

VisIVO  
VisIVO



INAF



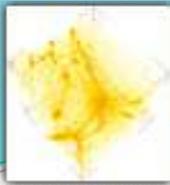
ITALIAN NATIONAL ASTRONOMICAL INSTITUTE

# Exploiting DCIs for Visualisations in Astrophysics: **VisIVO Science Gateway and VisIVO Mobile**

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VisIVO Team – Team Leader Ugo Becciani  
INAF- Astrophysical Observatory of Catania



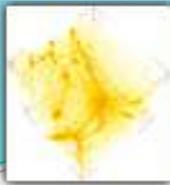
## Motivations

- Several TBs are often generated by modern cosmological simulations and large-scale astrophysical observations are stored in archives. Such large data volumes pose significant challenges in terms of data **analysis**, **storage** and **access**; a critical step forward in understanding, interpreting and verifying their intrinsic characteristics can be achieved through **visualization**.
  - **DCIs access**
- Multiple users need to **share** visualization experiences, by interacting simultaneously with astrophysical datasets giving feedback on what other participants are doing/seeing.
  - **Collaborative environment**
- The **reproduction** of specific visualization results is a challenging task as selecting suitable visualization parameters may not be a straightforward process.
  - **Workflow-driven application**



## Outline

- ❖ Background
  - Visualisation and Analysis Tools
- ❖ VisIVO Science Gateway
  - Portlets and workflows
- ❖ VisIVO Mobile
- ❖ A Case Study: Muon particles visualisation
- ❖ Supplementary Material



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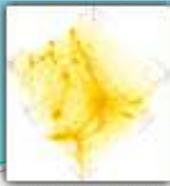


## VisIVO Tools

- Multidimensional Data Exploration →
  - Discovery of unknown data characteristics
  - Searching for:
    - *Outliers*
    - *Characteristic regions*
    - *Special properties*
- Large astrophysical datasets as well as any other multidimensional tabular data from other communities.

VisIVO is designed to deal with large datasets. It supports many types of data formats:

- HDF5, VOTables, Binary Tables, Ascii , csv, fits...



# VisIVO



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## VisIVODesktop

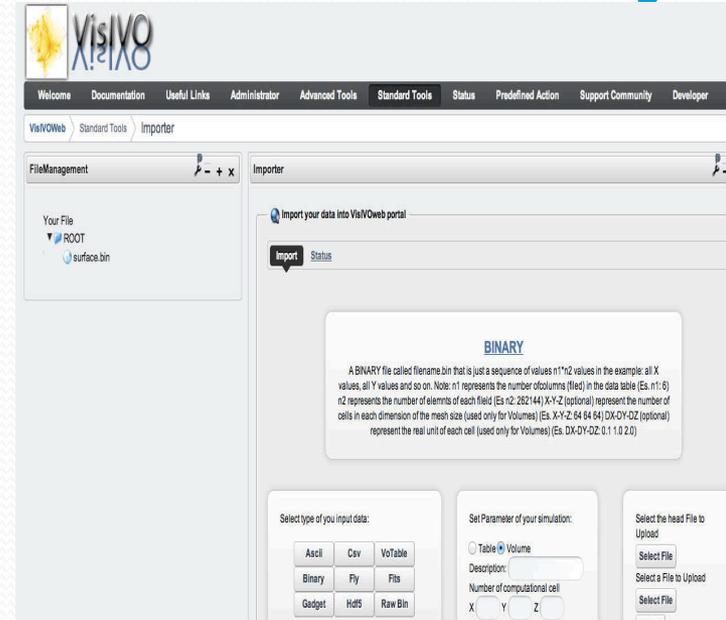
## VisIVO Server

```
--fformat votable /home/user/
demo/vizier.xml
```

```
.....
--x x --y y --z z --color --colortable
--colorscalar scalar0 --glyphs
sphere
```

