Paris Astronomical Data Centre: 20 ± 2 years

Stéphane Erard PADC / Observatoire de Paris
Zakaria Meliani
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+ board of former directors

PADC web site https://padc.obspm.fr/

SF2A 2025, Toulouse
5 juillet 2025

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Missions
Were always there, can now be read as:

1) Support the data-oriented services in ObsParis
(ANO5 services certified by INSU/CNRS)
- Provide a mutualized infrastructure (storage, computation, etc)
- Support work on VO standards => missions to IVOA Interop meetings

Reason for certification of PADC by INSU (2012+)
(1 / 6 CDOS + CDS)

Support & spread VO techniques and knowledge
In particular interoperability aspects => FAIR principles

2) Support the Open Science policy (data aspects) at ObsParis
Data distribution / access + sustainability
- Provide interoperability to science projects & programmes
+ historical / patrimonial data

Local, national & European policies (2018+)

Usage of these techniques in other contexts, including operation of space instruments, ground-based projects or experiments…

3) Reach worldwide visibility of PADC
Expected to favor applications to national / European calls
=> extra funding to specific services / areas

An objective in ObsParis 5-year plans (2013+)
Reaching & maintaining a critical mass

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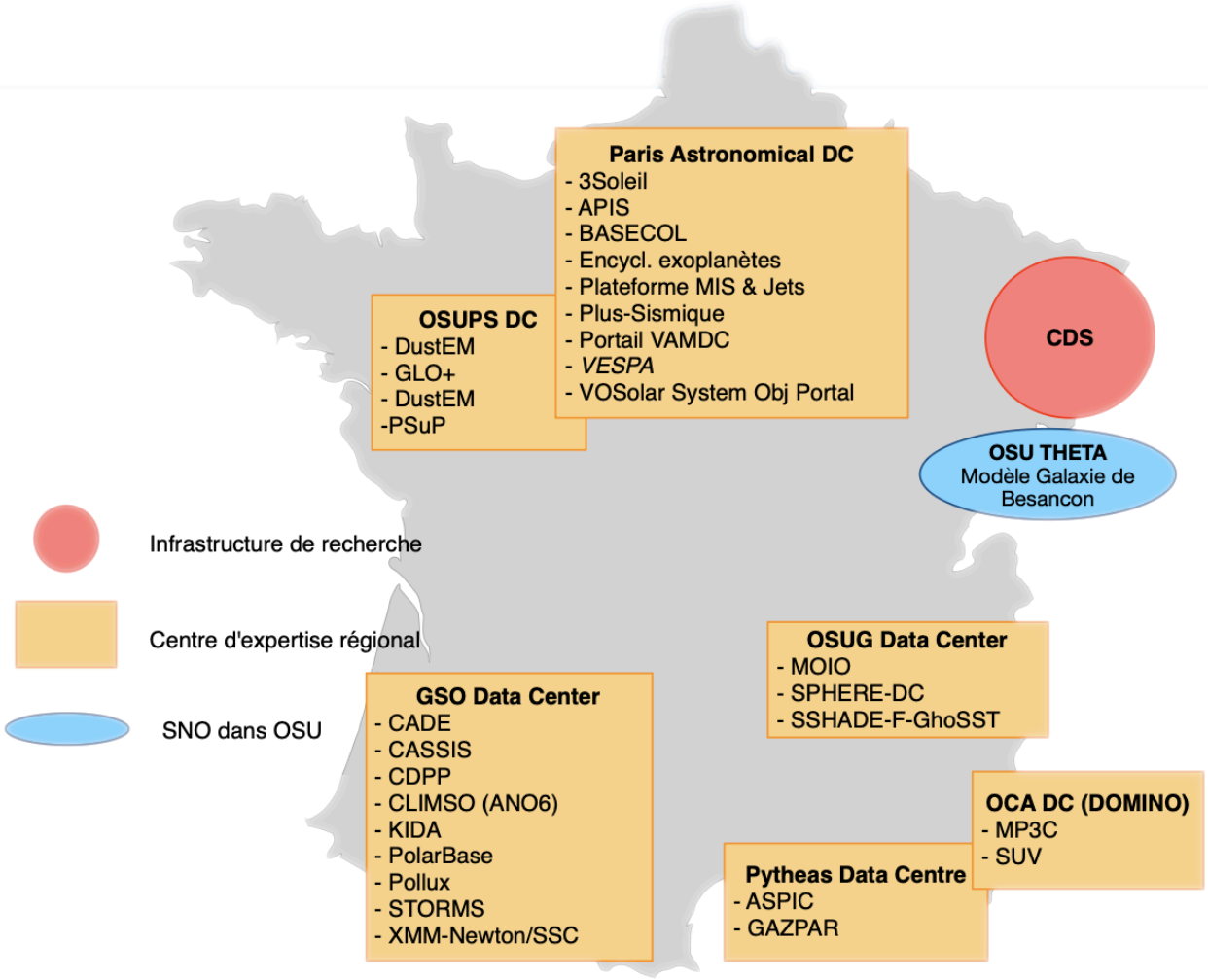
PADC timeline

