

From ISO to Gaia : a 20 year journey through ESA Science Archives

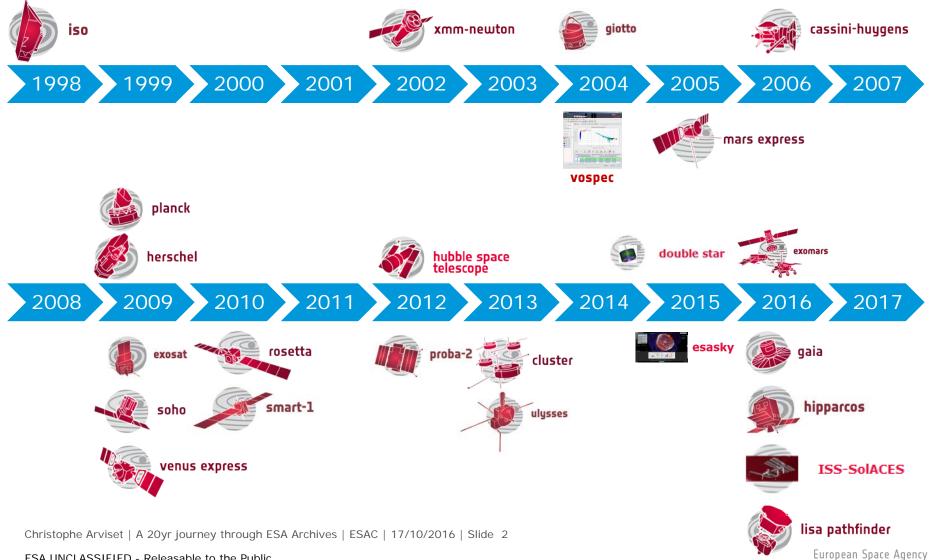
Christophe **Arviset**, Deborah **Baines**, Isa **Barbarisi**, Sebastien **Besse**, Guido **de Marchi**, Beatriz **Martinez**, Arnaud **Masson**, Bruno **Merin**, Jesus **Salgado**

ESAC Science Data Centre ADASS 2016, Trieste, 17/10/2016

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European Space Agency

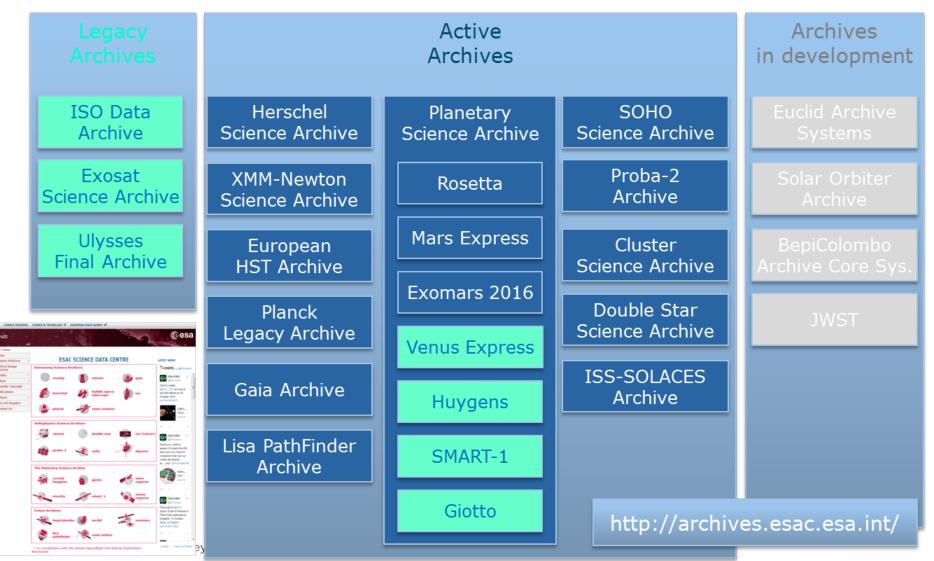
ESAC Archives : an ever growing family



4.

