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PIANO NAZIONALE
DI RIPRESA E RESILIENZA



Centro Nazionale di Ricerca in HPC,
Big Data and Quantum Computing

ASTRAI

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Spoke 3 III Technical Workshop, Perugia 26-29 Maggio, 2025

Team Koexai



<https://koexai.com>

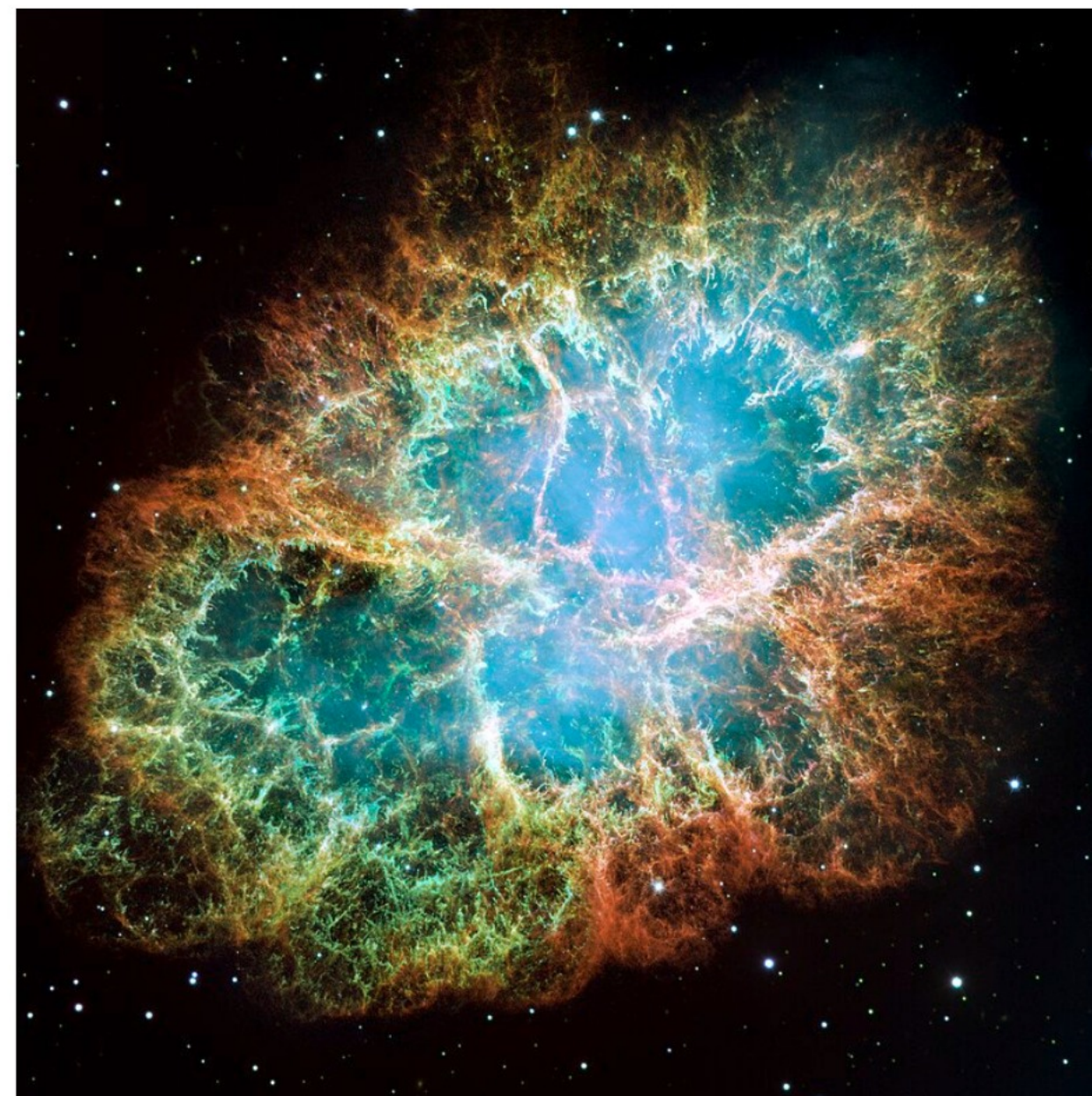
Scientific Rationale

Supernovae (SNe) are extremely energetic and fascinating events.

Unfortunately SNe are really rare and we had hard time in observing and collecting enough data to study them.

With modern technology we have collected only a few hundreds of events per year.