	Status	Operational council	Direction
~2004	**VO-Paris** Local funding ObsParis	CS-OV: *Representatives of labs, some outside ObsParis + experts + projects*	~2004-2009 Marie-Lise Dubernet, LERMA
2009	**VOParis Data Centre**		2009-2012 Jean Aboudarham, LESIA Deputy William Thuillot, IMCCE
2013	**PADC** CER ANO5 / INSU	Groupe Projet: *Science themes* *+ transverse activities* Restrained to ObsParis	2013-2016 William Thuillot, IMCCE Deputy Jean Aboudarham, LESIA
2023+	Pôle d'Expertise ObsParis (local status)	Comité Scientifique: *Heads of certified services headed in ObsParis (9 persons)*	2017+ Stéphane Erard, LESIA 2017-2024: deputy Catherine Boisson, LUTh 2024+ deputy Zakaria Meliani, LUTh
2024+	CER => CDOS		2026: *to be renewed*

2004+ Technical director: Pierre Le Sidaner, DIO

Services ANO5 vers 2020
(doc INSU)



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PADC specificities

- CDOS: mono-OSU, multi-lab, multi-site (Paris, Meudon, Nançay)
  Was always a transverse activity across science departments (labs)

- Multi-thematic (astronomy only) — VO activity often at the margins of the regular VO:
  Zwölf et al ASOV 2023 & 2024 Erard et al ASOV 2022 Boisson et al 2022, Servillat et al ASOV 2024
  Atomic & molecular physics, Solar system, modeling, radio, high-energy, etc

=> complements CDS expertise in other fields => many collaborations with CDS and the other CDOS

Cecconi et al ASOV 2024a

- PADC is therefore involved in consortia other than IVOA: IPDA, IHDEA, RDA, VAMDC, Europlanet

- The common infrastructure is maintained by a very solid IT service at ObsParis (DIO)
— where PADC support has been an explicit function from the start
Storage, computation, VM/Dockers, data servers, etc + interoperability standards / tools
Complements the thematic activity in the labs

- Successive directions have always favored
- flexible, collaborative activities, in particular between researchers and engineers
- cross-fertilization
- standardization, and simplicity over complexity

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ANO5 data services pilotés à ObsParis

2012 ANO5 refoundation	2013 PADC certification	2015	2017	2019	2020	2021	2024
F-VAMDC							
BASECOL						réuni à F-VAMDC à la demande du service	
Plateforme MIS & Jets							
VO SSO portal							
Encyclopédie exoplanètes							
BASS2000-OP				inclusion de BASSS2000-Tarbes	⇨ **3Soleil** regroupé avec des ANO6		
		APIS					
			VESPA-F				
				Plus-Sismique (suite de l'ANO4 CoRoT)			délabellisation à la demande de l'équipe — ?
						MASER	
	PTN données atomiques et moléculaires					délabellisation	
	PTN plasmas planétaires						
		PTN modèles MIS					

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Data services supported by PADC

• Initial ANO5 services:
(certified in 2012): **VAMDC, BaseCol, MIS & Jets, VOSSOP, Encyclopedia of exoplanets, BASS2000**

• Aspiring ANO5:
Historically (certified since 2015): **APIS, VESPA, Plus-Sismique, MASER**
Currently (applying): **NAROO, MMASC, TheOP, etc**

• ANO-non5 sharing data:
CTA, ALMA-ARTEMIX, SKATE / NenuFAR, Gaia-TAP, ORN (Nançay)…

