AstroVisio

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Spoke 3 Progetti Bandi a Cascata, 19/12 2024

Area tematica: 1 - Visualizzazione Scientifica con supporto di Intelligenza Artificiale

Sotto tematica: B

Project involvement

Consortium:

Auticon Srl
(Milan)

Net Service
(Cagliari, Cosenza, Lecce)

Alkemy SpA
(Milan)

+

Design Group Italia
Part of Alkemy (Milano)

Consultant:

University of Cagliari
Department of Physics

MetaVerso
(Asolo)

PROJECT GOAL

Developing an innovative tool for **analyzing** and **visualizing** astrophysics data using immersive technologies

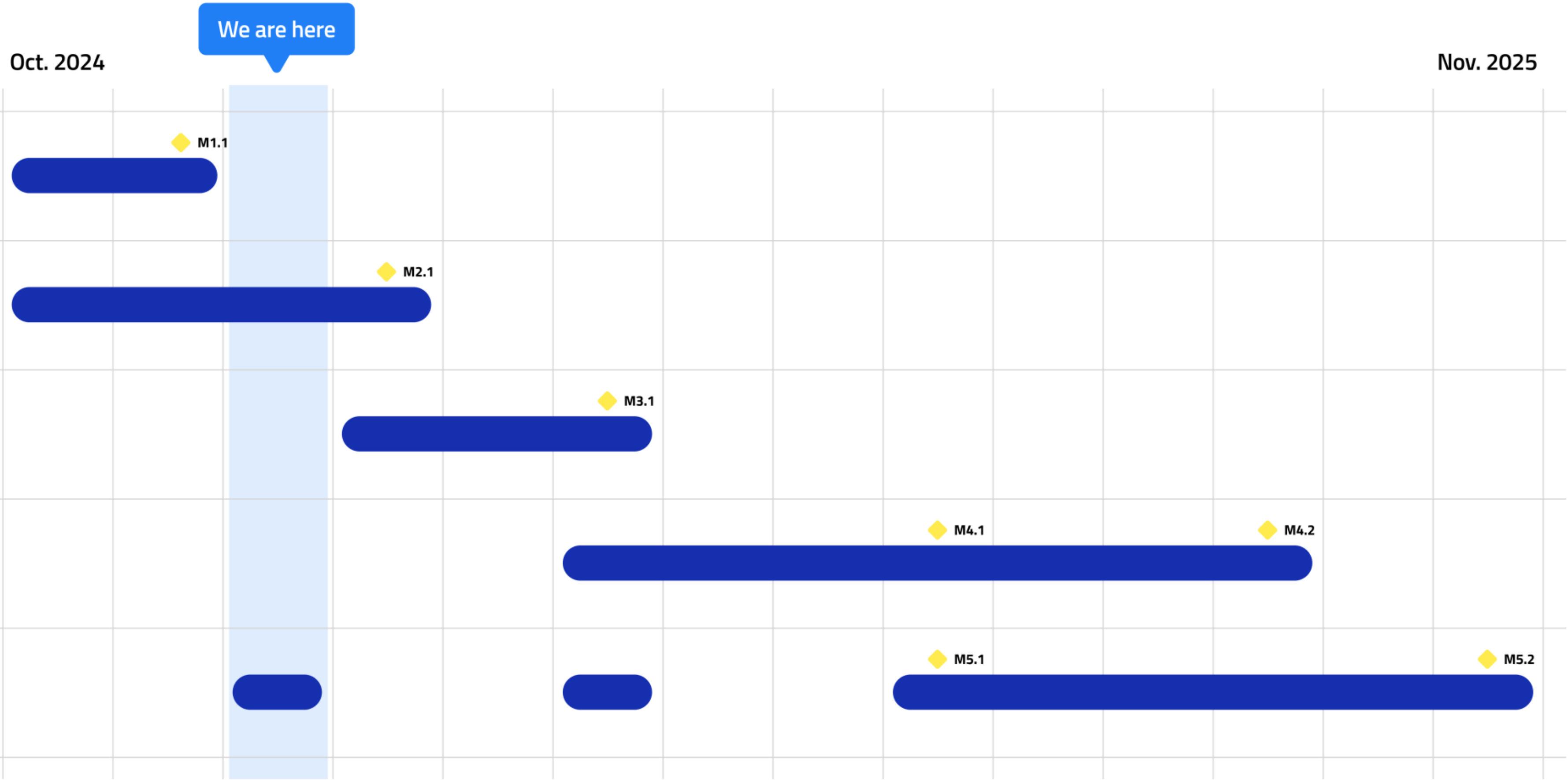
Finanziato dall'Unione europea
NextGenerationEU

