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Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
ICSC Centro Nazionale di Ricerca in HPC, Big Data and Quantum Computing

AstroTool

Fernando Carello, Marco Di Francesco, Matteo Farci, Simone Olmi

Spoke 3 III Technical Workshop, Perugia 28 Maggio, 2025

Project OverView

ICSC SPOKE 3

Supervisor: Fabio Roberto Vitello
Technical Consultant: Giuseppe Tudisco
Thematic Area: 1- Scientific Visualization with Artificial Intelligence support

Specific Topic

Advanced development of visualization tools for scientific Big Data, with support for remote and immersive rendering of Astrophysical and Geophysical data (observational and theoretical)

Main Goal

Achieve and validate a platform for efficiently visualize Astrophysical Big Data, using remote HPC resources, easily customizable to work in various Astrophysic Areas and flexible enough to be evolved and reuse in Geophysical applications in the near future

Project OverView

Consortium

Auticon Srl (Milan),
Alkemy SpA (Milan)
Net Service SpA (Cagliari, Cosenza, Lecce)

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Consultants

University of Cagliari, Department of Physics
MetaVerso

UNICA UNIVERSITÀ DEGLI STUDI DI CAGLIARI

METAVERSO

Project Plan

Work Packages	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 - Survey of libraries, tools, and technologies supporting the rendering and visualization of scientific big data of an astrophysical nature			M1.1											
2 - Definition of an architecture for remote data processing and data rendering of astrophysical data						M2.1								
3 - Development and integration of tools for remote data processing and rendering									M3.1					M3.2
4 - Development of the client application and validation on specific case studies (for example, Gamma-Ray Burst)									M4.1					M4.2
5 - Release of the software and documentation in Open format and dissemination of the results									M5.1					M5.2

Technical Objectives, Methodologies and Solutions

Pre-Processing of Astrophysics Big Data for data analysis and pre-rendering on HPC environment

Remote Pre-Rendering of AstroPhysics Data on HPC environment

View and Interact with the rendered images on a modern PC through a specific client application

Test the framework on a well-defined use case

Validate the product in a Laboratory Environment (TRL-4)

