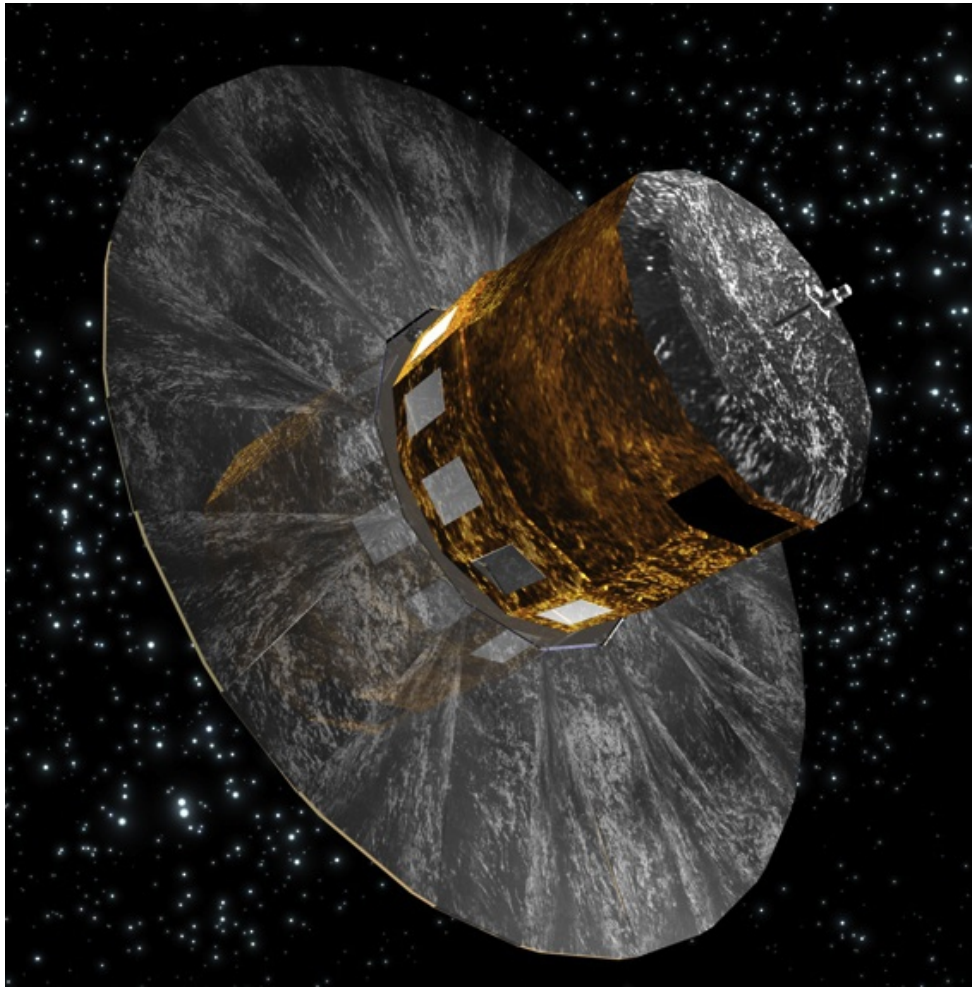
Gaia – Space VRC



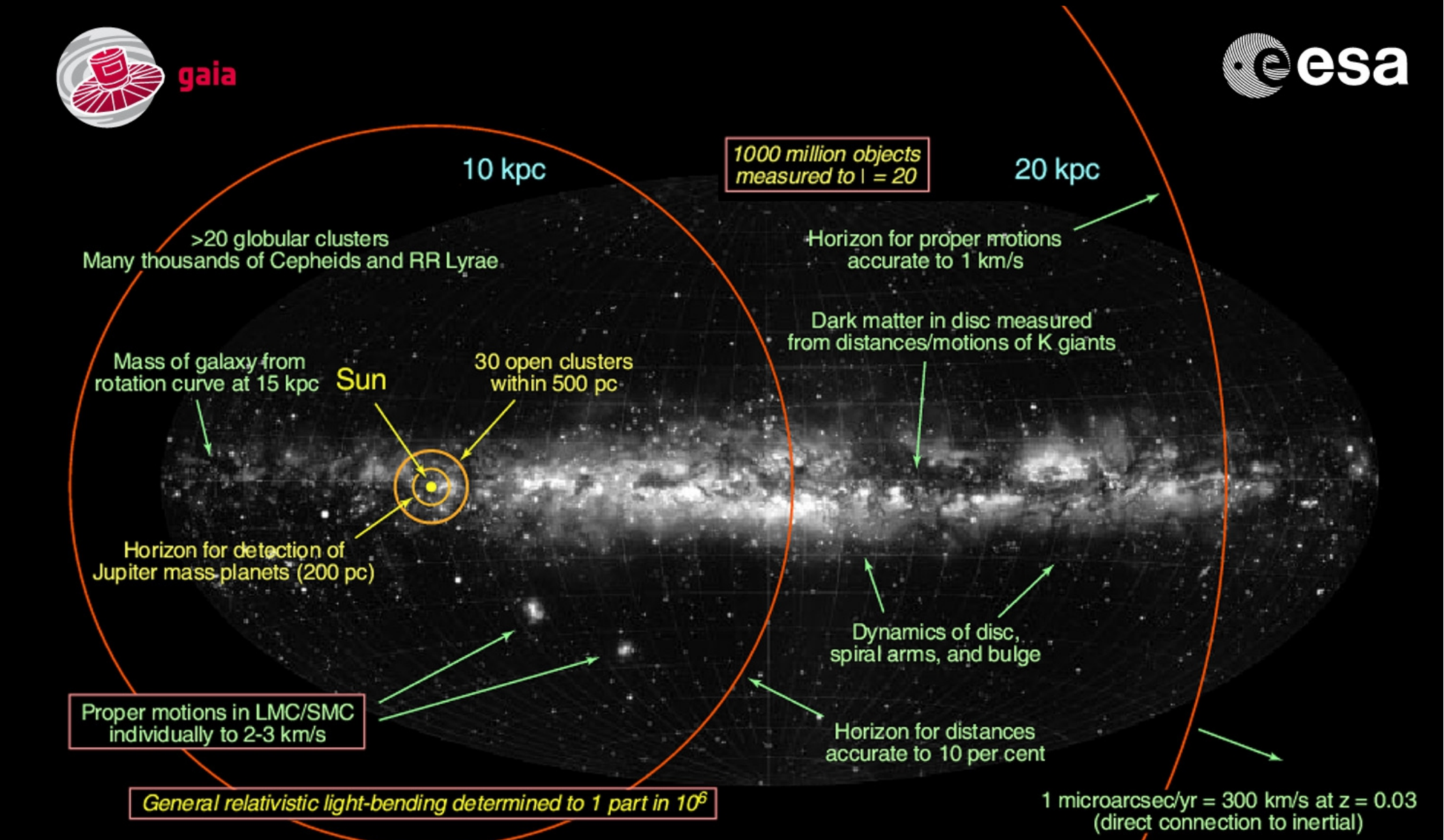
Pilot Data Services

Nicholas Walton & Guy Rixon

(Institute of Astronomy)

