

Overview of the Gaia project

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Gaia in a nutshell

Astrometry: positions, parallaxes,
proper motions

$10 \mu\text{as}$ @ $V=15$

All sky: 1 billion stars to $V=20$

Radial velocities / spectroscopy

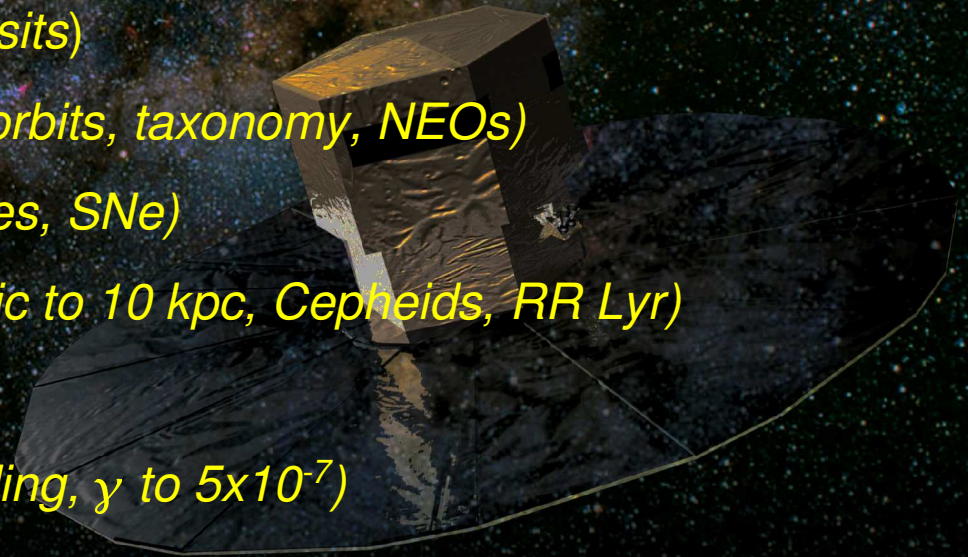
~15 band optical / IR photometry

ESA mission, launch 2011

Gaia science objectives

Main science driver: Galactic composition and formation

- sets parallax/proper motion precision and magnitude limit
- *dark matter, merger history, chemical evolution ...*
- Stellar astrophysics (*HRD, abundances, binaries*)
- Star formation (*OB assoc., clusters*)
- Exoplanets (*orbits, masses, transits*)
- Solar system (*new discoveries, orbits, taxonomy, NEOs*)
- Extragalactic (*local group galaxies, SNe*)
- Cosmic distance scale (*geometric to 10 kpc, Cepheids, RR Lyr*)
- Reference frame (*quasars*)
- Fundamental physics (*light bending, γ to 5×10^{-7}*)



Instrument and mission overview

- Astrometry
 - positions, parallaxes, proper motions
- Radial velocities / spectroscopy
 - 6th dimension of phase space
 - perspective acceleration, stellar diagnostics
- Photometry
 - object classification
 - determination of physical stellar parameters
- Pre-defined scanning law
 - no input catalogue; real-time onboard detection
 - 5 year mission
 - each star observed average of 85 times (minimum of 30) in Astro
 - complete sky coverage every 6 months

Summary of capabilities



Hipparcos

Gaia

Magnitude Limit
Completeness
No. sources

12.4
7.3-9.0
120 000

20
20
26 million to V=15
250 million to V=18
1000 million to V=20

No. quasars

none

0.5-1 million

No. galaxies

none

1-10 million

Target selection

input catalogue

onboard; mag. limited

Astrometric accuracy

~1000 uas

2-3 uas at V<10
5-15 uas at V=15
40-200 uas at V=20

Broad band photometry

2 (B,V – Tycho)