Linux Mac Windows

## VisIVO Science Gateway



## VisIVOMobile

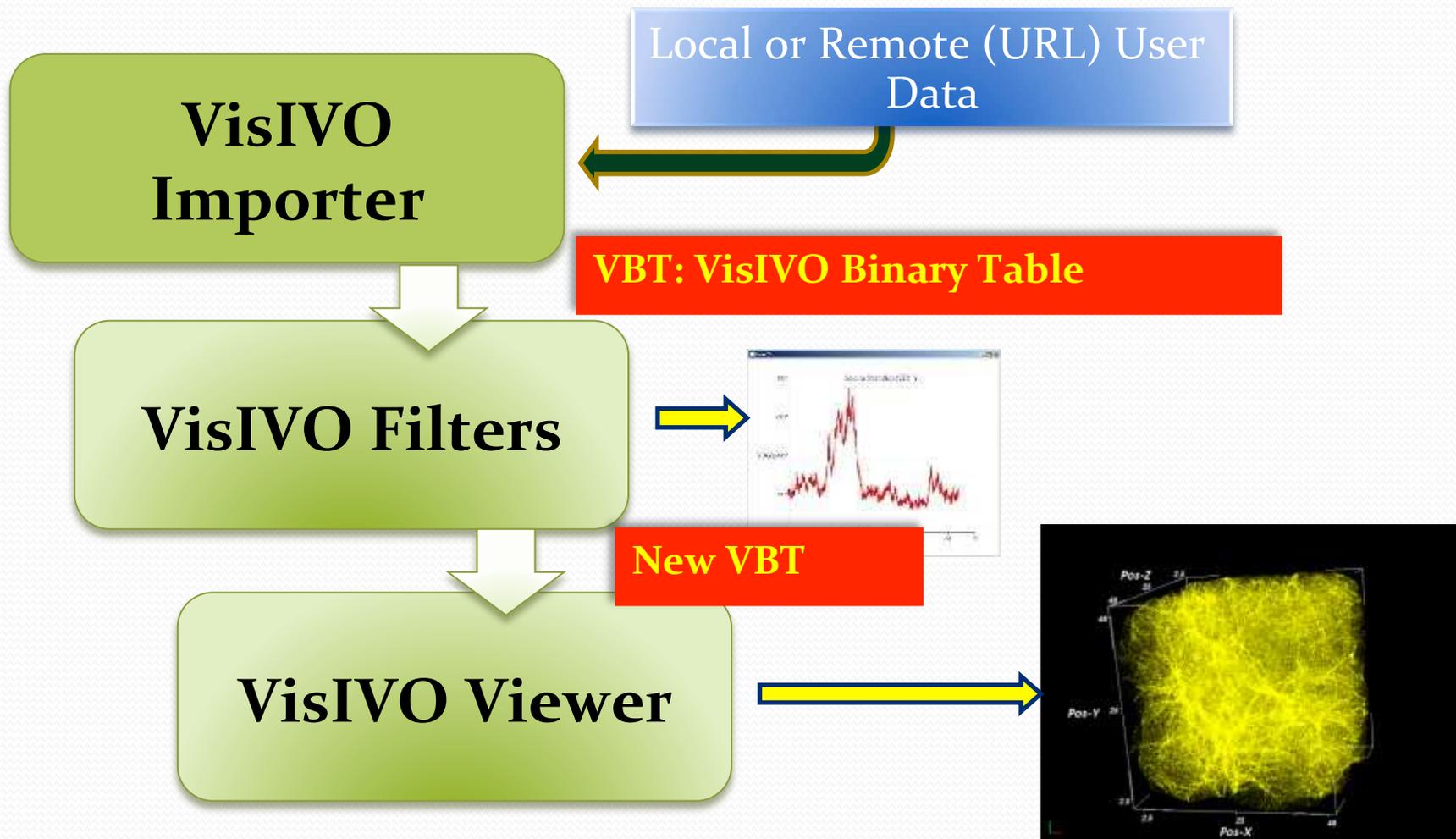


## VisIVO C/C++ Library

*Closely integrated, complementary and independent !*



## VisIVO Core Tools



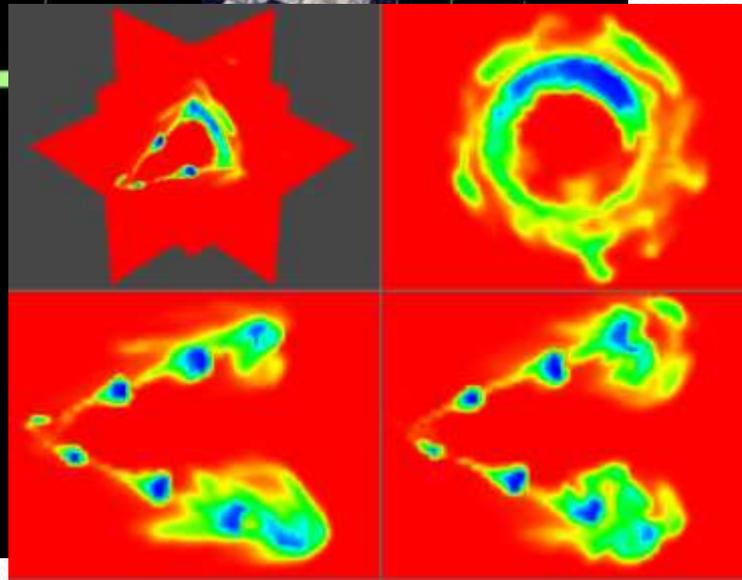
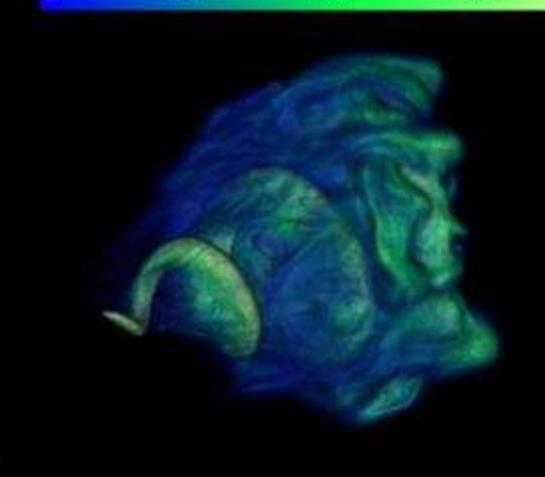
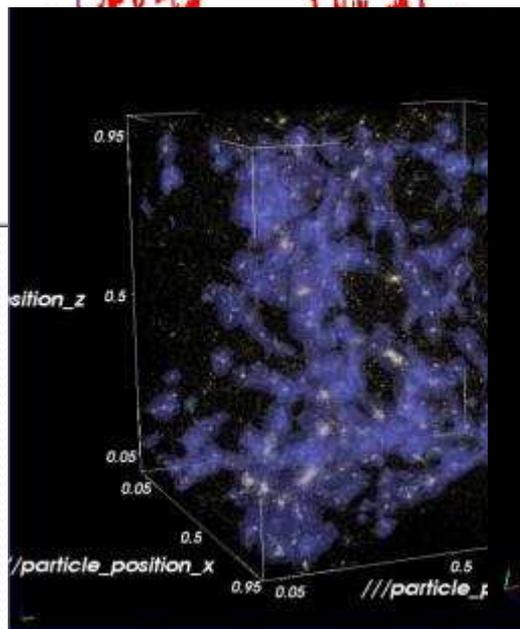
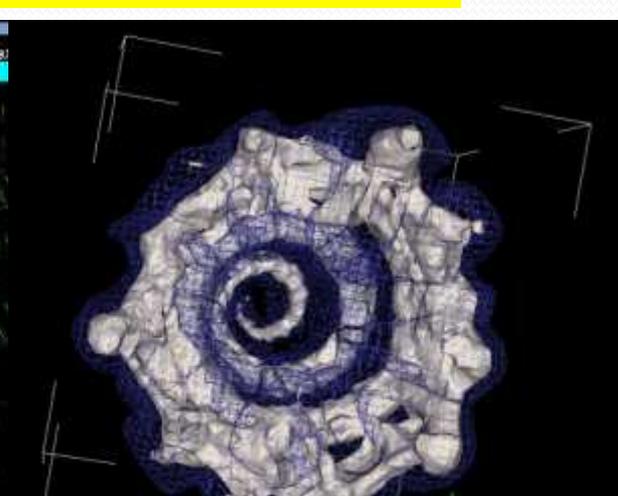
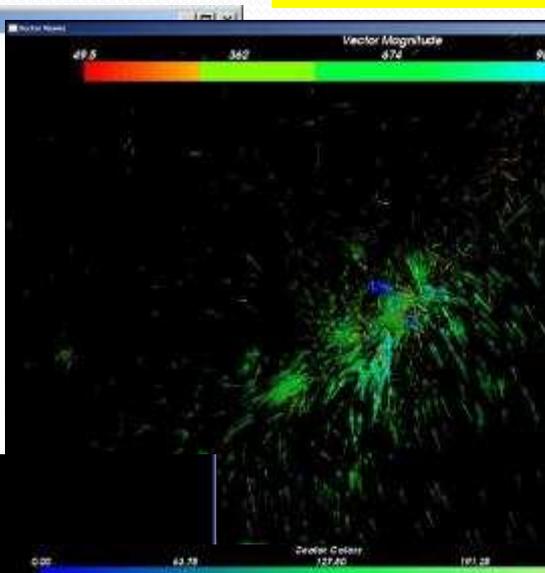
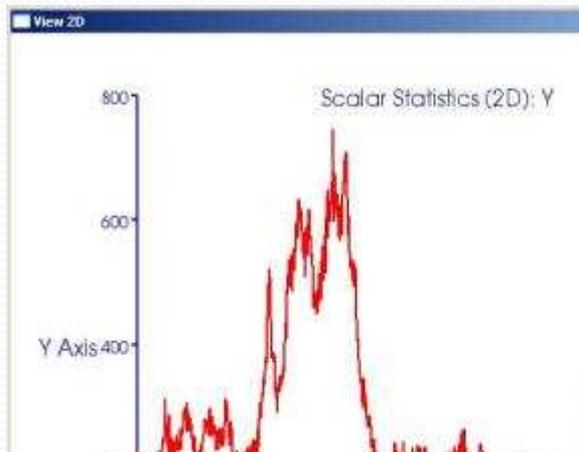


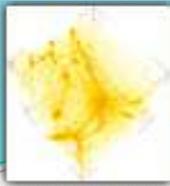
# VisIVO

Navigation -- Zoom -- Palette --  
Algorithms -- Data selection --  
Picker op.



