



## ASTERICS - H2020 - 653477

# Second European data Provider Forum and Training Event

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### Abstract

The Second ASTERICS European Data Provider Forum and Training Event was held in Heidelberg from 26 June to 29 June 2018. It convened 39 persons, joining the Virtual Observatory community with staff from a fair number of data-providing projects of markedly differing sizes, notably including the ASTERICS ESFRI partners. Covering a comprehensive set of topic areas, data providers presented their specific requirements, use cases, and solutions, documenting the success of existing VO technologies, VO developments instigated by ASTERICS WP4, and new challenges to VO use. Conversely, the VO community reached out to the data providers with discussions of new VO standards currently being developed or deployed, especially those corresponding to requirements previously identified within WP4. The afternoon before the main event was dedicated to a tutorial for VO newcomers, while the last day of the meeting was devoted to hands-on consulting sessions with VO experts. The event provided valuable input to all WP4 partners and showcased the advances and benefits of standards-compliant publishing in the wider community of astronomical data providers.

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## II. DELIVERY SLIP

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## IV. APPLICATION AREA

This document is a formal deliverable for the GA of the project, applicable to all members of the ASTERICS project, beneficiaries and third parties, as well as its collaborating projects.

## V. TERMINOLOGY

A&A	Authentication and authorisation (or vice versa)
ADASS	Astronomical Data Analysis Software and Systems conference
ADQL	IVOA Astronomical Data Query Language
AIP	Leibniz-Institut für Astrophysik Potsdam
ANTARES	Astronomy with a Neutrino Telescope and Abyss environmental RESearch project
APC	AstroParticule et Cosmologie
APPLAUSE	Archives of Photographic PLates for Astronomical USE
ARI	Astronomisches Rechen-Institut
ARTEMIX	Alma RemoTE MIning eXperiment
ASTERICS	Astronomy ESFRI & Research Infrastructure Cluster
ASTRON	Astronomisch Onderzoek in Nederland (The Netherlands Institute for Radio Astronomy)
CDS	Centre de Données astronomiques de Strasbourg (Strasbourg astronomical Data Centre)
CLEOPATRA	Connecting Locations of ESFRI Observatories and Partners in Astronomy for Timing and Real-time Alerts
CNRS	Centre National de la Recherche Scientifique
CoSADIE	Collaborative and Sustainable Astronomical Data Infrastructure for Europe
CPPM	Centre de physique des particules de Marseille (Centre for particle physics of Marseille)
CTA	Cherenkov Telescope Array
DADI	Data Access, Discovery and Interoperability (ASTERICS WP4)
DOI	Digital Object Identifier
ECAP	Erlangen Centre for Astroparticle Physics
E-ELT	European Extremely Large Telescope
Eduroam	Education Roaming
EGO	European Gravitational Observatory
ESA	European Space Agency
ESFRI	European Strategy Forum on Research Infrastructures
ESO	European Organization for Astronomical Research in the Southern Hemisphere
EST	European Solar Telescope

Euclid	ESA's Euclid space mission
FP7	7th Framework Programme for Research and Technological Development of the European Union
GA	Grant agreement
GAVO	German Astrophysical Virtual Observatory
H2020	Horizon 2020, (8th) Framework Programme for Research and Innovation of the European Union
HDF5	Hierarchical Data Format (version 5)
HiPS	Hierarchical Progressive Survey
IN2P3	Institut national de physique nucléaire et de physique des particules
INAF	Istituto Nazionale di Astrofisica
INAF-IA2	INAF project for preserving and providing access to the astrophysical data heritage
INAF-OAR	Osservatorio Astronomico di Roma
INAF-OATs	Osservatorio Astronomico di Trieste
INTA	Instituto Nacional de Técnica Aeroespacial (National Institute for Aerospace Technology)
INTA-CSIC	Centro de Astrobiología
IVOA	International Virtual Observatory Alliance
KM3NeT	Cubic Kilometre Neutrino Telescope
LIGO	Laser Interferometer Gravitational-Wave Observatory
LMU	Ludwig-Maximilians-Universität München
LOC	Local organising committee
LOFAR	Low Frequency Array
LUTH	Laboratoire Univers et Theories
OAS	Observatoire Astronomique de Strasbourg (Strasbourg Astronomical Observatory)
ObsCore	IVOA Observation Core components Data Model
OBSPAR	Observatoire de Paris
PDF	Portable Document Format
RDA	Research Data Alliance
RIA	Research and Innovation Actions
SAMP	IVOA Simple Application Messaging Protocol
SKA	Square Kilometre Array
SOC	Scientific and technical organising committee