Archives in different phases

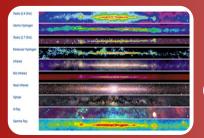




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European Space Agency

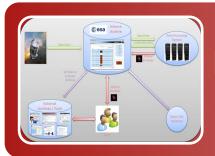
ESAC Science Archives Strategy



Enable maximum *scientific exploitation* of data sets



Enable efficient *long-term preservation* of data, software and knowledge, using modern technology

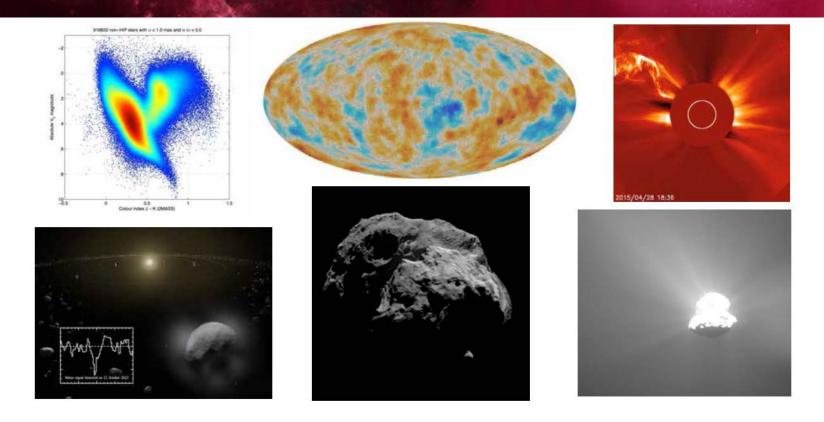


Enable cost-effective archive production by integration in, and across, projects

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Enable Maximum Science Exploitation





Scientists and Engineers working very closely together

Science driven Archives

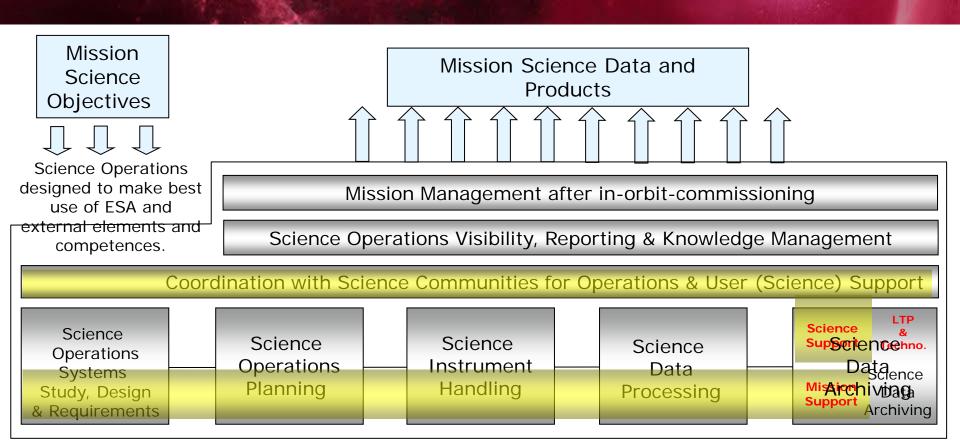
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Long Term Preservation Strategy

- 1. Consolidation of all ESA Space Science Archives at ESAC, with strong re-use across projects, ensuring easier and cheaper long term data preservation
 - Hardware infrastructure
 - Software architecture and code, including technology migration
 - Human technical and scientific expertise
 - Multi mission, multi instruments science exploitation
- 2. Long term preservation of data processing capabilities (on-going)
 - Preserve software coming from various places
 - Provide data processing capabilities as a "service"
 - Bring the "user software to the data" instead of the "data to the user"
- 3. Sharing and preservation of knowledge, including international cooperation
 - IVOA, IPDA

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Archives as a Core Component of ESA Science Operations



Archive is NOT an afterthought at the end of the in-orbit operations !

