



## ASTERICS - H2020 - 653477

# Fifth ASTERICS DADI Technology Forum

### ASTERICS GA DELIVERABLE: D4.14

Document identifier:	ASTERICS-D4.14.doc
Date:	29 April 2019
Work Package:	<b>WP4: Data Access, Discovery and Interoperability (DADI)</b>
Lead Partner:	<b>CNRS</b>
Document Status:	<b>Final</b>
Dissemination level:	<b>Public</b>
Document Link:	<a href="http://www.asterics2020.eu/documents/ASTERICS-D4.14.pdf">www.asterics2020.eu/documents/ASTERICS-D4.14.pdf</a>

### Abstract

The Fifth ASTERICS DADI Technology Forum was held in Strasbourg, France, 26-28 February 2019. As usual, the goals of the forum were to share information on technical activities between partners and to prepare for the May 2019 IVOA Interoperability Meeting, which will be held after the end of the ASTERICS project but in which ASTERICS results will be presented. The forum began with a review of ASTERICS DADI and was followed by sessions with contributed presentations, including sessions on DADI priorities, namely the time domain and provenance, plus feedback from implementation of the multi-dimensional standards, with also an overview of the IVOA activities in the domain of Data Models, a presentation by the European Solar Telescope, which recently joined ASTERICS, and one of modular access to datasets through VO standards. The detailed discussions and the hack-a-thon sessions fulfilled the role of the forum as a working meeting. The hack-a-thon sessions allowed the participants to get into detailed discussions on topics of common interest. Co-located events were organised to discuss the usage of the Virtual Observatory for Solar data with the new EST partner, on the one hand, and radio interferometric data, in the framework of the launch of the ESCAPE project, on the other hand. ASTERICS partners also held a meeting on the Multi-Messenger Platform. This Forum was the last event organised by ASTERICS WP4. It was concluded by a historical presentation of the series of Euro-VO Technology Forums and by an overview of DADI activities, impact and legacy.

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## II. DELIVERY SLIP

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## III. DOCUMENT LOG

Issue	Date	Comment	Author/Partner
1	23 April 2019	V0.1 shared with the co-authors	F. Genova (CNRS/CDS), M. (CNRS/CDS), K. Noddle (UEDIN)
2	24 April 2019	Final version	F. Genova (CNRS/CDS), M. (CNRS/CDS), K. Noddle (UEDIN)

## 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

ADASS: Astronomical Data Analysis Software and Systems

ADQL: Astronomical Data Query Language

AIDA: Astronomical Infrastructure for Data Access

ASTERICS: Astronomy ESFRI & Research Infrastructure Cluster

Astroquery: Set of tools for querying astronomical web forms and databases (Python)

CDS: Centre de Données astronomiques de Strasbourg

CEVO: Connecting ESFRI projects to EOSC through the Virtual Observatory framework (ESCAPE WP4)

CNRS: Centre National de la Recherche Scientifique

CoSADIE: Collaborative and Sustainable Astronomical Data Infrastructure for Europe

CTA: Cherenkov Telescope Array

DADI: Data Access, Discovery and Interoperability (ASTERICS Work Package 4)

ELT: Extremely Large Telescope (was E-ELT)

EPNTAP: Europlanet Table Access Protocol

ESAP: ESFRI Science Analysis Platform (ESCAPE WP5)

ESCAPE: European Science Cluster of Astronomy & Particle physics ESFRI research infrastructures

ESFRI: European Strategy Forum on Research Infrastructures

EST: European Solar Telescope

Euro-VO: European Virtual Observatory

FP: Framework Programme

GAPS: Global Architecture of Planetary Systems

HiPS: Hierarchical Progressive Survey

ICE: International Cooperation Empowerment

INAF: Istituto Nazionale di Astrofisica

IVOA: International Virtual Observatory Alliance

KIS: Leibnitz-Institut für SonnenPhysik

KM3NeT: A multi-km<sup>3</sup> sized Neutrino Telescope

MOC: Multi-Order Coverage

OBELICS: OBservatory E-environments Linked by common ChallengeS (ASTERICS Work Package 3)