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

Project Roadmap



WP1	Literature search on the latest advances in the field of Immersive Visualization / VR / XR / Spatial Computing and analysis of existing software and ecosystems
WP2	Interview sessions with researchers on the state of the art in astrophysical data visualization, with the goal of defining the most relevant visualizations to be included in the MVP, PoC and MVP definition.
WP3	Definition of data structures. Selection of technologies best suited for the defined data structures
WP4	Implementation of multi-user immersive visualization VR software and documentation
WP5	Release of the software and documentation in Open format and dissemination of the results

Multidisciplinary Approach

Data & Analytics

Alkemy SpA

Combining expertise in statistics, programming, machine learning and domain knowledge, data is transformed into strategic insights that support informed decisions and optimize business performance.

Design

Design Group Italia (Part of Alkemy)

Serving as a bridge between business and tech, they design intuitive, effective and efficient digital systems for users through a process that spans from initial research to implementation and final testing.

Development

MetaVerso

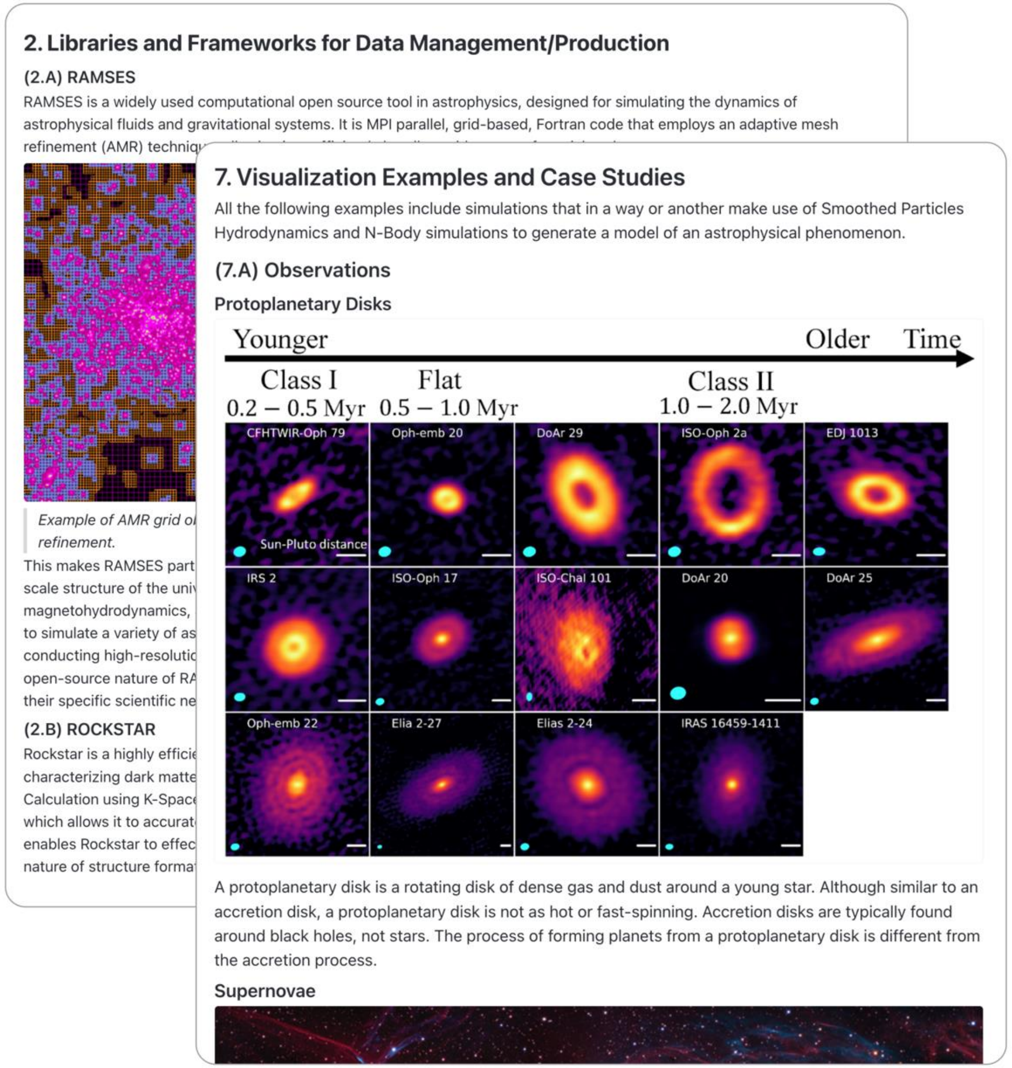
Leveraging coding and immersive technologies to develop innovative and scalable software solutions that guarantee smooth functionality and optimal performance.