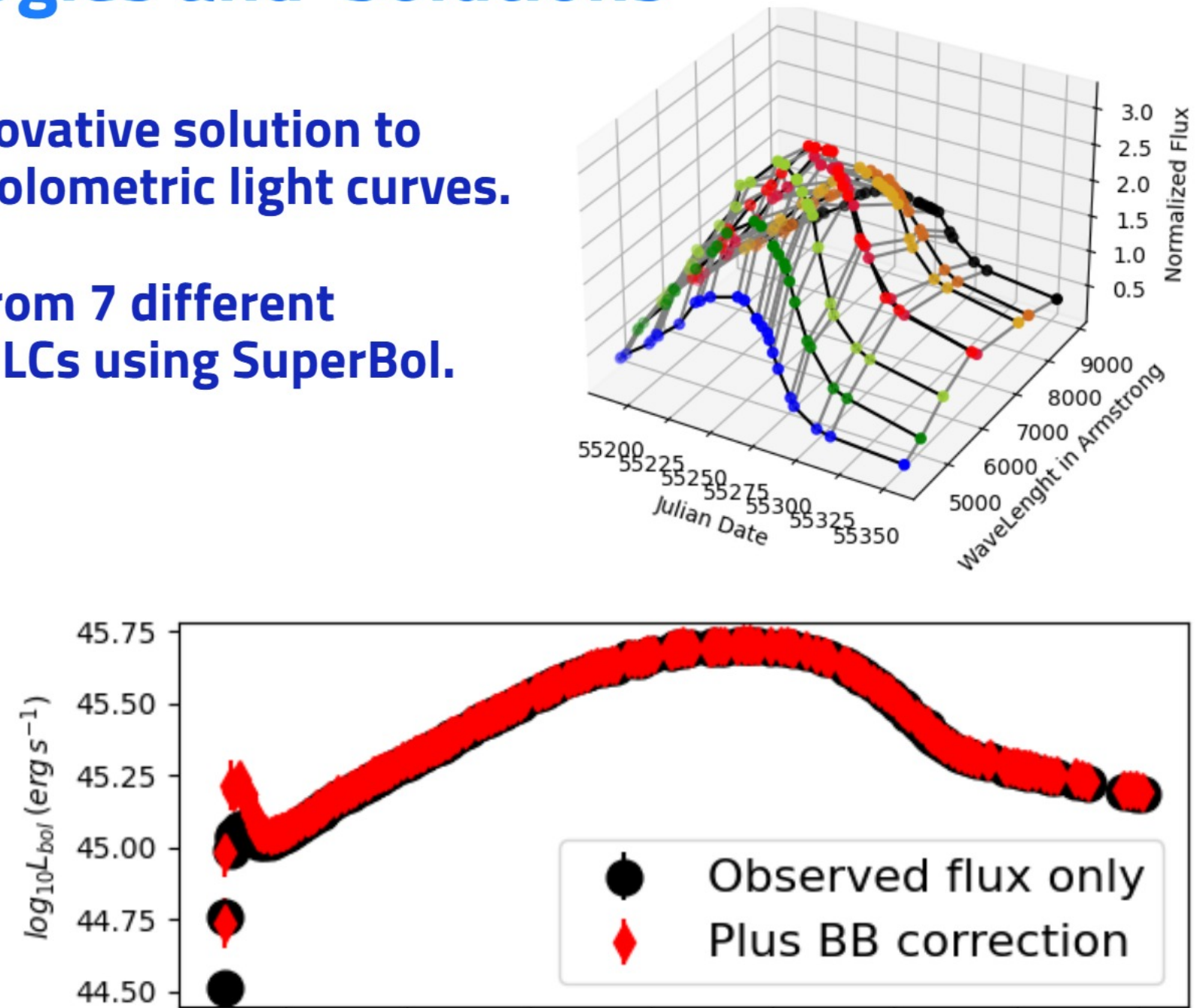
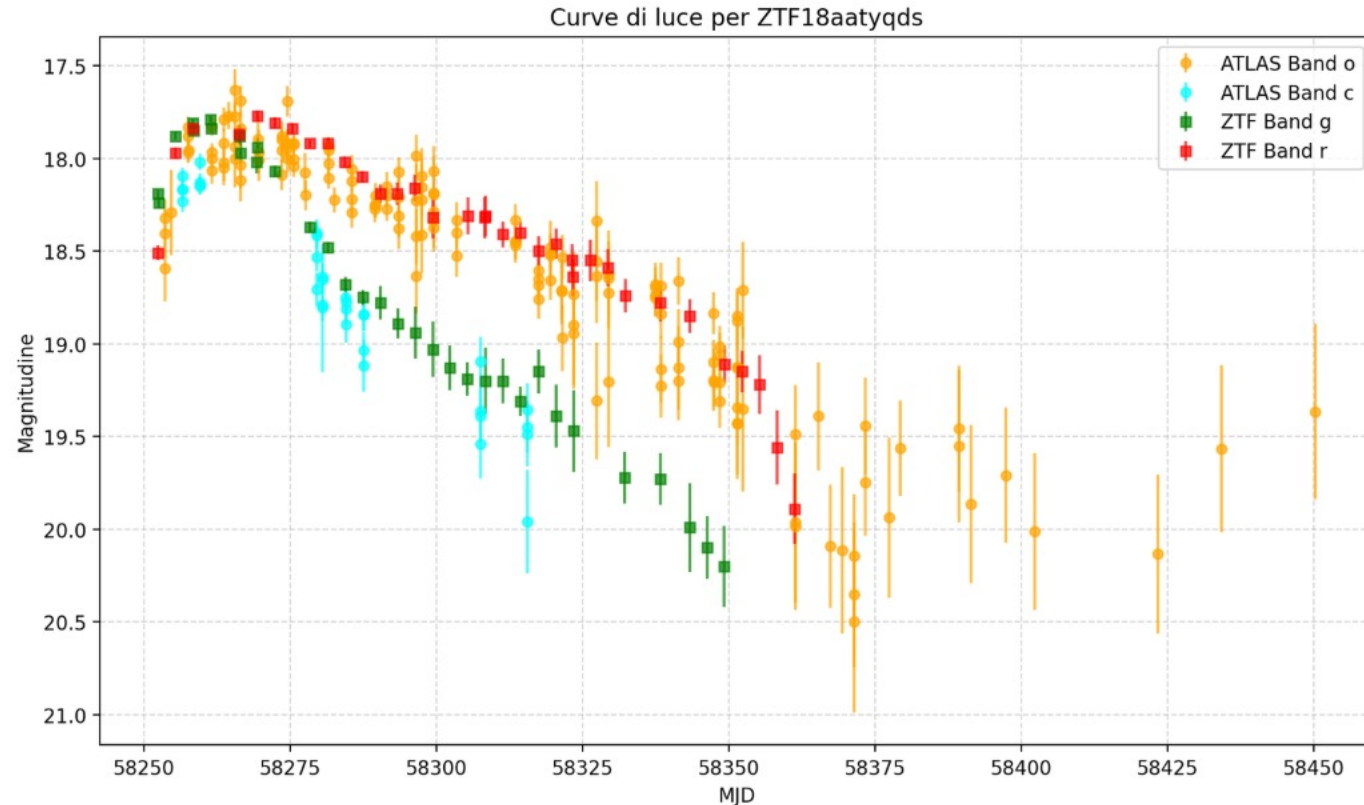
But we are expecting to collect much more thanks to the Large Synoptic Survey Telescope (LSST) in Chile that will soon be operational.