ObsCore: Observational Core Data Model

PostgreSQL: Postgres « after Ingres » SQL (relational database management system)

ProvTAP: Serialization of the Provenance data model with TAP

RDA: Research Data Alliance

SKA: Square Kilometre Array

SME: Small Medium Enterprise

SQL: Structured Query Language

T-MOC: Time Domain Multi-Order Coverage

TAP: Table Access Protocol

TOPCAT: Tool for Operations on Catalogues and Tables

TIMESYS: simple means to furnish time in VOTables with the necessary metadata

UEDIN: University of Edinburgh

UHEI: Ruprecht-Karls-Universität Heidelberg

UMR: Unité Mixte de Recherche

VizieR: Database of astronomical catalogues, published tables and other data

VO: Virtual Observatory

VO-DML: VO Data Modelling Language

VO-TECH: The European Virtual Observatory – VO Technology Centre

VOTable: IVOA data format for tables

WP: Work package

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

The Firth ASTERICS DADI Technology Forum, like its predecessors, was highly productive event, which enabled in-depth technical discussion of many developments performed by the DADI teams. The meeting was organised with the well-established structure of formal presentations complemented by informal working ‘hack-a-thon’ discussions, which as usual was effective for exchange of information, enabling lively discussion. The meeting allowed us to establish DADI results and legacy, which have been presented at the ASTERICS Final Event, The New Era of Multi-messenger Astrophysics conference, which was held in Groningen 25-29 March 2019. The discussions also prepared ASTERICS team participation in the May 2019 IVOA meeting, which will be held in Paris after the end of the project, and will also be used by the WP4 of the ESCAPE Cluster, CEVO – Connecting ESFRI projects to the EOSC through the Virtual Observatory, which includes a task on FAIRisation of ESFRI data.

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# 1. Introduction

The European Virtual Observatory initiative began to organise regular “Technology Forums” during the VO-TECH Design Study (2005-2009). VO-TECH was led by the University of Edinburgh (UEDIN). These meetings gathered the European teams involved in the development of the VO framework of standards and tools to disseminate information about technological activities and expertise, to build collaborations, to discuss future activities and to coordinate European participation in biannual International Virtual Observatory Alliance (IVOA) “Interoperability” meetings. The astronomical Virtual Observatory is an international endeavour, and the IVOA leads the development of the interoperability standards, in which European teams have been playing a key role since the beginning.

The usefulness of these meetings was immediately obvious, and they were continued by all of the follow-up projects funded by the European Commission in the e-Infrastructure framework during FP7: the Integrated Infrastructure Initiative Euro-VO Astronomical Infrastructure for Data Access (EuroVO-AIDA, 2008-2010), as well as the two small Coordination Actions on which the coordination of European VO activities relied from 2010 to 2015: Euro-VO International Coordination Empowerment (EuroVO-ICE, 2010-2012) and Collaborative and Sustainable Astronomical Data Infrastructure for Europe (CoSADIE, 2012- 2015).

Coordination of technological activities has been identified as one of the three pillars of the European Virtual Observatory<sup>1</sup>, together with the support given to data providers to publish their data in the VO, and to astronomers in their usage of the VO. It was clear, when the *Data Access, Discovery and Interoperability* Work Package was set up for the ASTERICS proposal, that regular gatherings of the technical teams in the work package would be necessary. The Forums are thus part of ASTERICS WP4 Task 4.3 “Update of the VO framework from feedback and requirements”, co-led by UEDIN and CNRS/UMR7550-CDS.

The history of Euro-VO Technology Forums was explained during one of the final talks presented during this meeting, “Tech Forums Retrospective” (K. Noddle).

