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PIANO NAZIONALE
DI RIPRESA E RESILIENZA



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

SPARSE REPRESENTATIONS FOR SPECTRAL IMAGES ALGORITHMS

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Spoke 3 Technical Workshop, Trieste October 9 / 11, 2023

Scientific Rationale

Sparse spectral-imaging and component separation algorithms for targeted and all-sky observations in the X-ray and mm bands for Galaxy cluster (or CMB) analysis.

Scientific problem:

Contaminations from dust content of our Galaxy, CMB, point sources, etc.

We need a component separation algorithms:

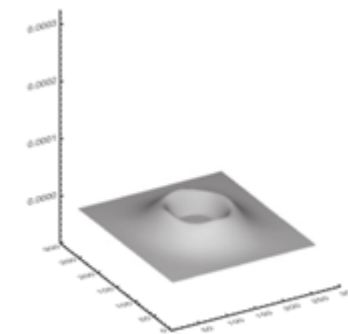
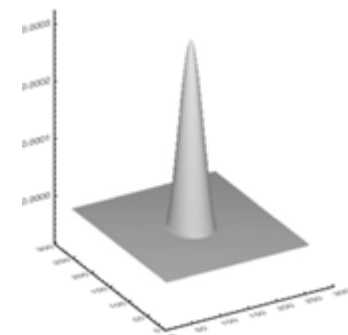
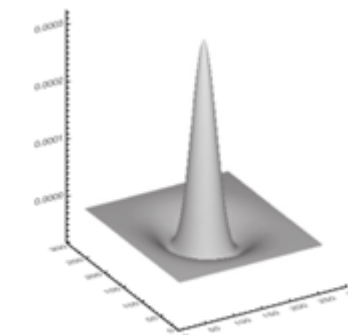
- Evolution of Bourdin et al. (2015), Baldi et al. (2020) method: Spectral imaging of the thermal Sunyaev–Zel'dovich effect.
- Planck HFI signals are recovered using wavelet transform.

Advantages of wavelet formalism:

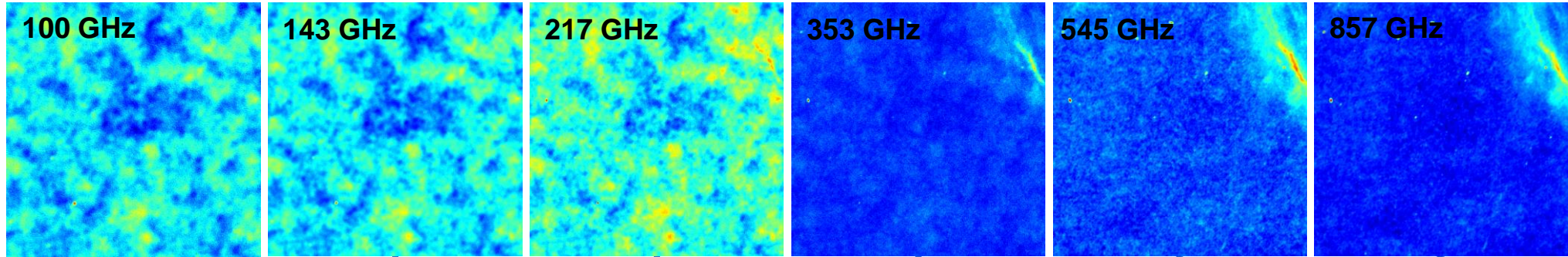
Representation of the signals in both the time and frequency domains.

Signal is sparse in wavelet bases, noise is dense (can be removed via thresholding).

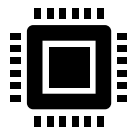
The spatially variable template are then estimated considering a weighted χ^2 estimate.



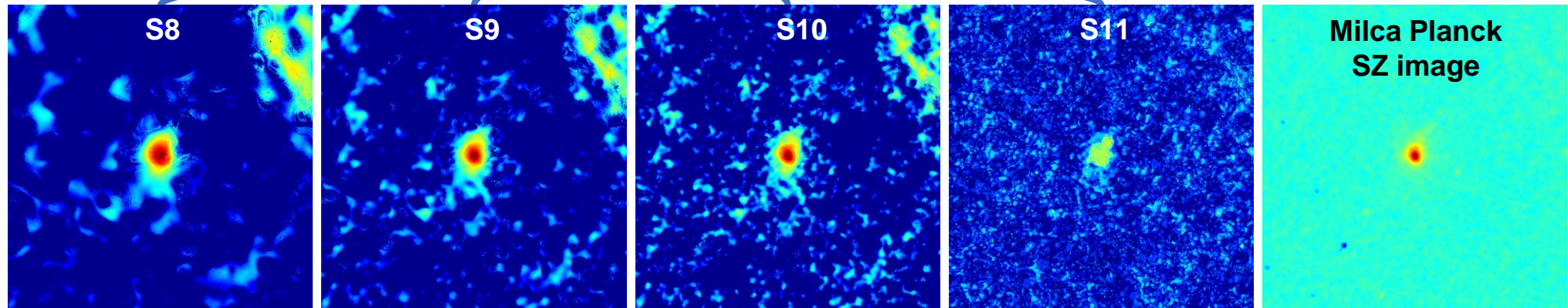
Technical Objectives, Methodologies and Solutions