• Non-leader participation to other ANO4-5-6:
CDPP, High-Contrast Data Centre, FRIPON, Monitoring pulsars radio

• Not applying for certification (includes former ANO2/3):
Many local databases: patrimonial, experiment-related, outcome of various projects
Some collections on sky now accessible via ObsCore: student observations (UFE), galaxy catalogues, high energy, plates, etc
Solar System collections may be handled in VESPA (HST, JSWT, former ANO2s, etc) or MASER (radio)

• Projects / programmes sharing data:
Any **Horizon Europe, ANR, ERC, etc**… commit to make their data available
PADC provides solutions to honor such commitments

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Human resources

• No dedicated staff
Only personnel from ObsParis departments and common services (DIO & Nançay station)

Labs: Researchers & engineers involved in interoperability activities (usually related to data services)
DIO: Engineers involved in hardware infrastructure or software activities
- PADC support has been an explicit function at DIO from the start (5 persons with large contribution)

No hierarchical relations, in particular researchers vs engineers — same as space experiments:
Efficiency results from mixing scientific and technical expertises

Issue: may be difficult to provide visibility to PADC actions (credits, affiliations…)

• Software engineers hired in departments thanks to a strong priority from ObsParis are expected to share their expertise with other departments / projects (up to 30% FTE)
=> 5 persons since 2012 (one at DIO)

Very efficient to spread knowledge — when it works

Issue: tends to vanish with time - DIO contribution is now much larger

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Actions / Organization

- Mutualized hardware infrastructure — now supported/maintained by INSU annual call (2021+)
  Paris-Meudon: relies on/contributes to ObsParis global infra - follows ObsParis strategy
  Nançay: contribution to maintenance of local system

- Biannual call, open to all personnels of ObsParis & associated labs
  Shared expertise + Participations to IVOA and other consortia
  Includes expertise in support to experiments/projects (e.g. JWST, MMX/MIRS, LuckyStar+, etc)
  and pro-am activities (SAMP in PRISM & ImageJ, occultation interface…) Erard & Haigron ADASS 2023
  Savalle et al SF2A 2024

- Global / long term actions can be decided by the CS or the direction
  Support to the global VO infra — e.g. monitoring, validators, registr(ies), mirrors… Cecconi et al ASOV 2024b
  VO interoperability / semantics — UCD, vocabulary mapping…
  New VO developments — e.g. new portals, web services, apps, plugins…
  Local software tools — e.g., Gitlab with AAI, ontology portal, ElasticSearch db… Le Sidaner et al ASOV 2023
  Assessment of VO standards & knowledge acquisition — e.g. footprints, datalinks… + education / seminars
  New fields in the VO — historically:
    grid
    workflows
    AI/ML Aicardi et al ASOV 2025
    EOSC Cecconi et al ASOV 2022

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Mutualizing & sharing expertise
between services