Research Phase

Research on astrophysical data and 2D visualizations

Research was conducted to gain an **overview of data structures** and **classical 2D visualizations** in astrophysics across different domains:

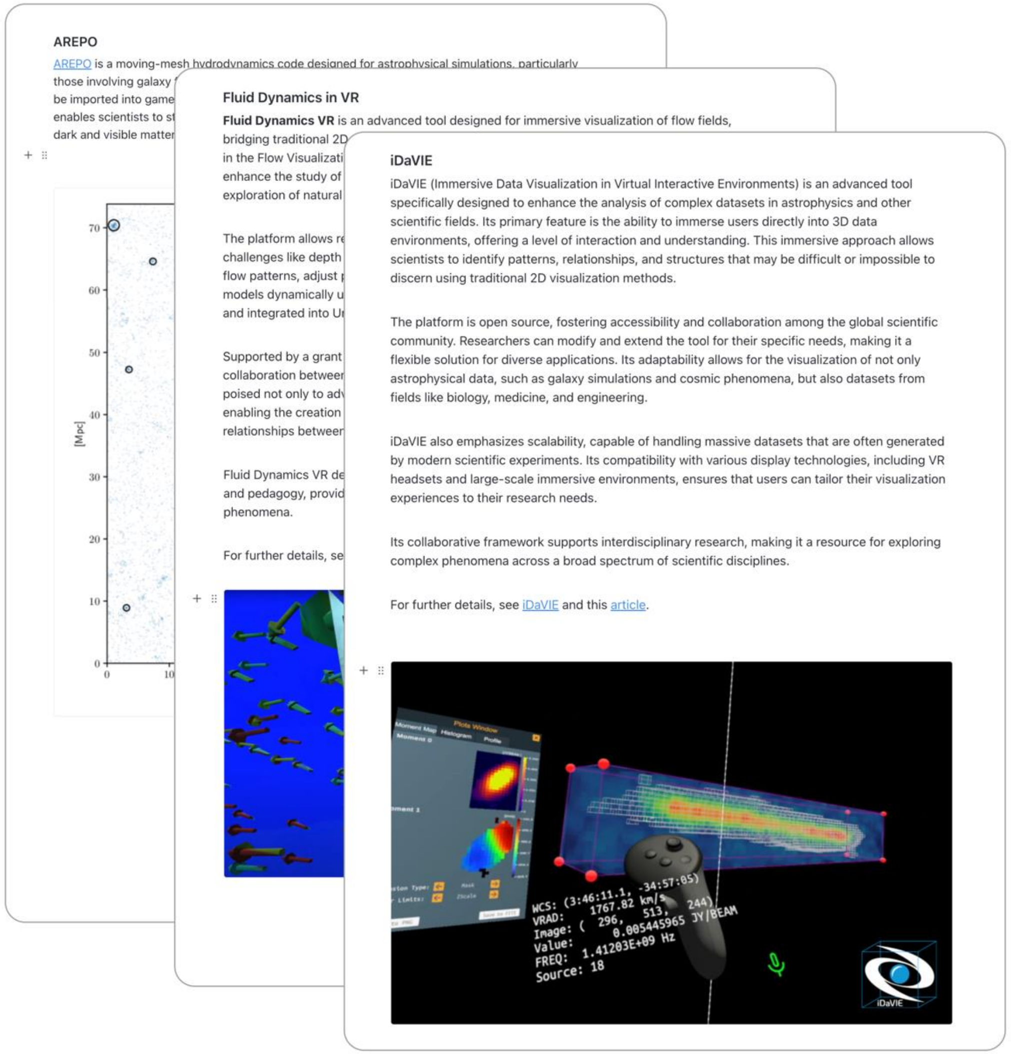
- Observations
- Simulations
- Tools and libraries



