WP10: NA1 Adaptive Optics networking

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Aim

• WP10 – NA1 – Adaptive Optics networking, aims at proposing new solutions and new tools for overcoming some of the current limitations of AO-assisted astronomical instrumentation.

• The proposed network aims at coordinating these latter aspects through the reinforcement of the existing synergies between the teams already involved in the AO activities within OPTICON, as well as by attracting new teams. The impact of such synergies, initiated since the FP5 programmes, has proven to be very successful.
WP breakdown

• WP10.1: Coordination
• WP10.2: Optical turbulence studies for Large Astronomical Telescopes
• WP10.3: Reconstructing the AO-corrected PSF for maximised science output
• WP10.4: Innovative control strategies for future adaptive optics systems
• WP10.5: On-Sky AO test platform using CANARY at WHT
Task 1: Coordination

Website:
https://sites.google.com/view/opticon-ao/home
Task 1: Coordination:
Week of Workshops, Durham 2018

AO Week of workshops: Durham March 2018
  • One week of back-to-back independent but related workshops sharing logistics
  • 5 days, over 80 delegates
H2020 OPTICON (730890)

Task 1: Coordination: WaveFront Sensing and Control, Paris 2018

• Over subscribed, >80 international delegates
Task 2: Optical turbulence studies for Large Astronomical Telescopes

- The purpose of this task is to develop new, and exploit existing facilities, to understand the complex implications of time varying atmospheric conditions on Adaptive Optics (AO) systems.
- The existing facilities include the Stereo-SCIDAR a state-of-the-art turbulence monitor, which was developed as part of the former OPTICON FP7 project. Data release of Over 100 nights of operation and over 10000 individual profiles.
- We will also develop global and localised turbulence forecast models.
Task 2: Dedicated Instruments: Stereo-SCIDAR

Turbulence Strength

Formal data release through ESO

Derie, Wilson, Osborn et al. ESO Messenger, 166, 41-66, 2017
Osborn, Wilson, Sarazin et al. MNRAS, 478 (1), 825 - 834, 2018
Task 2: Optical turbulence forecasts

Task 2: Optical turbulence studies for Large Astronomical Telescopes

To date, in this task, the following goals have been achieved:

• **Validate General Circulation Models** for low spatial and low temporal resolution turbulence forecasts

• Generate a set of ‘typical’ turbulence profiles which can be used for monte-carlo simulation, rather than trying to simulate AO performance with the full 15,000 Stereo-SCIDAR dataset
  *(Farley et al., MNRAS, 481, 2018)*

• Develop computationally efficient algorithms to extract atmospheric parameters from AO telemetry

• **Stereo-SCIDAR data release** – large community use (Durham, Paris, ONERA, LAM, INAF, ESO, TNO, MPIA…)
  *(Osborn et al., MNRAS, 478, 2018)*
Task 2: Future plans

• Measurement campaign
  • several instruments
  • La Palma
• Verify (not calibrate) models
• Use profiles for AO studies
Task 3: Reconstructing the AO-corrected PSF for maximised science output

- Coordinate the research on PSF reconstruction for complex high-order, both classical and tomographic systems
- Develop metrics as a function of the science case in terms of reconstructed Strehl-ratio, Ensquared-energy and PSF morphology in preparation for the future E-ELT instruments (MICADO, METIS, HARMONI, MOSAIC) – each with different requirements.
- Developing focal plane profiling
Task 3: Reconstructing the AO-corrected PSF for maximised science output

- PSF reconstruction for several AO modes under development
- Provide guidelines for PSF reconstruction to cater for the 1st light instruments on the European Extremely Large Telescope (ELT)
- Verification at MUSE (VLT) and NIRC2 (KeckII)
  - PSF reconstruction trialled on astronomical data to raise readiness level
- Recruitment for PDRA
  - Fellow to be hired in 2019/2020 to carry on and conclude proposed activities
Tasks 4: Innovative control strategies for future AO systems

- (i) developing (modeling, identification, control)
- (ii) testing (end-to-end simulations, on-sky data)
- (iii) validating on-sky (using CANARY)
- Task led by IOGS with contributions from ONERA, CNRS-LAM, CNRS-LESIA, CNRS-CRAL, U. Durham, NOVA-U. Delft and TNO.
WP10 – Task 4: Summary at T0+22
Innovative control strategies