Release the Developed product As Open Source Code

Technical Choice: Working with VisIVO and VTK

Well Known technologies inside INAF

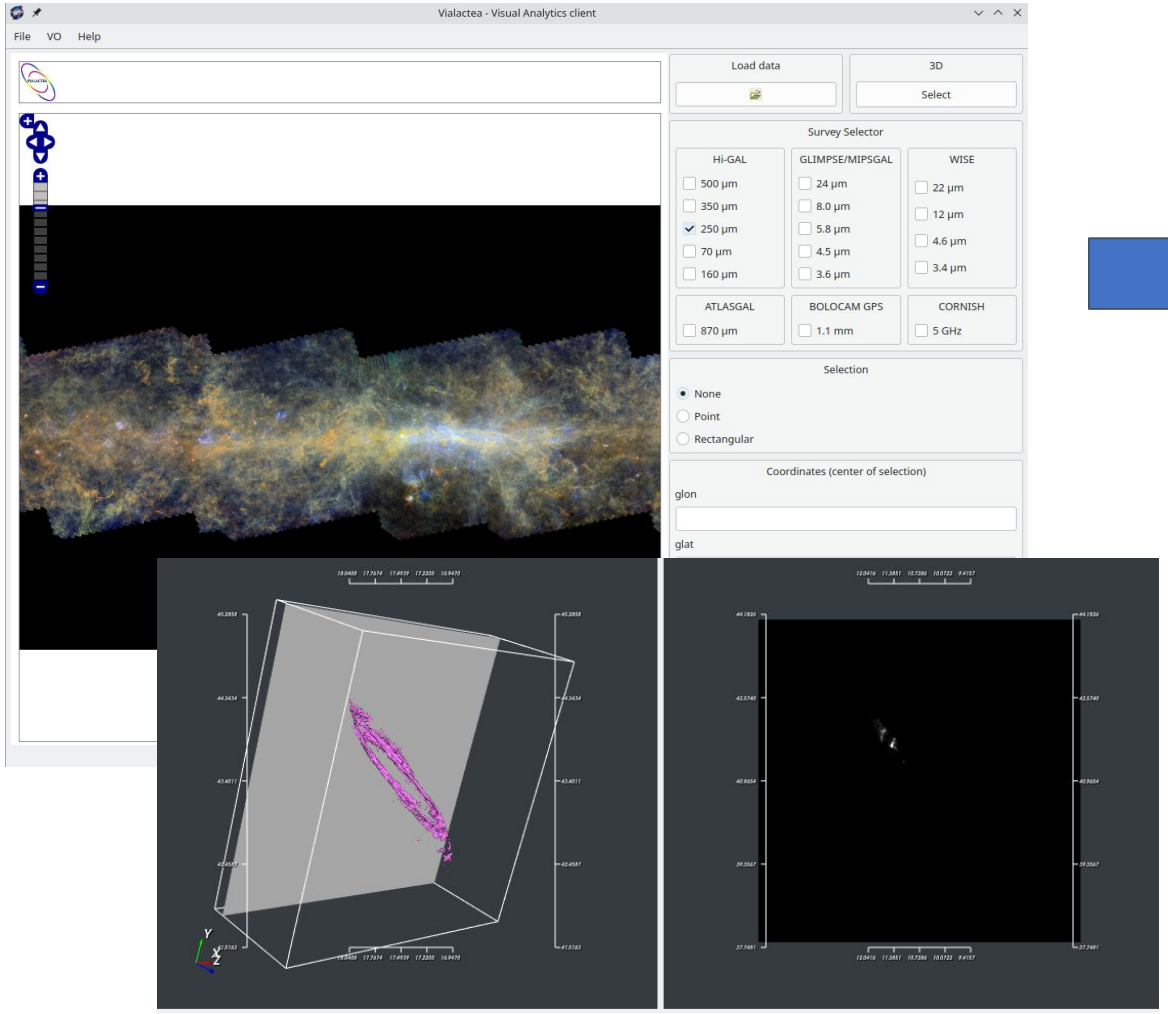
Already clear “Use Cases” and “Usage Scenarios”

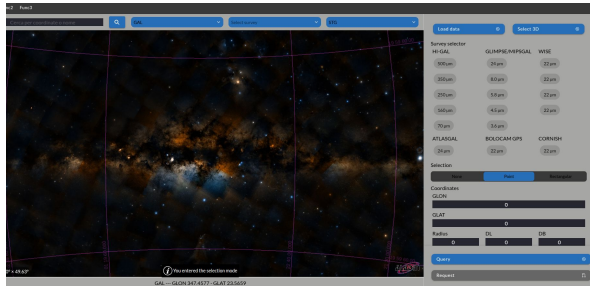
Spike Solutions already in place with Paraview and HPC

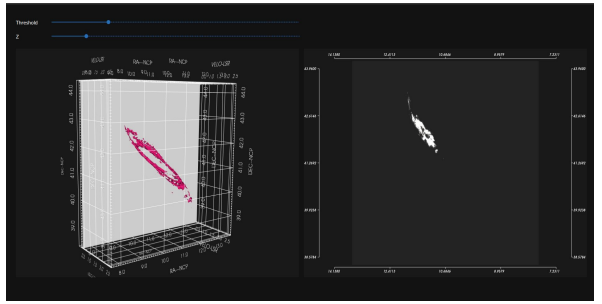
Direct support from INAF

Low Risks in Project Management (12 months project)