Technical Objectives, Methodologies and Solutions

The scope of project ASTRAL is to develop an innovative solution to characterise H-Rich Type II SNe based on their bolometric light curves.

We have collected observations and metadata from 7 different astronomical surveys and estimated bolometric LCs using SuperBol.

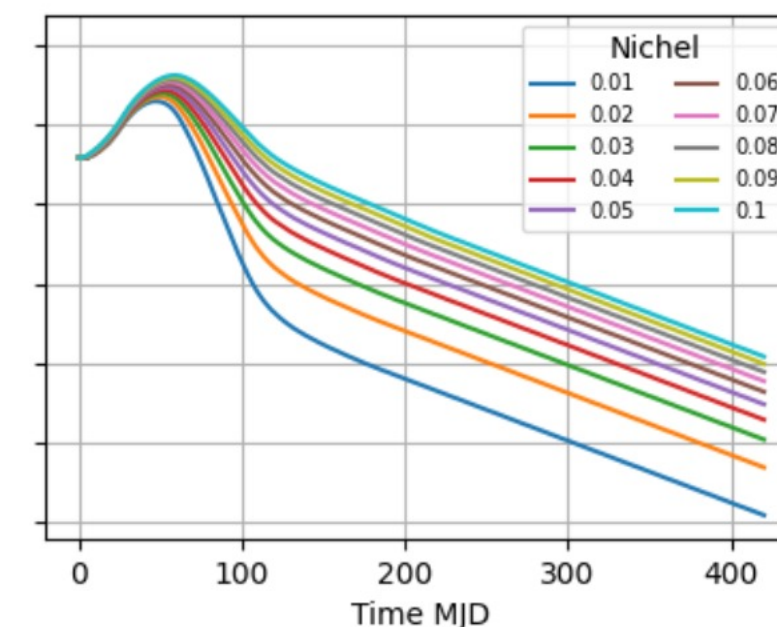
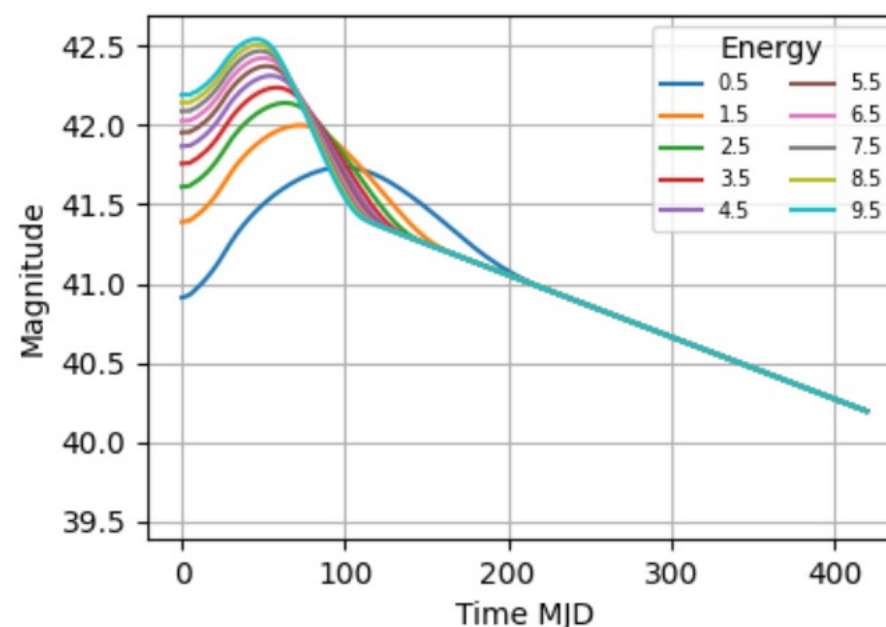
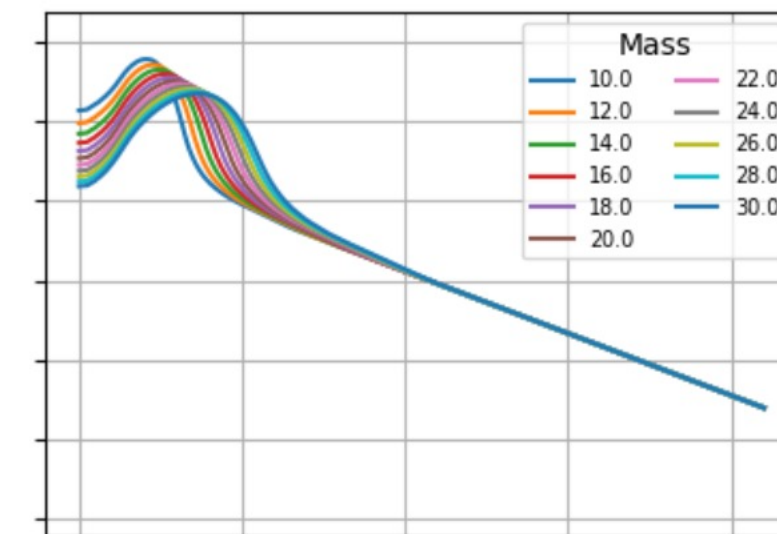
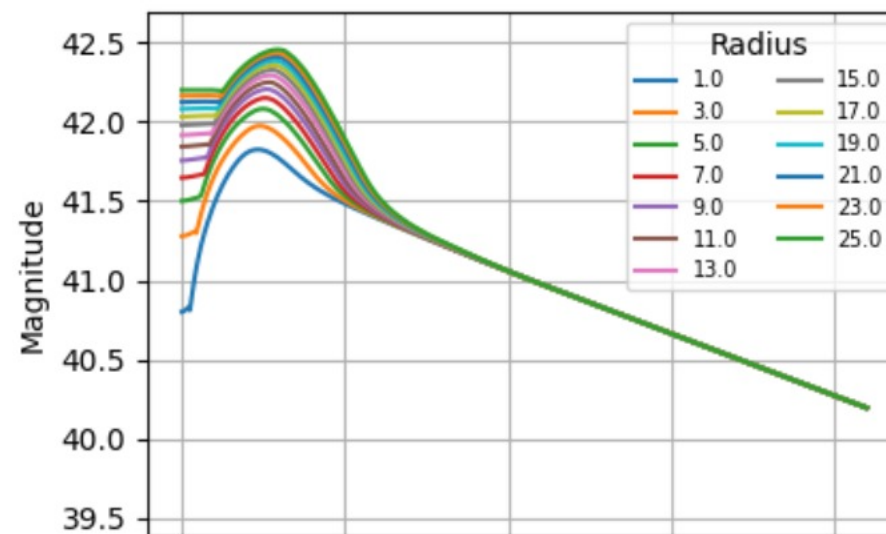


Technical Objectives, Methodologies and Solutions

We have generated a first synthetic dataset based on the 4-parameter analytical model proposed by Pumo & Cosentino 2025.