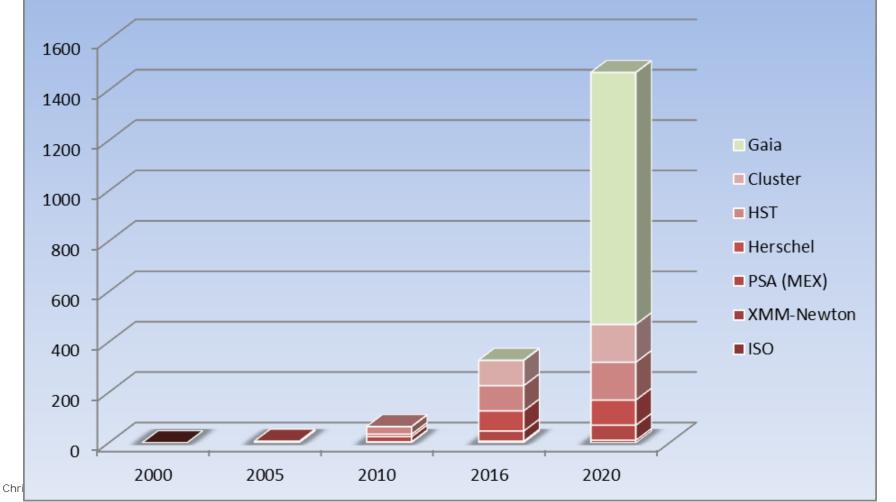
Archive development starts in the early phase of the project !

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Archives Volume evolution (2000-2020)

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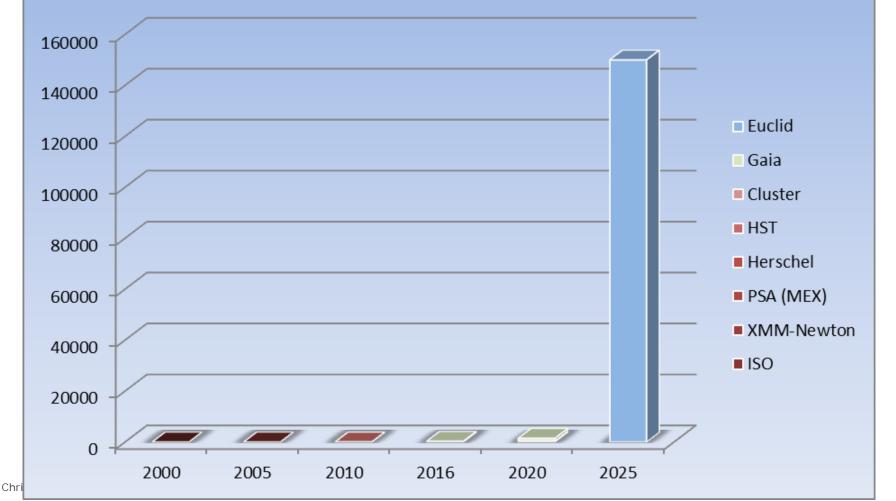
ESAC Archives Volume (in TB)



Archives Volume evolution (2000-2025)

esa

ESAC Archives Volume (in TB)



Software Design DOES Matter !



ISO Data Archive Top Level System Design - 1998 **ESAC Archives Common Architecture - 2009** esa BKRP Processed ISO data TOP LEVEL ARCHITECTURE. LEVEL 0. product Update (CDROM jukeboxes) Archive stored QUERY product INGEST MANAGER product BKRP 7 e-mail location product USER METADATA INTERFACE processing request request TDF reques Pipeline User Archive TDF Store User rocessing Engine nterface results processed REQUEST product EAS-DPS@SDC-NL/Slave FTP **Euclid Archive System** DPS CUS CDM product 2015 DPS Science Community í à à CDROM CPS Advanced DPS Application DPS MAL DATA Services MIS DPS-MDR EAS-SAS@ESAC Consortium SEDM User Services DPS-MRS STORAGE LAYER Metadat EC Users DPS CUS **VCDM** SAS SAS MAL MTS WEB DPS Job specification CPS DPS ⇒ Indestion DPS MAL Scientific access ൭ MIS SAS-MDR Job spec. DPS-MDR COORS EAS-DPS @ESAC/Master Query/Retrieval DPS-MDR: Metadata Repository Notify SDCs DPS-MAL: Metadata Access Layer Data (from any Ouerv/Retrieval Ingest Metadata DPS-MIS: Metadata Ingestion Service DSS SVR) Data DPS-CUS: Consortium User Services Community DPS-CPS: Consortium Processing Services DPS-MRS: Metadata Replication Service IAI IAI SAS-MTS: Metadata Transfer Service SAS-AUS: Archive User Services COORS: Coordination & Orchestration Syst. HPC] HPC1 . . . IAL: Infrastructure Abstraction Laver HPCI: High Performance Computing I. DSS-SVR: Distributed Storage System Syst. FS SDC FS FS DSS-SNI: Storage Node Interface CDM: Euclid Common Data Model SEDM: Science Exploitation Data Model Christophe Arviset | A SDC 1 SDC n SOC ESAC

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Archive Technology Evolution





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1st generation of Archives (1998...)