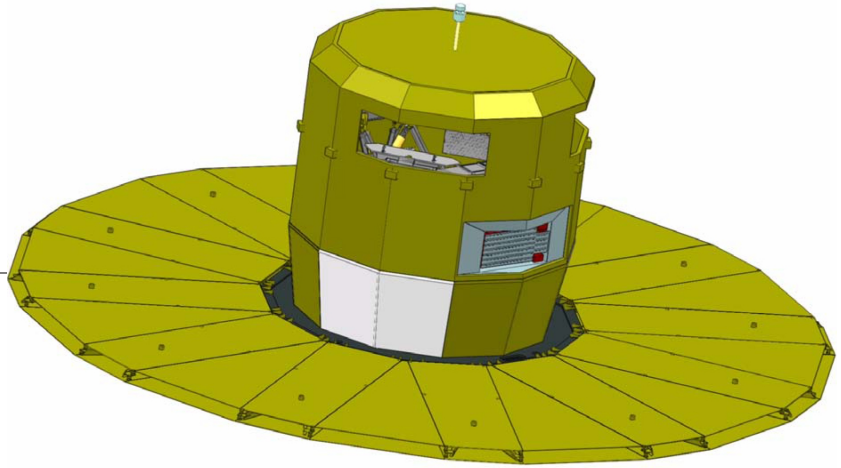
UNIVERSITY OF CAMBRIDGE

The Promise of Gaia
transformational science

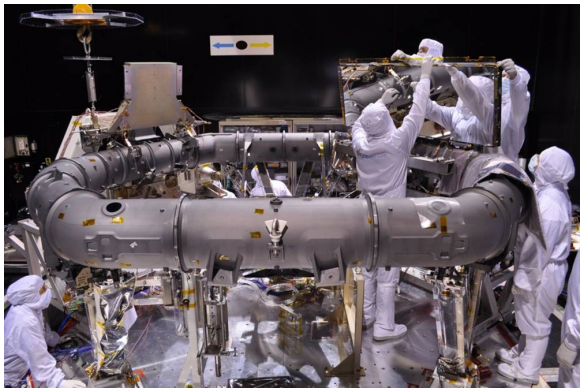


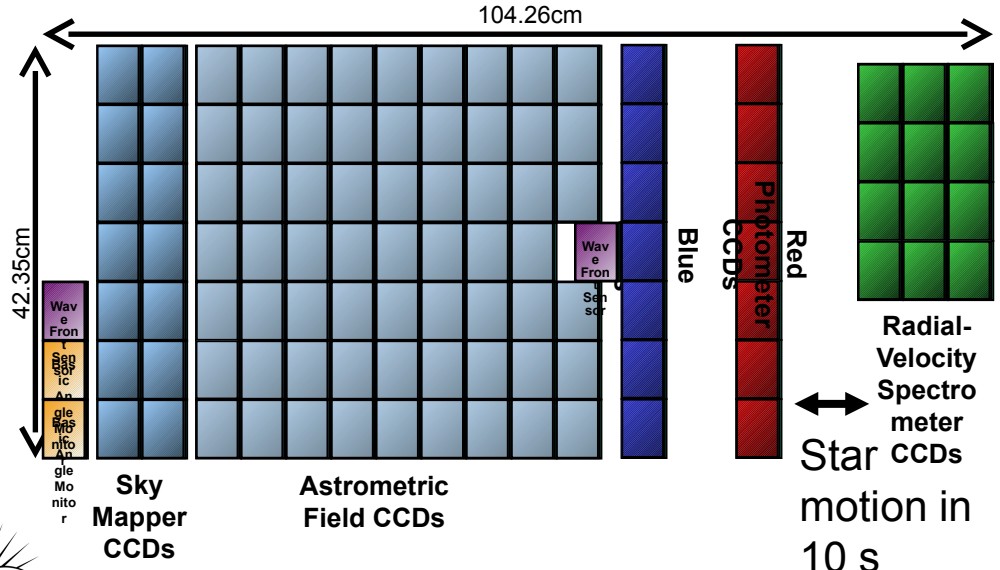
Gaia: mapping the Universe
launches August 2013

	Hipparcos	Gaia
Magnitude limit	12	20 mag
Completeness	7.3 – 9.0	20 mag
Bright limit	0	6 mag
Number of objects	120 000	26 million to V = 15 250 million to V = 18 1000 million to V = 20
Effective distance	1 kpc	1 Mpc
Quasars	None	5×10^5
Galaxies	None	$10^6 – 10^7$
Accuracy	1 milliarcsec	7 μarcsec at V = 10 10-25 μarcsec at V = 15 300 μarcsec at V = 20
Photometry	2-colour (B and V)	Low-res. spectra to V = 20
Radial velocity	None	15 km/s to V = 16-17
Observing	Pre-selected	Complete and unbiased

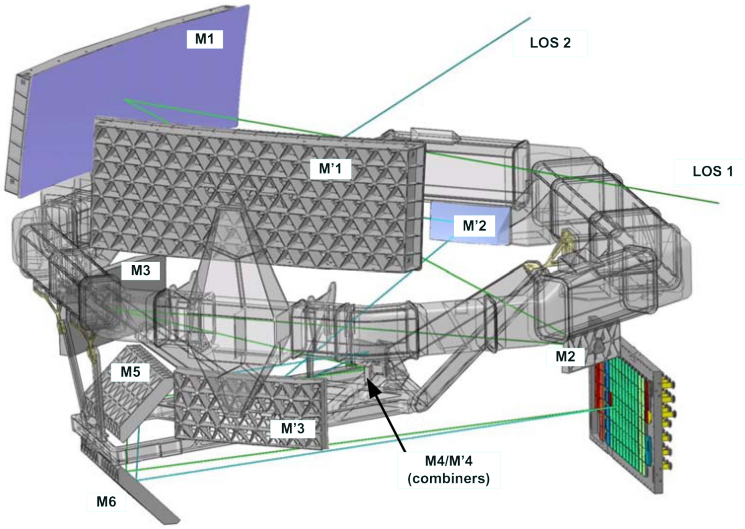


Images: ESA/ EADS Astrium





Star motion in 10 s



Gaia Accuracy: 10μas is very small!

