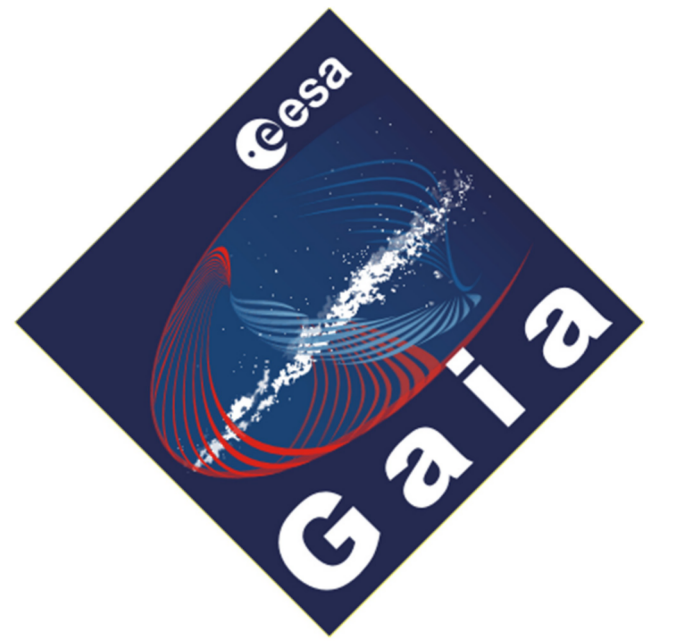# Gaia data simulations

E. Masana, X. Luri, F. Julbe, R. Borrachero, E. Antiche

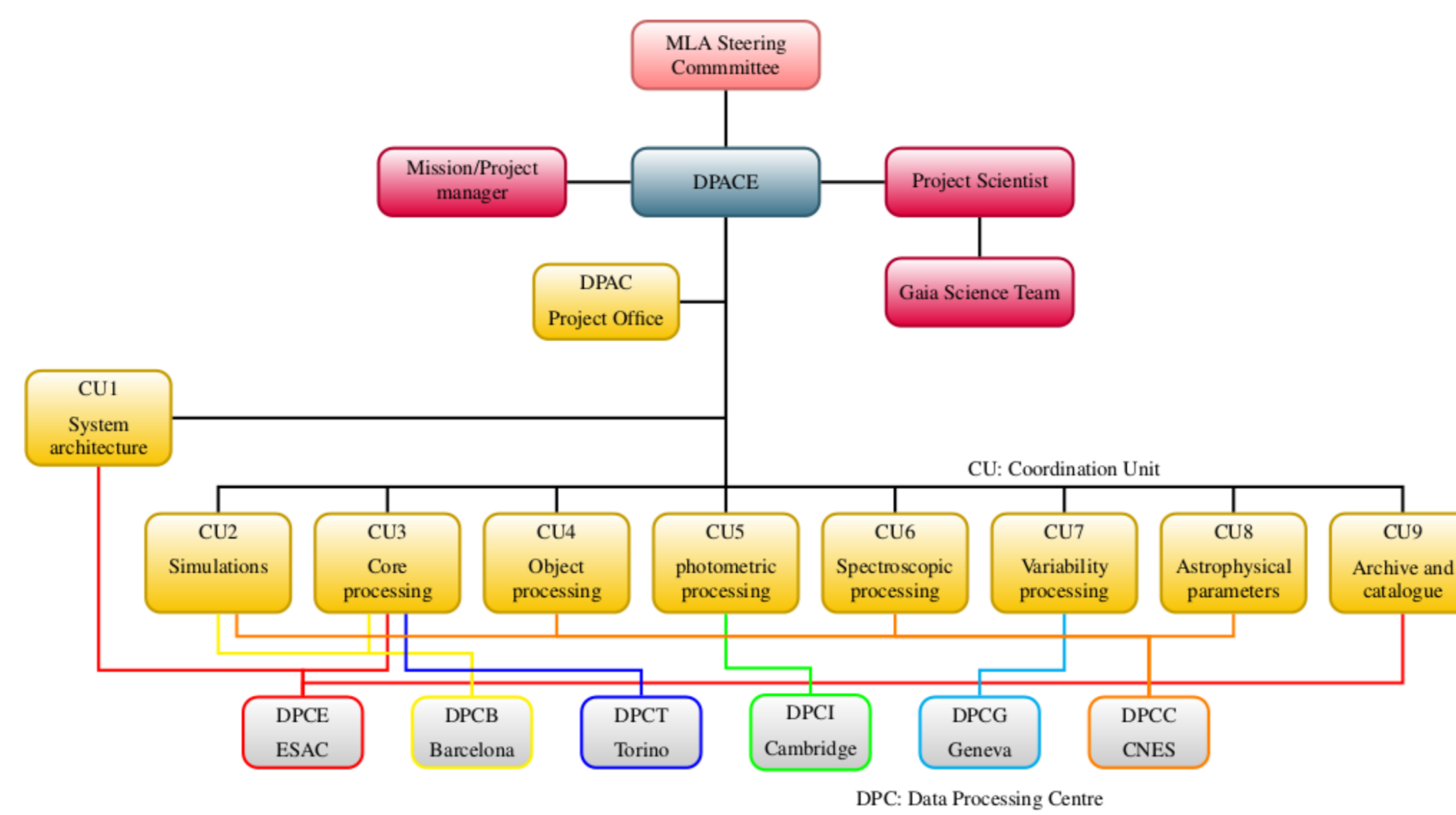*Departament d'Astronomia i Meteorologia, IEEC- ICC-UB, Barcelona, Spain*