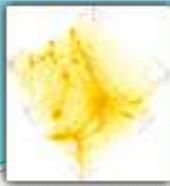
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## VisIVO Gateway

- The VisIVO Science Gateway is designed as a workflow enabled grid portal that is wrapped around **WS-PGRADE/gUSE** providing visualization and data management services to the scientific community.
- The gateway offers role-based authorization modules and supports login with user name and password.



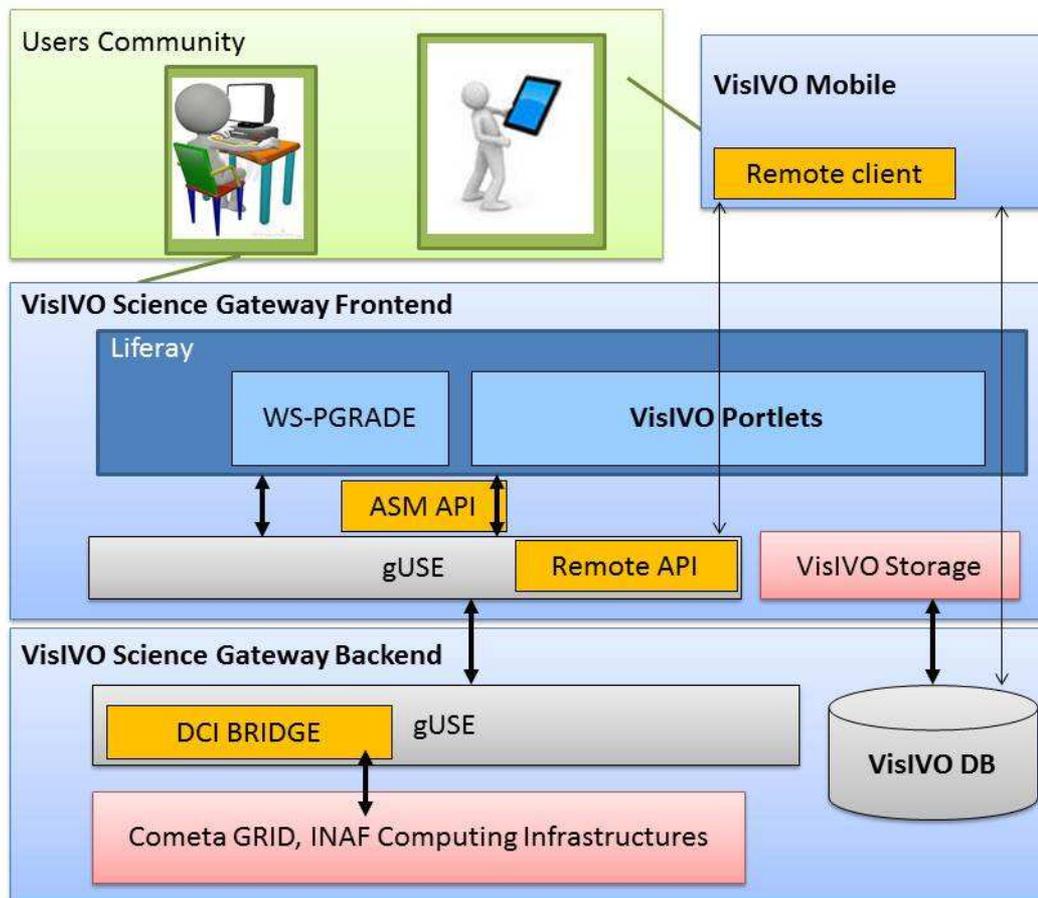
**Standard User** uses Workflow developed by a “workflow developer” via a web GUI.

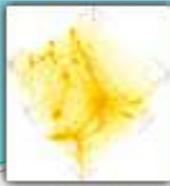
**Advanced User**, can develop and configure workflow. All WS-PGRADE/gUse functionalities are available.





# Architecture





## Infrastructures

- 2 X Server Intel Xeon 3060 2.4 GHz, Dual-Core, 2 GB RAM - Total storage: 23 TB
- Server Intel Xeon 3050 2.13 GHz, Dual-Core, 2 GB RAM - Total storage: 8 TB
- **Hybrid system** cpu-GPU, N 2: Intel(R) Xeon(R) CPU E5620 @ 2.40GHz, **24 GB RAM** DDR3-1333 NVIDIA TESLA C2070, **448 cuda core** + 6 GBRam
- **Trigrig Cluster** - AMD Dual Opteron 280 2.4 GHz, 14 Blades with 4 cores with 8 GB RAM / Blade (**52 CPU core**) - Total storage: 3.7 TB (lsf)
- **COMETA grid** – gLite nodes ~1500 CPU/core (**250 hosted at INAF-OACT**) AMD Dual Opteron 280 2.4 GHz (**jdl**) – Total storage: **8 TB**



## Portlets...

**FileManagement**

Your File

- ROOT
  - my data
    - surface.bin
    - clusterfields4.ascII
    - starmap.out
    - myData
  - Pictures
    - pointView
    - vectorview
    - splotchView
    - surface.bin.png
  - Movie
    - dataMovie
    - myMovie2
    - myMovie1

Context menu for 'surface.bin':

- Rename
- Properties
- Delete
- Filter
- View**
- Customized Movie

**Import Local or Remote User Dataset**

VisIVO Importer

**BINARY**

A BINARY file called filename.bin that is just a sequence of values n1\*n2 values in the example: all X values, all Y values and so on.

