simulation
- provisions for quality monitoring
- active compensatory control loops
- calibration plan derived from scientific requirements
- filters with standard passbands

Many

Richichi

Lorente (IFU's), Ramsay Howat (KMOS)

Clenet (NaCo)

Käufel (CRIRES)

Selman

- Surveys: homogeneity in sky and time

- weaving calibration nets
- special quality control (also using source catalogs)

Burke, Emerson, Hildebrandt,
Irwin, Keller, Lewis, Mellier,
Rosati, Riello, Selman

- Laboratory and telluric calibration tools and data

- Standard stars

Barrena, Bauwens, Burke,
Dobrzycka, Keller, Morel (CaVin),
Rodriguez Espinosa, Vernet

Araujo-Hauck,
Burke, Kerber,
Lovis, Papadaki,
Saitta, Schmidt

Merksätze (IV)

- ***False matches can confirm expectations most beautifully.***
(Izzo)
- ***If it's wrong, a polynomial will fit it.***
(Rosa)
- ***'Calibration Manifesto': A combination of meritocracy (physical models) and democracy (plain data) is the optimal constitution.***
(Izzo and Rosa)
- ***NIR polarimetry at ESO is a last-minute add-on for enthusiasts.***
(Ageorges, Schmid)
- ***Polarimetry would be more popular with better support.***
(Ageorges, Schmid / Patat)

Challenges (V)

- Performance monitoring and optimization of the tools
 - public test data and standard results
 - low-level interactivity
- Closing the feedback loops quickly and effectively
(Multidisciplinary Instrument Operations Teams)
- Gathering and disseminating the community-wide experience
 - Open-source tools**
 - Calibration workshops**
- Pipeline feedback to engineering calibrations, health checks ('preventive calibration'), etc.
Ageorges, Marconi, Möhler, Selman
- EMC
Millour, Pantin, Selman

Merksätze (V)

- ***If you know how to improve your calibrations and tools, do it.***
(Tycho – quoted by Rosa)
- ***Thou shalt not have parallel pipelines.***
(Emsellem / Möhler, Hummel / Hanuschik)
- ***The sky is the limit.***
(Many – meaning the Earth's atmosphere)
- ***ESO should accept and support calibration proposals.***
(Emsellem and the Calibrated Majority)
- ***The best quality check is a logarithmically scaled 3-color image.***
(Irwin)

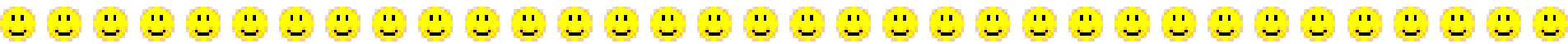
Everyone's Uncalibratable Pet



Eierlegende Wollmilchsau (aka egg-laying woolly milk pig)

Physical modell courtesy M. Rosa

The Calibration Workshop Experience



- We have covered a lot of ground, have exchanged encouragements, re-confirmations, and new inspirations.
- ESO has received a lot of valuable (calibrated!) feedback from its users community.
- In the area of public surveys, ESO is entering an era of qualitatively new cooperations (similar to the very successful joint Community/ESO development of instruments). This “Public Private Partnership” (PPP) could be a promising *ansatz* for other calibration tasks.
- ESO thanks you for your contributions,
- and we thank the organizers!

We look forward to the continuation: Auf Wiedersehen!