Infrastrutture software ad alte prestazioni per il supporto, le operazioni e i test delle attività scientifiche

Cristoforo Abbattista
Head of SpaceStream Strategic Business Unit

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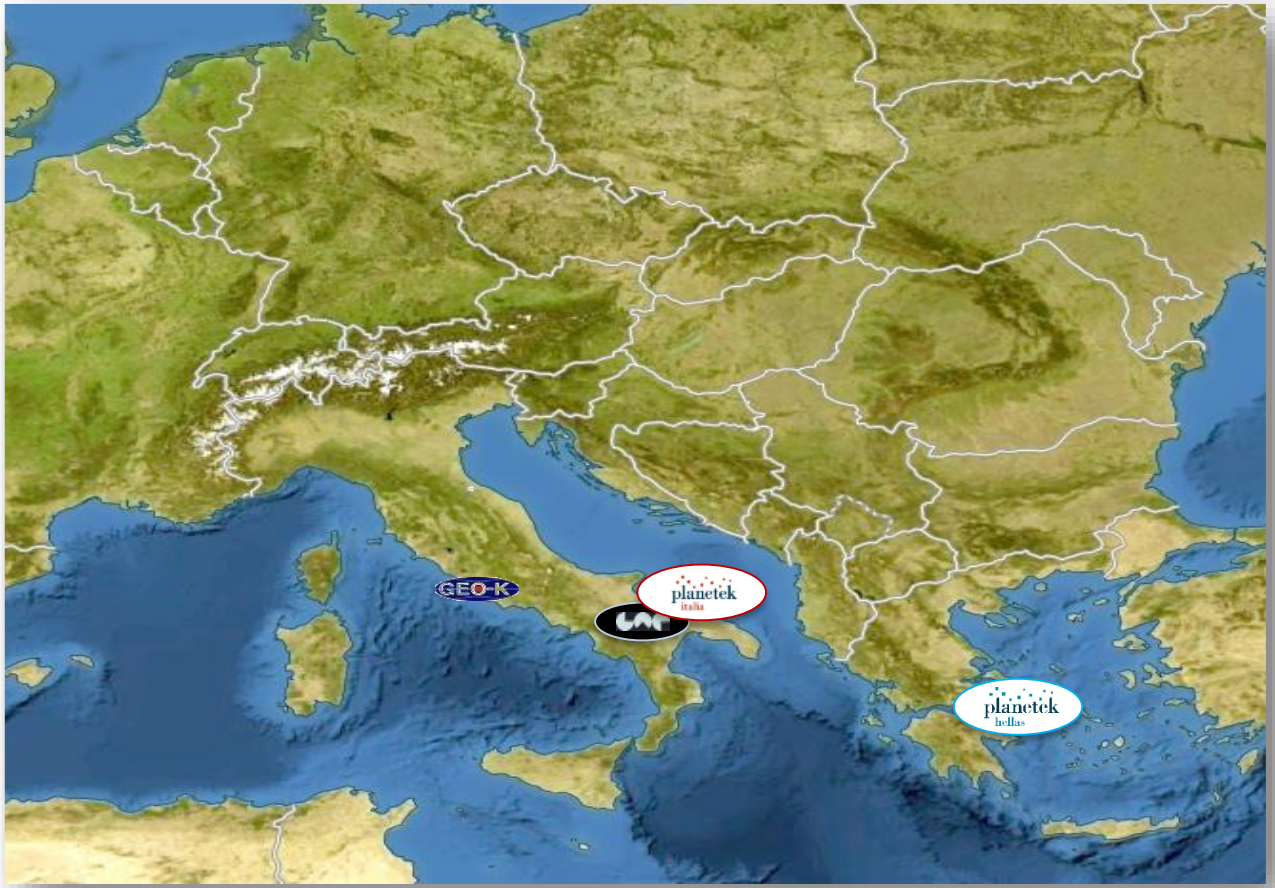
Planetek Group

Our Premises

Bari – Athens - Rome



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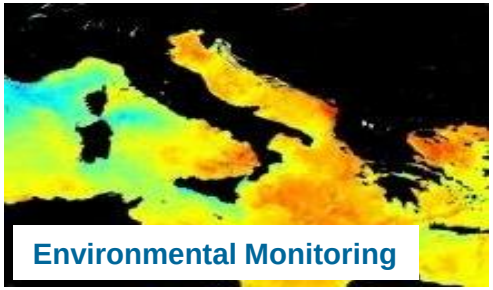
Planetek Activities



Spatial Data Infrastructure

INSPIRE
Infrastructure for Spatial Information in the European Community

Partnership

products

Master Dealer Italy

HEXAGON GEOSPATIAL

GeoMedia, Erdas Imagine, Imagine Photogrammetry, ER Mapper, Smart M.App, Apollo

Dealer

WORLDVIEW GLOBAL ALLIANCE™ AUTHORISED RESELLER

WorldView-3, WorldView-2, WorldView-1, GeoEye-1, QuickBird, IKONOS

AIRBUS DEFENCE & SPACE

Spot, TerraSAR-X, Pléiades

e-geos AN ASI/TELESPAZIO COMPANY

Cosmo-SkyMed

BLACKBRIDGE GEOMATICS

RapidEye

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Simplifying the complexity of space

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Dove si trova la complessità?

On Board Software	• OBP Data Processing • Real Time and Accurate processing
Ground Support Equipment	• Numerosità dei test e dei loro risultati
Ground and User Segment	• PDGS processing pipelines • System infrastructure • Accesso al dato

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Come rispondiamo

On Board Software	• Analisi algoritmica di dettaglio • Analisi informatica a basso livello • Semplificazione delle interfacce HW
Ground Support Equipment	• Automazione dei test • Semplificazione della verifica dei test

Ground and User Segment	• Valorizzazione delle nuove tecnologie
	  • basate su GPU
	  • di virtualizzazione

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On Board Software and Payload Data Processing

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On Board Software

OBP Data Processing and Compression

spacePDP – **Payload Data Processing**

- Available for different operational conditions, both for SW (RTEMS and VxWorks) and HW (LEON2 and 3, DSP, ARM)
- specifically designed IDE (Integrated Development Environment)
- Compression and Compressive sensing
- Clouds detection, Feature & Event detection, Debris Assessment, Autonomous tasking

- spaceOP3C – **On-board** Processing for hyperspectral **Compression** and Clouds Classification *(Patented)*

Attitude Determination and Control Systems

- spaceADM - **Attitude Determination Module**
  - Real time algorithm to evaluate satellite attitude
  - High precision estimates for different kind of satellites
  - Both on board and on ground

