

OmegaCEN report 2013-2015

Introduction NOVA has invested heavily in a suite of survey instruments that produce very large data streams. This provides the Dutch astronomical community with state-of-art raw data to be used for many science cases. OmegaCEN is NOVA's survey datacenter plus expertise center for astronomical information technology. It consists of a team of ~15 FTEs with primary basis at the Kapteyn Astronomical Institute and also involving Leiden Observatory. Its aim is to provide the environment and infrastructure in which the science teams together with their international partners can efficiently generate their science-grade data, embed their ever changing smart algorithms and thereby perform scientific analyses. OmegaCEN's strategy is to be efficient for NOVA by pooling its expertise, software and hardware across NOVA's projects.

In 2013-2015 OmegaCEN supported the data handling for NOVA's share in following ESO projects: (i) the OmegaCAM wide-field imager, leading the handling of its Dutch-led Kilo-Degree Survey and many GTO projects; (ii) leading the handling of GTO surveys with the MUSE multi-unit IFU spectrograph and (iii) leading the design for dataflow and pipelines for E-ELT's First Light imager and spectrograph MICADO. For the Science Ground Segment of ESA's Euclid Mission, OmegaCEN leads NOVA's share: hosting the national Science Data Center, co-leading with ESA the Euclid Archive System and co-leading with Germany the handling of all auxiliary ground- and space-based data. OmegaCEN also continued support for the LOFAR Long-Term Archive which it delivered in 2011.

The **scientific goals** of projects supported by OmegaCEN include Solar System studies, Galaxy and Local Group dwarfs (OmegaCAM, MICADO) the evolution of galaxies, dark matter and dark energy (OmegaCAM, MUSE, Euclid) and the early Universe (OmegaCAM, MICADO, MUSE, Euclid). We refer to the instrument specific sections in this report for a more in depth science discussion for each instrument.

OmegaCEN's "instrument" is its in-house developed WISE technology. WISE allows to build "Living Archives", which are information systems for massive data that integrate survey calibration, quality assessment, science analysis and data mining with archiving. This is achieved by integrating databases, storage and compute resources in a single system. WISE allows to connect heterogeneous hardware and software which are geographically distributed across dozen locations. In 2013 OmegaCEN published a comprehensive and in-depth description of the WISE technology and its applications in a topical issue of Experimental Astronomy (Valentijn et al., 2013, 389 pages). In 2013-2015, OmegaCEN operated Astro-WISE for OmegaCAM and dozen other wide-field imagers, MuseWise for MUSE and has used WISE technology for Euclid and MICADO dataflow design activities.

In 2013-2015, OmegaCEN led with Astro-WISE the survey calibration and data processing for the Kilo-Degree Survey for all public data releases to ESO and internal releases to the science consortium. OmegaCEN supported seven OmegaCAM GTO projects, hosting the survey data and managing the pipelines and tuning and expanding algorithms with the

science teams. Astro-WISE is installed at all NOVA institutes and at their partners in Bonn, Munich, Naples and Padua. At the end of 2015 Astro-WISE had over 300 users, ~150 Terabytes of pixel data and ~100 million source extractions.

OmegaCEN led the development of MuseWise survey system. It was commissioned together with the MUSE instrument in February 2014. Its role progressed from being an archive system for raw data to calibration production system to science-grade spectral-cube production system for the GTO projects by the end of 2015. MuseWise user community grew to 80 persons and connects hardware in Göttingen, Groningen, Leiden, Lyon, Potsdam, Toulouse and Zurich. It stores ~100 Terabyte of data including several million files.

For Euclid, OmegaCEN developed a design plus a prototype Euclid Archive System in collaboration with ESA and a design plus prototype pipeline to calibrate and combine the ground-based auxiliary surveys. These developments were used to pass the Preliminary Requirements Review and System Requirements Review in 2014 and 2015 for these parts of the Euclid Science Ground Segment..

For MICADO, OmegaCEN led the top-level design of its dataflow and pipelines on behalf of the consortium. This was part of the delivery which led eventually to the acceptance of the MICADO concept by ESO, signed as an agreement in September 2015.

The Target programme was a significant contributor to hardware and expertise for OmegaCEN's activities for NOVA. Target was an OmegaCEN-led multi-disciplinary project at the University of Groningen involving also ASTRON, IBM and Oracle among others. The OmegaCEN's Groningen datacenter was hosted in full on the Target hardware park and maintained by Target personnel at the University's Computing Center together with OmegaCEN.

Status and outlook

In 2013-2015 OmegaCEN developed into an internationally operating data and expertise center which on behalf of NOVA is the main Dutch partner for data handling for both the European Southern Observatory and the European Space Agency. As the "bit" part of ESA's and ESO's instruments keeps increasing its importance besides the "glass and steel" components, OmegaCEN has become for NOVA a means for *in-kind* contributions to their large international data-intensive instrumental projects.

In 2013-2015 OmegaCEN collaborated with ASTRON inside the Target programme on LOFAR storage and archiving. Continued sharing of expertise on technical aspects of data storage, transfer and on computing and databasing which are wavelength-agnostic will be efficient for the Dutch radio and optical/near-IR communities.

In 2013-2015 OmegaCEN expanded its development of information systems from optical cameras to (multi-)integral-field-unit spectrographs and near-infrared imagers. Increasing collaborations with NOVA's Optical/IR instrumentation group can result in ever better integrations of instruments consisting of "bits, glass and steel". This by a combined design approach to the software for data handling and the hardware for data acquisition.

Publications in 2015 based on data produced with Astro-WISE and MuseWise

Refereed papers

- Bacon R., Brinchmann J., Richard J., et al., 2015, ["The MUSE 3D view of the Hubble Deep Field South"](#), A&A, 575, A75
- Cavuoti et al., 2015, MNRAS, 452, 3100, [Machine Learning based photometric](#)

[redshifts for the KiDS galaxies](#)

- de Jong et al., 2015, A&A, accepted, [The first and second data releases of the Kilo-Degree Survey](#),
- Krajnovic D., Weilbacher P. M., Urrutia T., et al., 2015, MNRAS, 452, 2, "[Unveiling the counter-rotating nature of the kinematically distinct core in NGC 5813 with MUSE](#)",
- Kuijken et al., 2015, MNRAS, submitted, [Gravitational Lensing Analysis of the Kilo Degree Survey](#)
- Sifon et al., 2015, MNRAS, submitted, [The masses of satellites in GAMA galaxy groups from 100 square degrees of KiDS weak lensing data](#)
- Tortora et al., 2015, MNRAS submitted, [Towards a census of super-compact massive galaxies in the Kilo Degree Survey](#)
- Venemans et al., 2015, MNRAS, accepted, [First discoveries of z~6 quasars with the Kilo Degree Survey and VISTA Kilo-Degree Infrared Galaxy survey](#)
- Viola et al., 2015, MNRAS, 452, 3529, [Dark matter halo properties of GAMA galaxy groups from 100 square degrees of KiDS weak lensing data](#)
- Weilbacher P. M., Monreal-Ibero A., Kollatschny W., et al., 2015, arXiv, arXiv:1507.00006, "[A MUSE map of the central Orion Nebula \(M 42\)](#)",

Conference proceedings

- Napolitano et al., 2014, [Strong lens search in the ESO public Survey KiDS](#)
- Radovich et al., 2014, [Searching for galaxy clusters in the VST-KiDS Survey](#)
- Roy et al., 2014, [Early type galaxies and structural parameters from ESO public survey KiDS](#)
- Tortora et al., 2014, [Galaxy evolution within the Kilo-Degree Survey](#)