Research on potential applications of VR

Research was conducted to gain an **overview of existing software** and **projects for VR applications** across **three main categories**:

- Astrophysics
- Natural and Experimental Science
- Other tools on data visualization, VR and non-VR

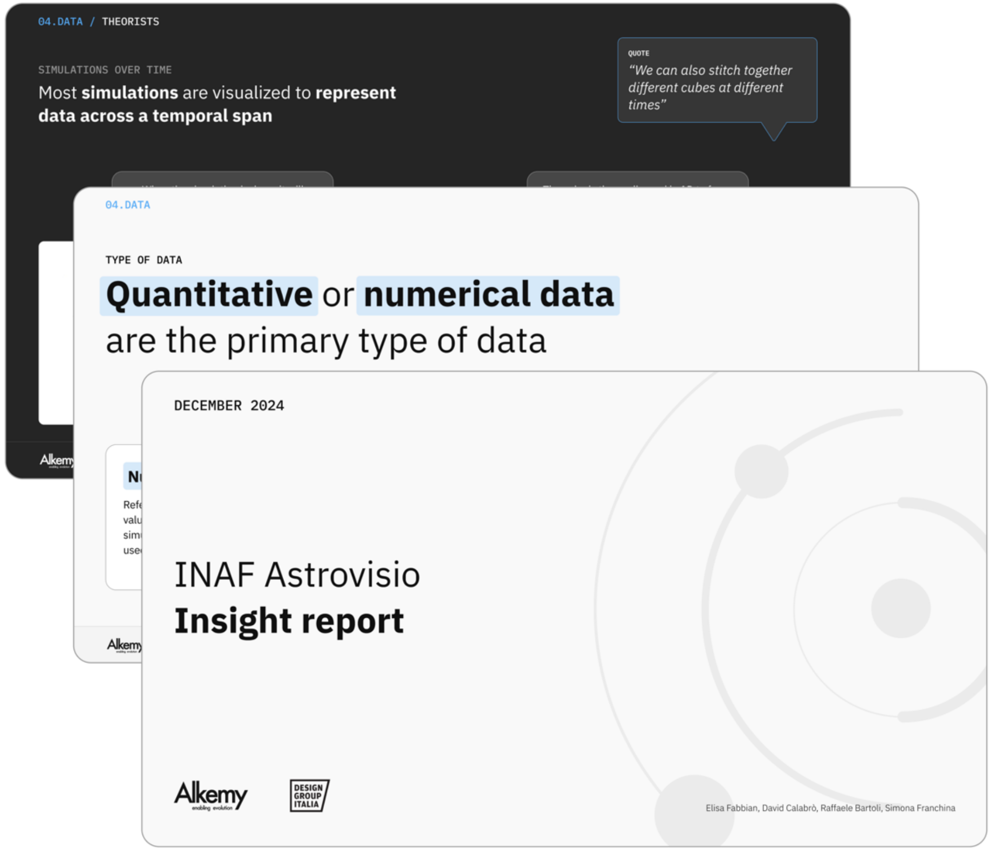


Interviews with astrophisics

Interviews play a crucial role in understanding the **needs and priorities of astrophysicists**, translating insights into **shared team knowledge** to enhance user empathy and building a **data-driven process** rooted in actionable insights.

We conducted 8 interviews with a target group from the **Scuola Normale Superiore of Pisa**:

- **3** Small-scale theoretical area
  Galaxies
- **3** Large-scale theoretical area
  Intergalactic medium
- **2** Observations
  Galaxies



KEY INSIGHTS 1

Observers' activities and data visualizations

01.