ASTERICS Deliverable 4.14 “Fifth ASTERICS DADI Technology Forum”, organised by CNRS/CDS in Strasbourg on 26-28 February 2019, was the 13<sup>th</sup> event organised by ASTERICS WP4 (these events also include Schools, “ESFRI Forum and Training Events” and “European Data Provider Forum and Training Event”). The ASTERICS Technology Forum series is shown in Table 1. The first one was organised a few months after the beginning of the project, and was used as DADI kick-off, to start discussion and collaboration between VO and ESFRI teams engaged in the

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<sup>1</sup> Genova, F., Allen, M.G., Arviset, C., Lawrence, A., Pasian, F., Solano, E., Wambsganss, J. : Euro-VO – Coordination of virtual observatory activities in Europe, [Astronomy & Computing, Vol. 11, pp. 181-189, 2015](#), [ArXiv 1506.06567](#)



work package. The second, organised 6 months later to continue to build the work package momentum, was more centred on Technology Forum proper aims, discussing technological work and collaboration and preparing European contribution to the following IVOA meeting. The next ones, third and fourth, were organised with the same aim on a yearly basis. This last one was the final event organised by DADI.

D4.1	First ASTERICS DADI Technology Forum	Strasbourg, 17 & 18 September 2015
D4.4	Second ASTERICS DADI Technology Forum	Edinburgh, 7 & 8 March 2016
D4.7	Third ASTERICS DADI Technology Forum	Strasbourg, 22 & 23 March 2017
D4.11	Fourth ASTERICS DADI Technology Forum	Edinburgh, 16 & 17 April 2018
D4.14	Fifth ASTERICS DADI Technology Forum	Strasbourg, 26-28 February 2019

**Table 1 : ASTERICS DADI Technology Forums**

The option to set up a six-monthly schedule was discussed at project mid-term, but it was decided to retain the yearly events until the end of the project and to continue to organise focused meetings on specific topics when appropriate. The relevant specific meetings organised since the Fourth DADI Technology Forum are listed in Table 2.

1	Strasbourg Time Series Data Model Meeting	Strasbourg, 17-20 July 2018
2	Provenance Days	Paris, 29-30 August 2018
3	Exo-Planetary Data Model Meeting	Padova, 20-21 September 2018
4	DADI/OBELICS A&A face-to-face meeting	Trieste, 29-30 January 2019

**Table 2: DADI specific meetings relevant to technological activities held between the Fourth and Fifth Technology Forums**

Participation in the Fifth Technology Forum is described in Section 2 of this document. The meeting programme was organised to disseminate relevant information, in addition to technical discussions. This programme is presented in Section 3, and a record of the event is provided on the Wiki at:

<https://www.asterics2020.eu/dokuwiki/doku.php?id=open:wp4:wp4techforum5> (Figure 1)

The proceedings and results are analysed in Section 4. The conclusions and next steps are given in Section 5. The meeting photograph is shown in the Annex.

The screenshot shows a web browser window displaying the ASTERICS Wiki page for the DADI Technology Forum 5. The browser's address bar shows the URL <https://www.asterics2020.eu/dokuwiki/doku.php?id=open:wp4:wp4techforum5>. The page header includes the ASTERICS logo and the text 'ASTERICS Wiki pages'. The main content area is titled 'ASTERICS DADI Technology Forum 5' and contains the following sections:

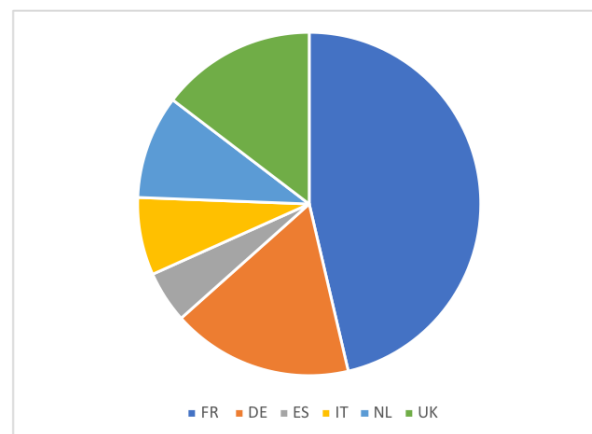
- The Forum is organised as a meeting of the DADI Work Package partners, and it will be the final Forum of the Work Package**
- Program Organisers: Mark Allen, Keith Noddle, Françoise Genova**
- Registration**: Please register using the Registration form on the Indico page. Registration deadline is February 8, 2019. Registration is now closed (Feb 15).
- Abstract for presentations and hack-a-thon topics**: The Tech Forum includes contributed presentations (15 min). Please submit an abstract for consideration via the registration form. Hack-a-thon topics can also be submitted. Note that you can modify your registration, allowing you to add the abstract after your initial registration. Please register as early as you can so that we know you're coming! The deadline for abstracts is February 8, 2019.
- Meeting Dates**: Meeting: 26 - 28 February 2019, Strasbourg
- Location**: Observatoire astronomique de Strasbourg, 11 rue de l'Université, Strasbourg, FRANCE