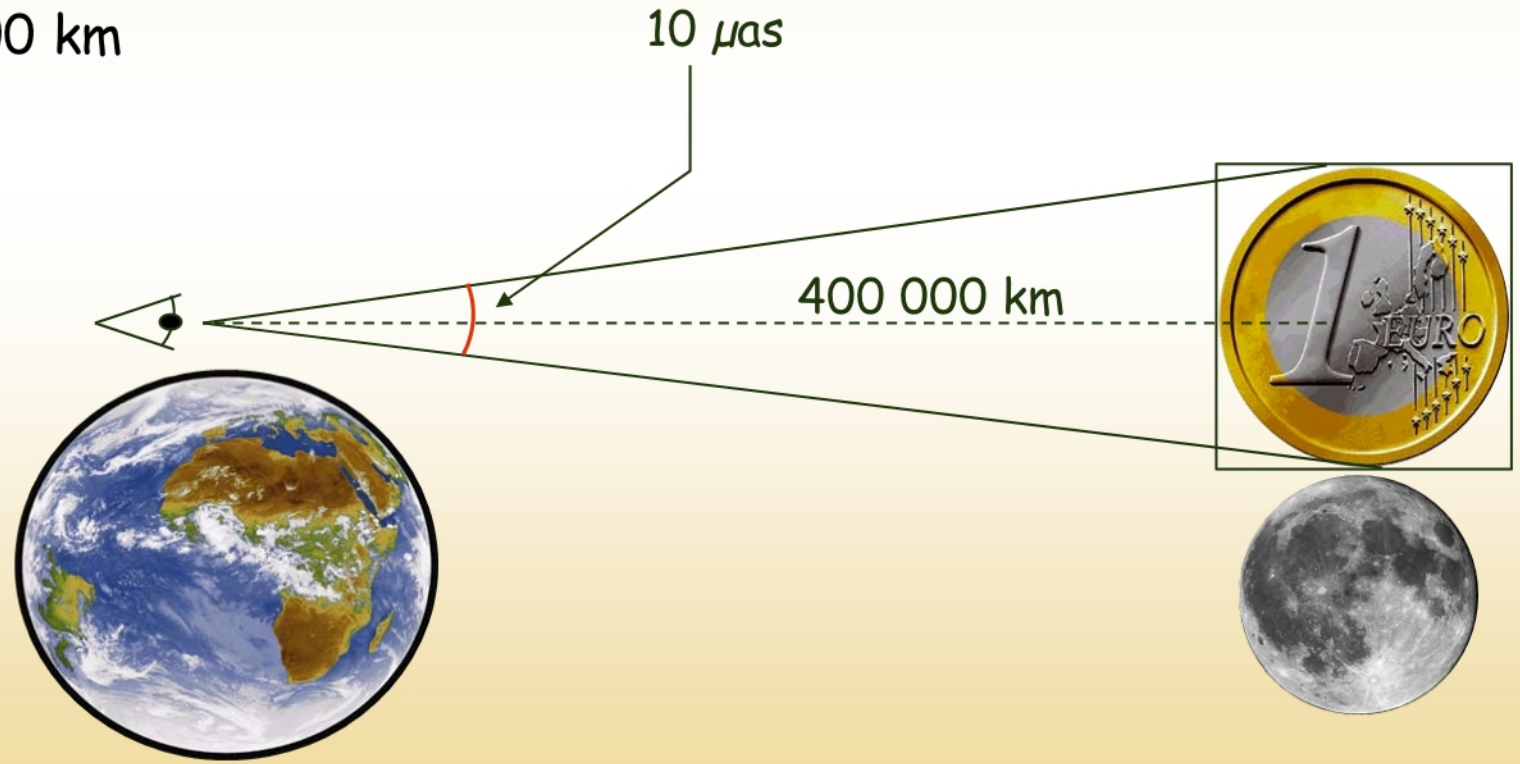
0.3 mm displacement on the Earth

Displacement of a 100 mas/yr star in one hour

Motion of a fast moving minor planet in 100 μs

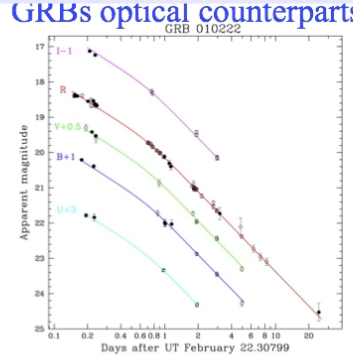
edge-on sheet of paper @ 2000 km

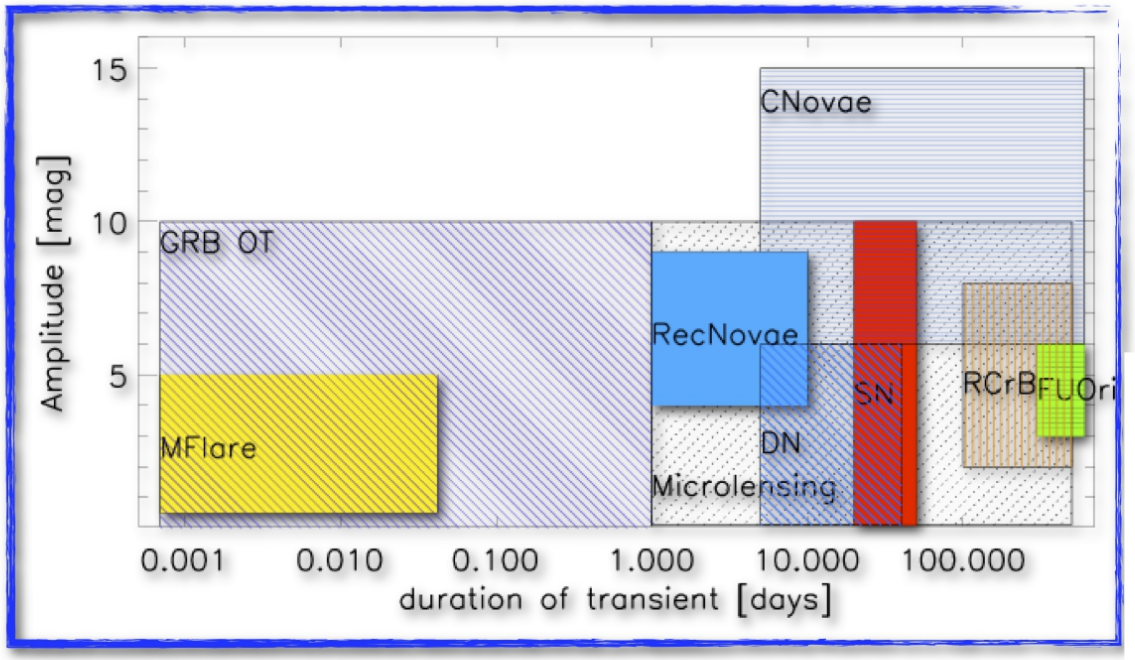
1 hair @ 1000 km



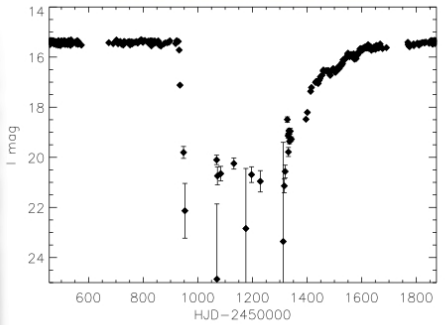
Gaia will also observe the transient sky

GRBs optical counterparts

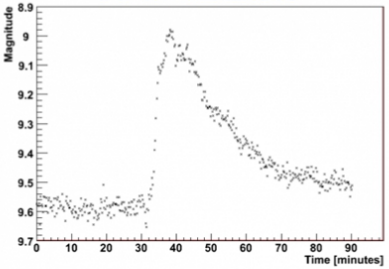




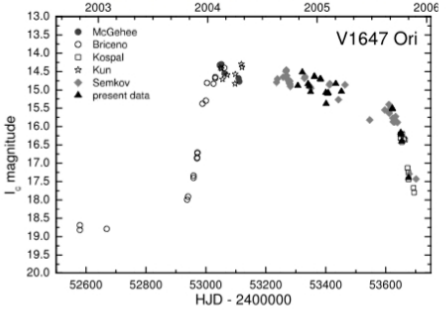
R Coronae Borealis



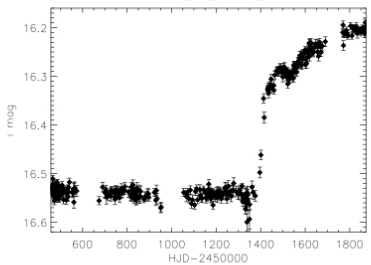
M-dwarf flares



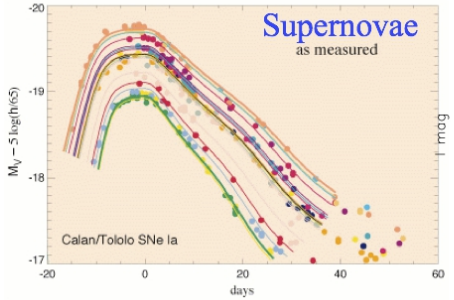
FU Orionis and similar

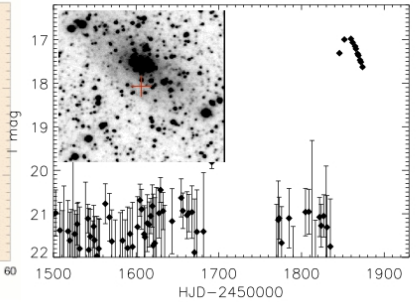


Be stars

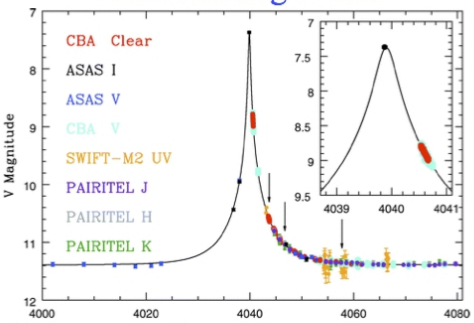


Supernovae

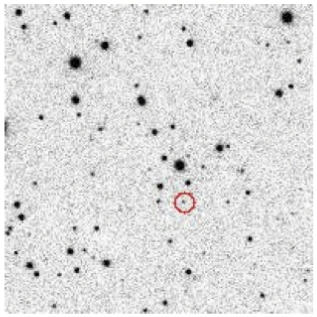




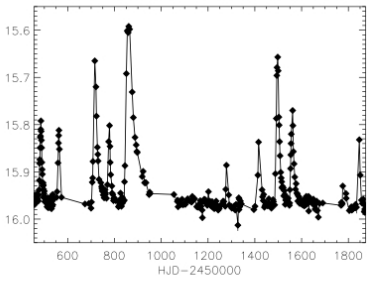
Microlensing events



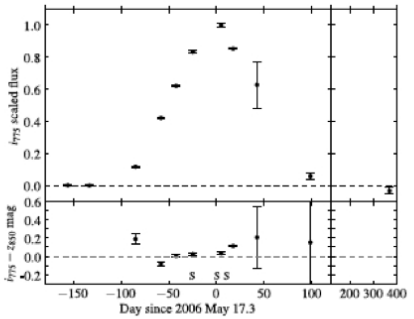
Asteroids



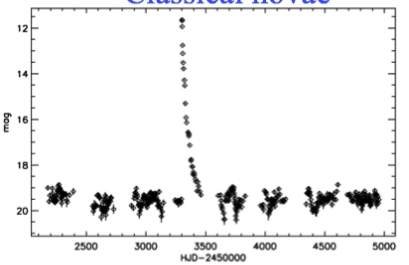
Dwarf novae



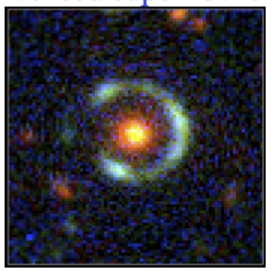
NEW THINGS??