Note:  
 n1 represents the number of columns (fields) in the data table (E.g. n1: 6)  
 n2 represents the number of elements of each field (E.g. n2: 202144)  
 X\*Y\*Z (optional) represent the number of cells in each dimension of the mesh size (used only for Volumes) (E.g. X\*Y\*Z: 64 64 64)  
 DX-DY-DZ (optional) represent the real unit of each cell (used only for Volumes) (E.g. DX-DY-DZ: 0.1 1.0 2.0)

Select the type of your input data

Ascii	Csv	VoTable
Binary	Fly	Fits
Gadget	Hdf5	Raw Bin

Set parameter of your simulation

Description: \_\_\_\_\_

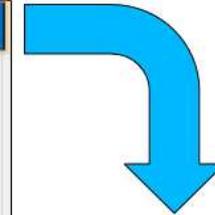
Number of Computational Cells

X: \_\_\_\_\_ Y: \_\_\_\_\_ Z: \_\_\_\_\_

Cell Sizes

X dim: \_\_\_\_\_ Y dim: \_\_\_\_\_ Z dim: \_\_\_\_\_

Select a File to Upload



**Filter Imported VBTs**

VisIVO Filters

The selected VBT is starmap.out

Please select an operation:

Cartesian 2 Po

Cartesian 2 Polar

This filter creates three new columns with names given in Column name for fields as the result of the spherical polar transformation of three existing columns given in Columns for point coordinates fields. A new table is created if the New Table option is selected.

Z: dark

Phi: \_\_\_\_\_

**Produce 3-D Images**

VisIVO Viewer

View your data into VisIVOweb portal : surface.bin

Field: density

Volume rendering:  Shadow

Isosurface:   Slider: \_\_\_\_\_

Isosurface Counter Value (0-255): 125

Basic Palette

BackColor: Black Forecolor: White

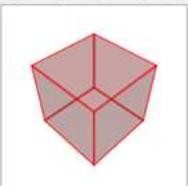
Show Palette  Show Box  Show Axes  Stereo

Image size: Medium

Amuth: 45 Elevation: 45 Zoom: 1

FRONT LEFT RIGHT DOWN UP BACK

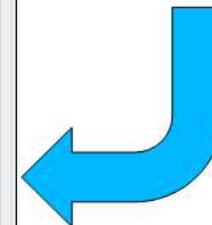
Save





Viewer Param File

Change Amuth and Elevation values using your mouse to drag the 3-d cube.  
To zoom in and out, hold the shift button and again drag the model.





### FileManagement

[Help](#)

Your Files

- ROOT
  - clusterfields4.ascII
  - MyCosmoData
    - snap.le\_type2GAS\_Randomizer
    - snap.le\_type2GAS\_Randomizer\_1.png
    - snap.le\_type2GAS\_Randomizer\_1.png.mp4
    - snap.le\_type2GAS
    - snap.le\_type2GAS\_1.png
    - snap.le\_type2GAS\_1.png
    - snap.le\_type2HALO

**Context Menu:**  
Rename  
Delete  
View  
**Panoramic Movie**

### Generate Movie

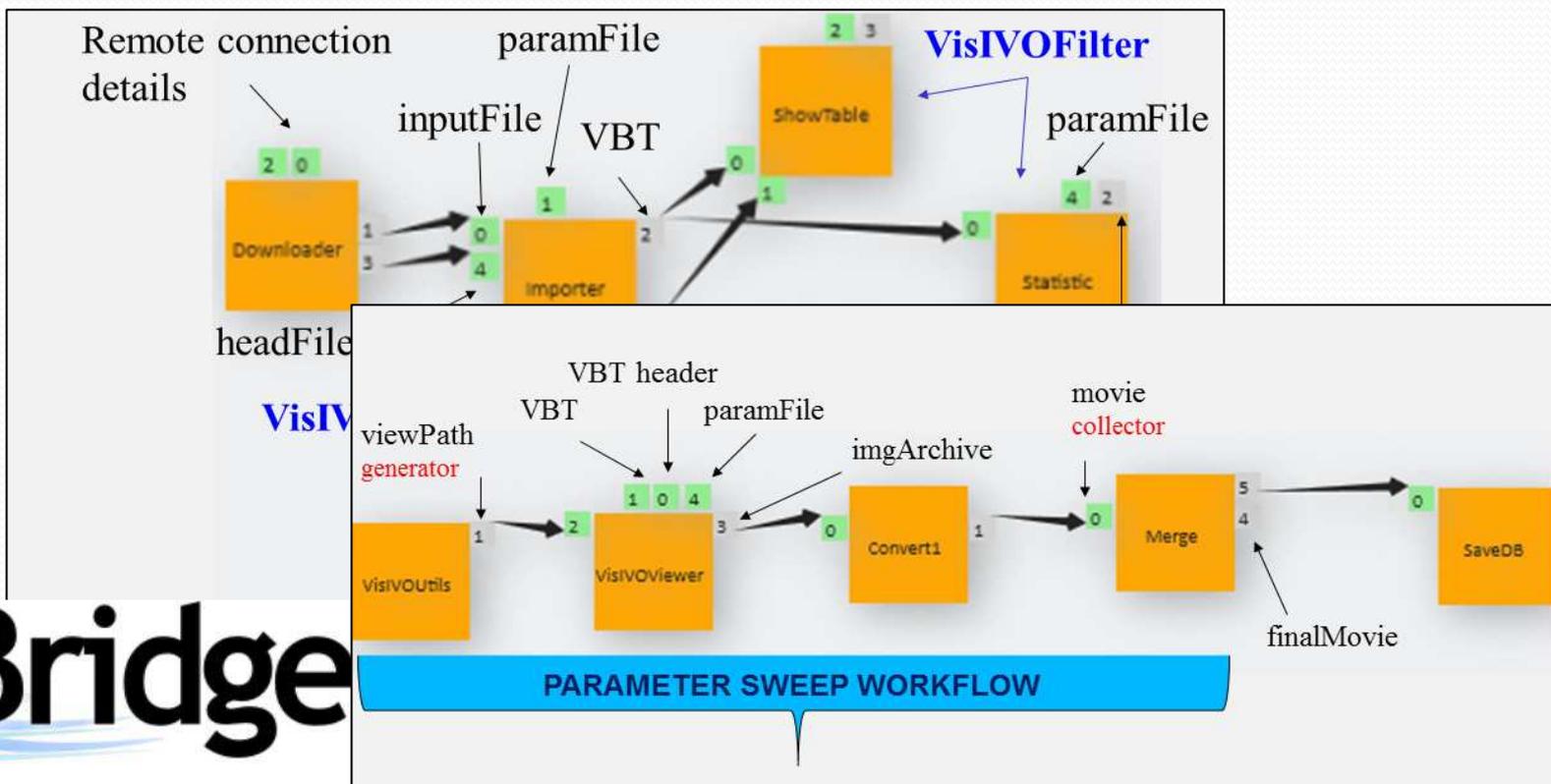
**Buttons:**  
Panoramic Movie    Dynamic Movie

A Panoramic Movie creates a movie rotating the camera around the cluster.