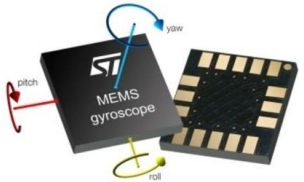
(Patent Pending)

On board Software

Innovative ADCS for mini and nano satellite and its applications

Algorithm based on the **Unscented Kalman Filter**

precisione	assi	EKF	SpaceADM
30arcsec	roll	69.92%	99.05%
	pitch	64.61%	99.31%
	yaw	69.27%	98.85%
20arcsec	roll	64.38%	93.70%
	pitch	58.39%	94.55%
	yaw	63.95%	93.77%
10arcsec	roll	57.77%	78.27%
	pitch	52.50%	78.78%
	yaw	58.19%	78.58%



SpaceADM ***is more effective both in terms of execution's speed and of error approximation***

Ground Support Equipment

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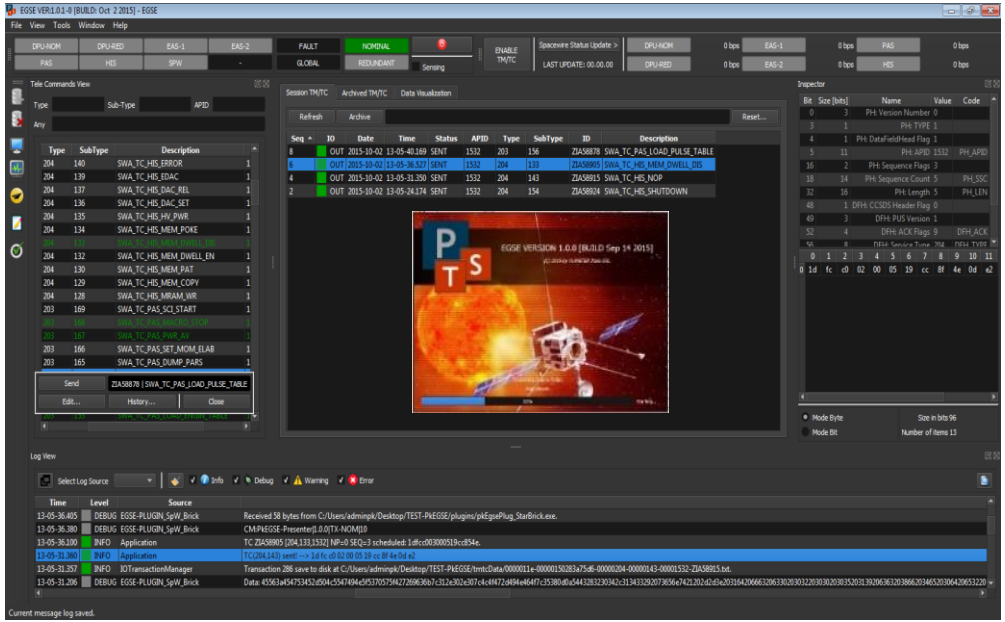
Ground Support Equipment

EGSE SW Front-End for Integration, Verification & Validation

- space Payload Test System
  - Off-the-shelf SW solution providing full front-end functionalities on top of a commercial HW platform
  - Native integration into a Central Check-out System (CCS)
  - Relied on the SCOS 2000 MIB
  - Supported languages: Python and Tcl/Tk

space PTS



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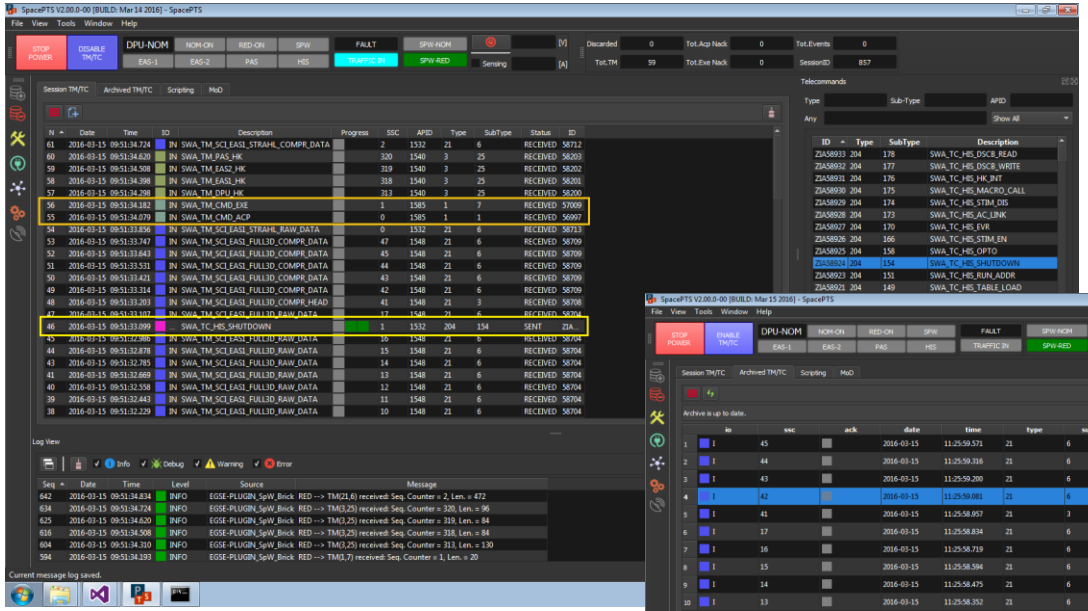
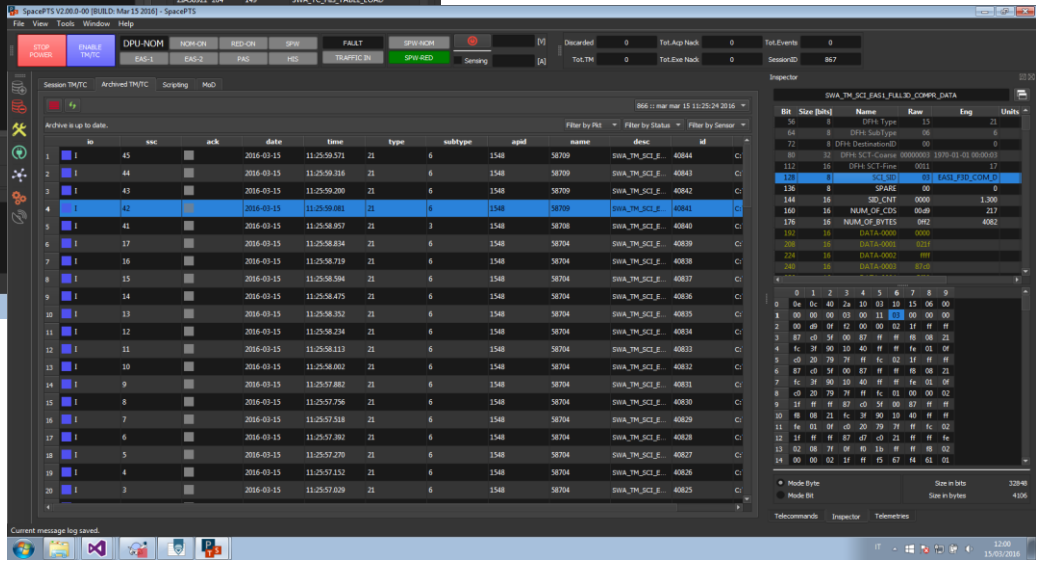
Ground Support Equipment