Examples of service requests
- typically via internal calls

APIS
- Accurate access monitoring
- AI processing

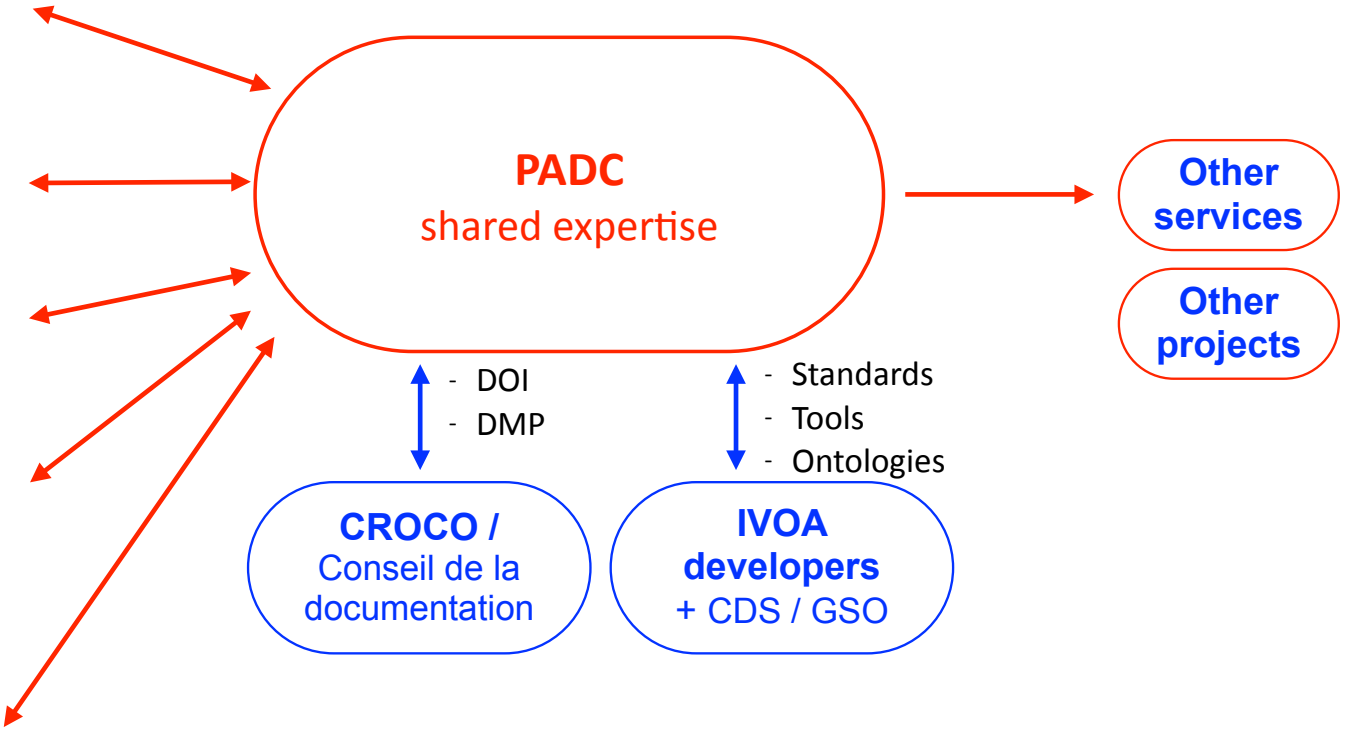
VESPA / MASER
- Monitoring of data services
- AI processing
- Clean registry for astropy
- MOC / HiPS / datalink
- ElasticSearch db

VAMDC
- Automated bib references
- Line lists
- Acces portal

Exoplanets
- Initial access portal

3Soleil
- ST-MOC

CTA / Pulsars
- ObsCore extensions, high energy



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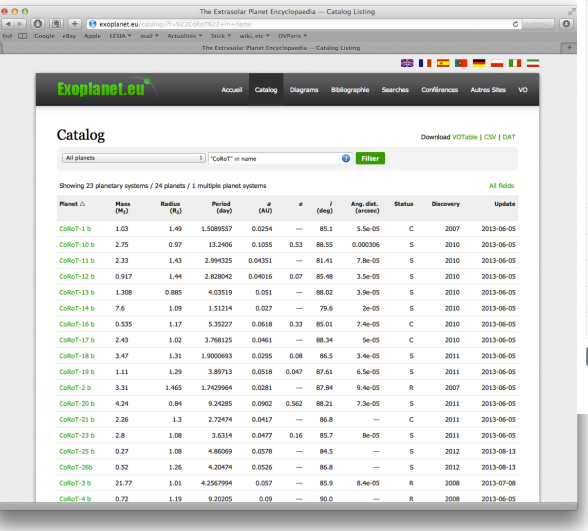
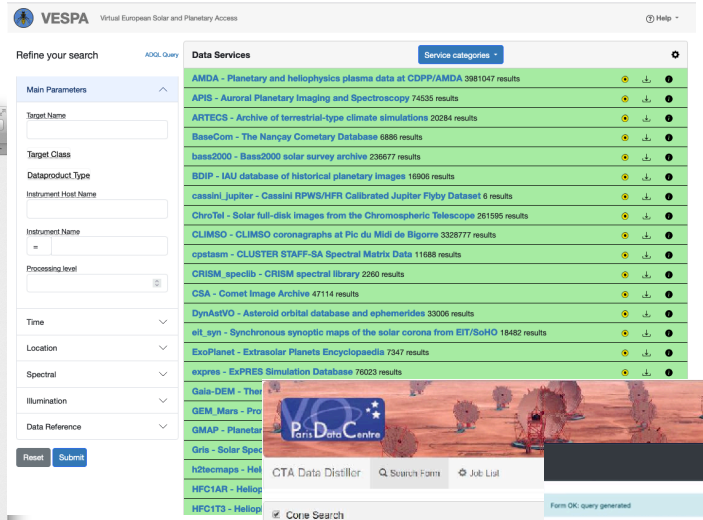
Portal activity
high-visibility element of the VO
— illustrates the benefit
of mutualized development



exoplanets ~ 2012
SQL-like, 1 table
(replaced by new dev in 2024)