At the same time new thermo-fluidodynamic simulations are currently underway to expand the dataset.

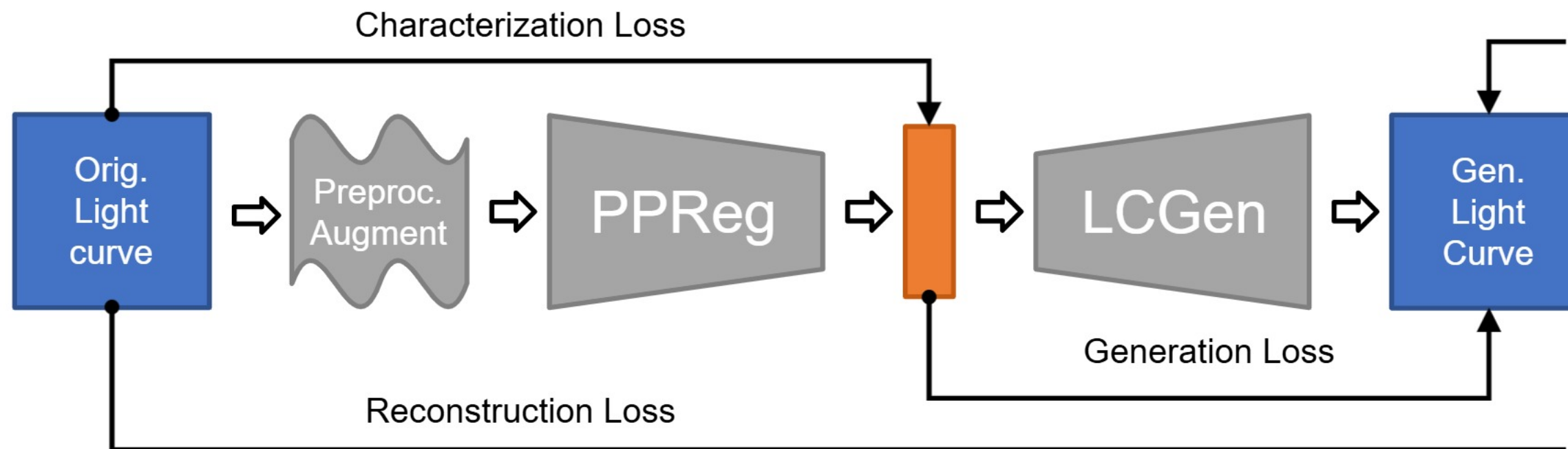
A new 7-parameters analytical model has been also proposed and will be soon added to the dataset.



Technical Objectives, Methodologies and Solutions

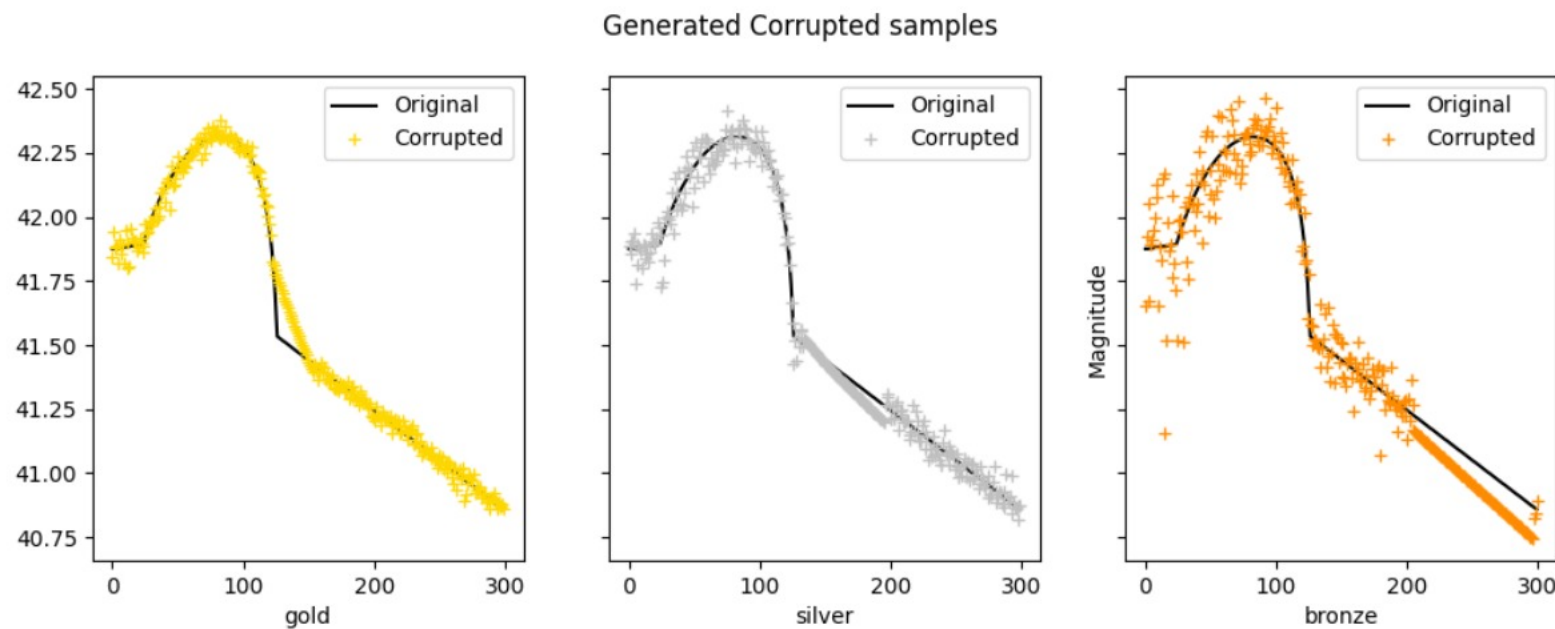
We have trained a Conditional VAE with Stable Diffusion techniques on both real and synthetic data in order to build a robust characterization model.