EGSE, GSE, Simulator & SCOE





TM/TC Management & Control

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Ground Support Equipment

EGSE, GSE, Simulator & SCOE

Parameters Display

SpacePTS V2.00.0-00 [BUILD: Mar 21 2016] - SpacePTS

File View Tools Window Help

STOP POWER | ENABLE TM/TC | DPU-RED | NOM-ON | RED-ON | SPW | EAS-1 | EAS-2 | PAS | HIS | FAULT | TRAFFIC IN | SPW-NOM | SPW-RED | [V] | Sensing | [A] | Discarded 0 | Tot.TM 0 | Tot.Acp Nack | Tot.Exe Nack

Session TM/TC | Archived TM/TC | Scripting | MoD

RUNNING | Save As

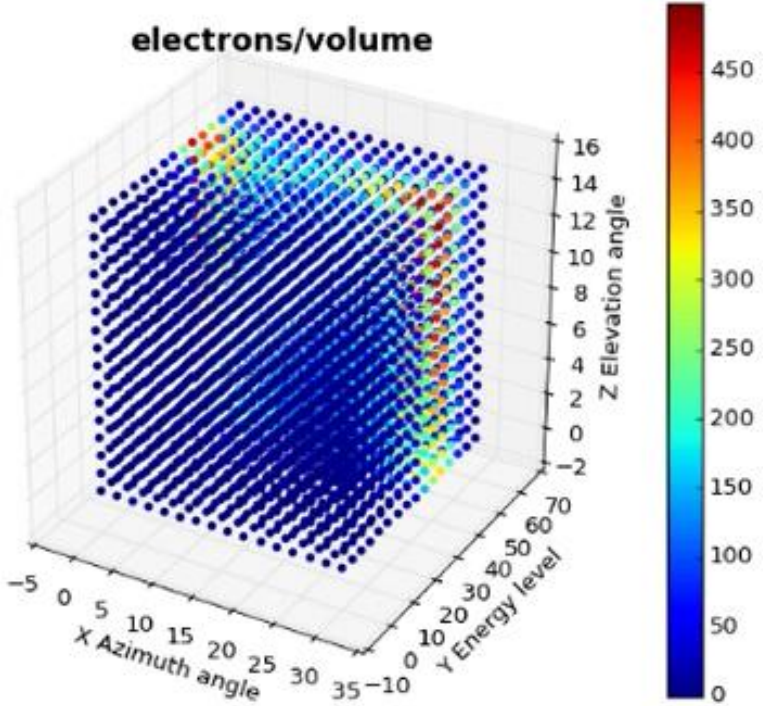
C:/SWA-DPU_EGSE/pyProcedures/PK_plotting_py27.py

```
1  '''
2  Created on 06/ott/2015
3
4  @author: adminpk
5  '''
6  from pyparsing import line
7  import numpy
8  from mpl_toolkits.mplot3d import Axes3D
9  import matplotlib.pyplot
10 from matplotlib import cm, matplotlib_fname, pyplot
11 import matplotlib
12
13
14 def plotting(path_file):
15     infile=open(path_file,mode='r')
16     endfile=True
17
18     size_elevation=16
19     size_energy=64
```

Transferring script to plugin...
Script running...

SpacePTS V2.00.0-00 [BUILD: Mar 21 2016] - SpacePTS

Figure 1

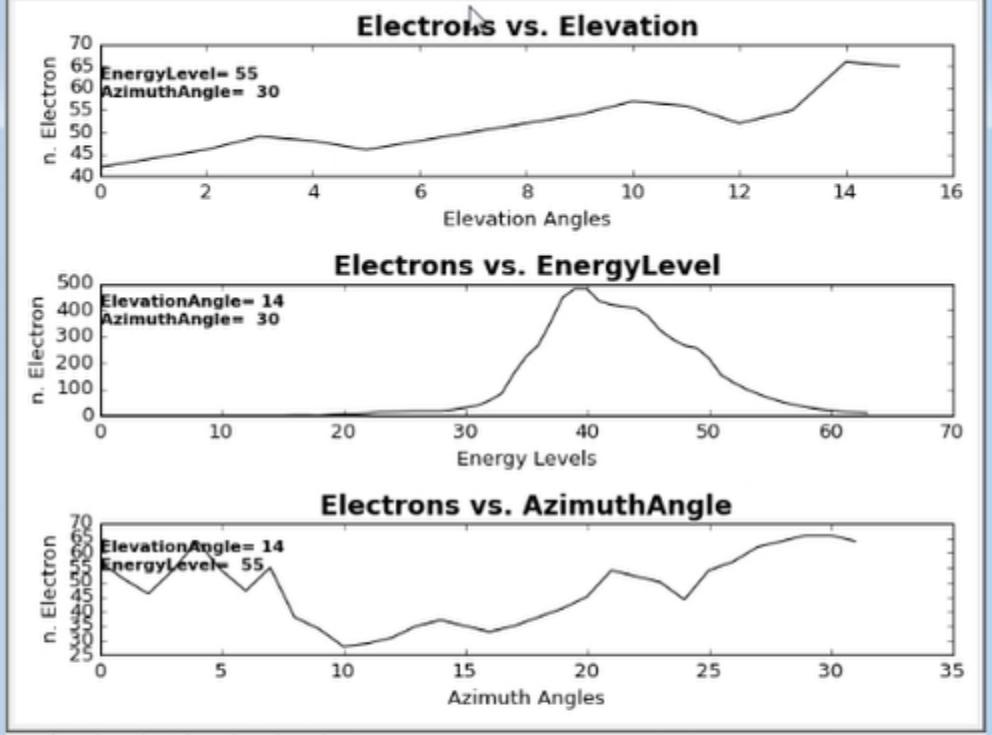


[V]
Sensing
[A]
Discarded 0
Tot.TM 0
Save As

Transferring script to plugin...
Script running...