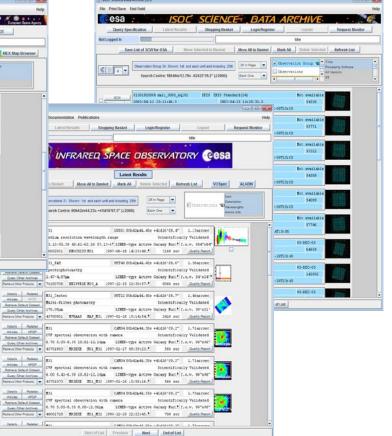
Java Applets, html could not support all requirements at the time

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Planetary Science Archive

Integral SOC Archive

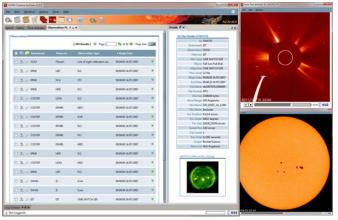


ISO Data Archive

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2nd generation of Archives (~2005...)

Java web start, more user friendly GUI

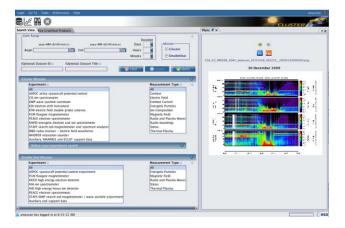


Soho Science Archive Including Proba-2 data

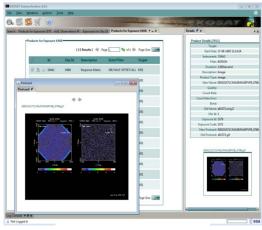


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Cluster Science Archive, Including Double Star data



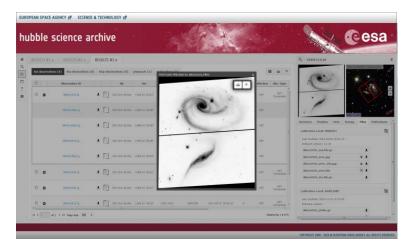
Exosat Archive

European Space Agency

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3rd generation of Archives (~2013-...)

Thin layer web clients



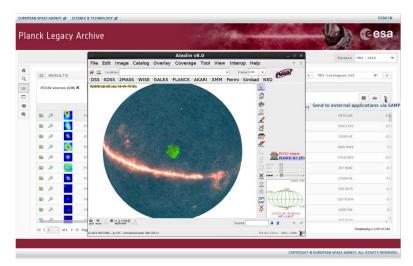
European HST Archive

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Gaia Archive

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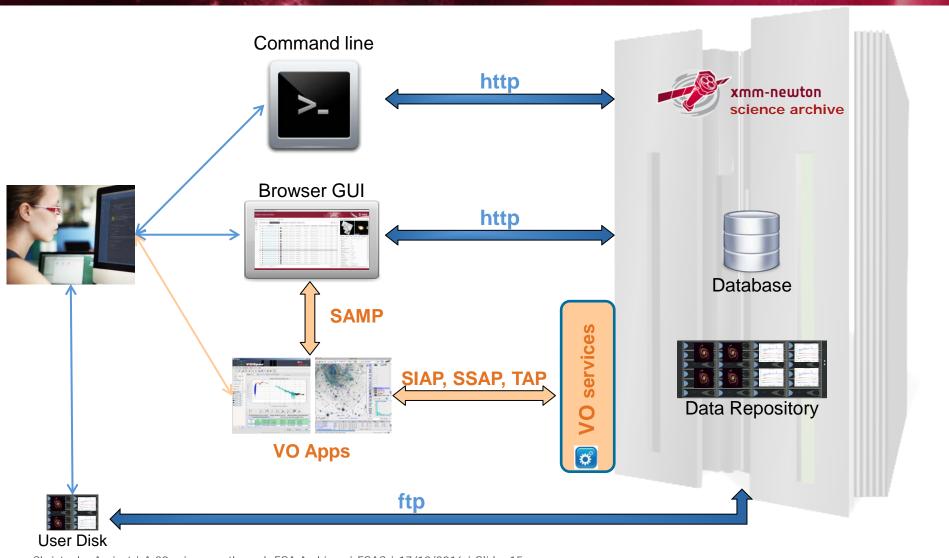
Planck Legacy Archive