The right sidebar contains a 'Table of Contents' with links to various sections of the forum, including 'Registration', 'Abstract for presentations and hack-a-thon topics', 'Meeting Dates', 'Location', 'Hotels', 'Dinner and Lunches', 'Participants', 'Agenda', 'Hack-a-thon Sessions', and 'Multi-messenger project'.

**Figure 1: Meeting web page**

## 2. Participants

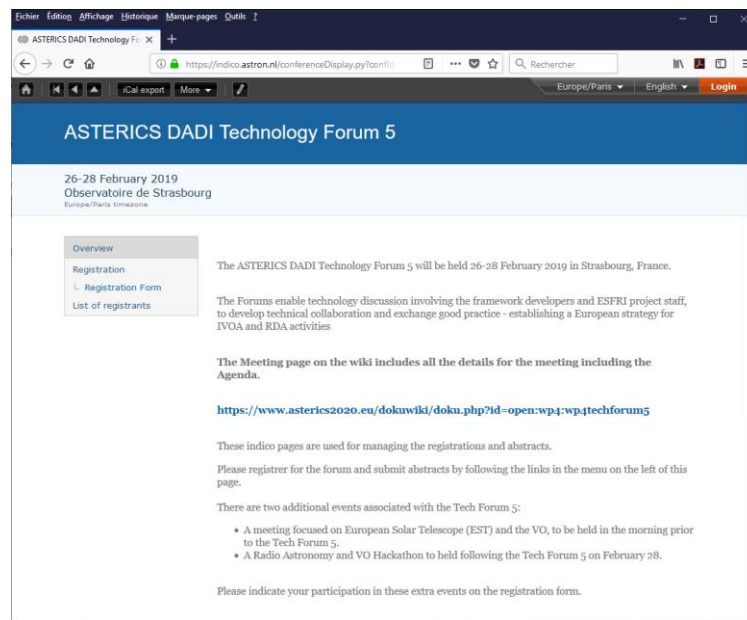
41 participants from France, Germany, Italy, the Netherlands, Spain and UK (Edinburgh and Bristol) attended the meeting. The distribution of participants from different countries is shown in the pie chart below (Figure 2). As usual, the professional profiles of the participants includes a mixture of scientists and software engineers working on VO, and staff from ESFRI and pathfinder teams. This is the highest participation of all ASTERICS DADI Technical Forums, also because the colocated events gathered additional participants who had not been involved previously. This is a good point, since it ensures that DADI legacy will be well understood, in particular in the ESCAPE framework, including for activities relevant to EST and radio-interferometry. The lead of ESCAPE WP5 ESAP (ESFRI Science Analysis Platform) participated in the meeting, as well as ASTERICS WP5 lead. The chairs and vice-chairs of several IVOA Working and Interest Groups as well as the chair of the IVOA Executive Board also attended, which ensures proper liaison with the international level: the vice-chair of the Data Model WG, the chair of the Data Access Layer WG, the chair and vice-chair of the Semantics WG, the chair of the Data Curation and Preservation Interest Group, the vice-chair of the Operations Interest Group, the chair and vice-chair of the Time Domain Interest Group.



**Figure 2: Participant countries of origin**

The meeting was advertised within the project, and the associated partners were also informed. In addition to the ASTERICS wiki, an INDICO system was also used for managing the registration of participants. The top level INDICO registration page<sup>2</sup> is shown in Figure 3 below.