SpacePTS V2.00.0-00 [BUILD: Mar 21 2016] - SpacePTS

Figure 3



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[A]
Sensing
Discarded 0
Tot.TM 0
Tot.Acp Nack 0
Tot.Exe Nack 0
Save As

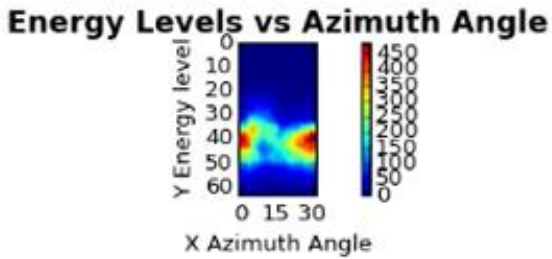
Transferring script to plugin...
Script running...

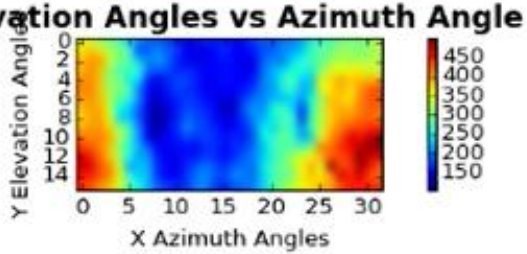
Log View
Info Debug Warning Error

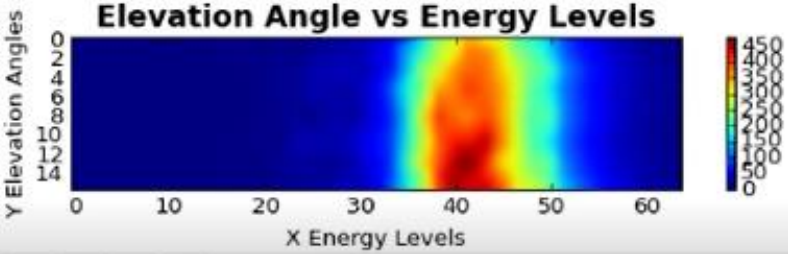
SpacePTS V2.00.0-00 [BUILD: Mar 21 2016] - SpacePTS

Figure 1

Figure 2







[V]
[A]
Sensing
Discarded 0
Tot.TM 0
Tot.Acp Nack
Tot.Exe Nack
Save As

Transferring script to plugin...
Script running...

Ground and User Segment

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Gli elementi chiave del Ground Segment

Interoperability

- Different Catalog, Data format, semantics, protocols….

Modularity & Scalability

- From the prototype to the continuos growth

Reliability

- From experimental to operational activities

Maintenability & Flexibility

- Design first

User Experience

- To take care of the user happiness; sometimes in real time. Big Data matter

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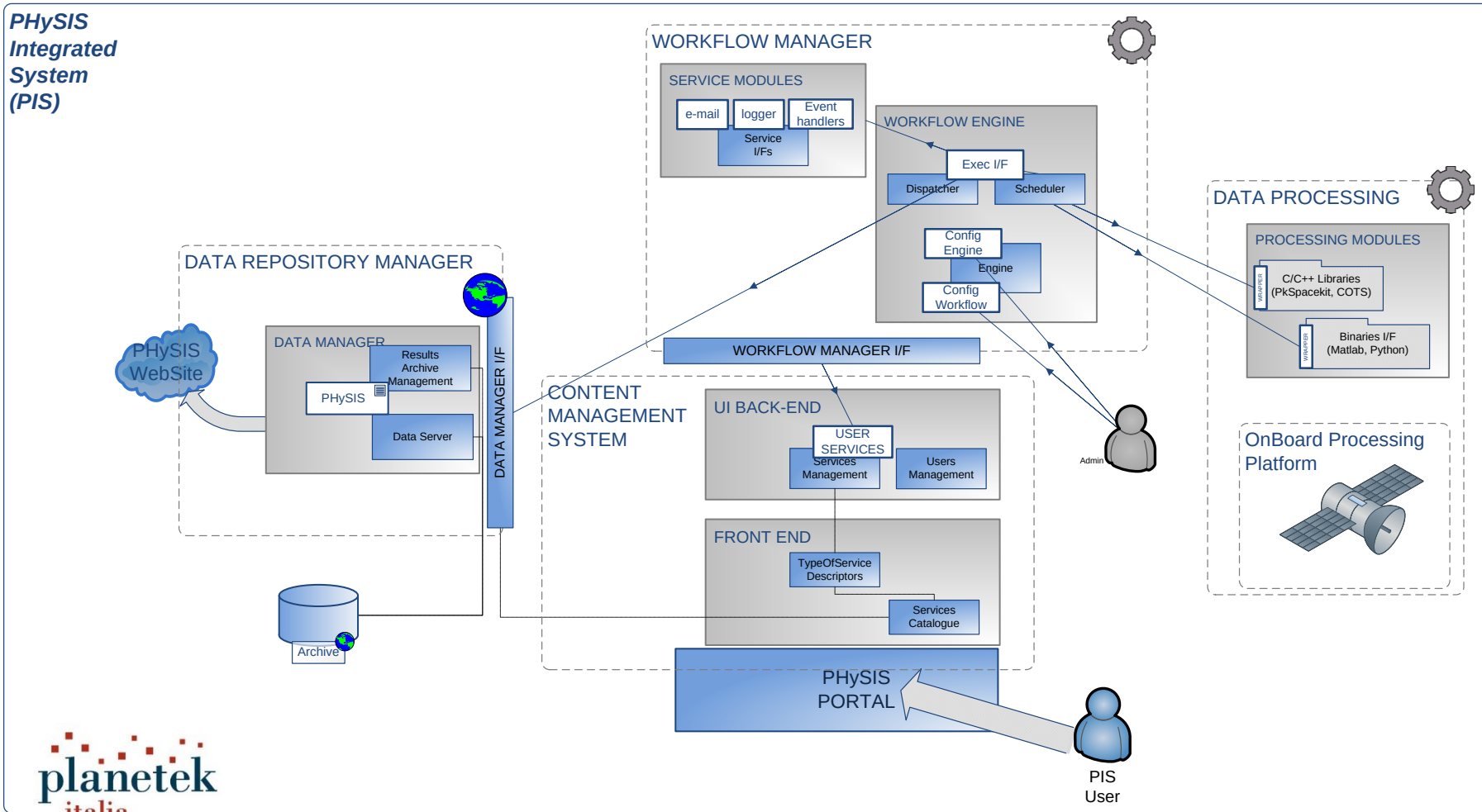
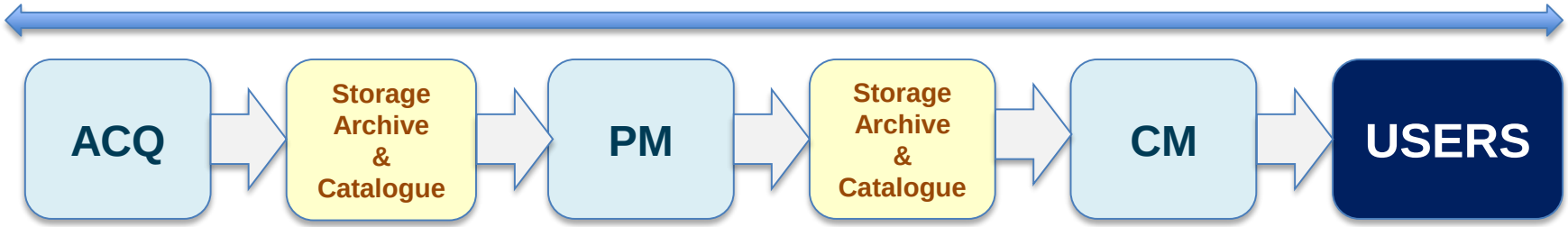
...Simplify the complexity of the Overall System…



