Best practice when coordinating space- and ground-based observatories

Willy Benz, University of Bern & ESO

Rob Ivison and Bruno Leibundgut, ESO

ESA-ESO cooperation

- ESO mission:
  1. Develop and operate world-class observing facilities for astronomical research
  2. *Foster collaboration in astronomy*
- In 2015, ESA and ESO signed a cooperation agreement at ESO's offices in Santiago, Chile
  - Considerable overlap of interests between ESO, pre-eminent in ground-based astronomy, and ESA, Europe's leader in space research and technology
  - Agreement provides a framework for future close cooperation and exchange of information in many areas
  - Working Groups: Science; Technology; Communications

History

- Close collaboration on *HST*
  - Space Telescope – European Coordinating Facility (ST-ECF) hosted at ESO
    - European *HST* archive ▸▸ development of ESO archive
    - Interaction on VLT operations model ▸▸ service observing
- Joint observing time with VLT–*XMM/Newton*
    - For over a decade now, but modest investments in truth
- Science collaborations
  - VST observations of *Gaia* satellite position
  - Near-Earth Objects: coordinated IAWN observations
    - Also ESA testbed telescope (pre-NEOST) heading to La Silla
  - *Gaia*-ESO Public Survey (community-driven)
  - EUCLID calibration observations with FORS2/KMOS
  - Some less successful attempts, e.g. MUSE deep field

Ground-based support of space missions

- Ground-based support can come in two flavours:
  1) Competitive processes, to ensure science cases and teams are as strong as they can be (and should be), e.g.
     - ESO Large Programme (~10–100 nights)
     - ESO Public Survey, e.g. *Gaia*-ESO (~50–1000 nights)
  2) "Guaranteed time"
     - Exists already in form of GTO for instrument teams, which are often one and the same as those driving space missions (~300 nights is typical)
     - Can in principle be provided in exchange for investments that benefit all users, i.e. in operations or infrastructure, e.g. instrumentation

Space/ground synergies

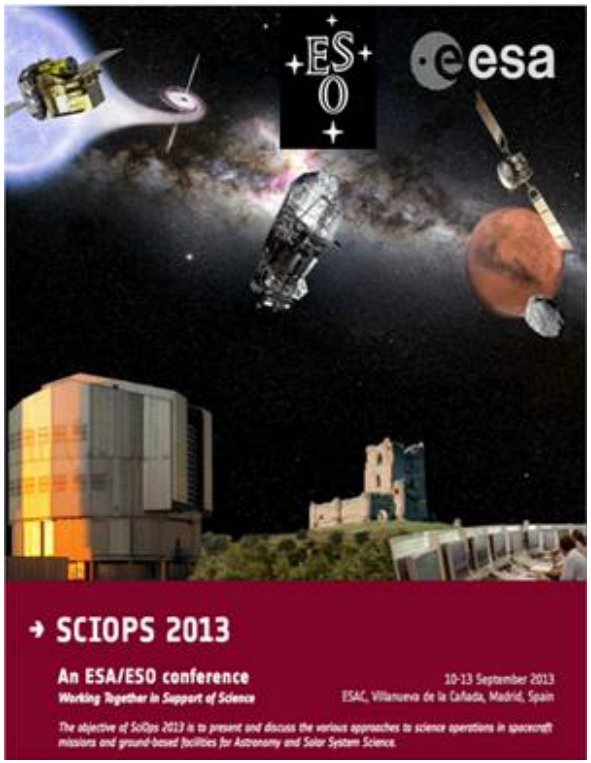
- Early planning very important
  - To ensure relevant instrumentation is available, e.g.
    - High-stability radial velocity machines capable of necessary cadence in support of PLATO, CHEOPS
    - Spectroscopic calibration of photometric redshifts for EUCLID
  - Avoid ‘blackmail’ situations
  - Reciprocity essential, to maintain healthy relationship between partners in space and on ground
    - e.g. VLT/MOONS requiring data from EUCLID should be just as valid as EUCLID requiring data from VLT/MOONS
  - Corporate-level involvement essential