Classical novae

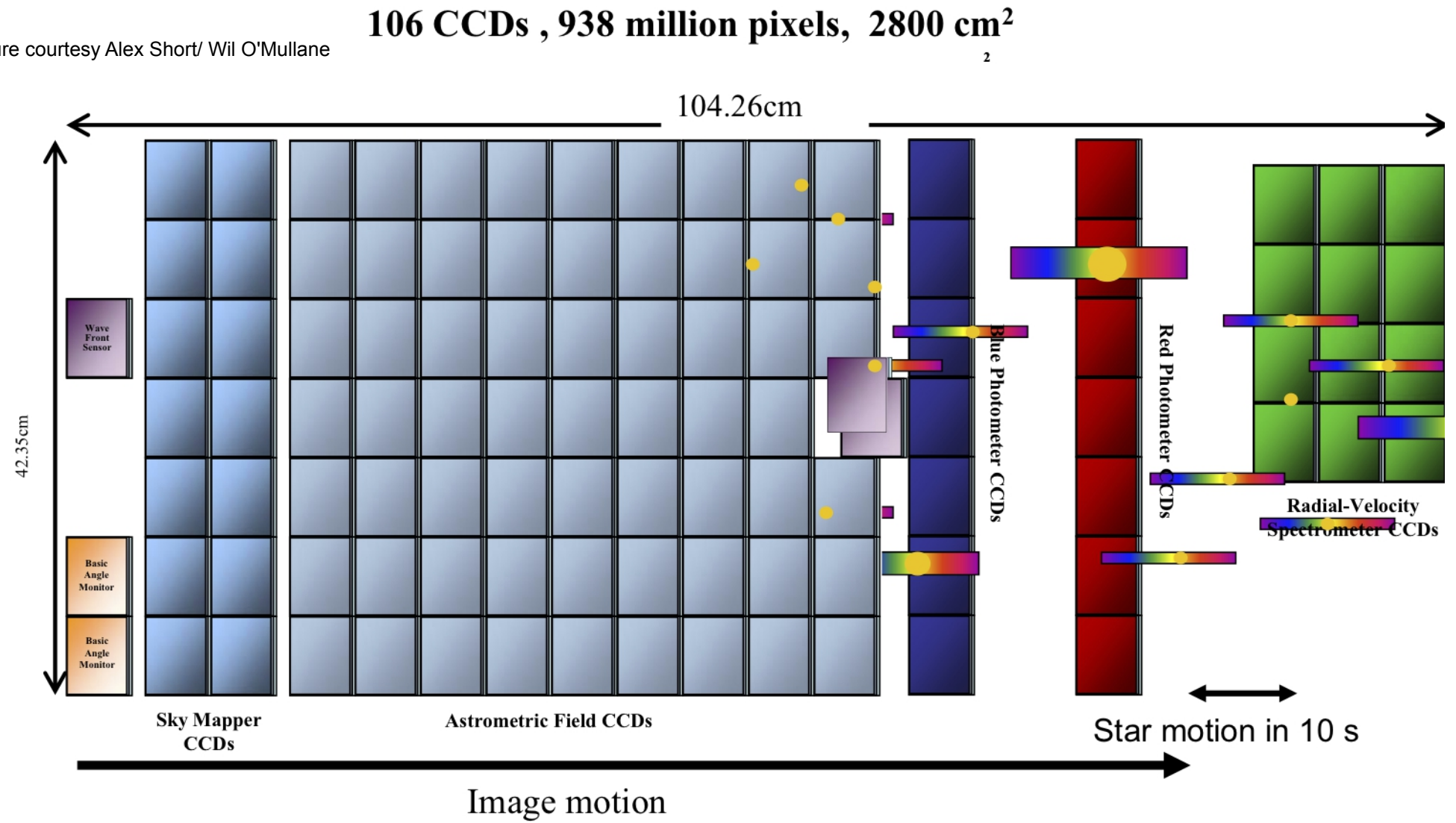


Lensed supernovae

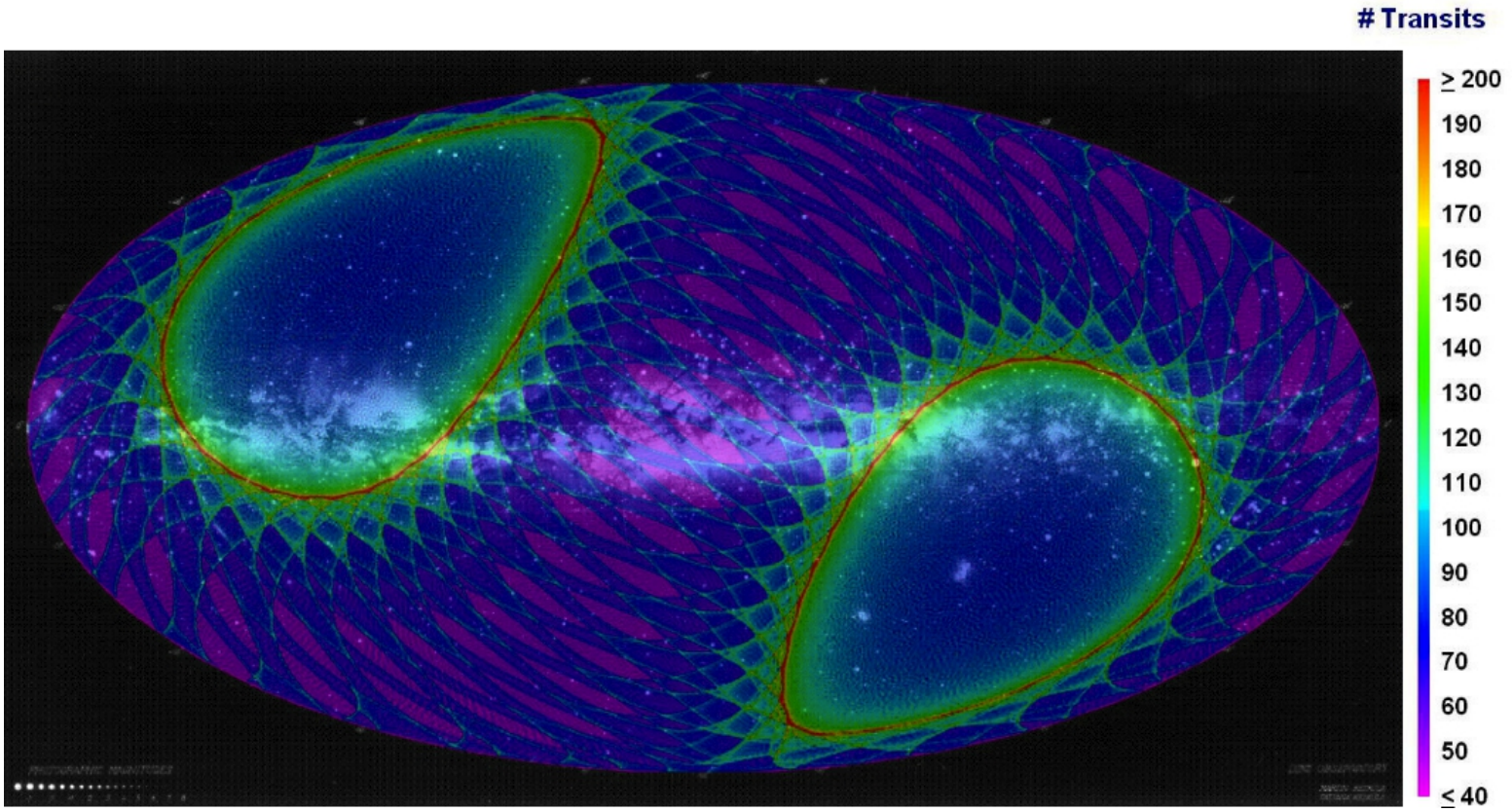


Focal Plane: multiplexing
a billion pixels - the largest camera in space

Figure courtesy Alex Short/ Wil O'Mullane



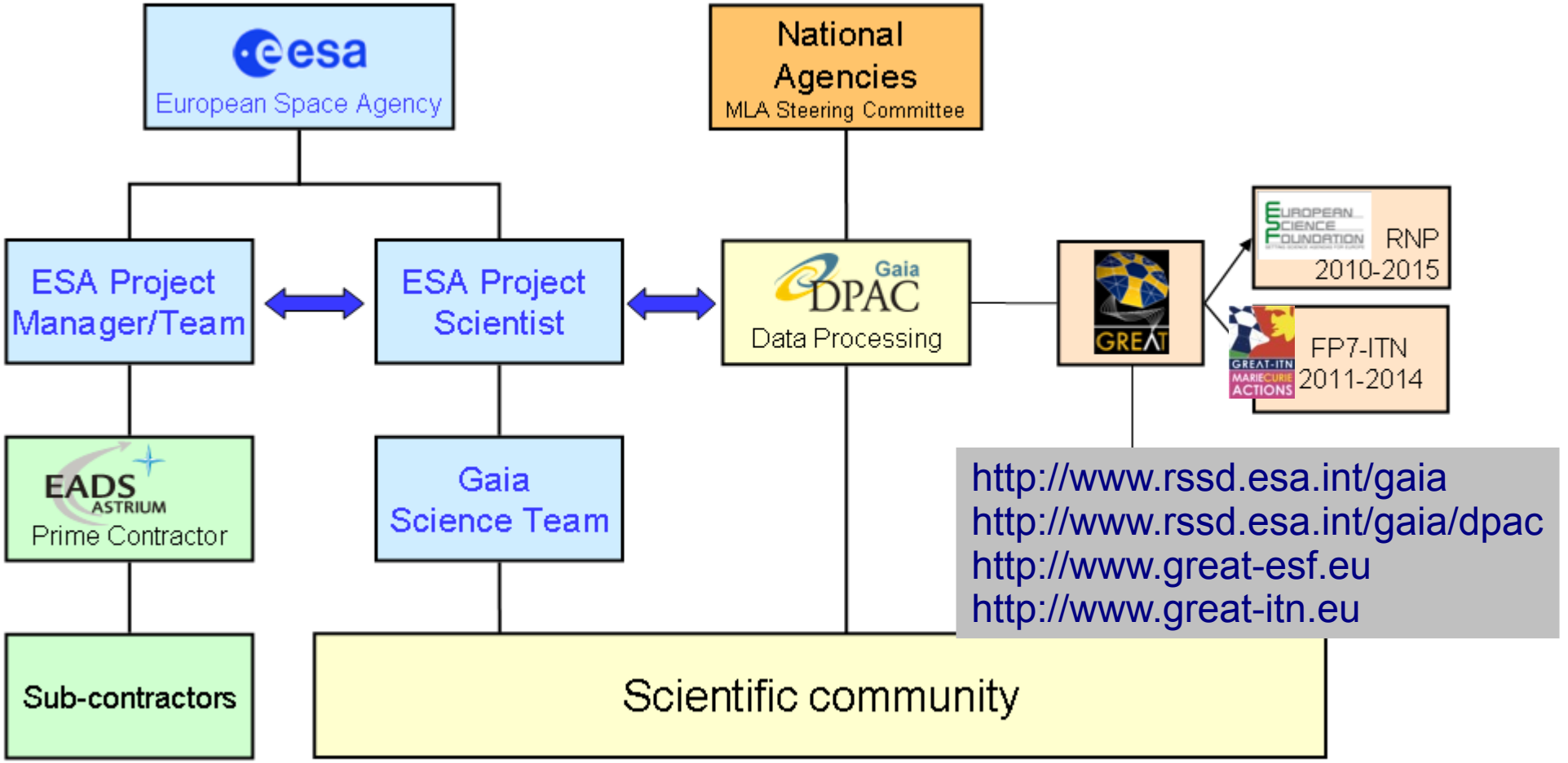
Gaia: Sky Coverage
All sky – many times



Each point: t_0, t_0 + 106 mins, t_0 + 6hrs, t_0 + 6hrs + 106 mins, repeated 10-30 days later

The Gaia Project

a complex mission on budget, on time (more or less)