SSAP	IVOA Simple Spectral Access Protocol
STOA	Script Tracking for Observational Astronomy
SVOCat	A tool to publish tables and catalogues in the VO through a ConeSearch service
TAP	IVOA Table Access Protocol
UEDIN	University of Edinburgh
UHEI	Ruprecht-Karls-Universität Heidelberg
UNISTRA	Université de Strasbourg
VAMDC	Virtual Atomic and Molecular Data Centre
VizieR	CDS' database of astronomical catalogues and large surveys
VO	Virtual observatory, cf. IVOA
VOEvent	IVOA Sky Event Reporting Metadata
VOTable	IVOA data format for tables
W3C	World Wide Web Consortium
WP	Work package
WP4	Work package 4 of ASTERICS, i. e., DADI
ZAH	Zentrum für Astronomie der Universität Heidelberg

A complete project glossary is provided at the following page:

<http://www.asterics2020.eu/glossary/>

## VI. PROJECT SUMMARY

ASTERICS (Astronomy ESFRI & Research Infrastructure Cluster) aims to address the cross-cutting synergies and common challenges shared by the various Astronomy ESFRI facilities (SKA, CTA, KM3Net & ELT). It brings together for the first time, the astronomy, astrophysics and particle astrophysics communities, in addition to other related research infrastructures.

The major objectives of ASTERICS are to support and accelerate the implementation of the ESFRI telescopes, to enhance their performance beyond the current state-of-the-art, and to see them interoperate as an integrated, multi-wavelength and multi-messenger facility. An important focal point is the management, processing and scientific exploitation of the huge datasets the ESFRI facilities will generate. ASTERICS will seek solutions to these problems outside of the traditional channels by directly engaging and collaborating with industry and

specialised SMEs. The various ESFRI pathfinders and precursors will present the perfect proving ground for new methodologies and prototype systems.

In addition, ASTERICS will enable astronomers from across the member states to have broad access to the reduced data products of the ESFRI telescopes via a seamless interface to the Virtual Observatory framework. This will massively increase the scientific impact of the telescopes, and greatly encourage use (and re-use) of the data in new and novel ways, typically not foreseen in the original proposals. By demonstrating cross-facility synchronicity, and by harmonising various policy aspects, ASTERICS will realise a distributed and interoperable approach that ushers in a new multi-messenger era for astronomy.

Through an active dissemination programme, including direct engagement with all relevant stakeholders, and via the development of citizen scientist mass participation experiments, ASTERICS has the ambition to be a flagship for the scientific, industrial and societal impact ESFRI projects can deliver.

## VII. EXECUTIVE SUMMARY

In Task 4.1 of the ASTERICS Data Access, Discovery and Interoperability (DADI) Work Package, the ASTERICS project has committed itself to maintaining close contact between the partners from the Virtual Observatory and its ESFRI partners, but also between the project and the wider European community of astronomical data providers. Acknowledging that intra-project communications has different characteristics from outreach and discussion with the wider community, DADI organised both Forum and Training events geared specifically at the ESFRI partners (those were held in Trieste in December 2015, D4.3, and December 2017, D4.10, respectively) as well as events addressing both the ESFRIs and the wider community. The event reported here is the second of the latter type after the first in Heidelberg in June 2016 (D4.6), concluding this series within ASTERICS.

Refining the concept and implementation of the first of these events two years before, the workshop assembled technical and scientific staff from 20 institutions and 7 countries for three and a half days of intense exchange on challenges and solutions in astronomical data publishing. Data providers of all sizes were present, notably representatives from the data-handling tasks of the ESFRI WP4 partners, and the associated partner ESO.

Major fields of the oral contributions, running for the two full days that constituted the Data Provider Forum, included:

- Progressive adoption of VO standards by data providers, in particular regarding how standards simplify common tasks (“success stories”)
- Development of VO standards from requirements, especially those identified within ASTERICS WP4. This made for a multi-way exchange, with participants rooted in the VO community presenting current developments, data providers defining missing or

non-matching aspects of the VO infrastructure, and last but not least data providers themselves beginning to engage in the VO community

- New solutions to data publishing tasks, presenting specific techniques with respect to their field of applicability and their limitations.

As a bonus to two days of forum, an afternoon of introduction to key VO concepts for newcomers was held on the day before, and a full day of hands-on consulting with VO specialists was held on the day after – both drawing on concepts developed for previous events organised by ASTERICS WP4. Although these days were frequented by only a relatively small proportion of the overall number of participants, we consider them a success, because in this way real-world show-stoppers for VO adoption have been removed.