The PPRegressor is trained to map the LC to the Progenitor parameters while the LCGenerator is trained on the opposite task. The two blocks are trained separately on synthetic data and jointly on the real data to ensure both realistic LC generation and physical consistency.



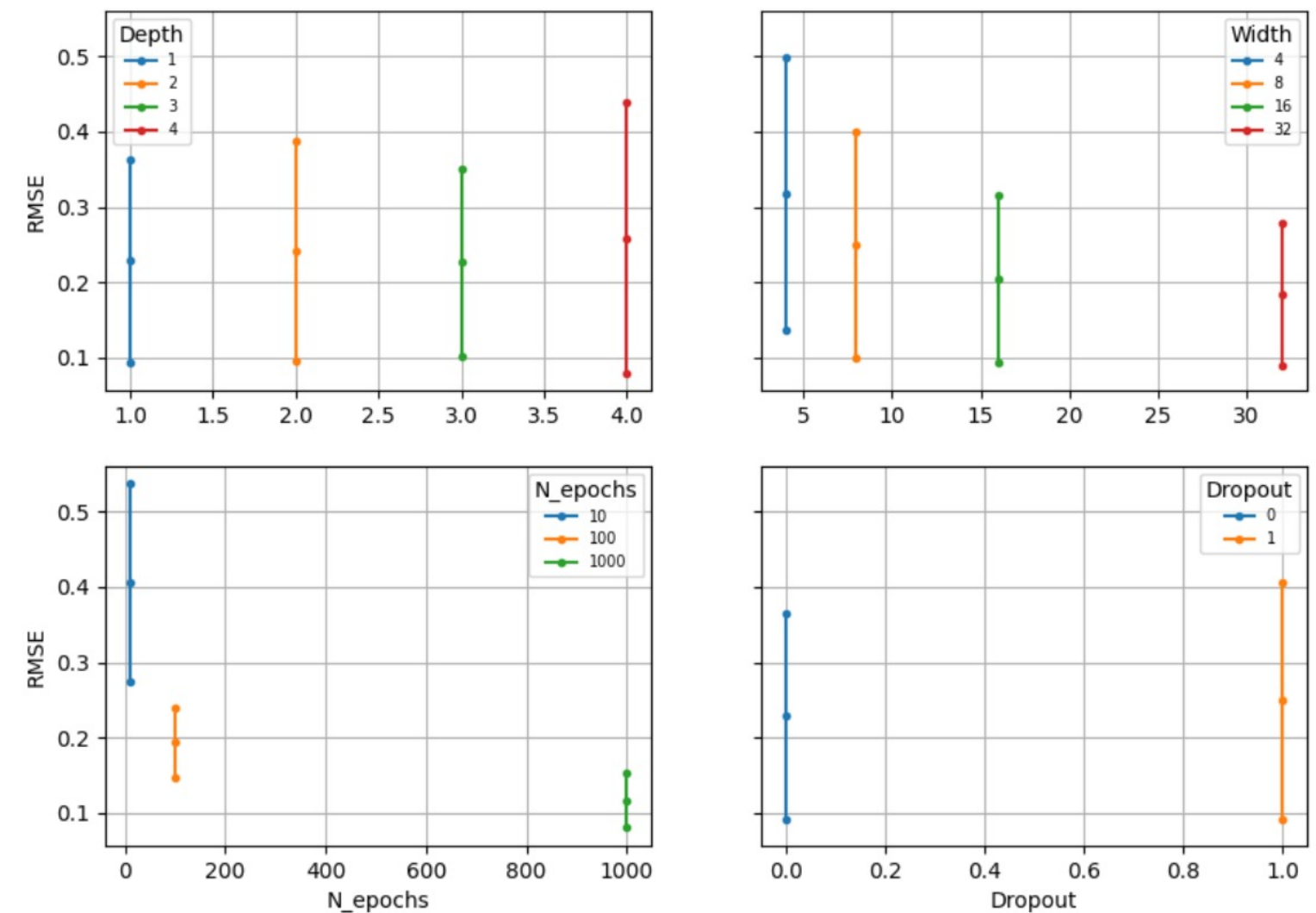
Technical Objectives, Methodologies and Solutions