Observers concentrate their activities on **astronomical images** and **data** from telescopes and other instruments.

02.

The **activities** to be conducted are determined by the desired outcome. They may involve tasks such as cleaning and gathering new data, or validating theories.

03.

The main task involves **interpolating the image** to **extract physical data** and assess its **reliability**. For this, they primarily use tools with graphic interfaces.

04.

The **quality of the data** appears to be **crucial** at different levels, such as the quality of the observation or the quality of the model

KEY INSIGHTS 2

Theorists' activities and data visualization

01.

Astrophysicists often develop **custom code** to meet their specific research needs, as standard tools may not always be sufficient. **Debugging** is essential to ensure the model's quality.

02.

Simulations evolve data over time in an **iterative process** to validate initial conditions and ensure the outcomes align with reality.

03.

The selection of **data visualization methods** depends on the preferences and expertise of the astrophysicist. **Simulations** are typically represented as **1D or 2D** visualizations.

KEY INSIGHTS 3

The role of **Papers** in scientific outreach

Scientific Outreach

01.

Papers play a central role in the academic world, serving as both the **foundation** and the **culmination** of the research process.

02.

Through **papers**, astrophysicists' **efforts** are solidified and formalized, turning insights and findings into tangible **contributions** to their field.

03.

Graphs and **visualizations** play a crucial role in enhancing the value of papers, bridging complex data and clear communication.

04.

Traditional papers **limit** how information is presented. Astrophysics papers may include **3D visualizations**, **interactive plots**, and **videos**.

KEY INSIGHTS 4

Astrophysic for the **public outreach**

01.

There is strong enthusiasm for sharing astrophysics with the **public**, with **schools** inspiring young minds and **festivals** offering opportunities to connect, learn, and share experiences.

02.

Astrophysics is challenging to make tangible, but developing **interactive**, **hands-on projects** can make its complexities more **accessible** to a wider audience.

03.

The choice of media depends on the **context** and **audience**, including videos, images, hands-on activities, and sensory experiences with astrophysical data.

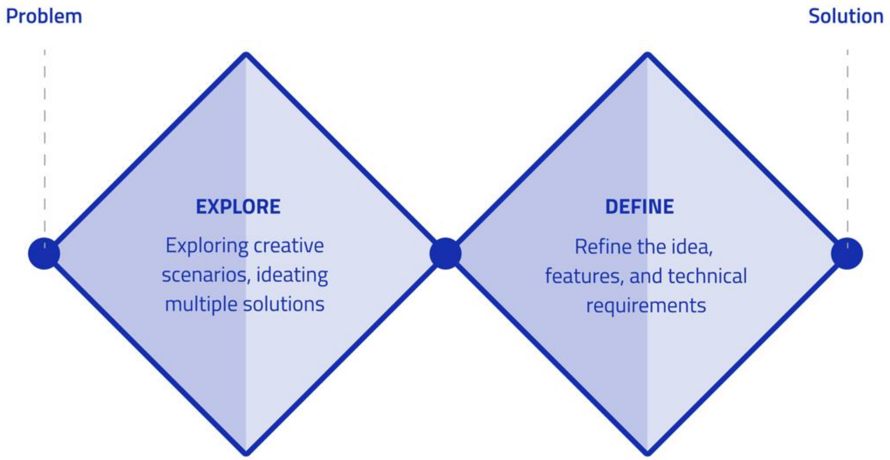
04.

Astrophysics could be more accessible for **people with disabilities, underprivileged children** and to encourage **young girls** to study in the STEM field.

Definition Phase

Collaborative session

After gathering the key insights during the research phase, we moved on to a **collaborative session** that brought together professionals with **diverse expertise** to **creatively explore possibilities and ideas** for addressing the needs and problems we identified



Archetypes introduction

Observers

#1

The

Sky-Watcher

Help the **observer** to manage and improve the **quality of astronomical datas** and **images**.