Once more, this workshop provided a platform for open communication channels between staff specialising in VO development and staff from data centres of all sizes. In this way, it was also a special occasion for those smaller data centres that usually have no means of participating in the regular interoperability meetings of the IVOA. It is of note that much of these exchanges took place not just in the plenary talks and discussions, but very much also in small impromptu discussions during breaks, the working dinner, and during the introductory and hands-on days, respectively. The event raised awareness for existing technologies and best practices, and it also exposed and induced synergies between very different participating institutions, thereby fostering operations and interoperability of the data providers' services.

Overall, the event showcased the significant progress that was made during the first three years of ASTERICS WP4 in furthering the goals of the ESFRI partners by integrating their data dissemination procedures into the data access, discovery, and interoperability frameworks of the Virtual Observatory as developed under the auspices of the IVOA. There are good reasons to believe that these processes initiated by WP4 will continue to yield results well after the end of the ASTERICS project.

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## 1. Introduction

The overall goal of the ASTERICS work package 4 (DADI) is making the data of the ESFRI projects and their pathfinders available to the astronomical community in the Virtual Observatory framework. However, the actual institutions and people providing data curation, formatting, and publication services effectively share many of their challenges with other astronomical data providers. Thus, in addition to the DADI “Technology Forums” with their focus on the VO framework, standards and tools, and to the “ESFRI Forum & Training Events” with a focus on networking the ESFRI and VO partners of DADI, two “European Data Provider Forum & Training Events” were held within the runtime of the project, joining ESFRI and other players with a special view on data publication activities.

The second of these meetings was held from 26 June to 29 June 2018 in Heidelberg and organised by DADI partner UHEI, who already ran the first one (ASTERICS deliverable D4.6) and a partially similar event in June 2013 in the context of the CoSADIE FP7 project. The date of the event was initially foreseen to be in November 2018 in the Grant Agreement, but taking into account the density of other meetings that potential participants had to attend after the summer break up to the end of the year, it was decided to re-schedule it in June in order to minimise conflicts, following the model of the first meeting in 2016.

Within the context of DADI Task 4.1, this deliverable D4.13, the “Second European Data Provider Forum & Training Event”, covers its “networking and training” and the “gathering ESFRI project requirements and feedback” objectives, expanding them to the wider European astronomical data provider community. INAF-OATs and UHEI, the partners leading Task 4.1, are working to identify these requirements as input to Task 4.3 and are contributing to DADI efforts to give technical support to the ESFRI partners. These and the associated networking activities seamlessly lead to the remaining objective of Task 4.1, namely “direct support to implementation of ESFRI facility data in the VO framework”, examples being the publication of ANTARES (KM3NeT pathfinder) neutrino observation data in the VO by UHEI or the usage of VO Tools by the gravitational wave community.

In coordination with the WP4 lead, a scientific and technical organising committee was established for overseeing this event, including representatives of all DADI partners. The organising committee was involved in the dissemination and program planning activities from the very beginning.

The event was open to all European data providers, big and small. The call for contributions in the official announcement e-mail<sup>1</sup> solicited contributions in any relevant area of on-line astronomical data publication and services, especially for:

- current challenges and case studies in data publication;
- publication tools, libraries, and techniques;
- developments to facilitate data exploitation by astronomers;
- use and adoption of Virtual Observatory standards.

Furthermore, the concluding discussion of the “First European Data Provider Forum & Training Event” in 2016 identified that some participants needed a general introduction into the Virtual Observatory ecosystem, resulting in a well-attended “newcomer afternoon” being held at the “Second ESFRI Forum and Training Event” (ASTERICS deliverable D4.10) in Trieste in December 2017. Given only a limited expected overlap of attendees of that event and the one reported here, an “Introductory course on the Virtual Observatory” was offered again on the afternoon

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<sup>1</sup> <http://www.g-vo.org/edp-forum-2018/announcement.txt>

before the main meeting. Also, drawing on the experiences with the additional hands-on training day staged at the first incarnation of the event in 2016, it was decided to again organise such a day. However, the setup was changed to offer rather task-oriented consulting sessions on data publication, in contrast to the tool-oriented sessions of 2016.

Section 2 of this document describes the activities undertaken in advance of the meeting. Section 3 details participation in the event, while Section 4 reports on the Data Provider Forum, the two main days of oral contributions, with a special view to their results as highlighted in the daily concluding discussions. The introductory afternoon and the training day are described in Sections 5 and 6, respectively. Conclusions and analysis are presented in Section 7. Finally, Section 8 lists the following ASTERICS WP4 steps. The event website with all relevant information will remain available as <http://www.g-vo.org/edp-forum-2018> and is linked from the DADI wiki page.