We have trained the model by adding custom damage on synthetic data in order to emulate real observation noise and missing data.



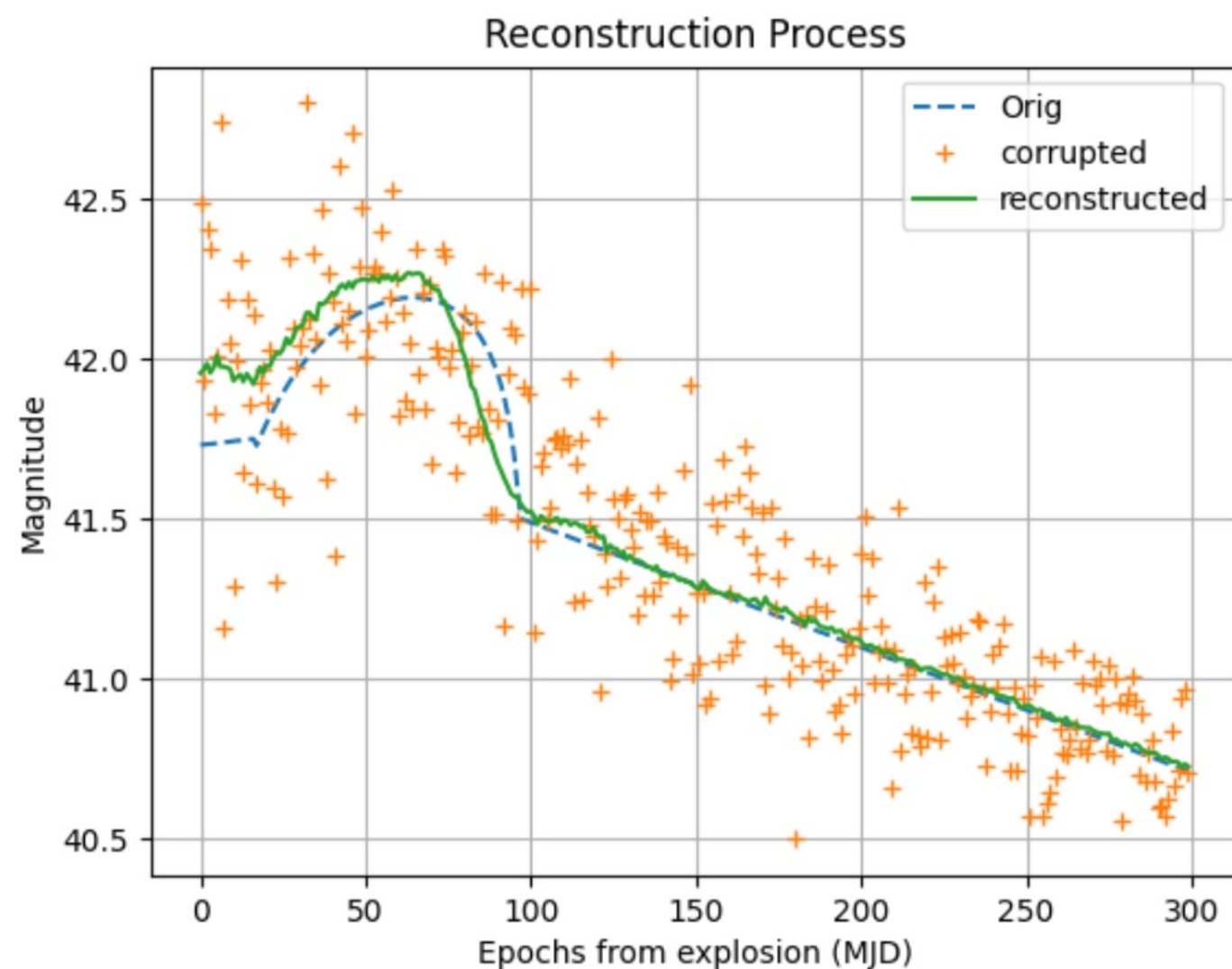
We have optimized the hyper-parameters of the models using grid search NAS techniques.