**Buttons:**  
Panoramic Movie

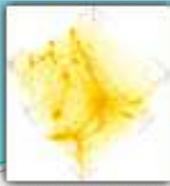


## ... and workflows



# DCI Bridge





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# VisIVO



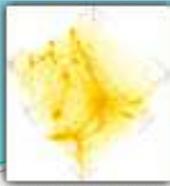
INAF



www.inaf.it

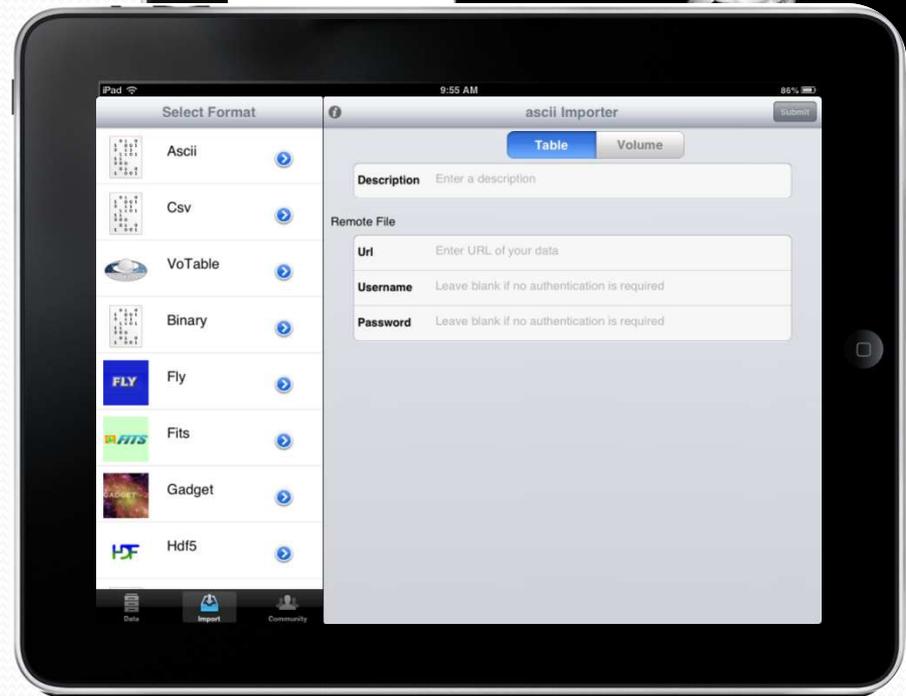
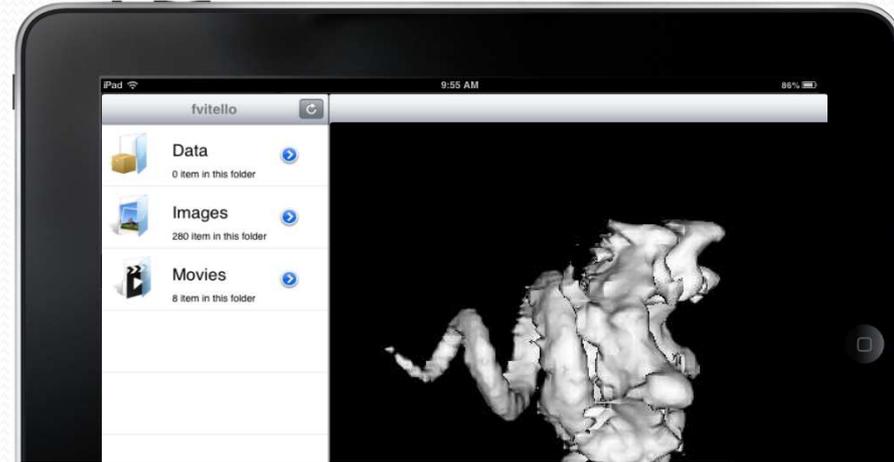
# VisIVO Mobile

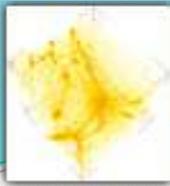




## VisIVO Mobile

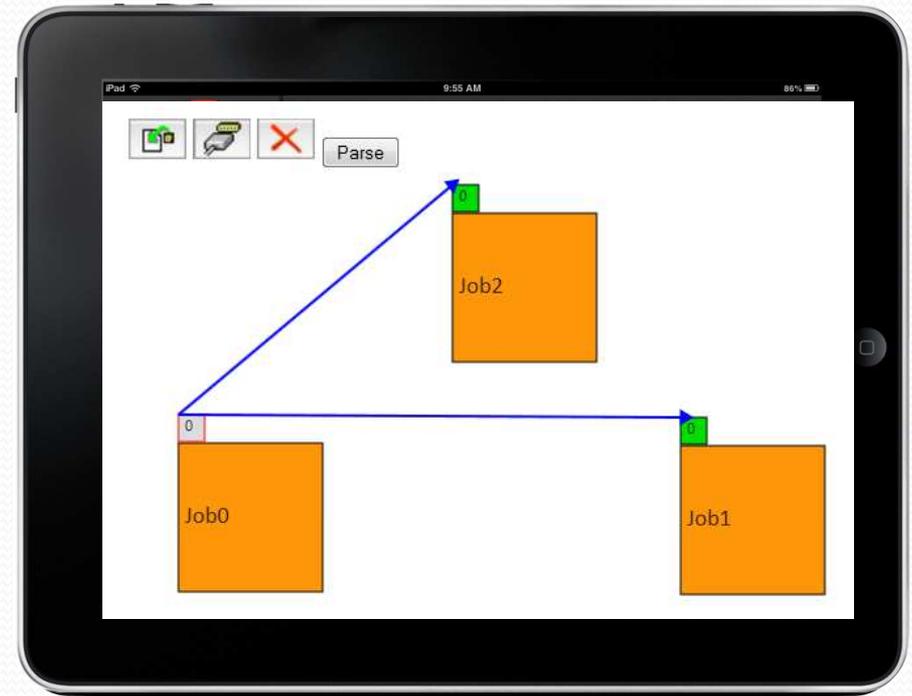
- Navigate through the data produced on the VisIVO Science Gateway: view produced images and scientific movies;
- Interactive 3D view of the dataset;
- Submit existing workflows;