Theorists

#2

The

Galaxy Writer

Develop methods to **enhance visual simulations** and tools to **efficiently debug** and **refine code**

Scientific Outreach

#3

The

Cosmic Guru

Help **astrophysicists communicate** the value of their studies in a easy and **appealing way**, spark interest and exploration in the field.

Public Outreach

#4

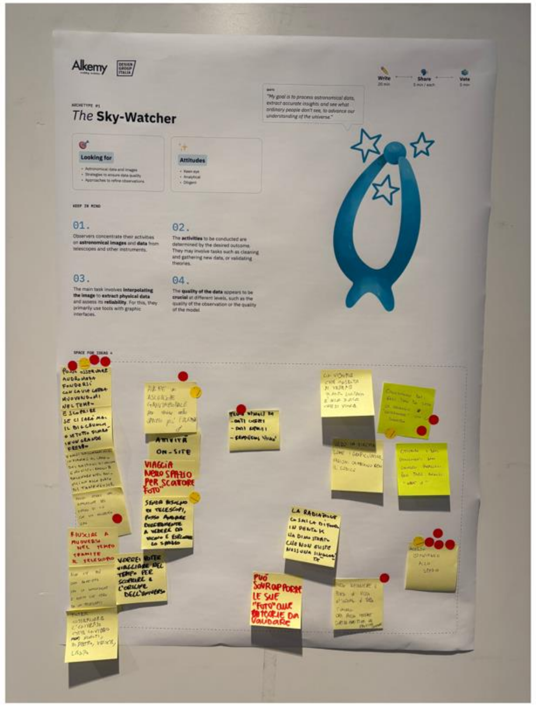
The

Little Star Dreamer

Help **astrophysics** connect with the **public** and create **engagement**, especially in **education**.

QUESTION TO ANSWER

"How might we **solve** the archetype's **problems** and **needs**?"



FINAL IDEA

An **application** leveraging **Virtual Reality (VR)** to **manage visualizations** and **time-lapses of simulations**, with **expressive potential** not only in visual terms but also in tactile and auditory modalities.

Add text

The application will include:

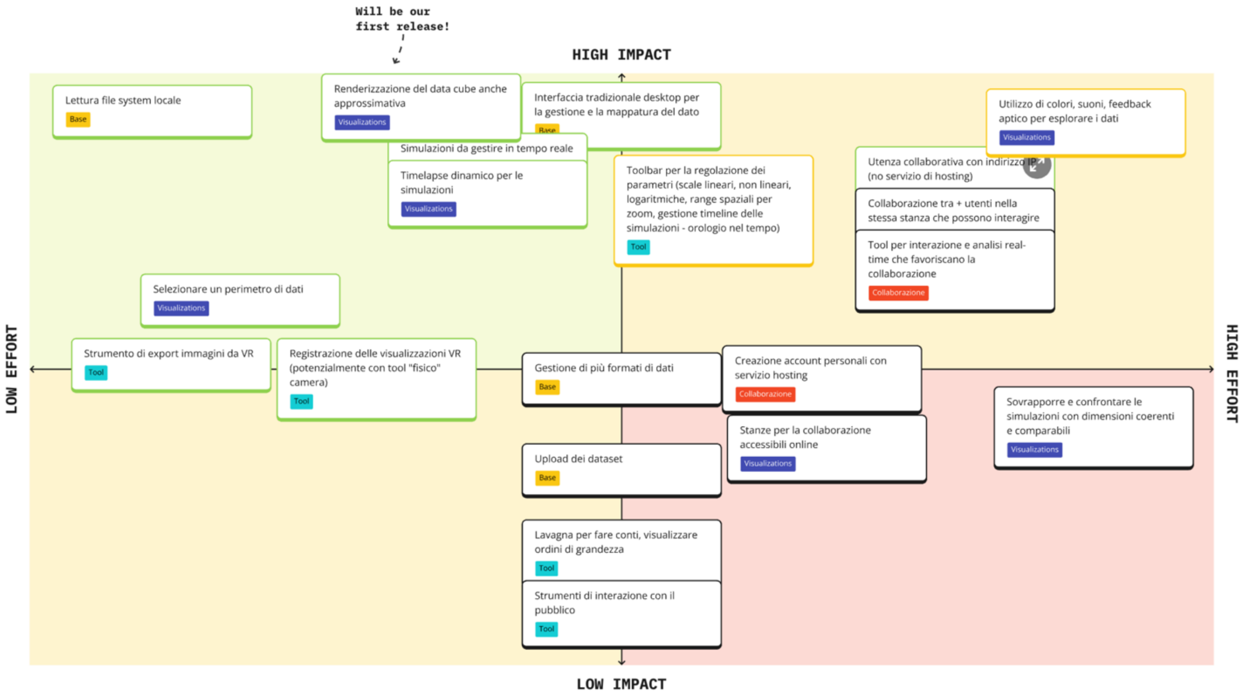
- **Controllers** designed to exploit the full potential of immersive technology for interacting with and manipulating data and visualizations.
- Will offer astrophysicists **autonomy in managing and creating representations**, enabling them to work with concatenated datasets.
- It will also provide the ability to **export materials for traditional papers**
- **Facilitate collaboration among multiple astrophysicists**, creating shared spaces within the virtual environment.