## 2. Planning, organisation and preparation

### 2.1. Organising committees

The organisation of the event was distributed between an organising committee (SOC) and a local organising committee (LOC). The SOC was composed of one representative from each ESFRI and from each VO partner of DADI, namely:

- Mark Allen, CNRS/OAS
- Catherine Boisson, CNRS/LUTH for CTA
- Eric Chassande-Mottin, CNRS/APC for EGO
- Ilaria Ermolli, INAF-OAR for EST
- Vladimir Kulikovskiy, CNRS/CPPM for KM3NeT
- Marco Molinaro, INAF
- Dave Morris, UEDIN
- Roberto Pizzo, ASTRON for SKA
- Carlos Rodrigo, INTA
- Martino Romaniello, ESO
- Joachim Wambsganz, UHEI

It is important to note that EST, which had sent participants to the first event, was invited to have a representative in the SOC (like they had been already for the SOC of the 2017 Trieste ESFRI Forum and Training Event).

The LOC was staffed by Markus Nullmeier, Margarida Castro Neves, Eleonora Grauer, and Hendrik Heinl.

The SOC was especially involved in giving input to the text of the official announcement, in its dissemination, and in planning and approving of the programme. In addition to e-mail

communication, two SOC conference calls were held on the 20 February 2018 and 22 May 2018, respectively. Also, another conference call to coordinate with the tutors of the training day was held on 8 June 2018. The fields of activity allocated to the LOC were the meeting website, the venue, some e-mail dissemination, registration issues, and related tasks.

## 2.2. Dissemination of the announcement

The announcement of the event was first sent out via e-mail on the 10 April 2018 to DADI ESFRI and VO partners, as well as to the associated partner ESO and to ESA, and to a list of a few hundred people of the European astronomical community, comprising staff from data providers (including potentially future ones) and individuals that have been known to be involved in VO activities in the past. The announcement was also sent to various international, national and local lists and to various individual contacts related to the SOC. Finally, the event was publicised on several web sites, including the main ASTERICS web site.

The website <http://www.g-vo.org/edp-forum-2018> was set up to communicate all useful information related to the event, and it was progressively updated, especially with programme content. It also provided an on-line registration system that allowed the participants to enter post-registration changes, including those for dietary choices.

During the event, the speakers were encouraged to upload PDF files of their slides directly to the website, which featured that functionality. In this way, the slides were available to all participants as soon as possible, and the effort spent on collecting the slides was considerably reduced for both the speakers and the organisers. Another benefit was that the slide-presenting computer had to be changed only if it was to display live elements of a presentation.

Figure 1: Poster shipped to WP4 partners for dissemination of the event



### 2.3. Venues

The main venue of the Second European Data Provider Forum and Training Event, located on the main science campus, was provided by the [facilities](#) of the “[Marsilius-Kolleg](#)”, a specialised institution of the University of Heidelberg that works towards fostering diverse approaches to interdisciplinary research. Having proved its suitability for the first of these events in 2016, the central two days were held there, with on-site lunch catering being handled by an external provider. Network connectivity was assured via [Eduroam](#), individual Wi-Fi conference accounts, and wired connections.

The introductory afternoon before the main event and the hands-on consulting session on data publication on the day after took place in seminar rooms and offices of the “[Astronomisches Rechen-Institut](#)” (ARI), which is part of the Centre for Astronomy of the University of Heidelberg (ZAH, “Zentrum für Astronomie der Universität Heidelberg”), with locally provided coffee breaks and lunch at a nearby university cafeteria.