Abstract

The ESA Gaia astrometric mission was launched on December 19th 2013. It has been designed to create an extraordinarily precise 3D map of about a billion stars throughout our Galaxy and beyond.

During the development phase of the mission, the simulation of the telemetry and astronomical sources to be observed by Gaia was a crucial task

The simulations allowed a deep analysis of some aspects of the instruments behavior and the preparation of the data reduction software.

The Gaia DPAC Consortium

DPAC (Data Processing and Analysis Consortium) is a large pan-European team of experts scientists and software developers responsible for the processing of Gaia's data with the objective of producing the Gaia Catalogue

DPAC is structured around specialized sub-units know as Coordination Units (CUs). Each CU is responsible for developing a particular sub-system of the overall Gaia data processing system.

CU2: Data Simulations

CU2 is in charge of developing the Gaia simulator that gives data to allow the development and validation of the data reduction of the mission, also generating big simulated samples to the common usage of the other CUs.

The Gaia Simulator

The Gaia Simulator is composed by three data generators, designed for different purposes:

GASS is designed to simulate the telemetry stream of Gaia according to the design specifications.
GIBIS simulates how the Gaia instruments observe the sky.
GOG is a tool to directly get catalogue, main database and final data. It uses analytical and numerical error models to create realistic observations.

All of them use models of the astronomical objects and instruments.