RMSE vs HyperParams



Main Results

We have compared the metrics obtained with different ML models.

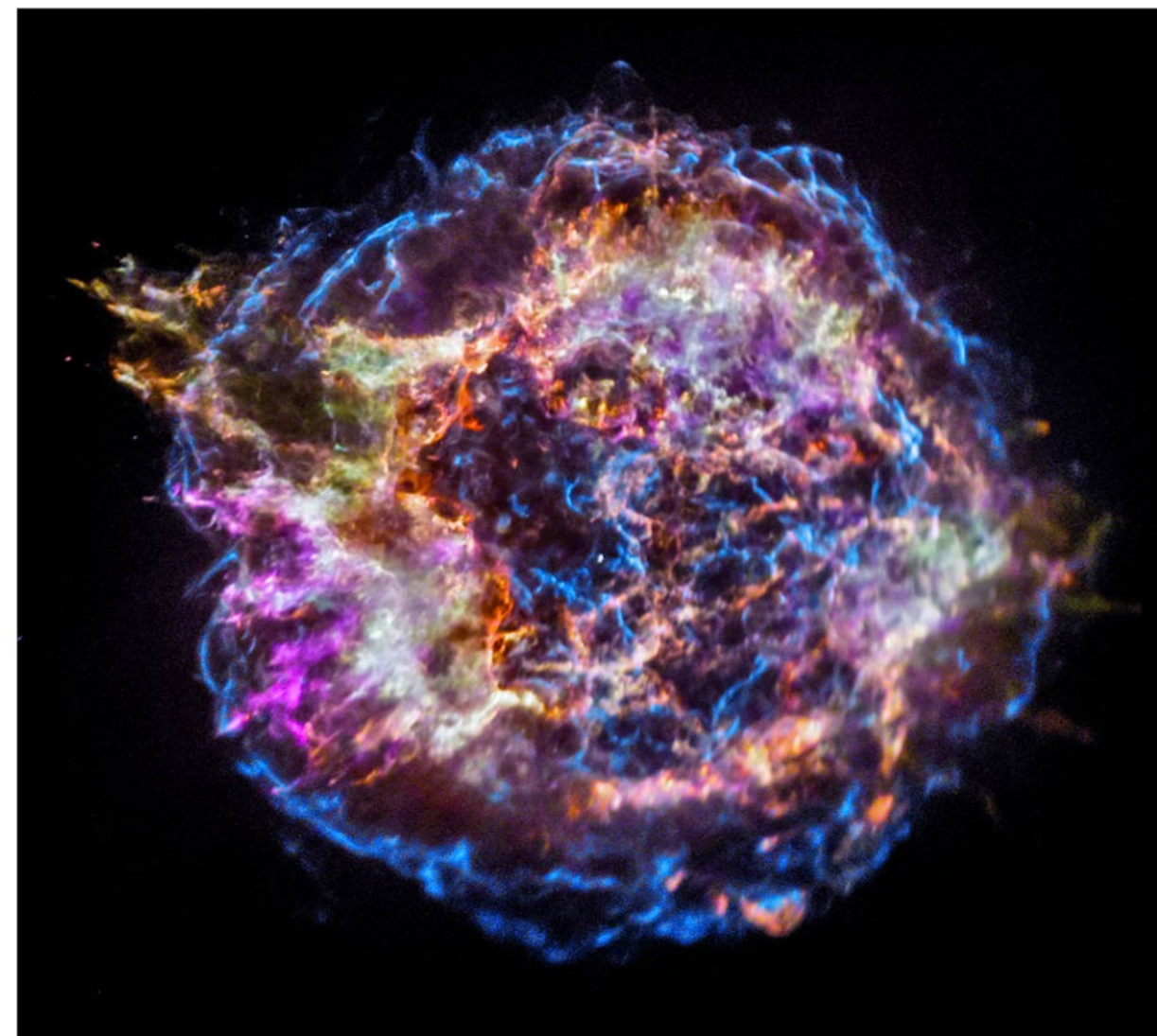


Final Steps

The results obtained are promising to further push the research in the direction we have just explored.

We aim to:

- expand the dataset with the thermo-fluido-dynamic simulations and the 7-parameter model.**
- expand the library we have used to interpolate real data to make it more stable and user-friendly.**
- publish the data and the code to make it available to the scientific community.**





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Thank you :)

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