Real Time?

- **SAR PDGS workflow**

30 seconds of acquisition need 60 minutes of processing -> target ONE minute



Acquisition and Deformatting

Level X Processing

Distribution

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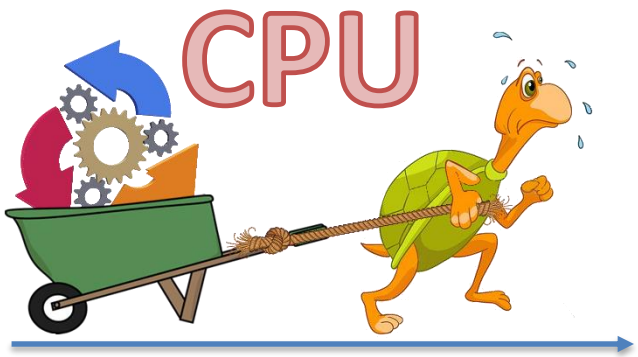
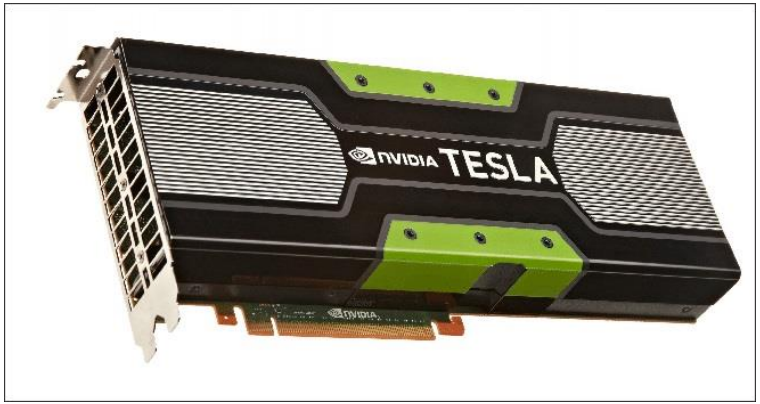
GPGPU is a solution!

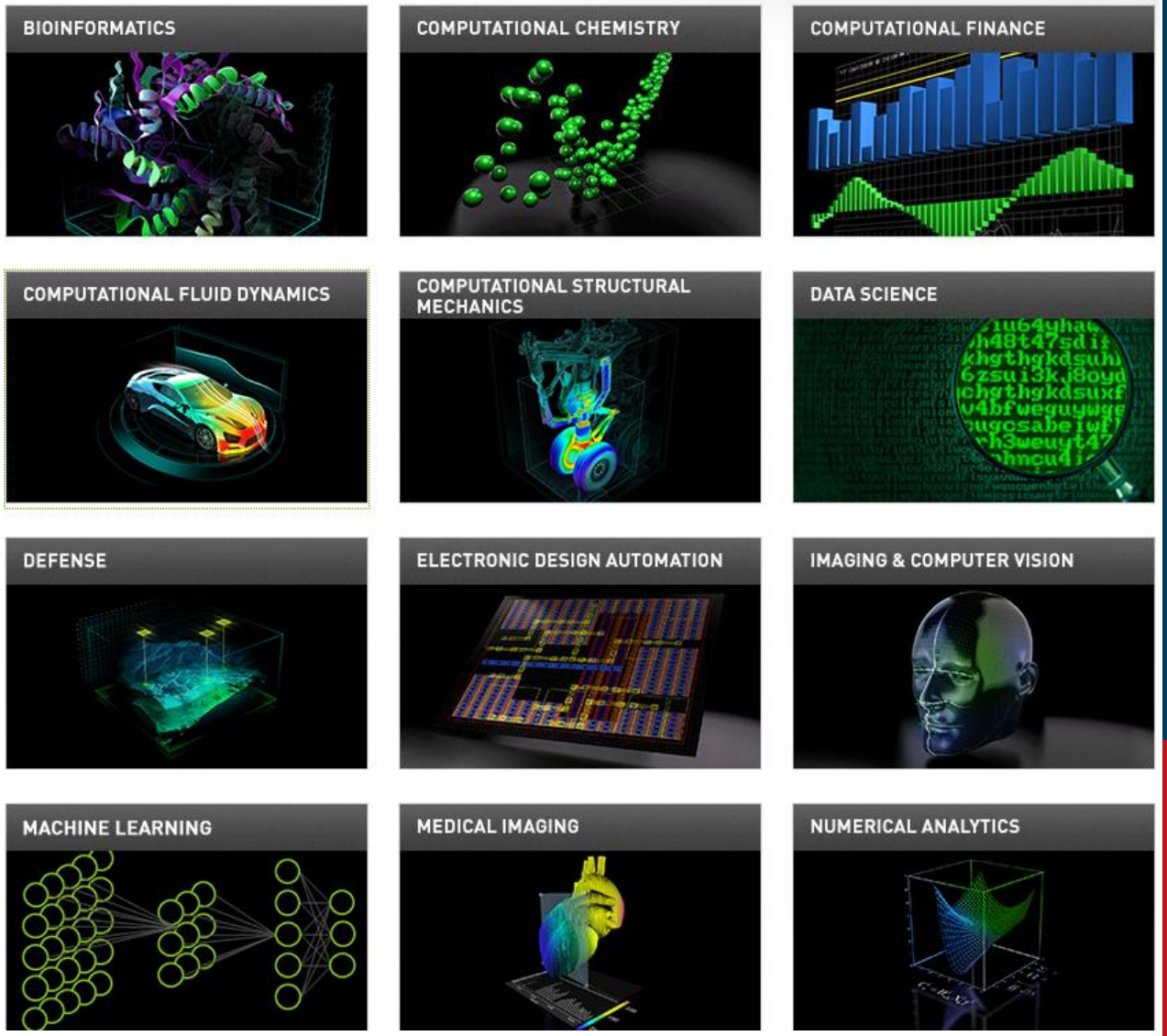




Compute capability	Thread processors	Clock (MHz)	Memory (MiB)	GFLOPs Single Precision	GFLOPs Double Precision
3.5	2880	745	12288	4290	1430