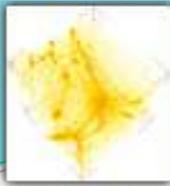




## VisIVO Mobile

- Navigate through the data produced on the VisIVO Science Gateway: view produced images and scientific movies;
- Interactive 3D view of the dataset;
- Submit existing workflows;
- Create new workflows using the graph editor





visivo

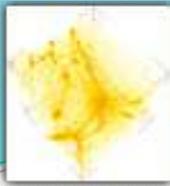


INAF



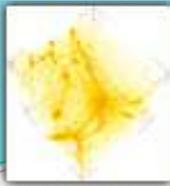
# A short demo

<http://visivo.oact.inaf.it:8080>



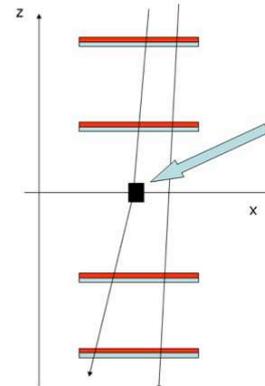
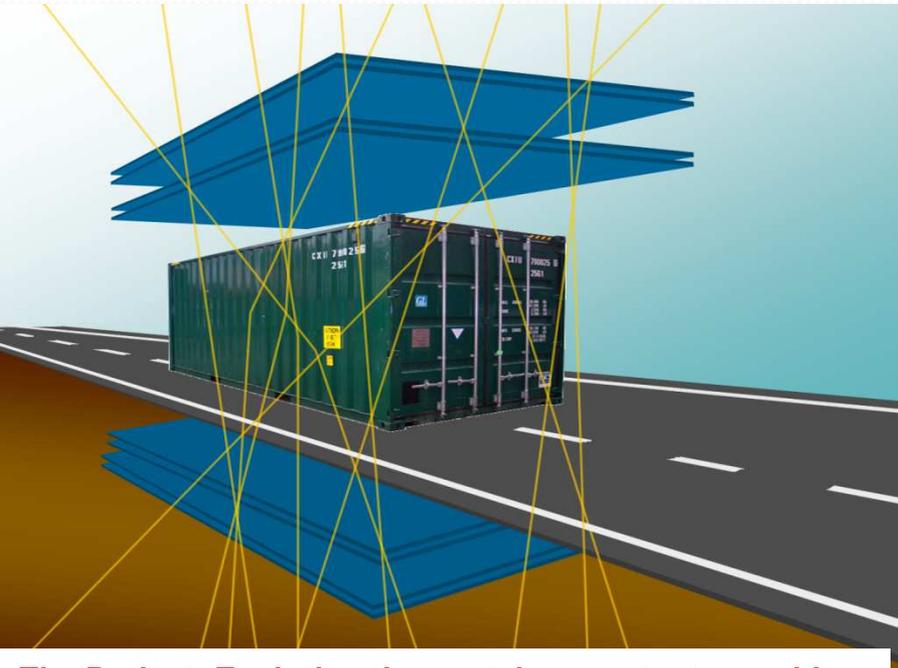
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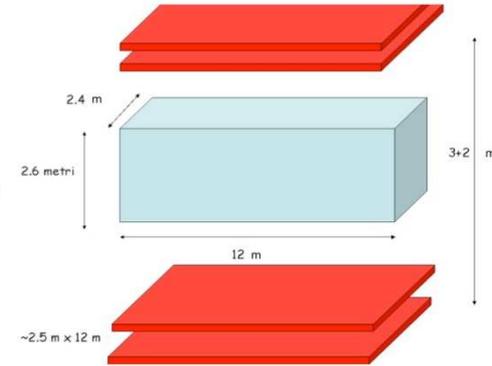


# VisIVO

# Muons Analysis



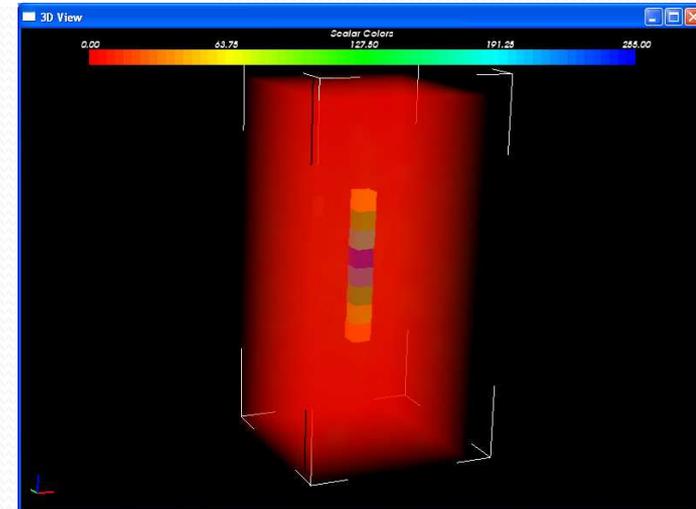
Heavy element in a box.  
(10 cm x 10 cm x 10 cm)



Prototype → muon track deviation

**The Project: Exploring the container content searching for nuclear material (uranium, plutonium)**

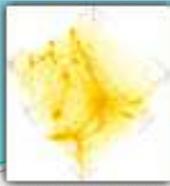
Compute: coordinates and deviation angle that the muon track has when high-Z material element is in the path.



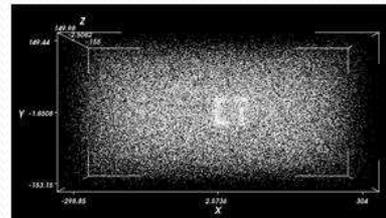


## Muon Analysis

- Input: data file containing the coordinates on the muon tracker planes (4 planes, 6 x 3 meters).
- Main processing steps:
  - POCA (Point of Closest Approach) algorithm to obtain the VBT containing the scattering deflection of cosmic radiations.
  - Noise filtering.
  - 3D Cloud-in-Cell (CIC) smoothing algorithm to obtain a volume dataset.
- Output: images and movies of the filtered and unfiltered datasets.

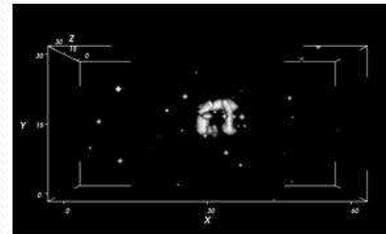
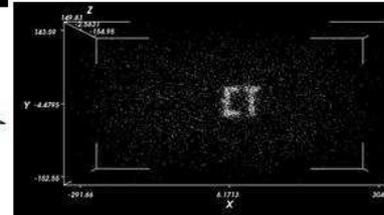