Main Results: UX/UI Revision and Branding Proposal







Main Results: Architecture

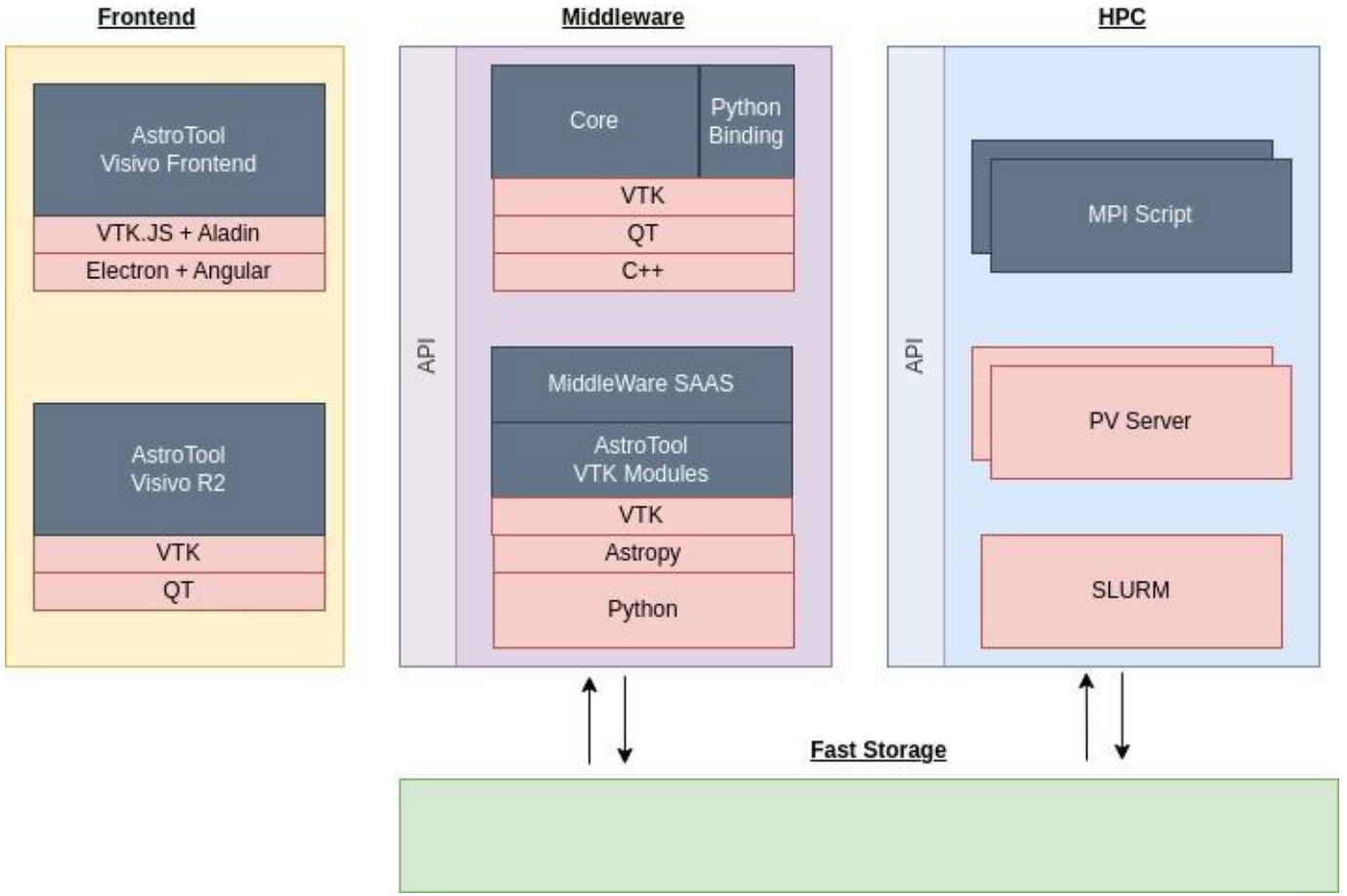
3-Layer Architecture

Client: Web and Electron Standalone
Middleware: Python, C++ Core, VTKModules
HPC: Testing on Pleiadi and Leonardo HPC