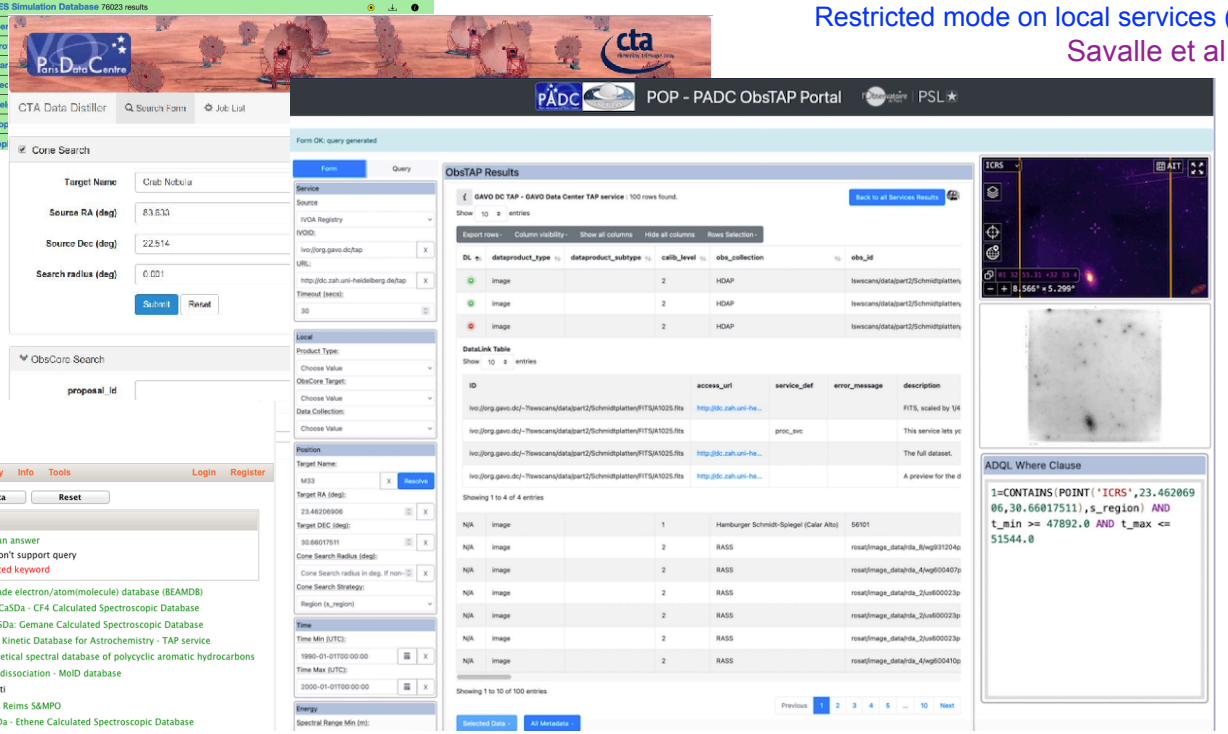


VESPA - 2014⇒24

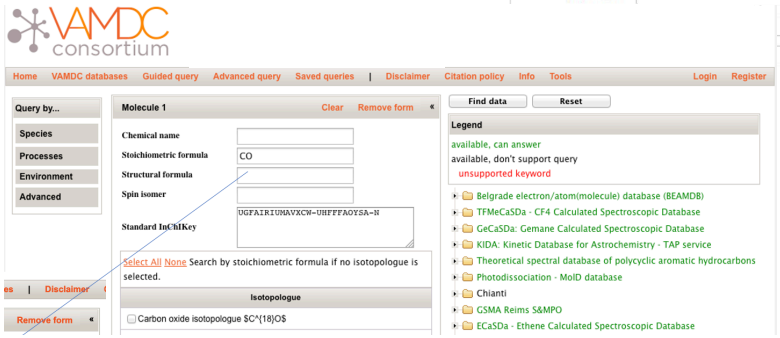
EPN-TAP, multi table from local registry
(Private dev version on IVOA registry)