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Planetary Science Archive

Standard Archives Architecture





Need for new paradigm

- 1. New ways required to access the Gaia catalogue and associated data
 - Powerful query mechanism, asynchronicity of results
 - One "query interface" for all archive services and VO services
- 2. User can not download all catalogue and all data
 - Need to have user workspaces IN the Archive
 - User database space, user disk space
 - User workspace shareable amongst various users
- 3. Bring user code to the data
 - Part of the user workspace in the archive
 - Share code with other users

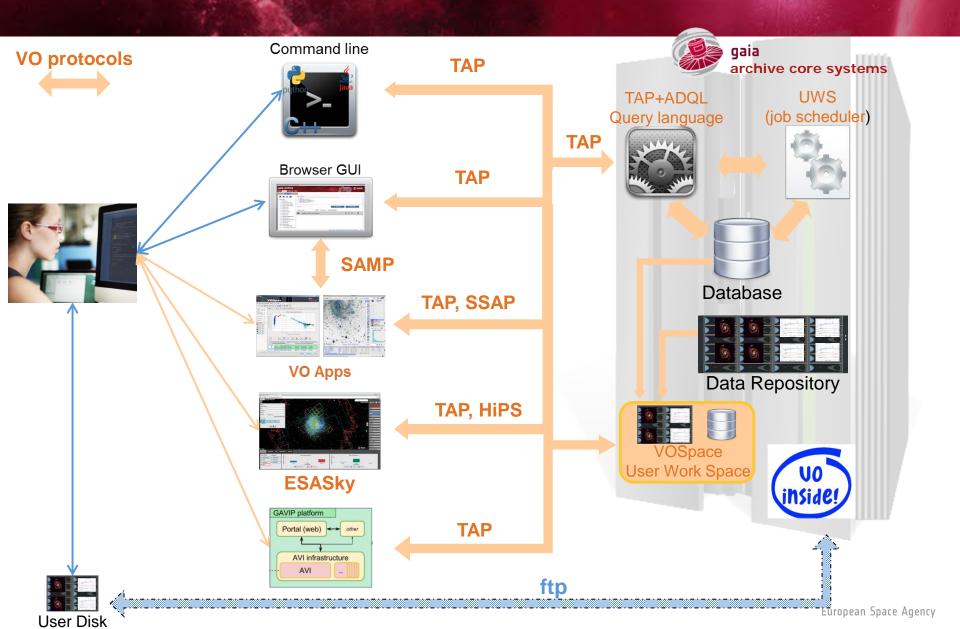


The user works with the data WHERE the data is : Archive 2.0 concept

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Gaia Archive Architecture





Towards multi wavelengths Science data exploitation

- **Goal**: to facilitate data discovery and archival science for ALL users
 - Multi-wavelength
 - Project agnostic
 - Exploration
- Interface "on top of" all ESA astronomy archives