**Figure 2: Conference room of the plenary session**



**Figure 3: Seminar room during the consulting day**

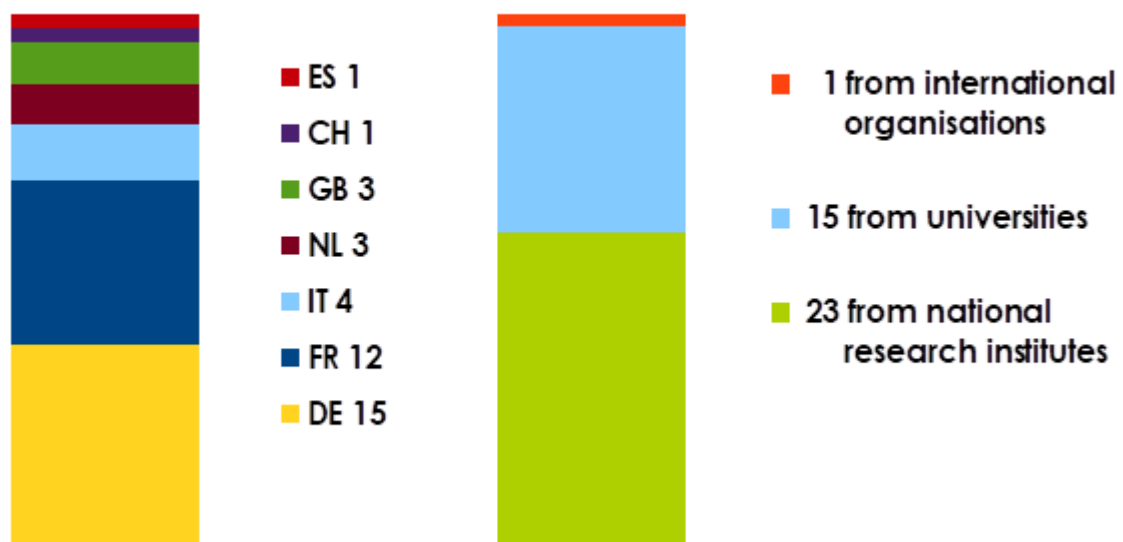


### 3. Participants

The forum was attended by 39 participants. All DADI partners CNRS/OAS, CNRS/LUTH, CNRS/APC, CNRS/CPPM, INAF, INTA, UEDIN, UHEI, and ASTRON, as well as the third parties UNISTRA and OBSPAR, were represented, complemented by representation of the associated partner ESO and the new ASTERICS member EST.

Nine participants were affiliated to seven further institutions, making for a total of 20 participating institutions. Thus, the goal of reaching out to and interacting with European data providers outside of DADI and its ESFRI partners has been achieved. Only two of these seven further institutions had been already present in the first event in 2016, with the new institutions mostly being smaller data providers in astronomy. Figure 4 provides an overview of the types of institutions that sent participants, including their institutional affiliation. The geographic and institutional diversity shown is very similar to those of the First DADI European Data Provider Forum & Training Event in 2016.

**Figure 4: Countries and types of participants' workplaces**



## 4. The Data Provider Forum

The call for contributions resulted in a wide range of contribution submissions covering all of the areas of interest that were highlighted by the call. From these, the organising committee approved a programme of 26 oral contributions that was complemented by concluding plenary discussions at the end of the two days. In addition to the introductory talk which provided a status report about Work Package 4 as a whole, the breath of the topic covered during the Forum can be characterised as follows:

- progress reports from the ESFRI WP4 partners;
- reports from WP4 VO partners, including the status of requirement implementation;
- developments in other European data providers in astronomy;
- publishing tools for data providers;
- handling of provenance data;
- specialised topics such as DOIs, observation alerts, and spectral data.

### 4.1. Virtual Observatory adoption by data providers

A cross-cutting feature of essentially all presentations was the progress in making use of virtual observatory features for data-providing infrastructures. Next to the “classic” use of VO standards and tools, namely, remote data discovery and access, several parties, such as CTA and ESO, also employ VO components within their on-line and off-line data management or their data processing pipelines.

All projects discussed in the oral presentations, both ESFRI and otherwise, universally work on implementing VO standards in order to provide VO-enabled services and tools. In order to make this work, they frequently use pre-existing libraries and tools of the VO ecosystem. There is also a general trend to open up legacy data assets by progressively interfacing those with the VO. The list of VO standards that is actually being implemented is quite extensive, encompassing the whole breadth of the IVOA architecture, including work-in-progress documents. In addition, it became apparent that more and more projects and institutions – those that are not primarily specialising on the Virtual Observatory as such – are themselves becoming actors within the VO community, in contrast to being mere users. This was one of DADI key objectives for the participation of the ESFRI projects in the Work Package.

### 4.2. Overarching key themes

A recurring theme of most oral contributions were the various data models that are being used to serve science data and metadata via VO protocols. A lot of these showed cross-disciplinary relevance within the palette of multi-messenger astronomy that was represented at the meeting, i. e., radio, optical, astroparticles, and gravitational wave. There was an especially broad interest in data cubes, including spectra, spectral properties (VAMDC), time domain, and provenance. For the latter, it became evident that it is important to conceptualise provenance modelling in lock-step with the development of actual data-processing pipelines.