Server Side rendering on the Middleware Through VTK

PreProcessing of Huge FITS Files on HPC

Online and Offline environments proposition



New C++ Library Core for server-side pre-processing activities

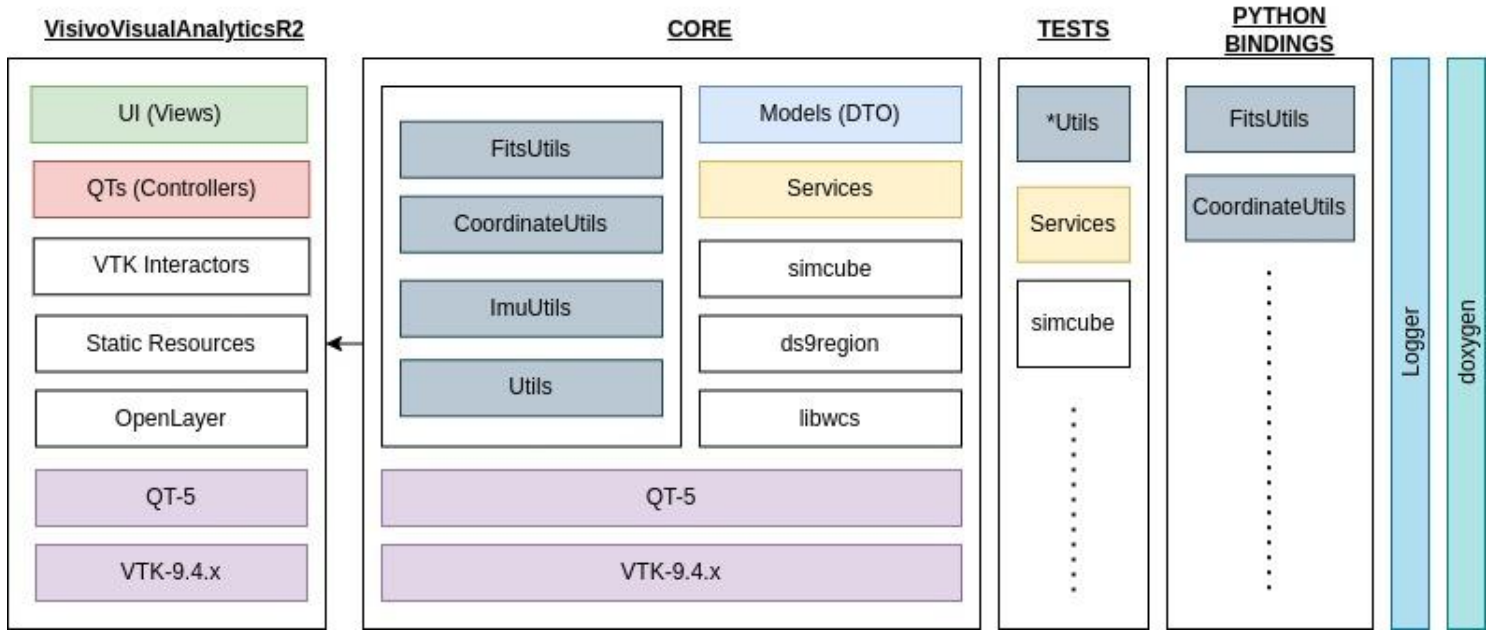
High Performance Utilities

Documentation through Doxygen

Unit Testing

Python Integration

VTK Modules compatible with VTK > 9.4



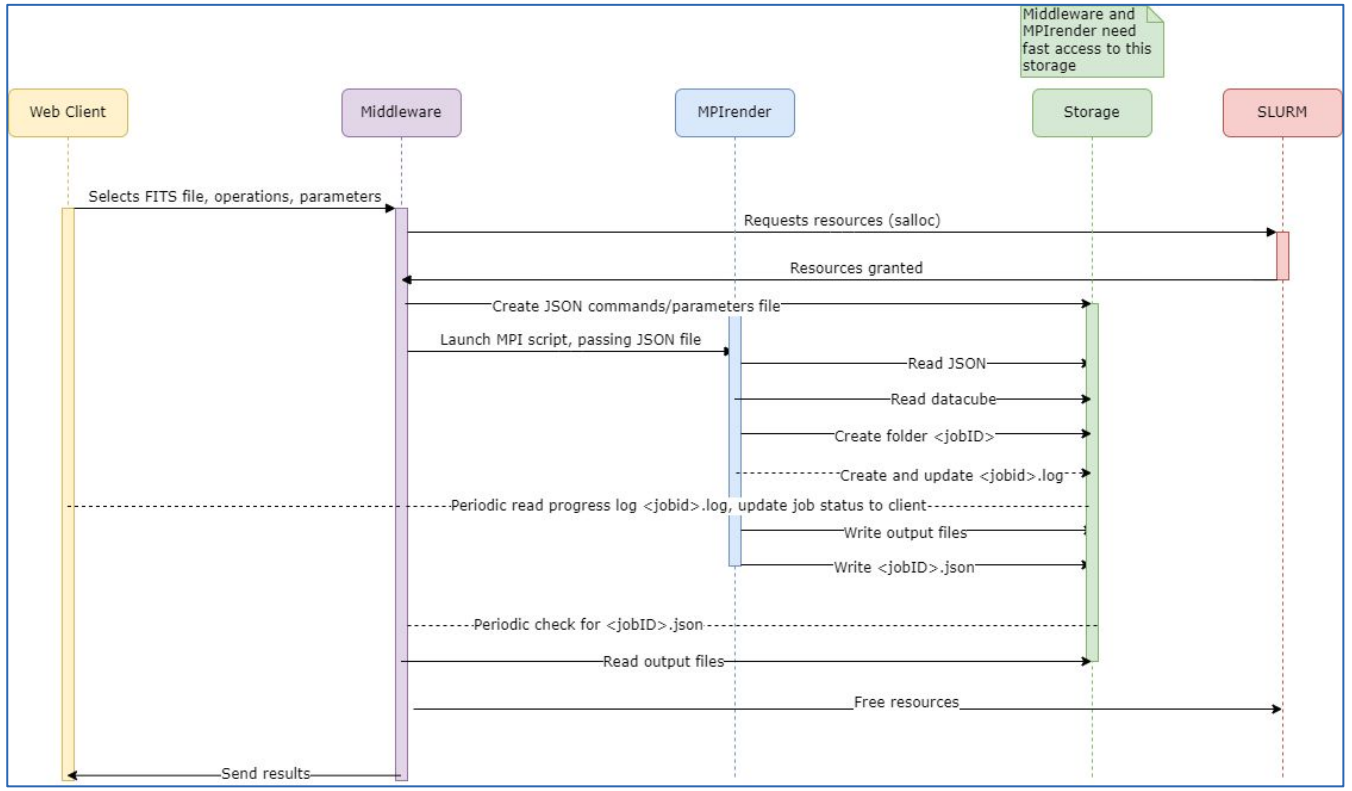
HPC Integration with OpenMPI 4.x and MPI v3 protocol

Synchronization with Middleware through parametric JSON APIs

SLURM request allocations managed with middleware supervision

Preprocessing Large FITS File (Like SKA FITS Files)

Common Fast Storage to share preprocessed objects



Demo

Next Steps

Complete the workflow to integrate Client, Middleware and HPC

Import Large FITS File on the Fast Storage

Pre-Process them on the HPC (Pleadi at first)

Rendering Data-Cubes on the Middleware Layer

Testing the smoothness and usability of the Web/Electron Client

Extend functionality of the new Web/Electron Client

Try to replicate more functionalities starting from the current VisIVO QT Client

Try to validate the offline client-middleware environment on Computer Desktops

Verify the possibility of building a resource control system to allow researchers to share their own works with teams and colleagues

Thank you!

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