Our Goal

To promote the development of a community and of an EO SW library based on the use of GPU



IV ASI SME Tender: Navigation and Earth Observation

FAST4MAP

Fast & Advanced SAR Techniques for Monitoring & Alerting Processes

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The GOAL of FAST4MAP

- To develop a GPU based library for Earth Observation Data processing and application

- To develop a Transportable High Performance Computing Box *(HW plus SW)*
  - Design and prototype at your home
  - Operate at Data Home -> **Data Centric Processing**

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The Testing Platforms

CPU				N°core	RAM
A	E5-2603	1.80 GHz	64 bit	2	16,0 GB
B	i7-4510U	2.60 GHz	64 bit	4	8,0 GB
C	E5-2650L	1.70 GHz	64 bit	2 socket 10 core per socket	264,0 GB

GPU Fermi		Multi Processor Count	maxThreads PerMultiProcessor	maxThreadsPerBlock	maxGridSize	clockRate
W	GeForce 820M	2	1536	1024	65535	625 MHz
X	Quadro K2000	2	2048	1024	2^{31}-1	954 MHz
Y	Tesla K20c	13	2048	1024	2^{31}-1	706 MHz
Z	Tesla K40m	15	2048	1024	2^{31}-1	745 MHz

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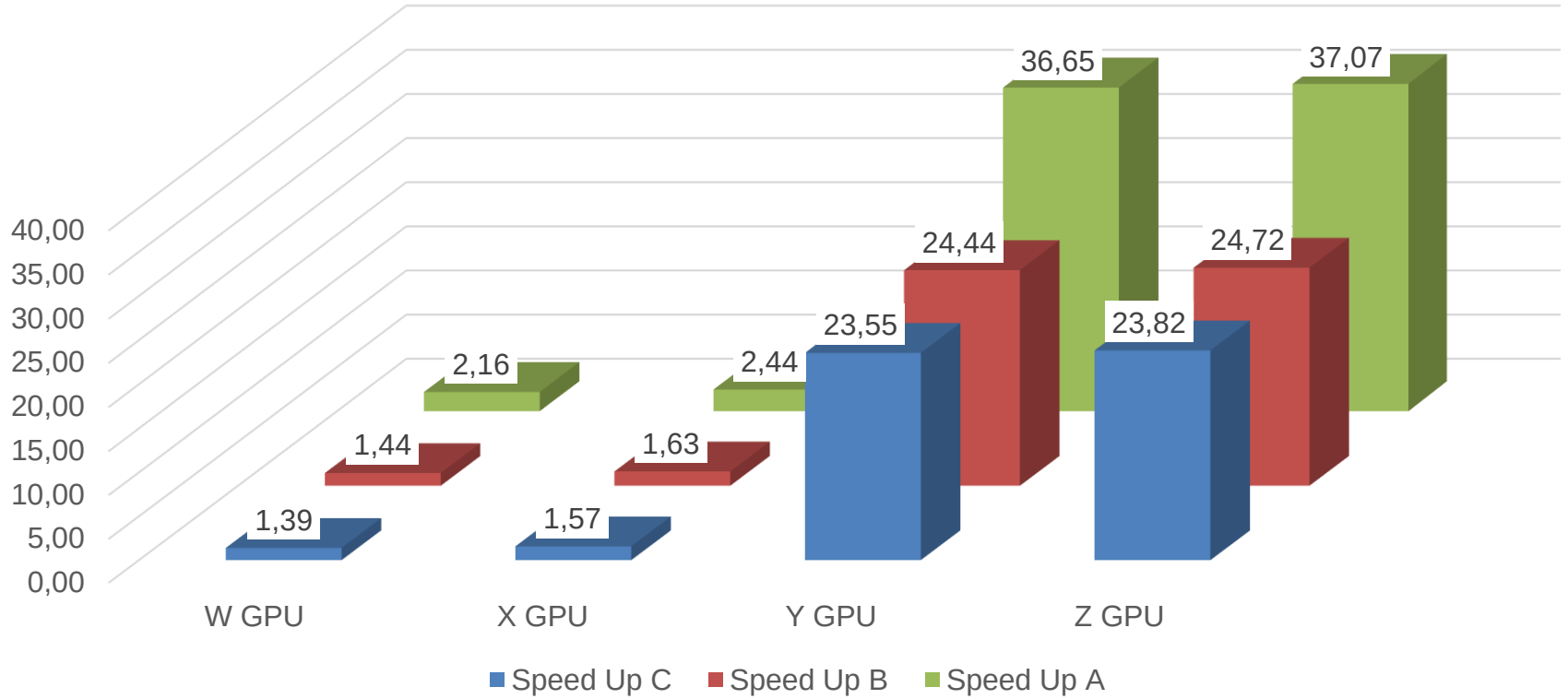
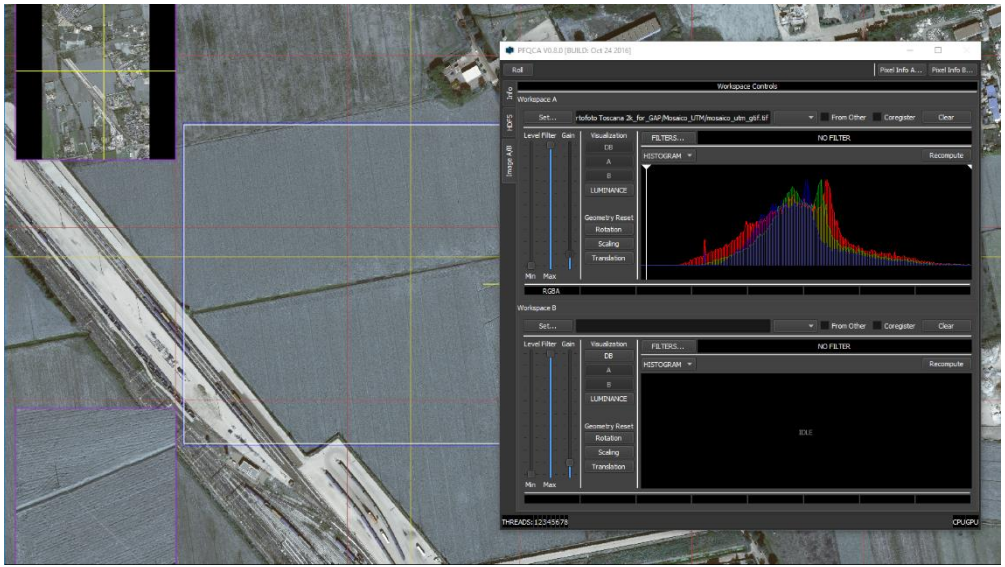
To reach 100 times faster…