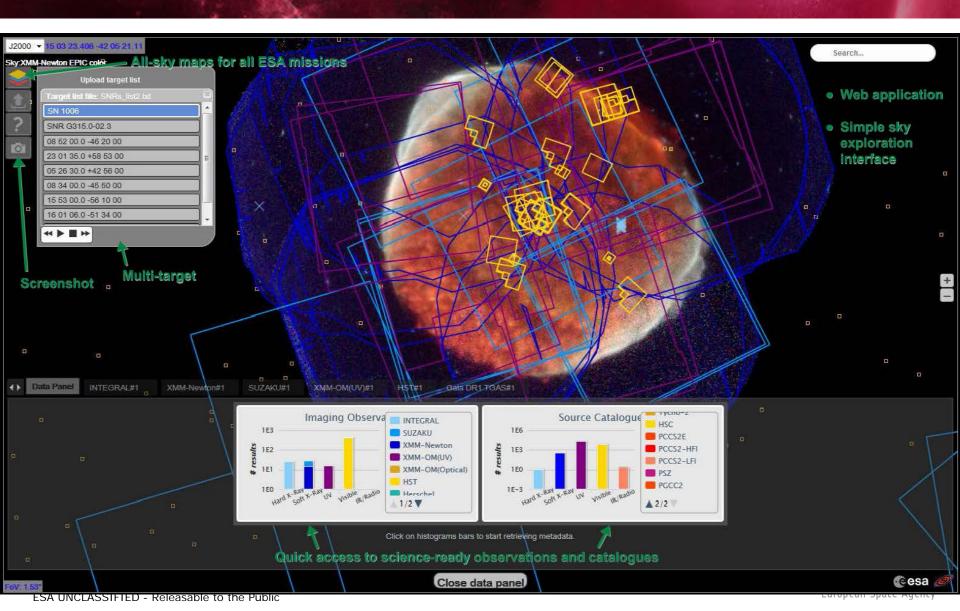




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sky.esa.int





Login or not Login : that is the question





Semi Open access (Free access to query, need login to retrieve data)

- "Burden" for the user, especially for public data
- Required to access proprietary data
- Enables asynchronous services
 - (long queries, big volume download, user spaces)
- Easier usage stats, better knowledge of the users



Full Open access (no login)

- Instant access for the users
- No reason to login for public data access
- Usage stats based on IP addresses more complex and not as accurate

Conclusion : combine both ! Open access is default, offer login for extra services

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1. Mission success usually measured by number of scientific papers

ESA-led Missions	Launch	<2000	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	To
COS-B	1975	173	1																ľ
IUE	1978	3,217	147	130	76	70	89	31	21	30	25	26	39	30	15	19	15	14	3,9
Exosat	1983	706	8	3	4			2	1	2	1	2			1	2	3		7.
Hipparcos	1989	729	194	154	147	133	107	100	120	92	89	89	85	67	89	71	59	42	2,3
Ulysses	1990	898	83	138	39	89	57	56	36	42	52	38	59	34	43	34	34	19	1,
ISO	1995	490	180	138	146	129	123	107	67	35	33	33	28	10	5	5	3	2	1,
SOHO	1995	588	292	203	283	301	324	321	271	368	332	323	274	298	243	189	211	122	4,9
Huygens	1997		7	8	15	7	12	24	21	26	26	16	15	8	11	7	5		2
XMM-Newton	1999		23	91	100	231	329	298	327	334	278	314	332	352	298	330	306	220	4,1
Cluster	2000	54	1	38	22	65	127	168	145	123	183	176	192	232	187	171	155	124	2,1
INTEGRAL	2002					79	27	67	99	84	84	96	80	60	67	45	47	41	8
SMART-1	2003						2	8	10	5	10	12	6	5	7	7	7	1	8
Mars Express	2003					4	21	49	87	75	83	89	109	96	82	64	63	19	8
Rosetta	2004						22	16	36	58	29	17	39	25	54	29	41	54	4
Venus Express	2005								21	44	79	48	41	54	75	60	40	52	5
Herschel	2009												228	109	255	323	336	241	1,4
Planck	2009													48	69	118	328	225	7
PROBA-2	2009													7	7	22	13	6	5
Gaia	2013																32	25	5
Non ESA-led	-	-															-	-	
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AKARI	2006								2	29	22	21	47	50	61	37	29	3	3
Hinode	2006									62	105	135	133	134	129	100	97	63	9
IRIS	2013															3	22	33	5