Input example: Raw Planck data around Coma cluster



Output: BSP wavelet reconstruction at different scales



Technical Objectives, Methodologies and Solutions

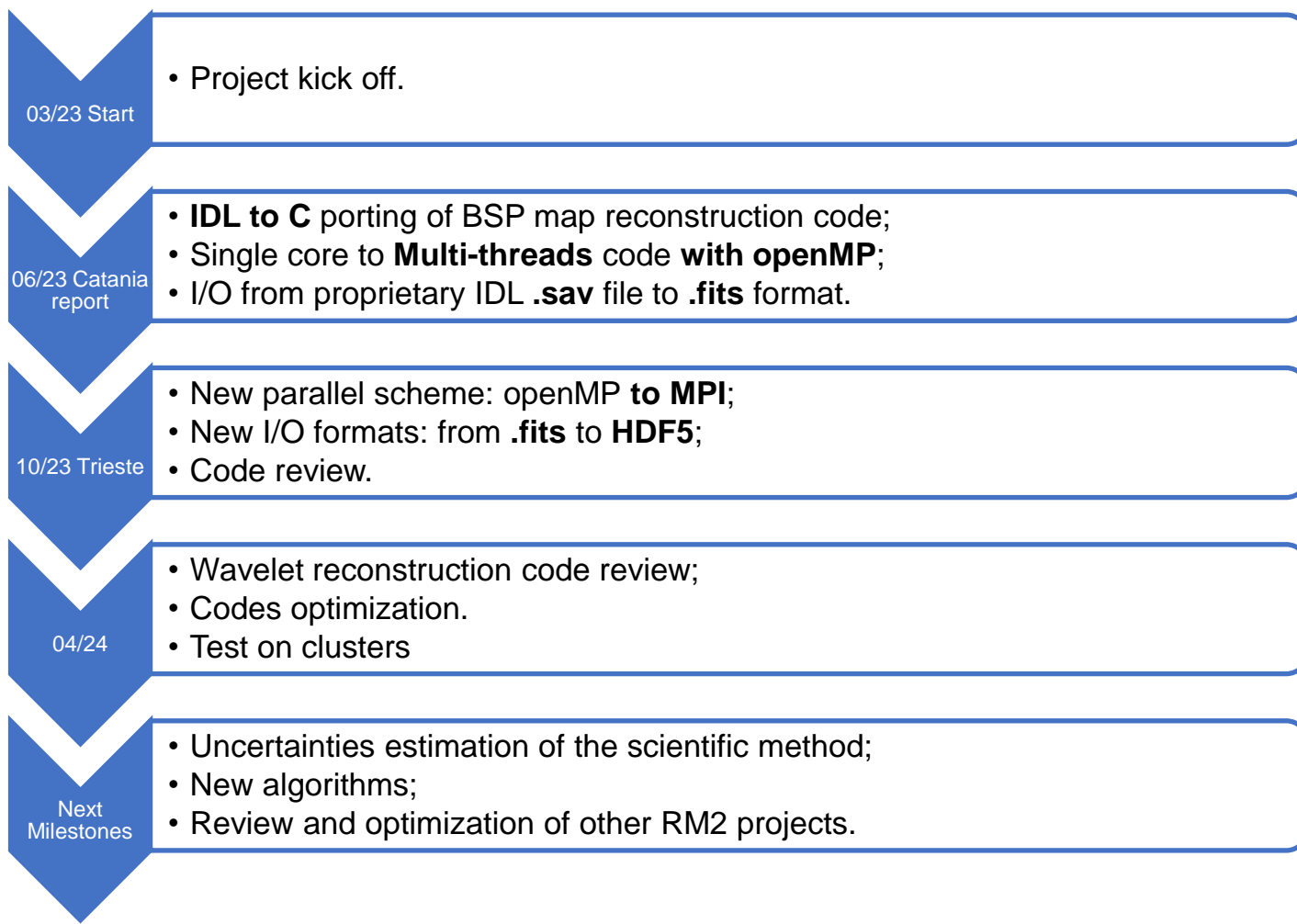
Technical Objectives

- **Use Open-Source Programming Language**
- **Meet IVOA requirements**
- **Optimize the code**
- **Make the code usable in HPC Clusters**

Methodologies and Solutions

- **Code Versioning**
- **Open libraries**
- **Open debug tools**
- **HTC cluster for testing**

Timescale, Milestones and KPIs



KPIs

Computation time Optimization

- At least a factor 2 *wrt* the IDL version

Memory Optimization

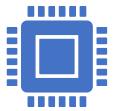
- Chunks/Hyperslab subdivision for I/O

Documentation

- w/ Subversioning

Accomplished Work, Results

Last Catania Report



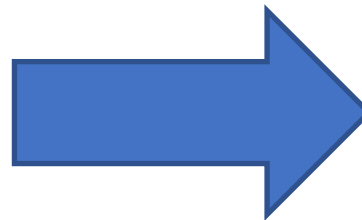
C - OpenMP code



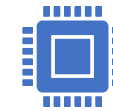
.fits files



**Cfitsio library
for I/O**



Trieste Report



C - openMPI code



.HDF5 files



**Wavelet reconstruction
code developing and
testing**

Next Steps and Expected Results (by next checkpoint: April 2024)

Uncertainties estimation of the scientific method

More astrophysical components

Higher number of wavelet scales

**Possible inclusion of more instrument
with different angular resolutions**

Full portability of the codes

Wavelet reconstruction code review

Codes optimization

Test on HPC/HTC clusters

Starting code review of TEPID-WINE