SpaceBIT

Very Big Image Tool based on GPU

- Desktop application
- Big Image & Data visualization (HDF5 & Tiff)
- GPU based acceleration Engine (OpenGL, Vulkan, OpenCL, Metal) for real-time visualization, graphical operation, image filtering and processing
- Multi-display support
- Plugin architecture
- Open to other image formats
- Open to other image processing tool



spaceBIT video

Cosmic Exploration

- spaceSVT – **space Science Value Tool**
  - *Science Archive Publication System (SAPS)*

The <u>whole</u> archive of ***ESA Scientific Missions***

- spaceSDI – **space Spatial Data Infrastructure**
  - *Planetary Geosciences Information System*
  - *Planetary Radar Operational Center*
  - *Moon WebGIS*
  - *PLAAVI*

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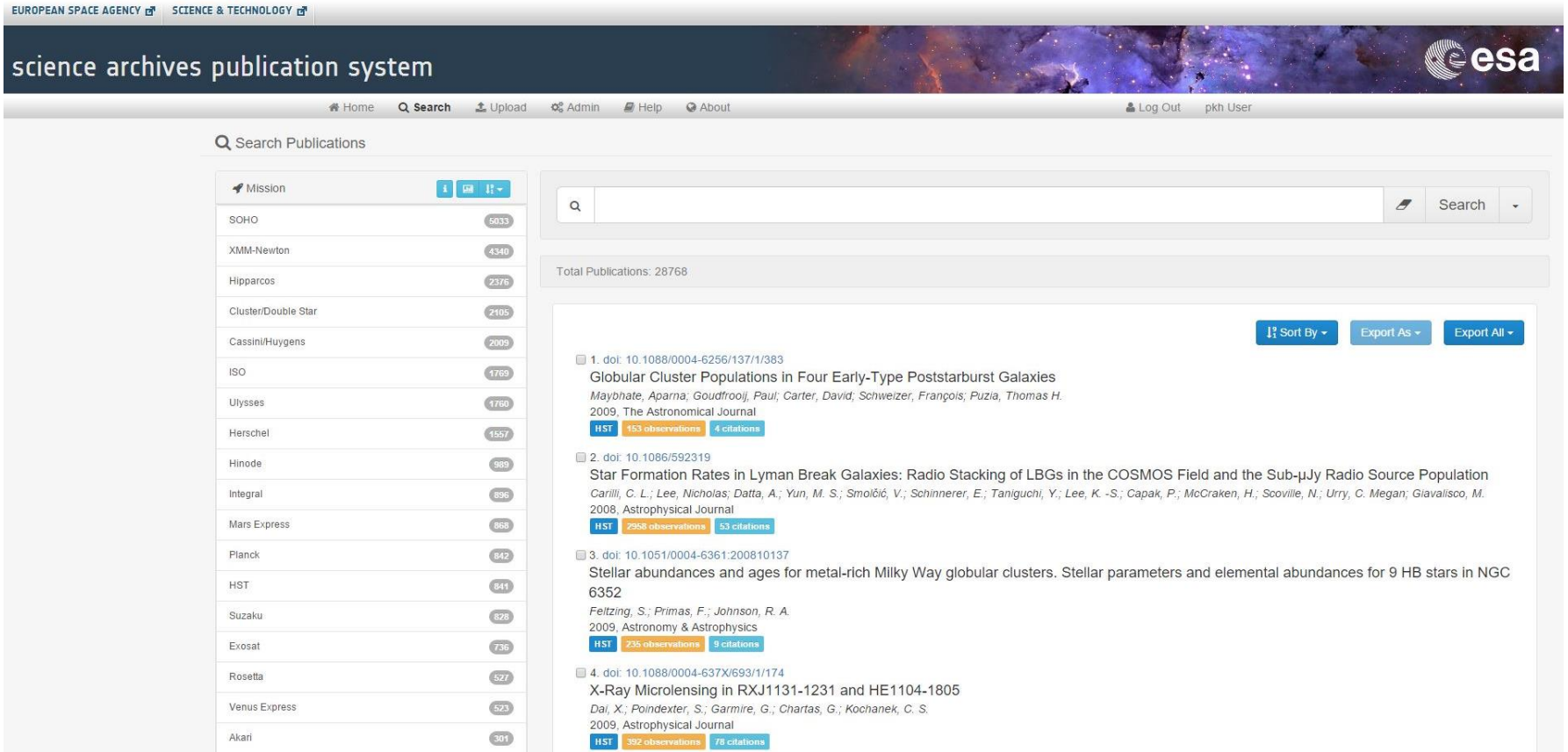
ESA SAPS - SpaceSVT