The Gaia Simulator was developed in Java. Including the three data generators and the common libraries, it has about 130,000 lines of code.
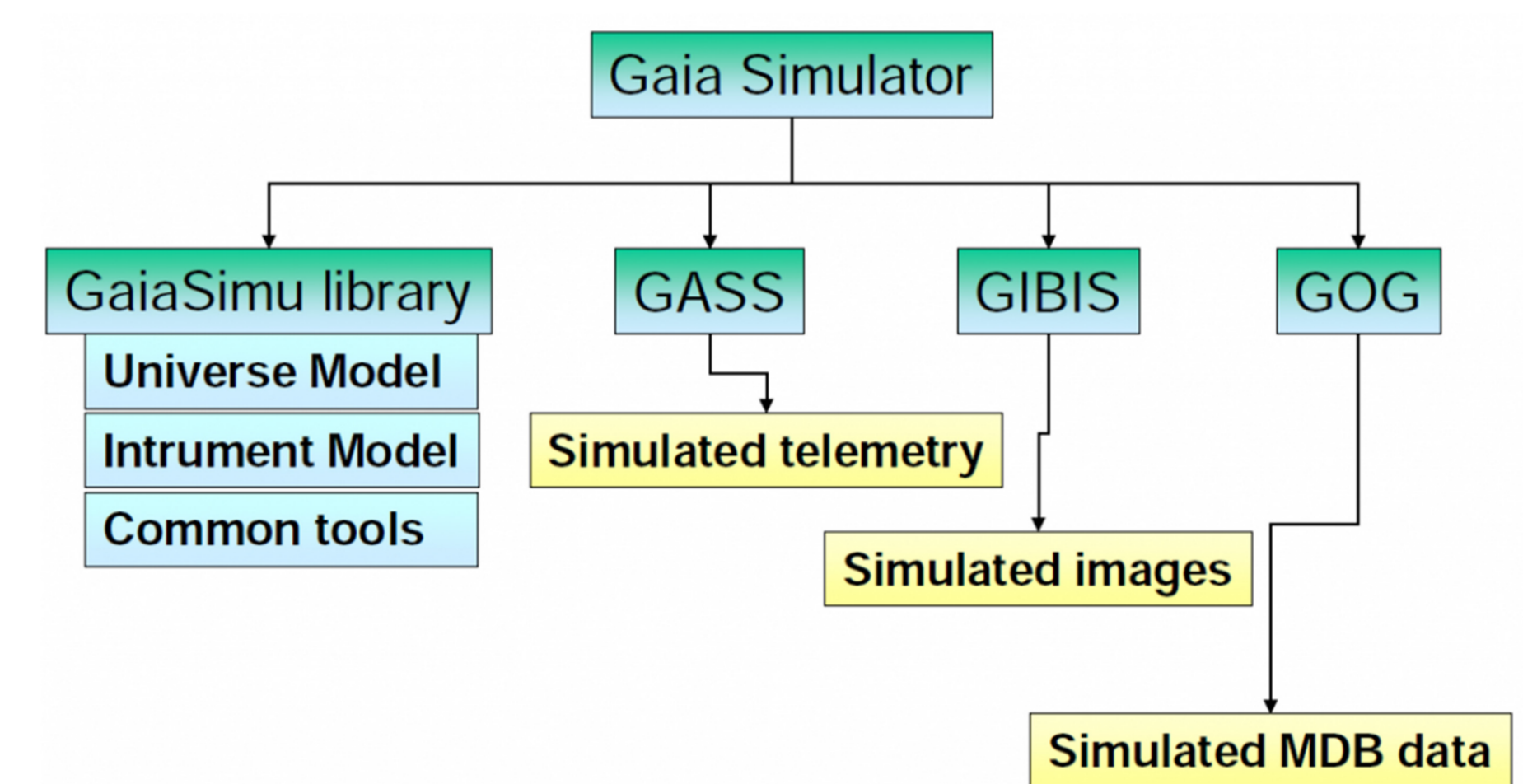

Some products

GASS

Gass has generated large dataset to check the more important steps in the data reduction chain, as the Initial Data Treatment or the Astrometric Global Iterative Solution.

In particular four Operational Rehearsal campaigns before the Gaia launch were performed using the data generated by Gass:

- 20 days of simulated data up to magnitude G=20.
- Up to 90 millions observations per day.
- 5 TB of data.
- 10 millions of CPU hours.

GIBIS

GIBIS is able to simulate detailed snapshots of the Gaia observations at pixel level, taken into account detailed PSFs or CCDs electronic behavior. This high level realism consumes a huge amount of CPU resources.


| AF | RP | RVS |
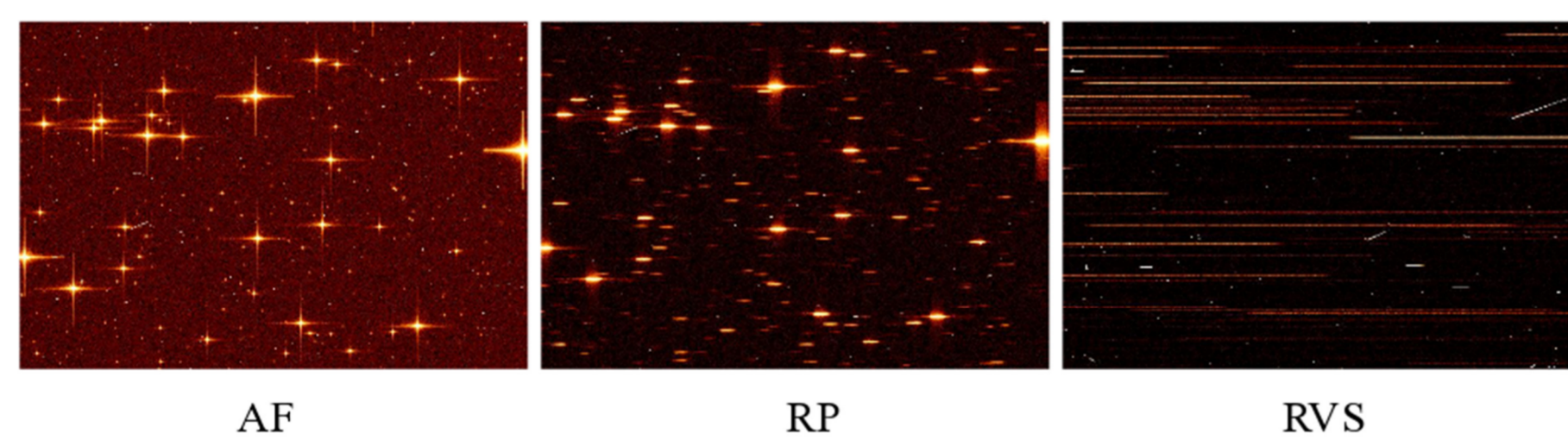
GIBIS simulations of AF, RP and RVS observations.