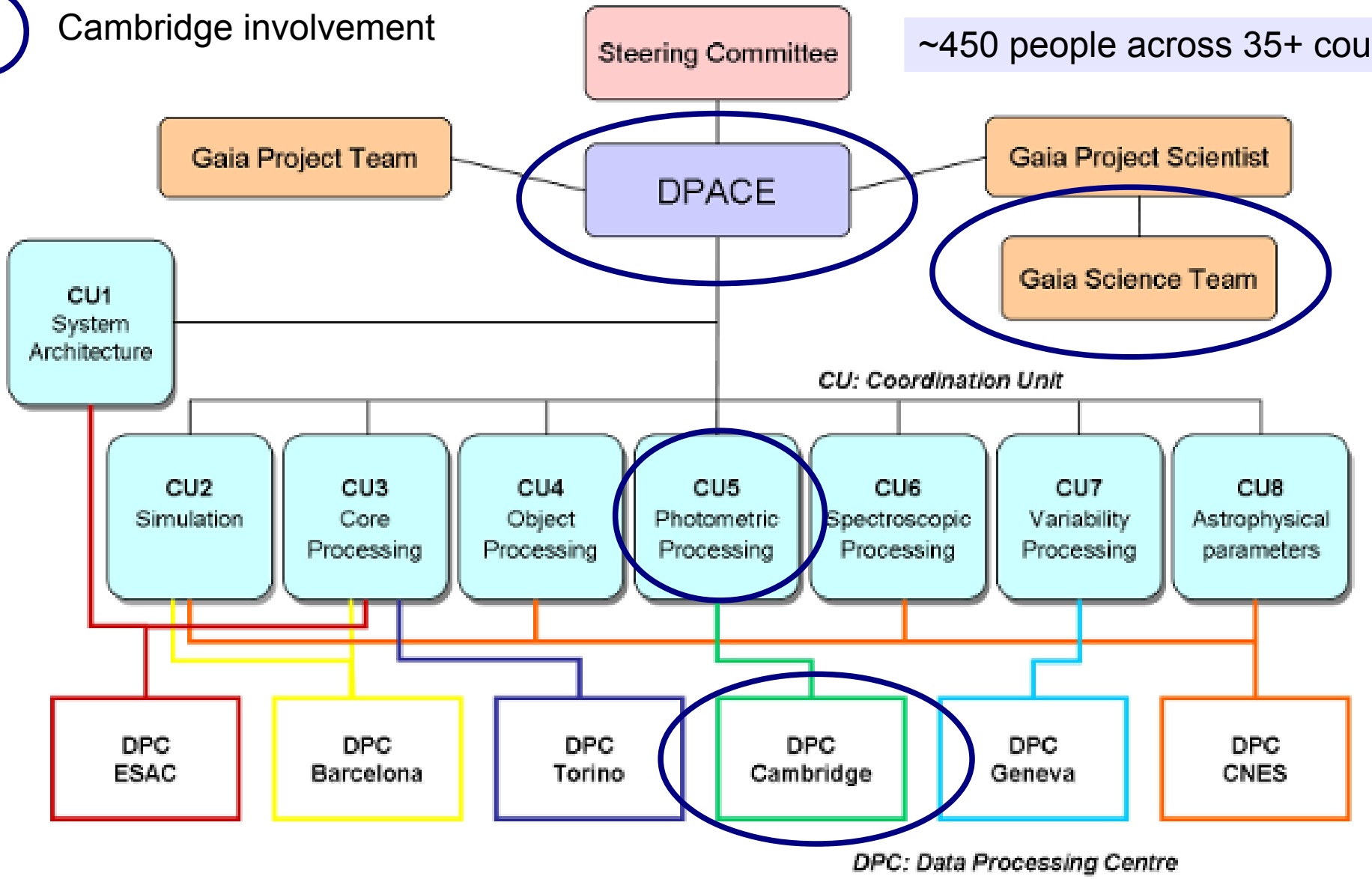


The Data Reduction Challenge

DPAC: Data Processing & Analysis Consortium

Cambridge involvement

~450 people across 35+ countries



Significant Computational Challenge

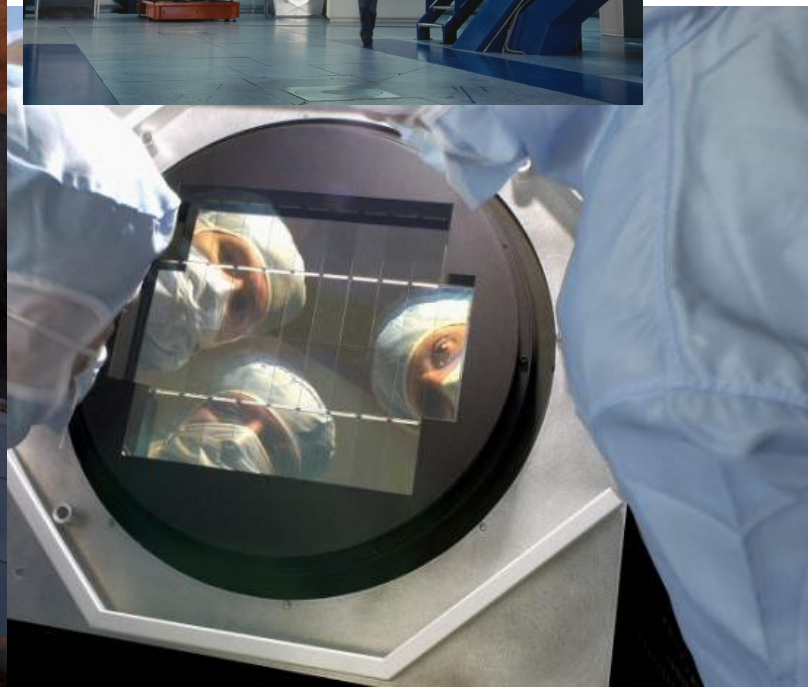
- Simulations & processing require large clusters
  - Barcelona Mare Nostrum

- Mid sized clusters
  - e.g Photometry at Cambridge
  - ~1000 core, 1PB
- Gaia processing on dedicated facilities

The ASTRA Challenge:
understanding Galaxy structure

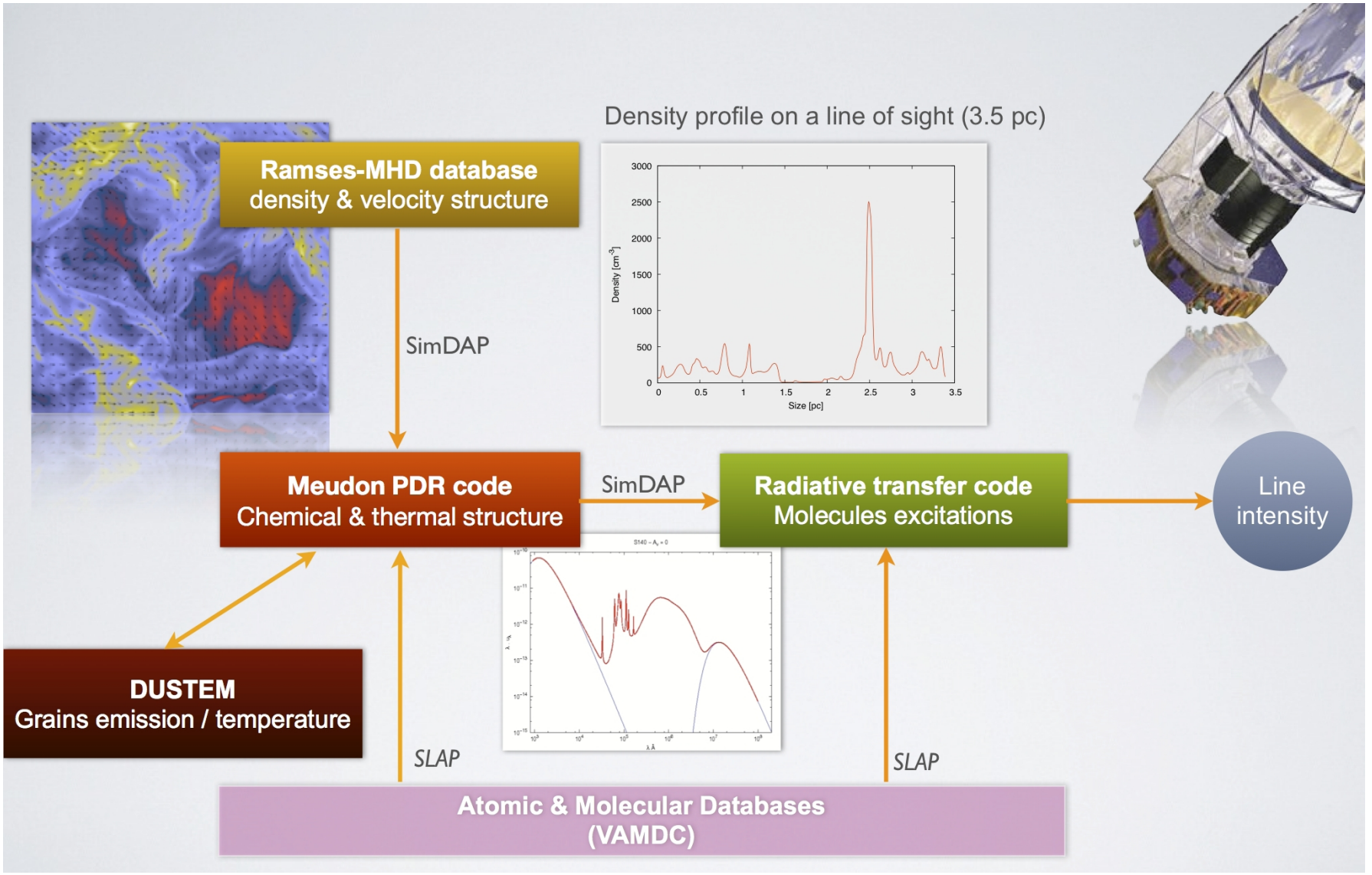
- Understanding the large scale structure of the Milky Way (MW) – formation mechanisms and evolution
- Integration of 3-D data
  - Radio – measure magnetic field structure in the MW
  - Infrared – map the MW dust
  - Optical Spectroscopy – the chemo-kinematics of the MW
  - ESA Planck – sub-mm – the dust in the MW
  - ESA Gaia – positional information of a billion stars
- Challenge to integrate heterogeneous data and compare with large scale models
- Distributed application / data infrastructure
- See http://www.gaia-astra.eu