Test case: *Gaia*–ESO

- *Gaia*–ESO: an ESO Public Spectroscopic Survey
  - PIs: Gilmore, Randich (188.B-3002 & 193.B-0936)
  - ≥10^5 stars to mag~19, covering all major MW components
  - Provide 4D map of kinematic gradients and abundances
  - Dataset will identify, on both chemical and kinematic grounds, phase-space sub-structures that bear witness to specific merger or starburst events
  - Beautifully complementary to ESA *Gaia* mission
  - ~240 nights (+ compensation for poor weather), P88+
  - Time allocated via competitive process, via ESO Public Spectroscopic Survey Panel and OPC
  - Advanced data products available through ESO archive
  - ADS search for Gaia.and.ESO: 72 ref. papers; h index 23

ESA-ESO Operations conferences

- Organised every two years, alternating between ESA and ESO



SCIOPS 2017

- *'Working together in support of science'*
  - 17-20 October 2017 at ESAC/Madrid, organised by Michael Sterzik (ESO) and Danny Lennon (ESA)
  - ~100 registered participants

SCIOPS 2017

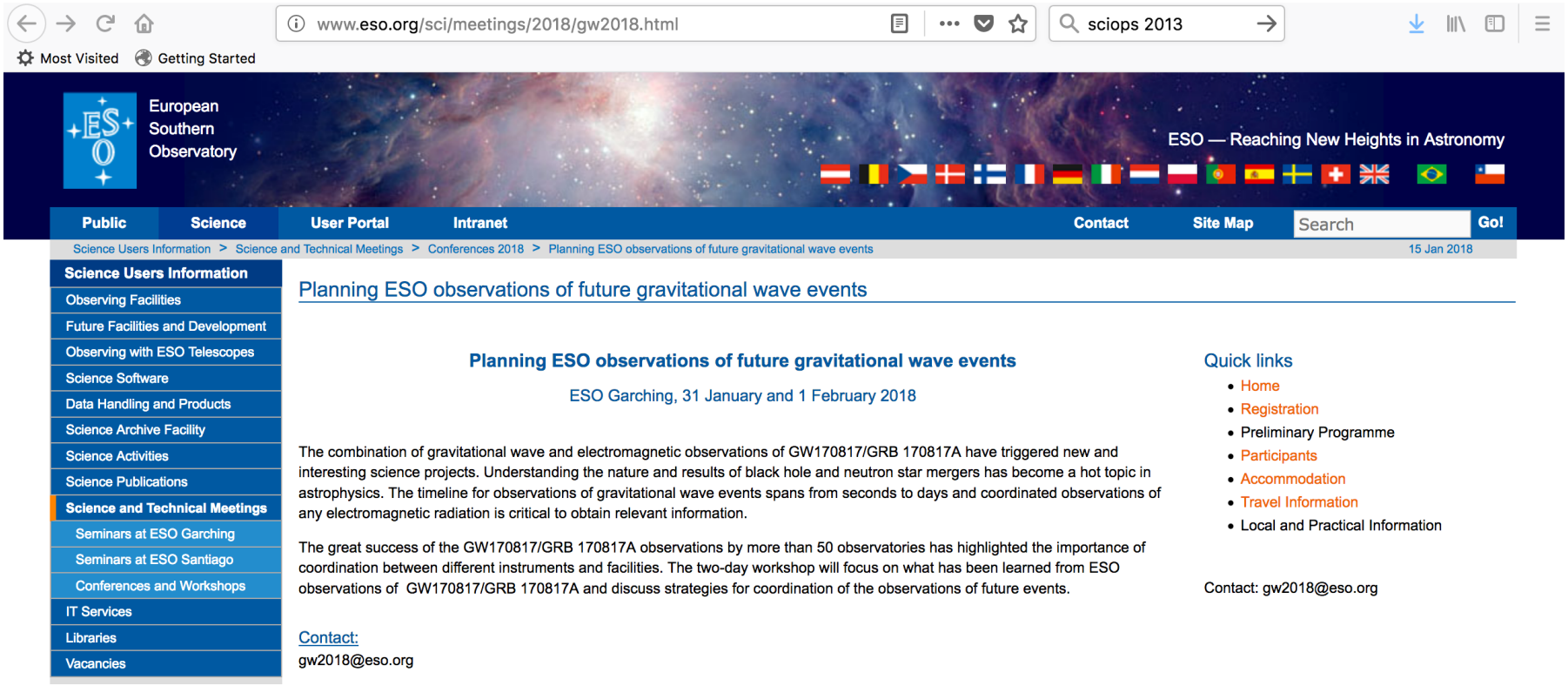
- Goals
  - Examine challenges of distributed science operations
  - Consultation with (joint) user community
  - Exchange ideas/experiences with SciOps experts from other facilities, e.g. LSST, CTA, SKA, LOFAR, JWST
- Topics
  - Current and future satellite missions
  - Lessons learned on space and ground
  - Common issues: archives, ops models, proposal selection processes
  - planning ground-based support of future ESA missions
  - presentations: Euclid, PLATO, LSST, SKA, 4MOST, ELT, LISA, *Gaia*, *Rosetta*, *Mars Express*, *Solar Orbiter*, JWST