# Results



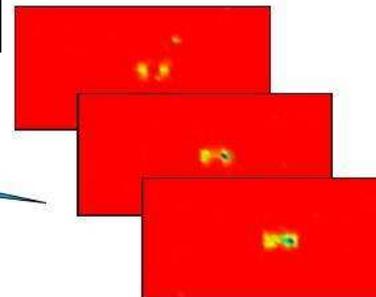
Step 1. Point visualization

Step 2. Filter application:  
**Select Rows**



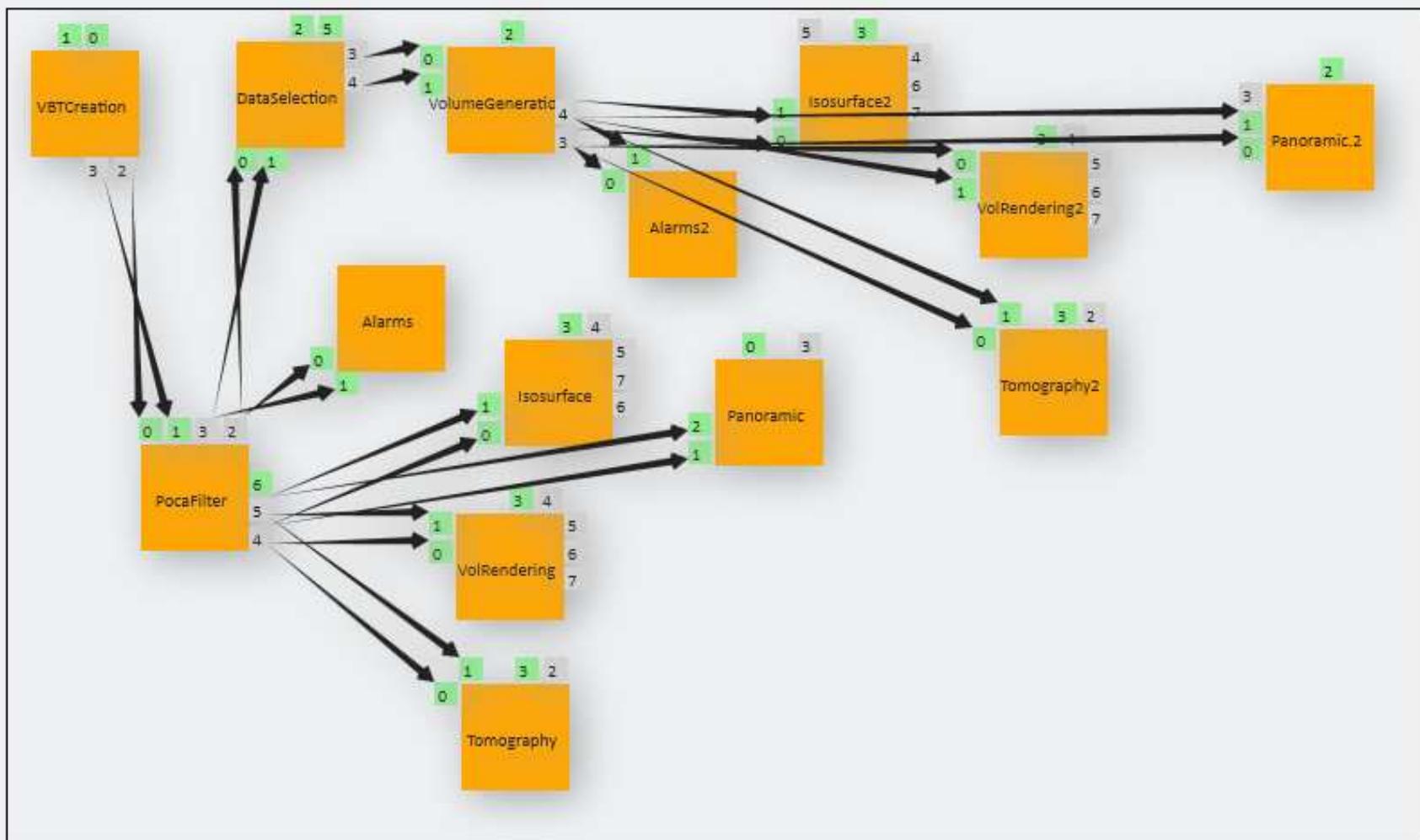
Step 3. Filter application:  
**Point Distribute**

Step 4 Volume tomographies visualization





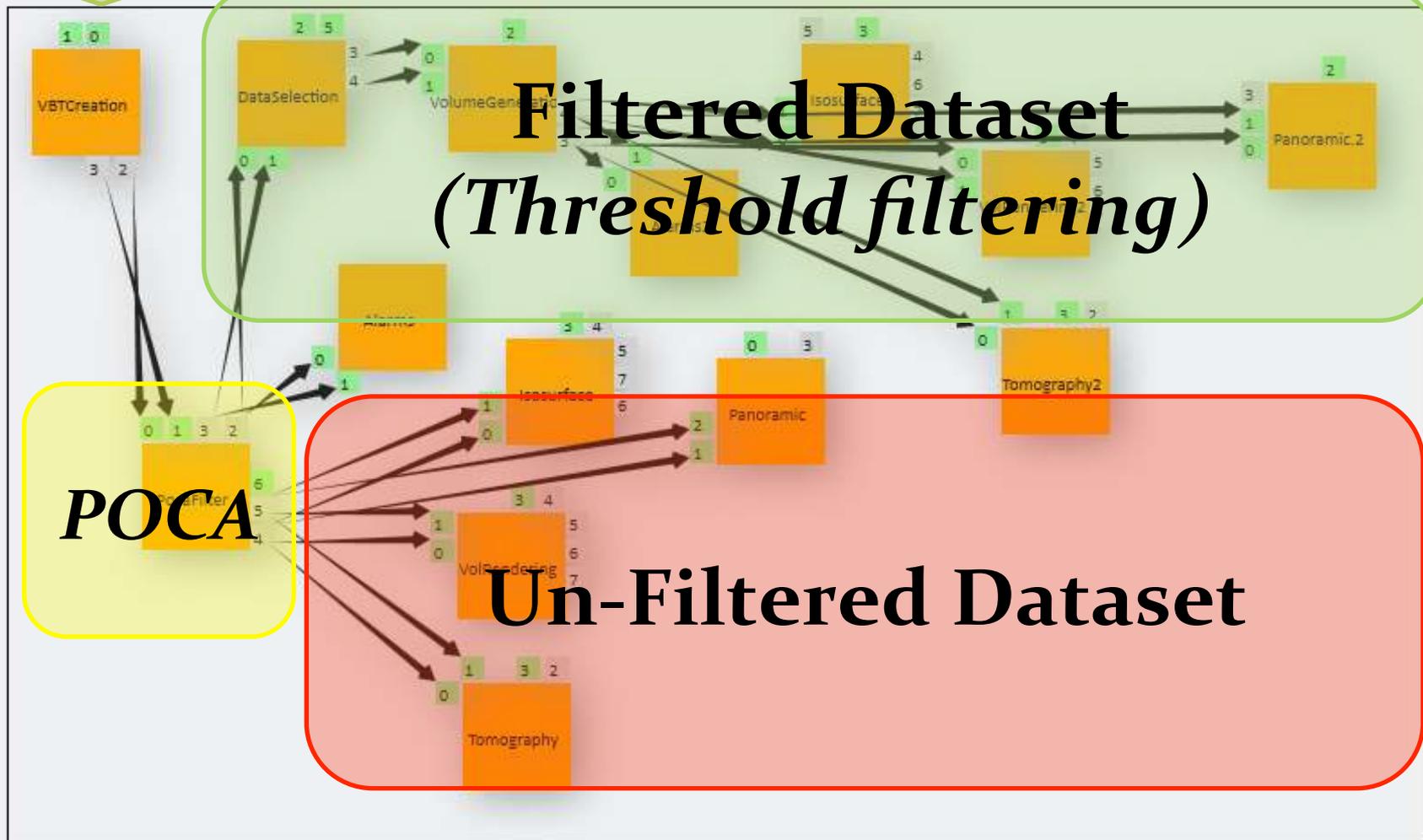
# Workflow





Input Dataset

## Dataset Processing





# Portlet Interface

**Muon Portal Workflow** 🔍 - + ✕

Select the Muon Portal simulation files to Upload

Local Upload   Remote Upload

Select data

muon.ascii

Select the visualization parameters

Resolution   X Res :   Y Res :   Z Res :   Voxel Dimension :