Large telescopes and large cameras

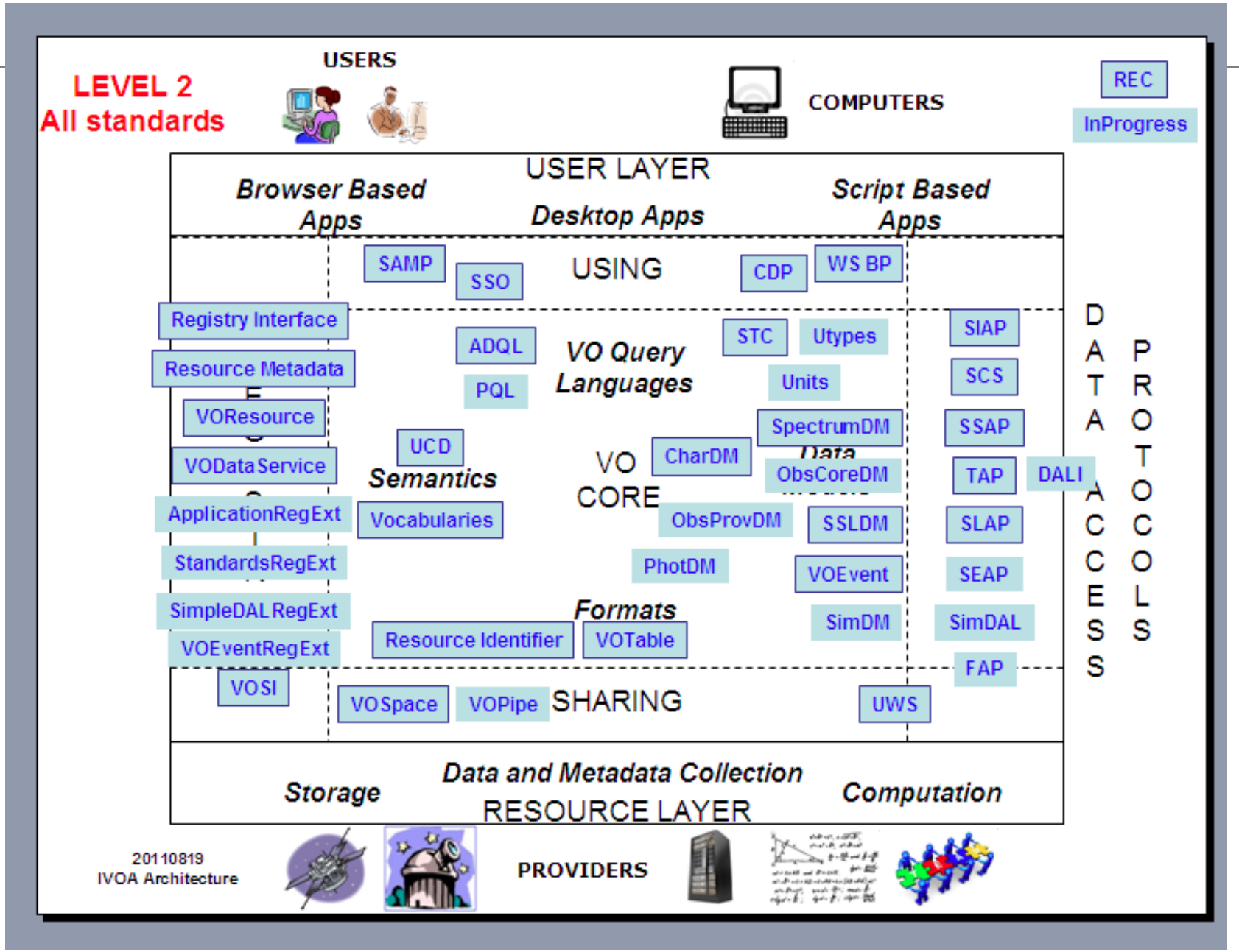


Credits: ESO, ESO, CFHT

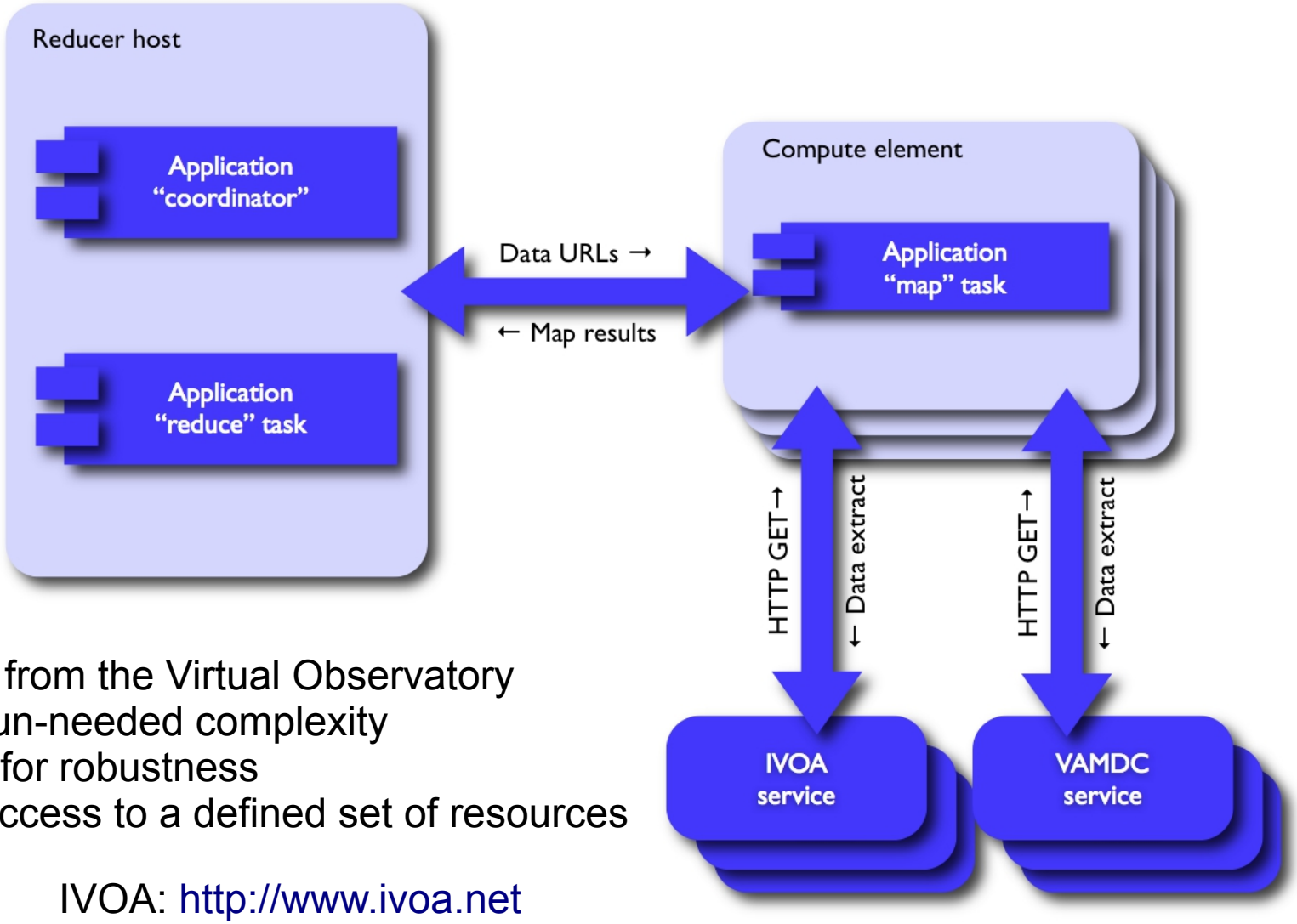
Model / Observation Integration
connecting infrastructures



IVOA Infrastructure



Towards the ASTRA Architecture



- Evolution from the Virtual Observatory
- Remove un-needed complexity
- Engineer for robustness
- Provide access to a defined set of resources

IVOA: http://www.ivoa.net
VAMDC: http://www.vamdc.eu

Credit: Guy Rixon

Gaia – SPACE VRC
initialisation activities in 2012