<sup>2</sup> <https://indico.astron.nl/conferenceDisplay.py?confId=201>



**Figure 3: Technology Forum 4 registration website**

### 3. Programme

The structure of the program followed the pattern used for the previous Technology Forums with an introduction followed by a set of presentations on current topics, and sufficient time for the informal hack-a-thon sessions. The program of presentations was built from the proposed contributions submitted by the participants when they registered for the meeting, and in addition a number were solicited to make sure that priority areas were fully covered. The program was developed by the chairs of the meeting. The first day, it included presentations of different technical developments of interest for DADI partners performed by the DADI teams, with two sessions focused on the current priorities, time domain and provenance. The third session included feedback from implementation of the multi-dimensional standards, which have been developed as one of DADI priorities with key input from the DADI teams, an overview of the IVOA data modelling activities, a presentation of the European Solar Telescope, and a description of modular access to datasets using VO standards, a strong requirement from users with the fast development of Python usage in particular. Two hack-a-thon sessions were scheduled, with rooms available for discussion in parallel.

The hack-a-thon discussions were presented during the first session on Day 2. The concluding session was devoted to a retrospective of the Technology Forums, and to a presentation from the DADI lead which put it in perspective by recalling the history of the Virtual Observatory development and of the European projects which supported it, and discussed DADI impact, highlights and legacy, with ESCAPE in perspective.

The program is available on the wiki with links to all of the presentations.

## Tuesday, February 26<sup>th</sup>

12:30	Lunch	
14:00	Welcome and introductions	Mark Allen
14:10	DADI Status	Francoise Genova & Mark Allen
<b>Time domain session</b>		
14:25	Enhancements of the VO standards for Time Domain	Ada Nebot
14:50	TIMESYS and VOTable 1.4: State of play	Markus Demleitner
15:15	GAPS series and exoplanet discovery and modelling	Marco Molinaro
15:40	Hack-a-thon introduction	Keith Noddle
16:00	Coffee break	
16:30	Hack-a-thon	
17:30	Close	

## Wednesday, February 27<sup>th</sup>

<b>Provenance session</b>		
09:00	IVOA Provenance Data Model: a synthetic view	Mireille Louys
09:25	CDS implementation of ProvTAP for HiPS provenance	François Bonnarel
09:50	Searching in provenance with custom ADQL functions	Markus Nullmeier
10:15	Discussion	
10:30	Coffee break	
<b>Presentation session</b>		
11:00	IVOA Data Model Working Group overview	Laurent Michel
11:25	EST presentation	Morten Franz
11:50	Modular components for quick retrieval of VO data sets	Matthieu Baumann
12:15	Feedback on development of multidimensional data standards and implementations	Francois Bonnarel
12:30	Lunch	
14:00	Hack-a-thon	
15:30	Coffee break	
16:00	Hack-a-thon	
17:30	Close	
19:30	Working dinner	

**Thursday, February 28<sup>th</sup>**

09:00	Presentations from Hack-a-thon sessions	chair: Keith Noddle
10:30	<i>Coffee break</i>	
<b><i>Discussion and conclusions</i></b>		
11:00	Tech Forums retrospective	Keith Noddle
11:25	Conclusions of the ASTERICS DADI Technology Forums	Francoise Genova
11:50	Concluding discussion	
12:30	<i>Lunch</i>	

**Co-located events**

*Preliminary meeting:* EST and the VO, 26 February, 10:00-12:00

*Extra event:* Radio Astronomy and the VO, 28 February, 14:00-18:00

*Project meeting:* Multi-messenger Platform, 28 February, 14:00-18:00

**4. Proceedings and Analysis**

The two short introductory talks were presented by Mark Allen (CNRS/CDS), who presented briefly Strasbourg Observatory and the meeting programme, and by Francoise Genova, who reported the current DADI status. She underlined that this meeting was the last workshop organized by ASTERICS DADI, and described the activities since the previous Technology Forum, the remaining deliverable, D4.15, the final version of the Repository of Data Products, and the way DADI activities are preparing smooth transition to the ESCAPE Cluster WP4, *Connecting ESFRI projects to EOSC* (CEVO), which is led by Mark Allen.