Secondly, the importance of enabling users of present and future archives to maximise their data exploitation was brought up. This includes providing concrete help to users with means such as help desks or community forums (such as the one run by ESO). It became clear that there is a need for providing users with templates for advanced data exploration methods, and also to improve still further the interoperability of data exploration tools.

Finally, there were intensive exchanges about several data centre management aspects, in particular about authentication and authorisation (used by several attending data providers), including federated identity management. Ideas were exchanged about the nascent field of running analytical processing within the data-providing data centres themselves. The discussion started in 2016 on how to properly integrate DOIs (digital object identifiers) into the VO framework continued. It was decided to continue it at the global level during the November 2018 IVOA Interoperability meeting.

### 4.3. VO Implementation and evolution, requirements

Next to reports on and discussions about the current IVOA implementation and standardisation activities for data cubes, time series, and provenance, all of which being especially relevant to ASTERICS WP4 as mentioned above, the case to include visibility information and field-of-view into the VO was made – potentially as extensions to the IVOA ObsCore standard. Furthermore, there is a long-term need for an interoperable format encoding deeply structured data sets, of the kind often processed with the HDF5 library.

Regarding the actual data publication process, the question of how to best inform potential users about the various existing respective toolkits for guided data curation and VO service hosting and dissemination was found to be not yet sufficiently answered, the existing IVOA tool overview page notwithstanding. In parallel, large data centres offer services such as CDS Vizier with this aim.

The question of attributing DOIs to data sets, with a view on having an exchange on current practices, was referred to the IVOA Data Curation & Preservation Interest Group, to be dealt with at the following IVOA interoperability meeting.

The participants were once again encouraged to provide feedback from VO implementation. One issue raised on the spot dealt with the questions of linking a bespoke VO deployment in a large data centre to the global VO registry – it was directly routed to a relevant expert during the consulting sessions on data publication that were held on the following day.

**Figure 5: Group photo**



## 5. The introductory afternoon “IVOA for Newcomers”

On the afternoon before the main event, an introductory session on the Virtual Observatory was held with the aim of giving a gentle introduction into the broad landscape of the various IVOA protocols and related standards, which would be referred to during the Forum.

Drawing on the experience of the first course of this kind at the “Second ESFRI Forum & Training Event” (D4.10) in Trieste in December 2017, the session targeted participants not yet familiar with the interworking of the VO standards and their level of applicability. A comprehensive use case served to introduce several standards and protocols. In particular, the protocols TAP, SAMP and SSAP were covered, in addition to the VO-table, ADQL, UCD, and Registry standards. This included references to the relevant IVOA working groups. The procedures through which IVOA standards actually come into being were also explained, with the aim of encouraging the audience to take part in VO discussions and standardisation activities.

Finally, the concrete mechanics of the Virtual Observatory framework were actively discussed on the basis of actual use cases from the participants themselves. The session, being attended by five technicians, was very well received as a whole. The experience gained by the tutors led afterwards to a written introductory VO standard tutorial that was accepted for presentation at the 2018 ADASS conference.

## 6. Consulting sessions on data publication

In line with the advanced stage of the ASTERICS project, the hands-on day after the main meeting was geared towards helping technicians to perform defined data publication tasks. For this, several seasoned VO experts were attending. They were matched, beforehand, to those participants who registered for this extra day by an extra field in the meeting registration form which asked for their publication issues at hand. In addition, for the more novice participants who needed to understand how a basic real-world VO service implementation works internally, one of the VO experts devised and held a newly-created tutorial session entitled “Development of a VO Simple ConeSearch service from scratch”.

Participation in the consulting day was optional, with registration offered via the event on-line registration form. In addition to the 6 VO consultants, all of which also participated in the main event, 9 participants from 6 different institutions attended that day. This level of attendance was similar to one of the first event two years before. Pre-matched one-on-one or one-on-two sessions of participants and experts were held in the morning, with a plenary setup in the afternoon, where everybody freely associated into small workgroups tackling various questions. cursory feedback from the participants revealed that several concrete stumbling blocks to VO implementation at the participant’s institutions were lifted thanks to this last day of the event.

**Figure 6: Consulting day group photo**

## 7. Conclusions and analysis

Overall, the meeting highlighted many challenges common to the participants that were coming from a wide spectrum of astronomy and astroparticle physics data providers, thus matching the core target of ASTERICS WP4. Consequently, the potential for not reinventing the wheel was exposed, with potential synergies between the ESFRI partners CTA and KM3Net being conspicuous. There were also interesting insights on the on-going progression from the pathfinder “experiments” to the ESFRI observatories: science data, including event alerts, are opening up towards public availability, which constitutes a cultural evolution for some communities.