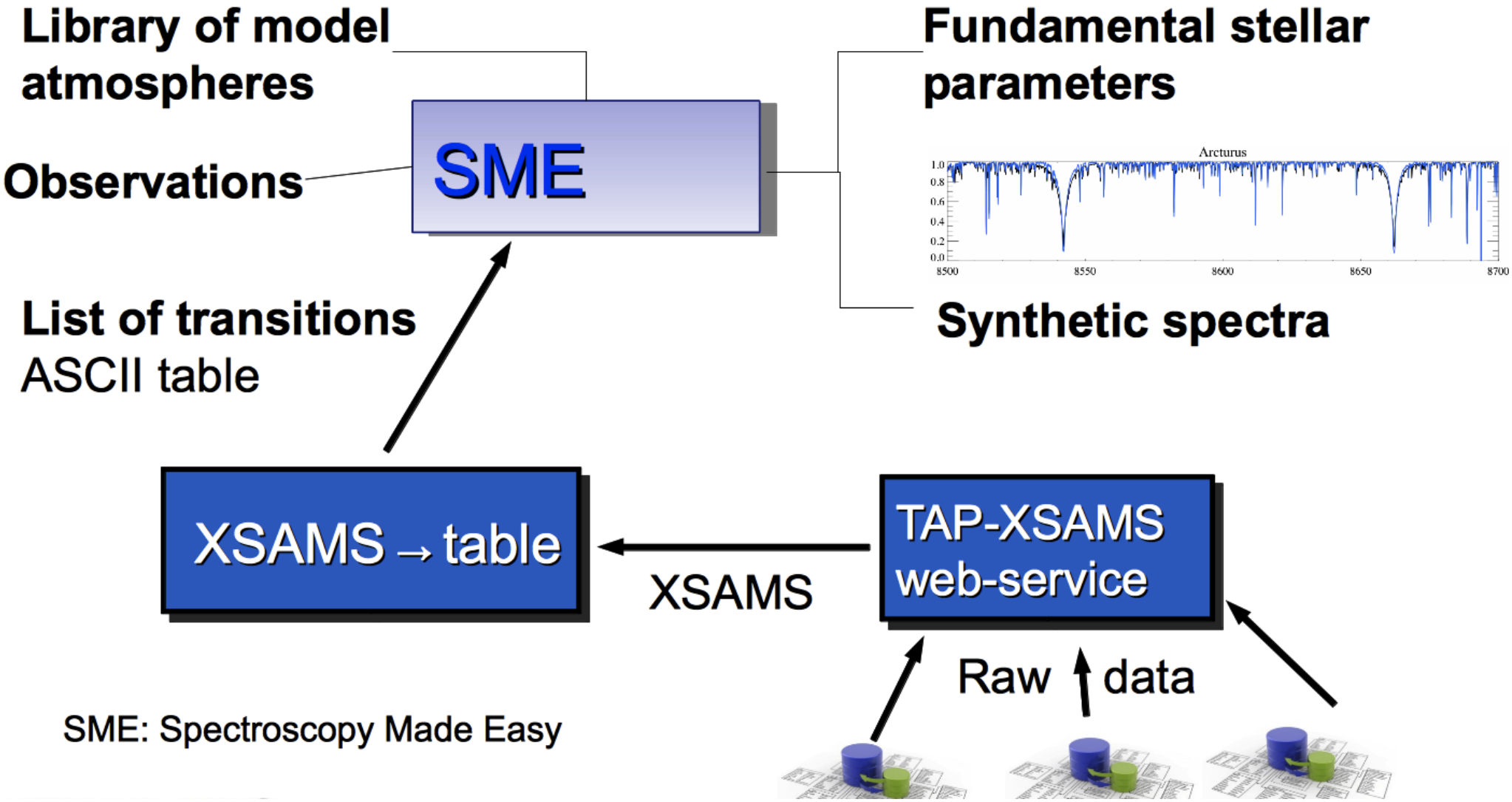
- Activity focussed on following areas:
  - Input use case requirements to Cloud task force
  - Define model for access to existing grid resources
    - On-demand access to enable load-balancing
  - Define initial requirement on computational resources to enable pilot data integration services
  - Define application database providing a registry of available resources
  - Implement initial training plan
- Feedback experience of focussed astronomy community needs to the EGI