The following session was devoted to discussing activities in the Time Domain. First, Ada Nebot (CNRS/CDS, chair of the IVOA Time Domain Interest Group) described the enhancements of the Virtual Observatory standards and tools for the time domain to enable user needs to search and find, visualize and analyse data. Search and find require a minimal set of metadata about the time system, which are the basis of the TIMESYS element in VOTable discussed by Markus Demleitner in the following talk. She showed how applications can use it, taking the example of T-MOC (Time Multi-Order Coverage) use to define time coverage. Additional time constraints beside the time of observation will likely lead to an extension of the ObsCore standard, which sets up the essential elements to describe a dataset, for time. She then discussed time visualisation with the example of a time viewer for Vizier and requirements on time visualisers. She underlined the efforts of the Time Domain Working Group and the existing serialisations, and briefly addressed needs for data analysis. Markus Demleitner (UHEI, vice-chair of the IVOA Semantics WG) then presented the status of the TIMESYS

element proposed for VOTable 1.4, with the items on which there is consensus, those which are being discussed, and desiderata, and whether or not to implement them now. VOTable 1.4 will be submitted for comments soon. Finally, Marco Molinaro (INAF, chair of the IVOA Data Access Layer WG) presented the GAPS exoplanet use case – GAPS is the Global Architecture of Planetary Systems, a project which produces time series. He summarized the work done to describe the data based on ObsCore for discovery, with an illustration of TAP queries through TOPCAT. He then described the first efforts to define a model of exo-planetary systems, which was discussed during a dedicated meeting listed in Table 2 (meeting #3), and the next steps.

The last talk of the afternoon was an introduction to the Hack-a-Thon sessions by Keith Noddle (UEDIN). The participants then gathered in smaller groups for the first hack-a-thon session.

The first session on the second day was dedicated to presentations of the Provenance activities. Mireille Louys (CDS, chair of the IVOA Semantics WG) first gave a synthetic view of the current status of the Provenance Data Model, its goals, the timeline, the data model elements and their bindings, the implementations which are currently operational and those in development, with the data model features they cover. She concluded with the next steps, underlining that the Provenance Model is an important product of DADI, and the follow-up, in particular in collaboration with the IVOA Data Access Layer Working Group, and the RDA Provenance activities, and implementation by CTA. Francois Bonnarel (CNRS/CDS) then presented a reference implementation of the Table Access Protocol TAP which serializes the Provenance metadata model, ProvTAP, for the HiPS service at CDS. The service gives access to images with hierarchical multi-resolution created using the HiPS standard. ProvTAP enables to select the datasets by provenance. Finally, Markus Nullmeier (UHEI) discussed the usage of custom ADQL functions for ProvTAP to navigate the “provenance graph”, with an implementation in PostgreSQL.

The second session of the second day consisted of talks about different topics relevant to WP4. An enlightening presentation of the purpose and prospects of Data Models in the VO by Laurent Michel (Strasbourg Observatory, vice-chair of the IVOA Data Model Working Group) begun the session, with an assessment of the current status of the implementation of the VO-DML standard, which provides a formal way to specify any VO data model. Then Morten Franz (KIS) introduced the European Solar Telescope EST, underlining the specific challenges for archiving and dissemination of solar data – EST and the VO had been discussed in more details during the preliminary meeting. The third talk, by Matthieu Baumann (CNRS/CDS), presented Python and Javascript components for quick retrieval of VO data collections. Python has been a hot topic of the ADASS meetings during the last years, and high in the list of user requirements, and the talk showed an Astroquery widget that queries the CDS MOCServer and a new data collections discovery widget for web portals. Finally, Francois Bonnarel gave an excellent overview of the development and implementation of the set of multi-dimensional VO standards, which have been the first priority of DADI and are one of the highlights of the work package: they enable multi-D data discovery, link of resources, cutouts, as well as the management of HiPS, interfaces with applications, and virtual data generation.

The afternoon was devoted to two hack-a-thon sessions.