Comparison in
Erard et al ASOV 2024

ObsCore - 2024 (new!):
https://voparis-portal.obspm.fr/
ObsTAP, multi table from IVOA registry
Restricted mode on local services (in dev)
Savalle et al ADASS 2024



CTA - 2017
CS + ObsCore



VAMDC ~ 2012
SQL-like, multi table

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Activité / besoins des services labellisés (2022-24)

Support spécifique aux services labellisés :

dont ANO5

F-VAMDC
- Installation de 8 VM pour réplication à Meudon,
- + 5 VM de production sur un hyperviseur Paris, et passage à l'infra mutualisée

MIS et Jets
- Installation de 5 VM avec contrôle complet - remplace un hyperviseur physique
- Achat et installation de lames de calcul prioritaires dédiées sur Tycho

Exoplanets
- Ingestion des données Gaia
- Serveur miroir en lecture seule (réplique)

APIS
- Méthodes de traitement ML (correction erreur pointage HST)
- Interface avec données radio/NDA (via EPN-TAP)
- Support infra / stockage, maintenance

MASER
- Maintenance serveurs Das2 (time series), UWS, Outils AI
- Achat d'une lame de calcul prioritaire dédiée sur Tycho

VESPA-F
- Maintenance / jouvence portail, monitoring serveurs EPN-TAP
- Etude d'un portail géospatial (en dev) sur bdd ElasticSearch
- Hébergement web services CNES pour Pôle Surfaces

CTA-diffusion
- AAI sur UWS / OPUS

Centre de Données Nançay
- Support infra Centre de Données Nançay

Hors réponse à l'AO :

+Sismique
- Jouvence de l'ensemble logiciel du service

3Soleil
- OV-isation et publication des bdd NDA, ORFEES, NRH
- MaJ et interopérabilité BASS2000 dans VESPA
- Nouvelles données THEMIS

CDPP
- Miroir contenu (demande GSO)

VOSSP
- Pas de demande infra (infra IMCCE)

Monitoring pulsars
- Mise en forme métadonnées et préparation pour la distribution
- Evolution des standards radio dans le cadre IVOA

FRIPON
- Pas de demande (infra Marseille)

Services ANO1 IMCCE
- Pas de demande (infra IMCCE)

Services ANO1 SYRTE
- Pas de demande actuelle (distribution hors OV)

=> toutes demandes des services traitées ou anticipées

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Autres activités / services (2022-24)

Support générique PADC à l'Obs :

Publication du **portail global ObsCore** pour données sur le ciel
(remplacement du vieux portail très technique, peu lisible)

Etude **segment sol OV pour MIRS/MMX** (ANO2)
Pipeline NenuFAR sur EOSC & OKD (ANO3)
Réorganisation de l'accès aux données depuis le site web (en instance)
MaJ **APERICubes** pour visu cubes spectraux
Interface portail ElasticSearch
GitLab avec AAI / eduTEAMS
Etude attribution DOIs / landing pages sur les données (avec le CROCO)
Accès à EOSC via AAI pour tests notebooks, openstack, etc
Contribution CEPH ObsParis (stockage distribué)
Maquette OKD pour gestion dans conteneurs + Kubernetes

Infrastructure de l'OV / IVOA+ :

MaJ complète du **publishing registry** IVOA à PADC, sur GitLab avec CI
Monitoring détaillé de l'ensemble des services IVOA
Validateur VOTable 1.5
Proto **Gitlab IVOA** avec contrôle d'accès (WG Grid & web services)
Rapprochement des registry IHDEA / IVOA, en cours
VM et portail pour **listes sémantiques** IVOA/IPDA/IHDEA
Maquette **portail de calcul dans EOSC** (VM + nœuds + UWS)
ElasticSearch + name-resolver pour ObsFacility (avec CDS)
Contributions à Astropy, GammaPy, PyHC, etc

Le Sidaner et al ASOV 2025

Nouveaux services ObsCore

Support aux projets émergents (certains financés sur contrat ou CS):

Serveur images OHP UFE
Quasi-finalisation du service ObsCore => astrométrie dans headers fits
Serveur NAROO
Avancée du service ObsCore, très demandeur
Mise en forme des en-têtes fits, serveur VM + stockage
Très grandes images => utilisation de HiPS & cutout (collab CDS)
Serveur pour surveys historiques (galaxies, etc)
Serveur hautes énergies (H.E.S.S. et CTA)