GOG

GOG has produced several terabytes of simulated data in the last years that have been used to check the Gaia mission design, as well as to develop and test the data reduction algorithms.

- Several simulations with more than 1,500 millions of objects each
- Up to 1,000,000 CPU hours
- GOG data used by teams in France, UK, Belgium. Italy, Netherlands and Mexico
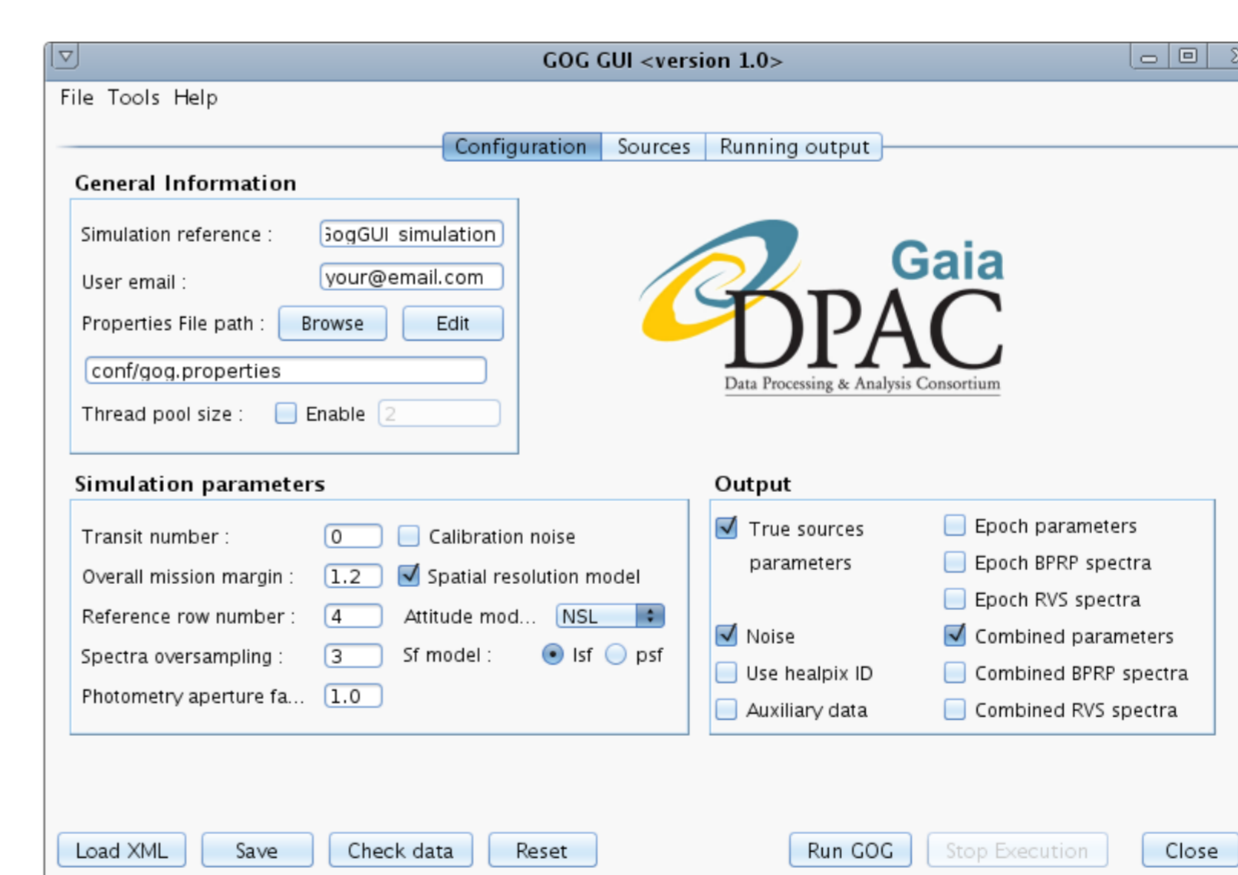
GOG Graphic User Interface
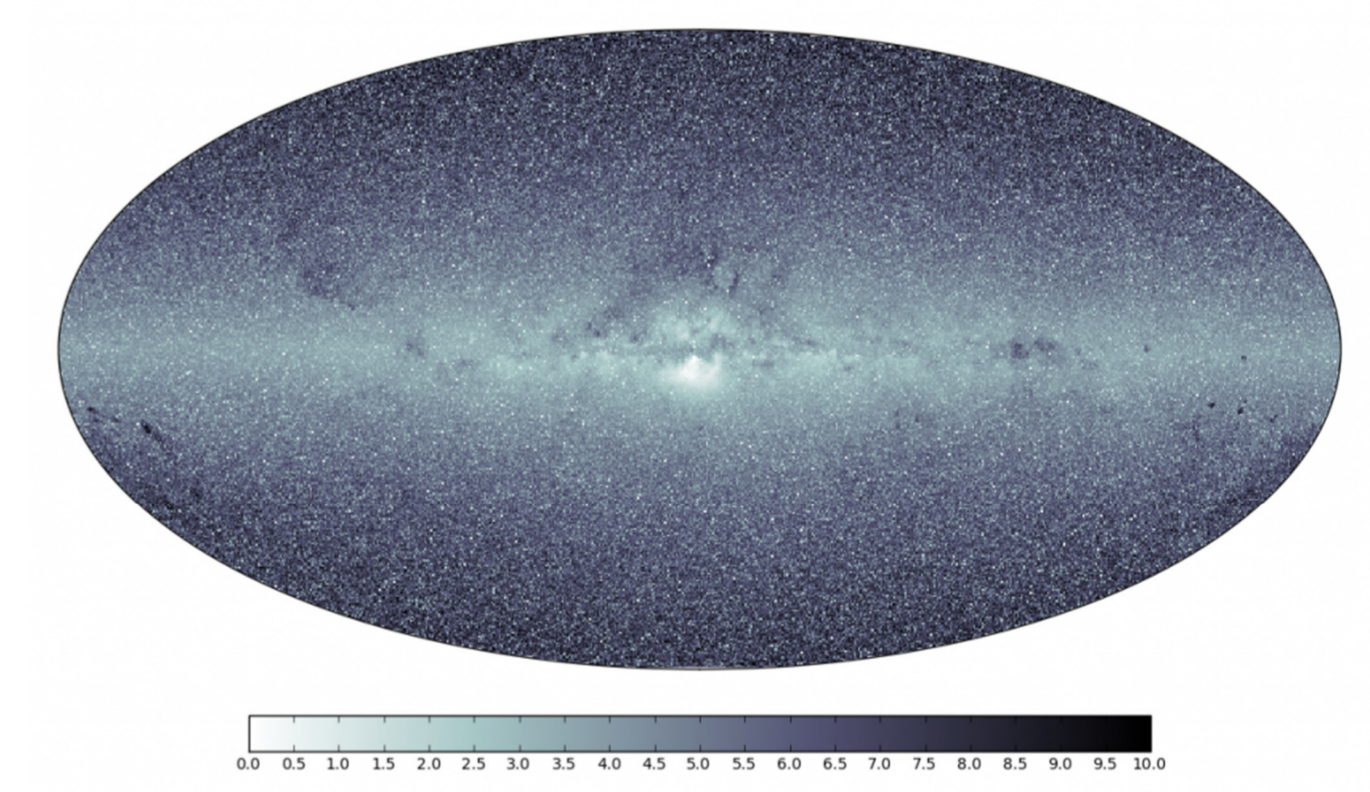