• Developments
  • Model order reduction of uncertain linear systems, with application to AO
  • Flexible methodology to avoid bumps when switching controllers
  • Performance evaluation for any linear controller and any classical AO system
  • LQG control with frozen flow modelling in zonal basis

• Easy access to simulation parameters for a selection of AO systems
  • To be integrated on the project web page: NAOS, SAXO/SPHERE, SCAO+LTAO-HARMONI, GeMS
  • List of public simulation tools that could potentially integrate the parameters sheets
    • https://github.com/agb32/dasp (DURHAM)
    • https://github.com/compas-dev/compas (LESIA)
    • https://github.com/cmcorreia/LAM-Public (ONERA-LAM)

• 1-year post-doc to be recruited
WP10 – Task 4: Perspectives

• Modeling integrating wind profiles for high-performance control
  • Turbulence modeling/identification
    • zonal/model models with accurate representation of spatial and temporal statistics,
    • data-driven controller updating schemes
    • AO telemetry and wind/turbulence profiles (Networking)

• On-sky tests on CANARY (Networking)

• Extension to ELT-sized AO systems
  • Adaptation to massively parallelizable schemes
  • domain decomposition techniques
  • mixed LQG/integrator control

• Performance evaluation on COMPAS (GPU-based simulator)
  • first ELT test case: HARMONI SCAO mode (Networking)
Task 5: On-Sky AO test platform using CANARY at WHT

• CANARY is an on-sky tomographic adaptive optics demonstrator installed at the 4.2m William Herschel Telescope in the Canary Islands. Since initial commissioning in 2010, it has since provided the first on-sky demonstrations of NGS and LGS MOAO, LTAO and tomographic LQG control as well as hosting several visitor experiments.
CALL FOR PROPOSALS

- OPTICON has provided funds to allow members of the instrumentation community to apply for observing time using CANARY to test novel instrumentation concepts that would benefit from on-sky demonstration. Up to 20 nights of observing time is available to be shared between several projects that will be allocated by a committee representing both the OPTICON and ING instrumentation communities. Observations will be supported by members of the CANARY team who will be able to assist with the design, installation and operation of your experiment with CANARY.

- Collaboration agreement in place
- TAC nearly assigned (3 of 5 agreed)
- Submission process open – deadline end of December
- Information on website:
  - https://sites.google.com/view/opticon-ao/canary-tests
CANARY at the WHT using ESO's Wendelstein laser guide star launch system (Image: L. Bardou)
2.5m Isaac Newton Telescope
Photo: Matt Townson

ESO Wendelstein Sodium laser
Photo: Lisa Bardou
Potential Issues

• Both the WHT and INT telescopes are currently undergoing major programmes to prepare for the arrival of the WEAVE spectrograph at the WHT and HARPS3 spectrograph at the INT. This may have an impact on telescope availability:
  • A stand-down for the installation of WEAVE is currently planned for the last few months of 2019, hence all of 19A and the first half of 19B will remain available
  • WHT access for 20A is under negotiation.
  • We do not expect access to the INT to be impacted on the timescale of H2020 funding.
Deliverables

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Effort projection on

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Failed recruitment at IOTA - re-trying with additional funds from Durham for extra 0.5 year
Outputs:

• Task 1:
  • AO Week of Workshops: Durham March 2018, >80 delegates
  • Wavefront sensing and control in the VLT/ELT era: Paris 2018, 84 delegates registered

• Task 2:
  • Many groups using Stereo-SCIDAR data
    • Durham, Lesia, ONERA, LAM, INAF, ESO, TMT, TNO, MPIA…
  • 6 + 4 publications (conference + peer-review)

• Task 3:
  • 6 + 2 publications (conference + peer-review)

• Task 4:
  • 5 + 2 publications (conference + peer-review)

• Task 5:
  • 5 + 1 publications (conference + peer-review)
  • Canary call for proposals
Future

• TNA for instrument development
  • Extremely important
  • Canary and other facilities
    • Lesson learnt: needs support effort as well as T+S

• Workshops
  • Instrumentation
    • Large demand
  • Bring together Instrumentation and astronomers
    • Both highly specialised

• Ethnographic study
  • Study and improve communication between instrumentation and astronomy