BeSS / Etoiles Be Evaluation jouvence
MESSIER Pré-étude
VL4Ions Pré-étude, stockage
Spectral survey of nearby galaxies Espace + VM pour tests
Bdd redshifts blazars Site web
Actions Pro-Am:
Interfaces SAMP sur ImageJ et AstroImageJ (traitement)
SAMP + Alert system sur PRISM et SharpCap (acquisition) — réponse API ProAm
Etude hébergement de l'interface amateurs pour occultations (LuckyStar+)

Ateliers :

Interop spring meeting 2019
IHDEA-cloud: Paris, juillet 2023
Invitations, e.g. Markus Demleitner, fev 2024
Séminaire astrométrie images
Discussions avec les chairs IVOA

Participations to **semi-hackathon ASOV**
CTAO: France, mars 2023 (contribution)
VAMDC: Paris, juillet 2023 (contribution)
MOOC / Vidéos / cours en ligne OV et Exoplanet
(modules de 15 min)

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2017+ short summary

- Local status at ObsParis (= Pôle d'expertise)
  Required for CTS certification — first criterion

- Evolution of common infra, extended usage by ANO services, start integrating Nançay DC in PADC
  Plus: 4 new ANO5 services certified by INSU (3 since 2017)

- Supports a strong involvement in IVOA and other consortia
  3 chairs, 1 co-chair of WG and IG
  largest French contribution with CDS
  lead for several standards: Provenance, EPN-TAP, UCDs, ObsCore extensions, TFCat, ObsFacility, SLAP2…

  IPDA: current co-chair, 2 representatives (for CNES and Europlanet)
  + IHDEA, RDA, VAMDC

- Takes over from ANO services for joint or long-term activities
  Service monitoring, validation, VO infra / expertise, ObsCore portal + access to local collections
  => workaround the growing shortage of manpower in individual services
  => direct involvement in Horizon Europe bids (SpaceSci RI 2023, ASTRO-CC/OSCARS 2025)

Erard et al ASOV 2023

- PADC is the main contributor at ObsParis for EOSC, and / in particular for AI/ML activities
  E.g., involvement in Minerva / SKA, EXTRACT

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Hints for future activities

The direction will be renewed in 2026

- Clarify support to data services (with CROCO)
  doi on data collections - consistently with recherche.data.gouv
  DMP (model available) - to be automatized on doi attribution

Cecconi et al ASOV 2023, 2025

- Improve monitoring of ANO5 & data servers *(in progress)*:
  - status of servers & services (setup by VESPA / MASER)
  - access statistics (requested by APIS)
  - automated references (publications on a service / using a service) (requested by VAMDC)

- Step forward CoreTrustSeal certification? RDA recommendations is to check the boxes

- Provide access to more existing collections
  some are preserved by PADC with ~ no access (some 100 TB), others in labs & Nançay

- Favor interoperability between disciplines => more vocabulary mapping

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Needs / wish list

- Budget is not currently critical ;)
  Hardware infra now supported thanks to INSU call (2021+)
  - expected to carry on (but no news for this year?)
  Local budget has just increased - more room to support interactions in consortia
  Was becoming difficult with ending of EU programmes / funding of new ones

- **Manpower becomes critical though ;(**
  Expertise sharing is less efficient, while many ANO services lack manpower
  Will soon jeopardize ANO5 functioning and Open Science policy, with impact on EU programmes
  This is particularly sensitive in LIRA
  - Need to hire a new high-profile engineer in support of ANO services + implementation of IVOA std
  - Also need to enforce the support of Open Science activities in ObsParis

- New local status results in less collegial, more directive functioning
  does not encourage the sharing of expertise
  Can be improved - to be discussed with next ObsParis CS / new departments

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Prospects

- Need to host **foreign databases at risk**?

Discussion started with requests from the Space Weather community
Potentially applies to many astronomical db (starting with NASA) and lab activities (NIST, etc)
Feasible punctually, but would require additional resources if recurrent (= hiring people)

Need to coordinate with other CDOS / at INSU level?
Need to involve European level / agencies for broader actions
even if this requires hiring people, would be much cheaper than welcoming researchers in exile