Skymap of total integrated flux over the Milky Way, in the G band, computed using GUMS.
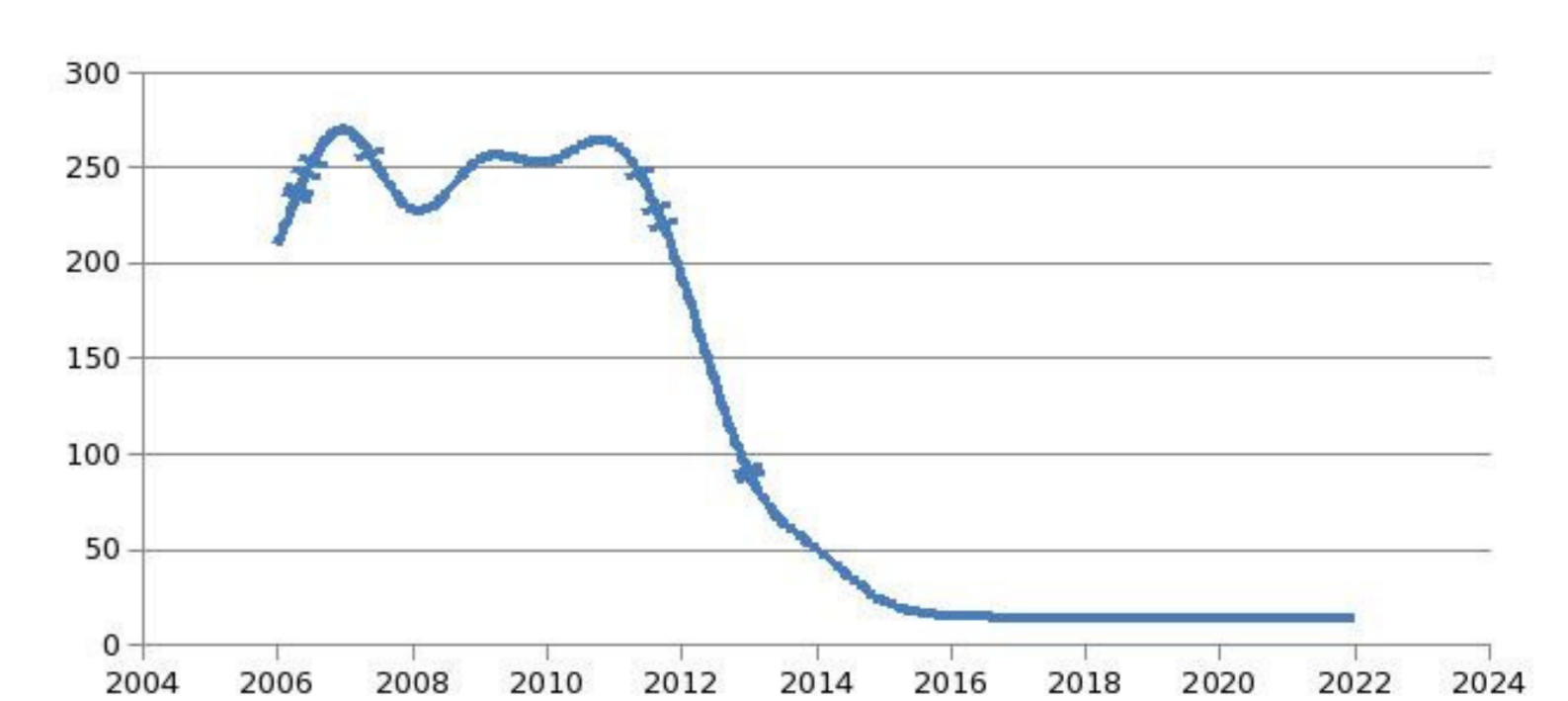
Gaia Universe Model Snapshot (GUMS) is a simulation of the full sky as viewed by Gaia. It is part of GOG and is based on the Besançon Galaxy Model.

CU2 in numbers

50 scientists and software developers
A dozen of countries involved
15 years of work (from 1999, first development of the Gaia Simulator)
3 main software products (GASS, GIBIS and GOG)
130,000 lines of code
15 TB of generated data
12 millions of CPU hours used in simulations

Simulations after Gaia launch

CU2 work doesn't finish with the Gaia launch. Until the first catalogue release is published, several CUs need still to work with GOG simulated data. However, the amount of effort decreased significantly after the launch.

CU2 effort as function of time.

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