The programme provided a good overview of how research infrastructures can make use of the Virtual Observatory, and of the impact of WP4. A key aspect for making this success permanent is the continuing future participation of these players as actors in their own right within the VO community – a process that is presently beginning for some of them and is already well advanced for others, another important impact of WP4.

The usefulness of including the whole spectrum of astronomical data providers as a complement to the large ESFRI and ESFRI-like partners was once again apparent. The benefits from the synergies between these different projects revealed to go both ways – from large to small institutions and vice versa. Notably, this time several smaller data providers participated that

were not yet present in 2016, whereas some of those present then could not join a second time, resulting in a wider overall impact.

Putting the Second ASTERICS European Data Provider Forum and Training Event into the perspective of research data processing in general, a number of topics came up that are shared with other disciplines. One example is the steady de facto standardisation of the Python programming language ecosystem for doing data analysis, another is the need for efficient and reliable software sharing frameworks. Of special mention here are the pertinent cross-disciplinary RDA recommendations.

**Figure 7: Impression of an oral contribution**



**Figures 8 and 9: Discussions during the main event and the consulting day**



## 8. Next steps

ASTERICS WP4 events following the one reported here were, firstly, the Strasbourg Time Series Data Model meeting<sup>2</sup>, from 17 to 20 July 2018 in Strasbourg, France, then, the 12th RDA Plenary Meeting<sup>3</sup>, as part of the International Data Week, which took place 5-8 November 2018 in Gaborone, Botswana. After came the IVOA Interoperability meeting<sup>4</sup> in College Park, Maryland, USA, from 8 to 10 November, directly before the ADASS XXVIII Conference<sup>5</sup> from 11 to 15 November 2018, both with significant contributions from WP4 partners and follow-up work from this Second ASTERICS European Data Provider Forum and Training Event.

The subsequent DADI deliverable is the fourth ASTERICS European School<sup>6</sup>, which took place from 20 to 22 November 2018 in Strasbourg, France (D4.12). The last WP4 meeting, the fifth ASTERICS DADI Technology Forum (D4.14), will take place at the same venue in February 2019.

In addition, there are strong incentives to organise one or more focused meetings on specific subjects within the WP4 context. During the meeting reported here, a definite case was made for an authentication and authorisation event, where the means of how to make these features work in the VO context would be discussed. Also, a meeting for EST as the new WP4 partner appears to be in order – as one means to explore the ways the EST project will be able to make use of the VO. For this, the way the planetary sciences are participating in the VO community to cater for their specific needs may be a possible model. Thus, participation from VO specialists from the Europlanet 2020 Research Infrastructure will be sought.

With only a few months of the project duration of ASTERICS left, it is expected that the following priorities that are linked to the high-level goals of WP4 will receive special efforts:

- the proposed IVOA recommendation of the provenance data model;
- the time domain data model;
- supporting CTA / KM3Net synergies.

2 [http://wiki.ivoa.net/twiki/bin/view/IVOA/IvoaVOEvent#Strasbourg\\_2018\\_Meeting](http://wiki.ivoa.net/twiki/bin/view/IVOA/IvoaVOEvent#Strasbourg_2018_Meeting)

3 <https://www.rd-alliance.org/plenaries/rdas-12th-plenary-meeting-part-international-data-week-2018-gaborone-botswana>

4 <http://wiki.ivoa.net/twiki/bin/view/IVOA/InterOpNov2018MeetingPage>

5 <http://adass2018.umd.edu>

6 <https://www.asterics2020.eu/dokuwiki/doku.php?id=open:wp4:school4>

## ANNEX: Forum schedule with links to slides

See the on-line version of the programme at <http://www.g-vo.org/edp-forum-2018/programme.html> for abstracts.