The **immersive and sensory potential** of the tool will make **visualizations engaging even for non-scientific audiences in outreach activities**, generating interest in the material and allowing astrophysicists to produce tangible content for public interaction.

Feature Prioritization

After further exploring the practical applications of each idea, we analyzed the features we would prioritize for the first release by evaluating them on a **scale of high/low impact** and **high/low effort**.

We focused on the **high impact/low effort quadrant** for the first release.



First Release Features

First release

- **Local file system reading**: Allowing the import and management of data directly from the user's device. In the first release, both the builder interface and the VR environment will be locally handled.
- **Builder area:** A desktop interface that allows users to independently upload datasets and configure visualizations that will be rendered in VR.
- **Visualization rendering:** Representations that may be more or less approximate depending on the tool's capabilities and the effort involved.
- **Dynamic time-lapse:** Enabling users to observe the evolution of data over time.
- **Data selection:** A feature allowing users to focus on specific portions of a dataset for more targeted analysis.
- **Image export:** Enabling the export and saving of VR visualizations in image format.
- **Visualization recording and export:** Of the view of the user or potentially utilizing a "physical" tool like a camera to create videos that can be shared or used in presentations.
- **Support multiple data format:** Support for multiple data formats to ensure compatibility with different types of datasets and maximize the application's flexibility.

First release

- ***Control toolbar:** Allowing users to adjust parameters within the immersive environment. Examples include linear and logarithmic scales, spatial zoom, and timeline management of simulations.
- ***Enhanced visualization expressiveness:** Adding sound and haptic feedback alongside colors to explore data within visualizations.

**Given the higher effort involved, the feasibility of including the following in the first release will be evaluated during the design and development phases*

Future releases

- **Multi-user collaboration:** Transitioning the platform from local to an online hosting service (a middle-term solution could be also to use IP addresses), creating online-accessible collaboration rooms, and enabling each user to have their own personal account.
- **Expand tools for the user:** Adding tools like a whiteboard for calculations and visualizing orders of magnitude.
- **Collaboration tools:** Expanding the tools for real-time collaboration among users in the same room, enabling interaction with elements and analysis tools for collaborative work.
- **Public interaction:** Introducing tools for interacting with the public within the VR environment.
- **Model comparison:** The ability to overlay and compare simulations with consistent and comparable dimensions.

Next Steps

Next Steps

WP2

- User Experience and User Interface Design

WP3

- Definition of data structures and data management strategies
- Definition and implementation of data abstraction interface
- Design and implementation of data storage solution

Synergy with AI Visio Lab

Integration of **one graphical output** from **AI Visio Lab** into AstroVisio

The idea is to apply the same concept of "exploring data from the inside" to a particularly meaningful graphical representation that will be identified during the AI Visio Lab project.

ACTION

To enable the integration, the AI Visio Lab team will need to **adhere to specific data requirements** provided by the AstroVisio team, ensuring the data is prepared in compliance with AstroVisio's standards.

ACTION

For the VR visualization, the **same logic and aesthetic features** defined by the AstroVisio team during the ongoing design process will be applied.

Thank you!