pean Space Agency

			E	SA Science Arch	ives Usage S	Statistics				
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				Active	Archives					
			2015-H1	171	3.43	3%		CSA @ESAC data		
	Cluster	2000-	2015-H2	194	2.57	3%		distribution since Oct 2014		
	ordator	2000	2016-H1	171	2.34	2%		Since 2015-H2, archive size		
			2016-H2	124	2.85	3%		reflects only Science Data		
Mis			2015-H1	901	10.99	21%	52.67			
	Herschel	2009-2013	2015-H2	855	7.89	20%		7 Archive used as prime mean		
	Thersonier	2003-2013	2016-H1	944	14.74	23%		for data distribution		
			2016-H2	797	15.09	19%	78.35			
			2015-H1	204	1.01	1%	95.23			
	HST	1990-	2015-H2	181	0.19	0%		6 European HST Archive now at		
Ho		1000-	2016-H1	188	0.42	0%				
			2016-H2	231	0.13	0%	103.63			
			2015-H1	758	14.01	36%	39.40			
	Planck	2009-2013	2015-H2	615	12.16	23%		Public opening of the Planck		
	- ranon	2000 2010	2016-H1	609	1.23	2%		Archive on 21st March 2013		
			2016-H2	554	1.74	3%	52.00			
			2015-H1	395	5.74	20%	28.40	20 MEX, Rosetta and Huygens data also available via NASA 40 PDS 60		
	PSA (MEX, VEX, Ro		2015-H2	444	9.14	27%	34.20			
	Smart-1, Huygens a	nd Giotto)	2016-H1	403	5.52	15%	37.40			
			2016-H2	143	2.63	6%	41.60			
			2015-H1	168	0.34	5%	7.14			
	Soho @ ESAC	1995-	2015-H2	152	0.04	1%		3.00 ESA		
	00000 @ 20000		2016-H1	165	0.01	0%				
			2016-H2	152	0.01	0%	8.09			
			2015-H1	717	2.92		6.46			
	XMM-Newton	1999-	2015-H2	788	2.01	30%		Archive used as prime mean		
			2016-H1	930	2.07	30%		for data distribution		
			2016-H2	941	2.37	32%	7.39			
	Gaia	2013-	2016-H2	1,153	73.00	5214.29%	1.40	Gaia Archive at ESAC, released on 14/09/2016		
	ISS-SolACES	2008-	2016-H2	21	0. 11	8%	1.30	ISS-SolACES at ESAC released 31/08/2016 (values in GB)		
					y Archives					
			2015-H1	0	1.50	2%	83.90	D Legacy Archive		
	Exosat	1983-1985	2015-H2	1	0.93	1%				
			2016-H1	0	4.24	5%		(values in GB)		
			2016-H2	1	0.51	1%	83.90			
			2015-H1	88	0.49	0%	171.00			
	ISO	1995-1998	2015-H2	82	0.65			Legacy Archive since 2002		
		1000 1000	2016-H1	91	0.96	1%		(values in GB)		
			2016-H2	78	1.48		171.00			
			2015-H1	27	26.19		204.78	Legacy Archive		
	Ulysses	1990-2009	2015-H2	18	23.38		204.78	Legacy Archive Released in February 2013		
	019 33 63	1330-2009	2016-H1	33	18.88	9%	204.70	Avaluate in CD)		
he Ar			2016-H2	24	10.33	5%	204.78	(rados in ob)		
e Al										
AS	active users	means		d downloading data at leas						
_,			IP address downl	oading data at least once a	a month					

- 1. Mission success usually measured by number of scientific papers
- 2. How to measure success of the archives ?
 - Number of active users / IP addresses ?
 - Volume of data being downloaded vs size of the archive ?
 - Ratio of data-out vs data-in ?



. Miss				
	Mission	Data-in	Data-out	Ratio
. How	Cluster	30	29	1.0
	SOHO	4	5	1.2
	PSA	19	262	13.8
	Herschel	53	206	3.9
	HST	67	28	0.4
	Planck	42	168	4.0
	XMM	3	98	32.7
	Total (TB)	67	173	2.6

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- 1. Mission success usually measured by number of scientific papers
- 2. How to measure success of the archives ?
 - Number of active users / IP addresses
 - Volume of data being downloaded vs size of the archive
 - Ratio of data-out vs data-in ?
- 3. Still not perfectly unified metrics, still big differences
 - between disciplines,
 - between missions,
 - between missions phases
- 4. Would be useful to hear how others archive centre do?



Looking back and looking forward

Archives serves various functions

- Maximum science exploitation of data
- Ensure long term preservation of data, software and knowledge
- Support Science Ground Segments from early phases

Scientists and Engineers working together

- Archives must be science driven
- Archives require strong IT expertise
- Regular technology evolution through time

Towards Archives 2.0

- Open data, open source, open archives
- Paradigm shift towards "bring your code to the data"

Acknowledgements to all Archive stakeholders



And to people who played

a special role in the ESAC

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Archives lifetime Pedro Osuna **ESDC ESDC ESDC** Inaki Ortiz • Leads Science Software Engineers Leads Ignacio Leon Science • Ground Instrument Segment Teams Jose Hernandez • Teams John Dowson Mission Mission Managers Consortium Archive Archive Science Scientists Users Project General Archives Scientists Public