27 June 2018	
09:00 – 09:30	Registration and get-together with coffee and snacks
09:30 – 10:00	Opening and welcome Joachim Wambsganß (ZAH / ARI, Uni Heidelberg) Short self-introduction of all participants
10:00 – 12:10	Plenary session, chair: Markus Nullmeier
10:00	Françoise Genova (CDS Observatoire Astronomique de Strasbourg) <a href="#">ASTERICS DADI status</a>
10:25	Kay Graf (ECAP - University of Erlangen): <a href="#">KM3NeT data management and open access data</a>
10:45	Agata Trovato (CNRS - APC, Paris): <a href="#">LIGO / Virgo open science</a>
11:05	Alberto Micol (ESO): <a href="#">Publishing astronomical data: an ESO perspective</a>
11:25	Catherine Boisson (LUTH — Observatoire de Paris): <a href="#">Provenance and data access in the context of Cherenkov astronomy</a>
11:50	Morten Franz (Kiepenheuer-Institut für Sonnenphysik): <a href="#">Towards the data centre for the European Solar Telescope (EST)</a>
12:10 – 13:10	Lunch
13:10 – 14:55	Plenary session, chair: Catherine Boisson
13:10	Harry Enke (Leibniz-Institut für Astrophysik (AIP)): <a href="#">Usage of DOI by astronomy data providers</a>
13:30	Carlo Maria Zwölf (Observatoire de Paris): <a href="#">Recent outcomes of the Virtual Atomic and Molecular Data Center (VAMDC) in data publication, interoperability and standards</a>

13:55	Yaye Awa Ba (Observatoire de Paris): <a href="#">News of the Spectool tool</a>
14:15	Carlos Rodrigo (Centro de Astrobiología, INTA-CSIC): <a href="#">Easy Virtual Observatory publishing of catalogues with SVOCat</a>
14:35	Harry Enke, in lieu of Anastasia Galkin (Leibniz Institute for Astrophysics Potsdam (AIP)): <a href="#">Daiquiri — an IVOA-ready solution for medium-sized data providers</a>
14:55 – 15:25	Coffee break
15:25 – 16:05	Plenary session, chair: Dave Morris
15:25	Pierre Fernique (CDS Observatoire Astronomique de Strasbourg): <a href="#">Do HiPS yourself!</a>
15:45	Christian Dersch (Philipps-Universität Marburg): <a href="#">The benefits for astronomical software from integration into a Linux distribution: The case of Fedora Astronomy</a>
16:05 – 17:00	Concluding discussion of the day's results Chair: Marco Molinaro
19:30	Conference dinner
<b>28 June 2018</b>	
09:00 – 10:30	Plenary session, chair: Alberto Micol
09:00	Marco Giardino (Agenzia Spaziale Italiana): <a href="#">VO activities at the ASI Space Science Data Center</a>
09:20	Nicola Fulvio Calabria (INAF — Osservatorio Astronomico di Trieste): <a href="#">The IA2 Data Center</a>
09:40	Adriaan Renting (ASTRON): <a href="#">LOFAR data formats and the Virtual Observatory</a>
10:10	Marco Iacobelli (ASTRON): <a href="#">The ASTRON data portal: enabling access and exploitation of radio data collections through the VO</a>
10:30 – 11:00	Coffee break
11:00 – 12:40	Plenary session, chair: Agata Trovato

11:00	Volodymyr Savchenko (University of Geneva): <a href="#">The Astrophysical Online Analysis System, powered by a provenance data model</a> <a href="#">Application to a "live" data archive and real-time analytics of multi-messenger transients</a>
11:20	Martin Kuemmel (LMU-Munich, Faculty of Physics): <a href="#">Euclid data processing</a>
11:40	Yaye Awa Ba (Observatoire de Paris): <a href="#">ARTEMIX - Alma RemoTE MIning eXperiment</a>
12:00	Peter Hague (University of Cambridge): <a href="#">Workflows and data with STOA</a>
12:20 – 13:20	Lunch
13:20 – 14:40	Plenary session, chair: Dave Morris
13:20	13:20 Massimiliano Lincetto (CNRS/IN2P3, CPPM, Marseille): <a href="#">KM3NeT core-collapse supernova and high energy neutrino alerts</a>
13:40	Mireille Louys (CDS Observatoire Astronomique de Strasbourg): <a href="#">The provenance of data products: IVOA and W3C modelling efforts</a>
14:00	Harry Enke, in lieu of Anastasia Galkin (Leibniz Institute for Astrophysics Potsdam (AIP)): <a href="#">Provenance from the data provider view - constructing provenance information for the APPLAUSE</a>
14:20	Markus Nullmeier (GAVO / Uni Heidelberg): <a href="#">Effective searching in provenance graphs with custom ADQL functions</a>
14:40 – 15:10	Coffee break
15:10 – 15:30	Plenary session, chair: Markus Nullmeier
15:10	François Bonnarel (CDS Observatoire Astronomique de Strasbourg): <a href="#">Description, discovery, and access of multi-dimensional data and time series in the VO</a>
15:30 - 16:30	<a href="#">Concluding discussion of the meeting's results</a> Chair: Françoise Genova
16:30 – 16:40	Conclusion and final remarks (Markus Nullmeier)