600   300   300   10

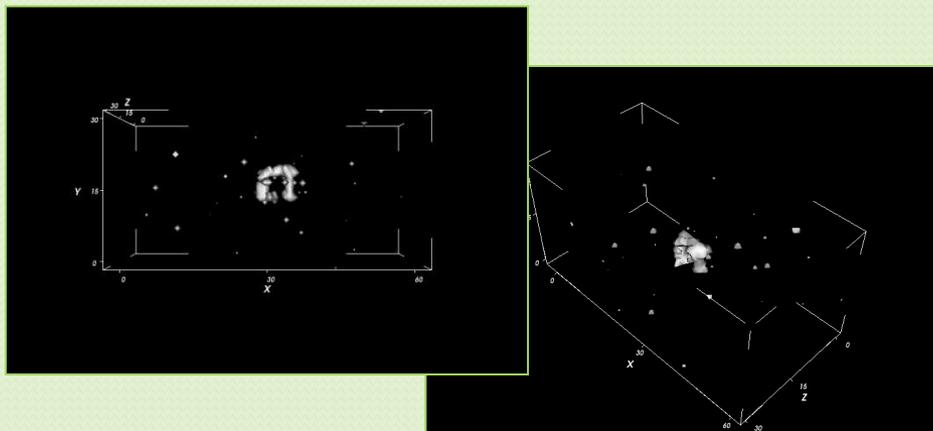
Theta Threshold:

60

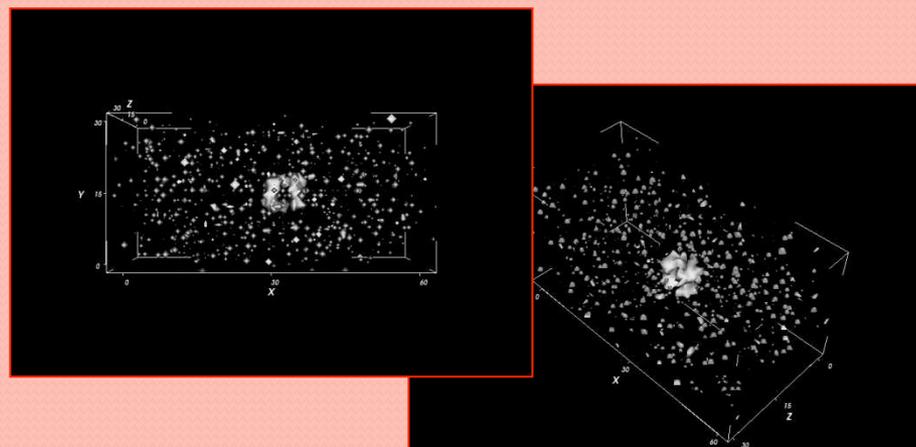
Submit



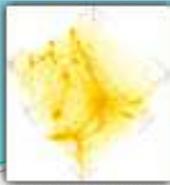
## Isosurface Images



**Filtered Dataset**



**Un-Filtered Dataset**



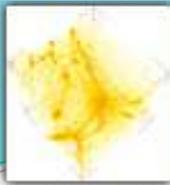
## Panoramic Movies



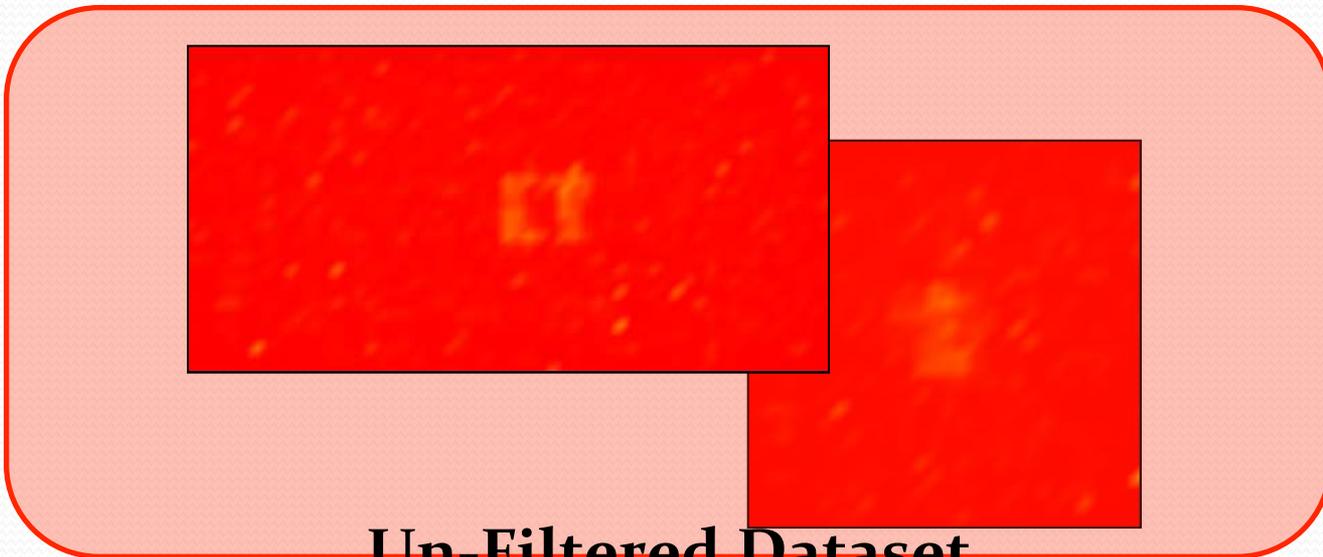
**Filtered Dataset**



**Un-Filtered Dataset**



**Filtered Dataset**

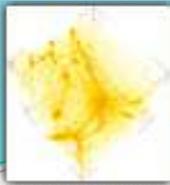


**Un-Filtered Dataset**



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## Supplementary Material

- SCI-BUS Project: <http://www.sci-bus.eu>
- Er-Flow Project: <http://www.erflow.eu>
- WSPgrade/gUse: <http://www.guse.hu>
- VisIVO Science Gateway: <http://visivo.oact.inaf.it:8080>
- Scientific Visualization:
  - ✓ Will Schroeder, Ken Martin, and Bill Lorensen  
**Visualization Toolkit: An Object-Oriented Approach to 3D Graphics.**
  - ✓ Kitware, Inc.  
**VTK User's Guide**