ASTRA and software solutions

- The multi-wavelength approach requires seamless access to Gaia and related data
- Presentations pointing at example capabilities to:
  - Mine the Gaia data
  - Access fundamental data
  - Utilise European level computational processing clouds
- ASTRA focussed on a bottom up process of pilot application development, within a standard framework built from standard technologies

ASTRA Pilot Example

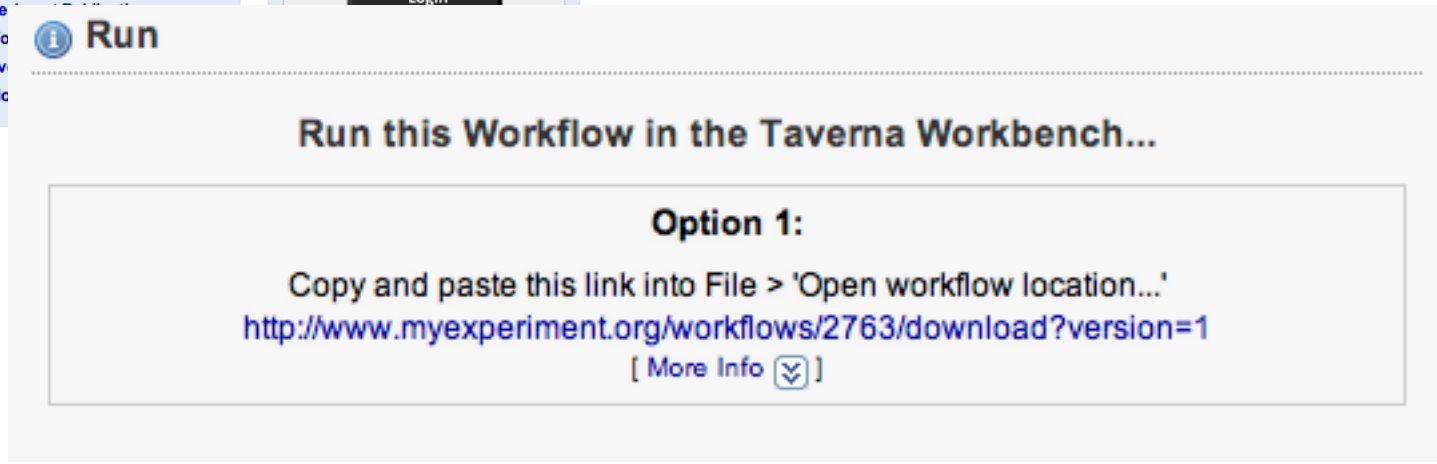
linking VAMDC (http://www.vamdc.eu) services

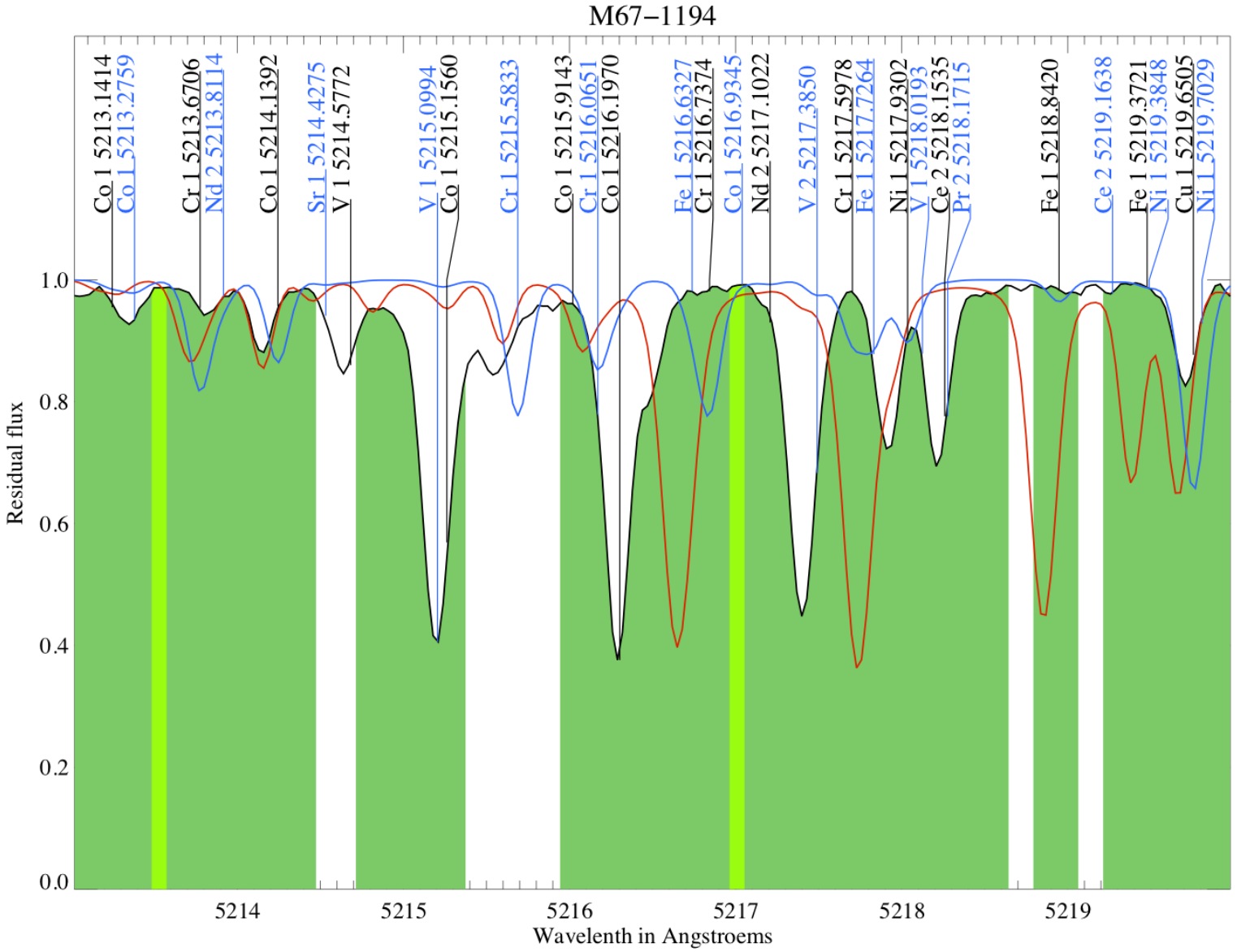


Workflow Access: Publish & Run

myExperiment makes it easy to **find**, **use** and **share scientific workflows** and other **Research Objects**, and to build **communities**.

http://www.myexperiment.org



ASTRA Demo Outputs

- VAMDC/VALD demo