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ESA SAPS - SpaceSVT

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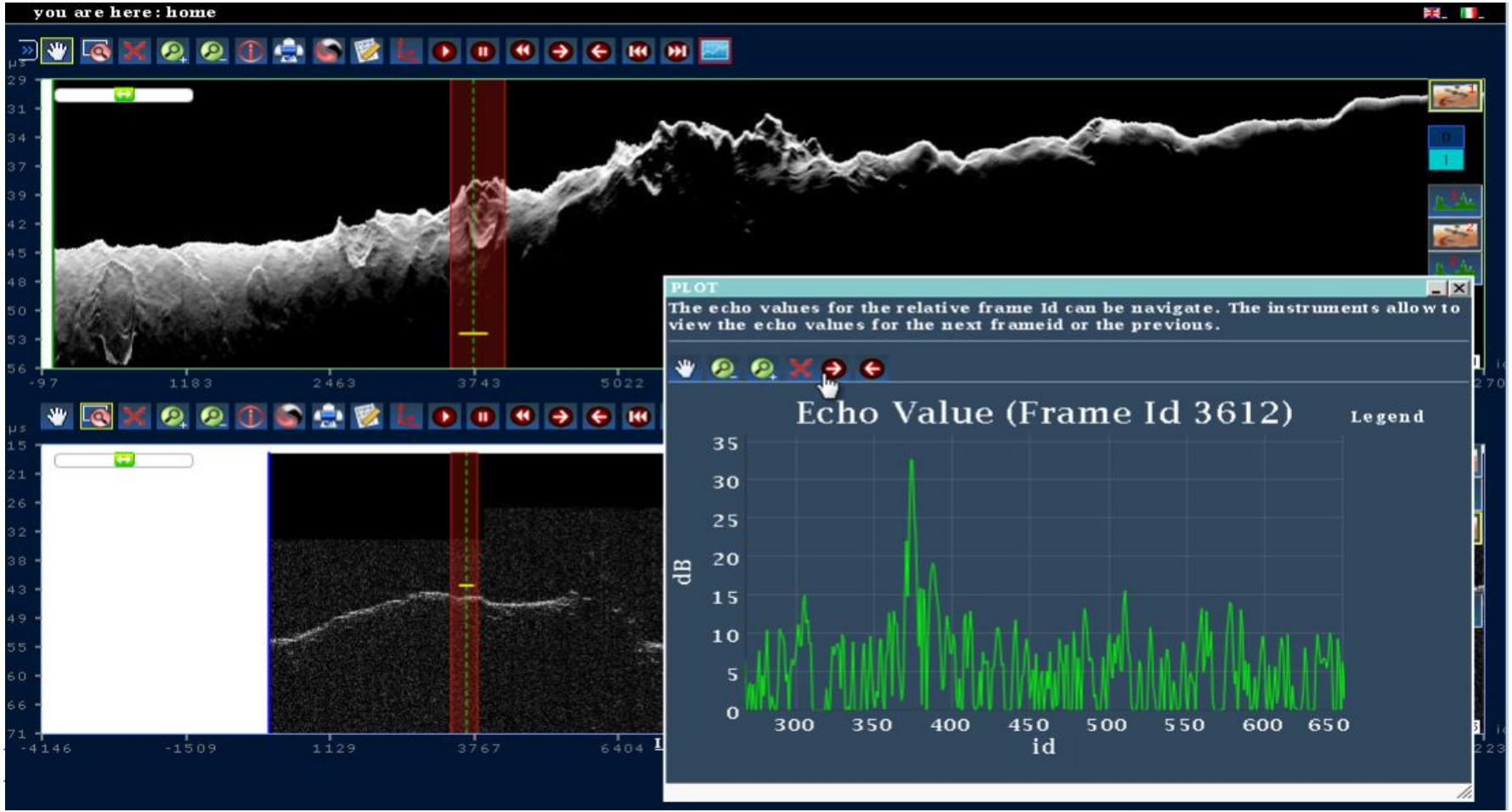
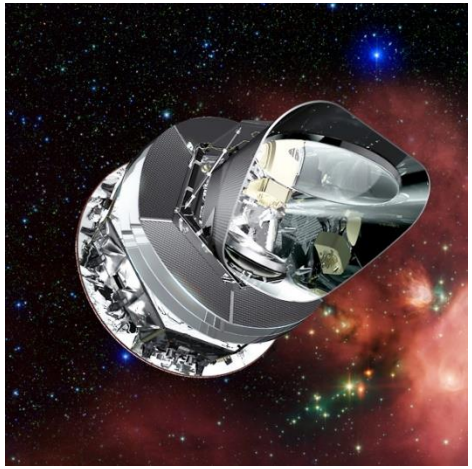
PROC (Planetary Radar Operational Center)



PLAAVI (Planck Legacy Archive Added Value Interface)

- Develop a **Web Application Portal** (front-end and back-end services) to provide additional functionality to the already existing Planck Dataset
- Develop 7 Added Value Interfaces:
  - Noise Map Cut-out
  - Effective Beam Averaging on Map Cut-out
  - Unit Conversion
  - Colour Correction
  - Planck Sky Model (PSM)
  - Map-making
  - Component separation



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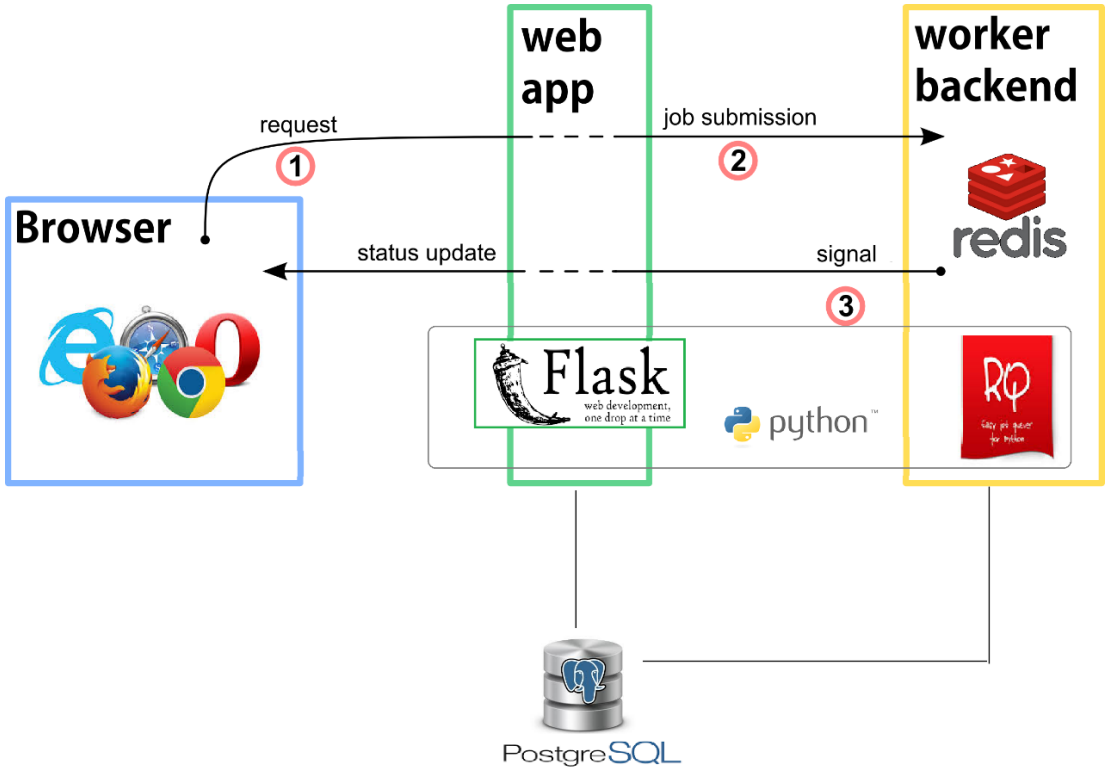
System Design – Functions and Technologies

1. Users send requests through web browser
2. Web application layer submits jobs to remote server, decoupling client interface from backend worker
3. Backend worker responds to client layer enqueuing job and updating request status



Flask → web microframework for building web applications with Python

Redis → key-value storage database can be used to host queues

RQ (Redis Queue) → simple Python library for queueing jobs and processing them in the background with workers

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PLAAVI video

Thank you!

For further information

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