The first session of the last day was devoted to presentations from the hack-a-thon sessions, chaired by Keith Noddle. They included a discussion of possible usage of ObsCore/EPNTAP and other VO standards in the context of EST and solar data (the discussion had begun during the preliminary meeting EST and the VO); time series and more generally the time domain in the VO; the next steps of Provenance; science platforms; transition to ADQL 2.1. The hack-a-thon discussions are kept track of at

<https://www.asterics2020.eu/dokuwiki/doku.php?id=open:wp4:wp4techforum5:hackathon>.

The final session was also effectively the conclusion of ASTERICS DADI, being the last session of the last workshop organized by the work package. Keith Noddle presented a retrospective of the Technology Forums, going back to their origin during the VO-TECH project. Francoise Genova's concluding talk described ASTERICS highlights and impact, in particular in terms of VO usage by the ESFRIs, putting them in the perspective of the VO development and the series of projects funded by the European Commission in support to it since 2001, and its expected legacy, including in the ESCAPE Cluster. Questions and comments concluded the meeting.

## 5. Conclusions and next steps

Like the previous ones, the Fifth ASTERICS DADI Technology Forum completely fulfilled its purpose of sharing information between DADI members and served to prepare input for the following Interoperability Meeting, which will be held in Paris, 13-17 May 2019<sup>3</sup>, after the end of the ASTERICS project. The meeting was the final workshop organized by ASTERICS DADI, and it also allowed the participants to present and discuss DADI impact, outcomes and legacy.

The next step for DADI has been its contributions to the ASTERICS final event, The New Era of Multi-Messenger Astrophysics<sup>4</sup>, which was held in Groningen 25-29 March 2019, before this report was finalized. :

- Access, Discover and Interoperability of multi-wavelength/multi messenger data, F. Genova, M. Allen, C. Boisson, E. Chassande-Mottin, P. Coyle, A. Lawrence, M. Molinaro, E. Solano, J. Wambsganss, M. Wise, and ASTERICS WP4 Team (invited)
- All-Sky astrophysics enabled by innovative systems for indexing the sky, M. Allen, P. Fernique, T. Boch, C. Bot, A. Nebot, S. Derriere, M. Baumann, K. Lutz, F. Genova
- Exploring time-domain multi-messenger astronomy through the Virtual Observatory, A. Nebot, A. Nebot, M. Allen, F. Genova, and the CDS team

<sup>3</sup> <https://indico.obspm.fr/event/64/overview>

<sup>4</sup> <http://multi-messenger.asterics2020.eu/index.php>



- Working with Gravitational-Wave sky localizations: new methods and implementations, G. Greco, M. Branchesi, E. Chassande-Mottin, G. Stratta, G. Dály, M.W. Coughlin, E. Brocato, P. Capellacci, P. Fernique, T. Boch, S. Derriere, F. Genova, M. Allen
- ESFRIs and the VO: Networking and discussing, M. Molinaro, F. Pasian
- GWOSC: Gravitational Wave Open Science Center, A. Trovato for the LIGO/VIRGO collaboration
- Archiving data from a software telescope, C. Boisson, M. Servillat, K. Kosack, M. Louys, F. Bonnarel
- The ASTERICS VO schools. Getting closer to the astronomical community, E. Solano, Ada Nebot (poster)

The following steps will be outside of the direct remit of ASTERICS.

The May 2019 IVOA Interoperability meeting will be held in Paris, France, 12-17 May 2019, after the end of the project. The meeting web site, <http://wiki.ivoa.net/twiki/bin/view/IVOA/InterOpMay2019>, is progressively updated with information on the agenda when this document is being written. DADI products and implementations will be presented in the relevant Working Group and Interest Group sessions.

ASTERICS DADI legacy, with the ESFRIs that have become both consumers and actors of the Virtual Observatory, astronomy and astroparticle physics working hand in hand, the first contact taken with EST, leadership in and strong contributions to VO activities, schools and tutorials, a set of standards and the evolution of existing tools and provision of new tools to fulfil the requirements of the ESFRIs and of the astronomical community, will be an excellent basis for the CEVO work package (WP4) of the ESCAPE Cluster, which begun in February 2019.

## Annex: Photo taken during the meeting