Data curation/Archives

- Increasing importance of data products
  - Community expects uniform data products for surveys
    - Ensures genuine legacy
    - *e.g.* ESO surveys, *Gaia*, EUCLID, PLATO
  - Archives most useful when data can be applied trivially to science questions ("science-ready data")
- Data access
  - Promise of the virtual observatory
    - → increase synergies between ESA and ESO archives
  - ESASky: excellent interface to multi-mission archives
  - ESO developments towards increased functionality
    - Portal to La Silla Paranal and ALMA data
    - Emphasis on physical searches

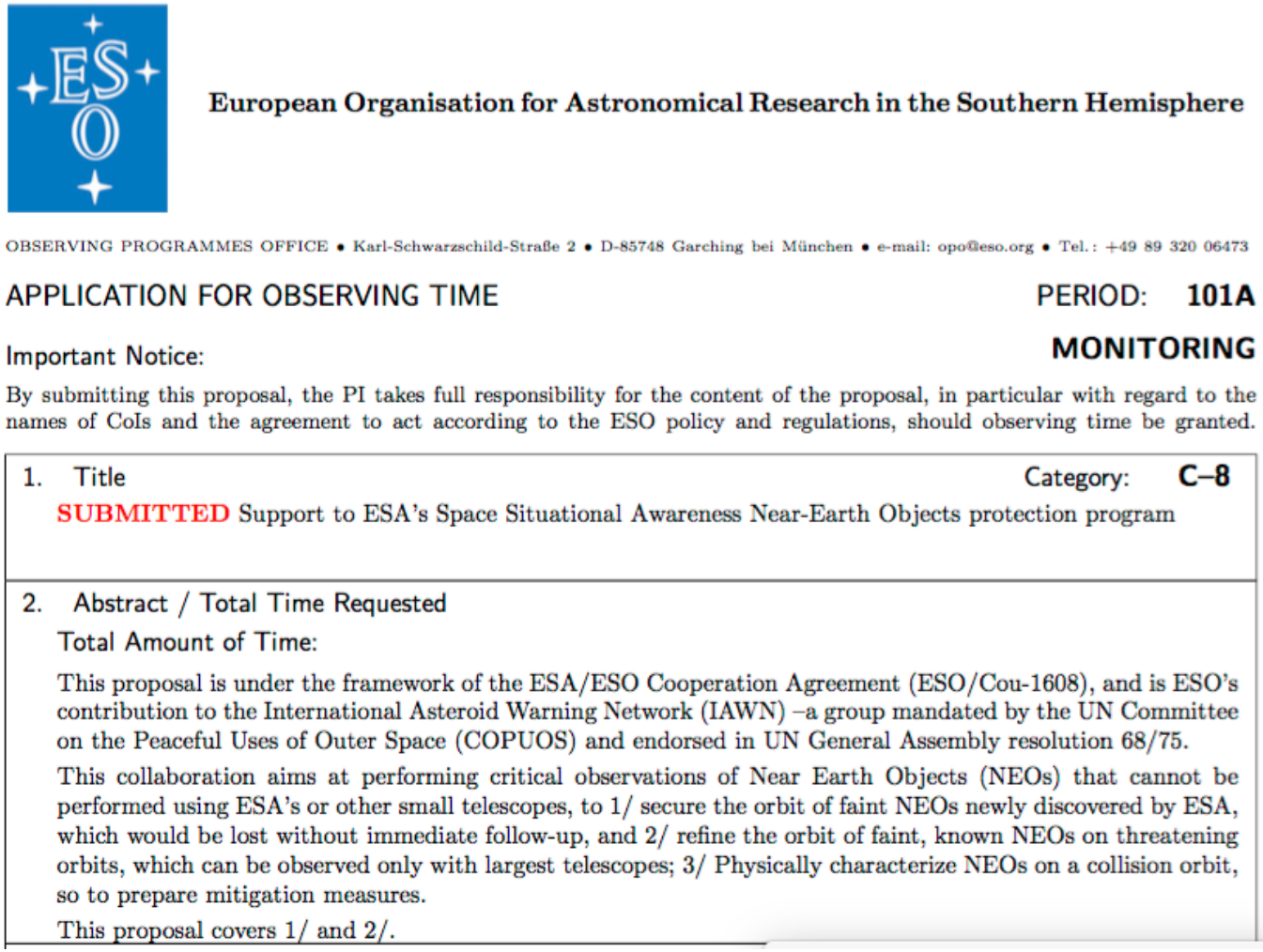
Coordinated observations

- Example: gravitational-wave events
  - ESO-organised coordination workshop 31 Jan - 1 Feb 2018
  - Including coordination between facilities (ESA: *XMM, INTEGRAL*)



Coordinated observations

- Common task force to observe potentially hazardous Near-Earth Objects



European Organisation for Astronomical Research in the Southern Hemisphere

OBSERVING PROGRAMMES OFFICE • Karl-Schwarzschild-Straße 2 • D-85748 Garching bei München • e-mail: opo@eso.org • Tel.: +49 89 320 06473

APPLICATION FOR OBSERVING TIME PERIOD: **101A**

Important Notice: **MONITORING**

By submitting this proposal, the PI takes full responsibility for the content of the proposal, in particular with regard to the names of CoIs and the agreement to act according to the ESO policy and regulations, should observing time be granted.

1. Title Category: **C–8**

SUBMITTED Support to ESA's Space Situational Awareness Near-Earth Objects protection program

2. Abstract / Total Time Requested

Total Amount of Time:

This proposal is under the framework of the ESA/ESO Cooperation Agreement (ESO/Cou-1608), and is ESO's contribution to the International Asteroid Warning Network (IAWN) –a group mandated by the UN Committee on the Peaceful Uses of Outer Space (COPUOS) and endorsed in UN General Assembly resolution 68/75.

This collaboration aims at performing critical observations of Near Earth Objects (NEOs) that cannot be performed using ESA's or other small telescopes, to 1/ secure the orbit of faint NEOs newly discovered by ESA, which would be lost without immediate follow-up, and 2/ refine the orbit of faint, known NEOs on threatening orbits, which can be observed only with largest telescopes; 3/ Physically characterize NEOs on a collision orbit, so to prepare mitigation measures.

This proposal covers 1/ and 2/.