4-6

Medium band photometry

none

10-16

Spectroscopy

none

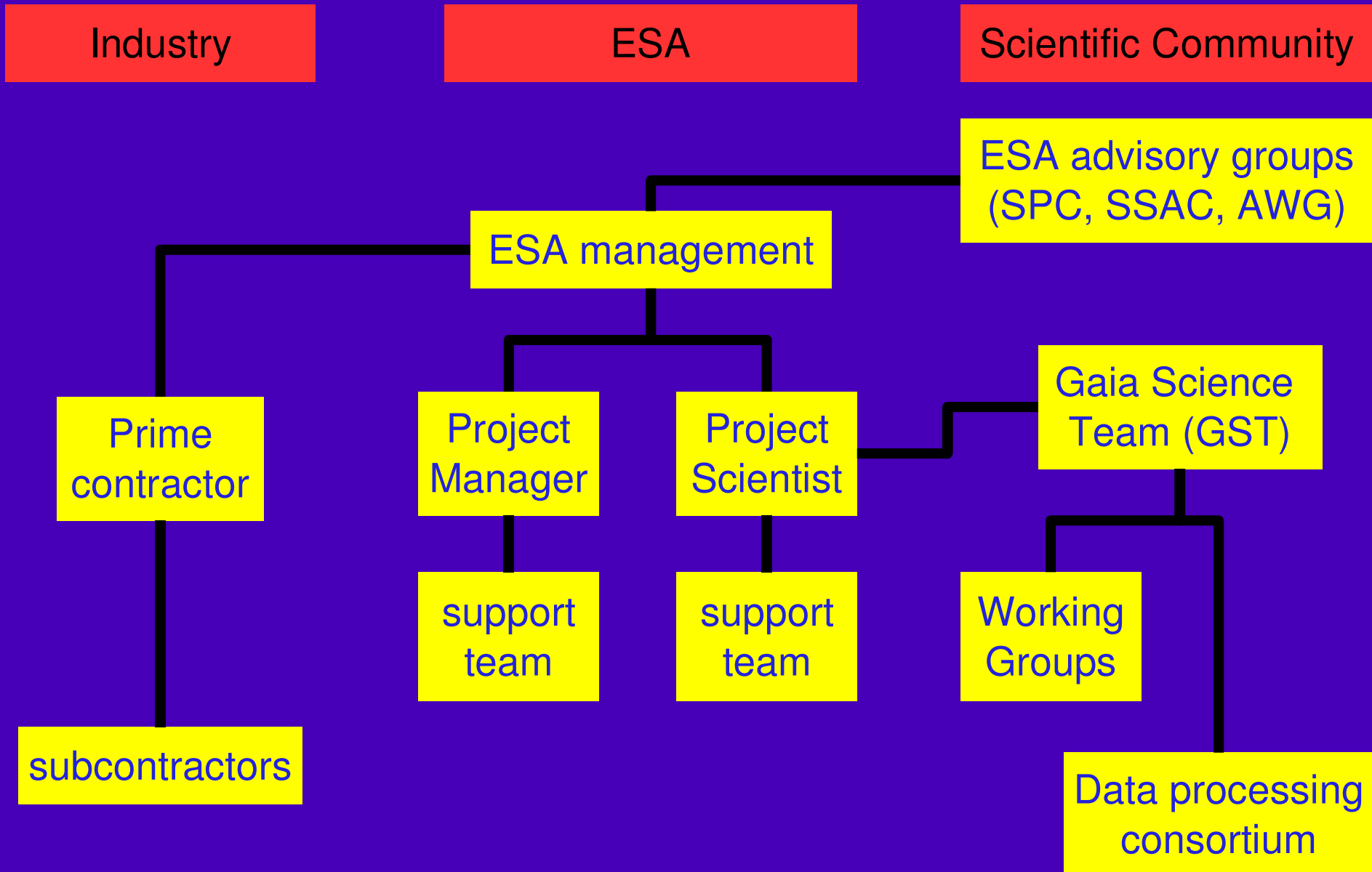
R=11 500 (848-874 nm)

Radial velocities

none

1-10 km/s to V=17-18

Gaia organization

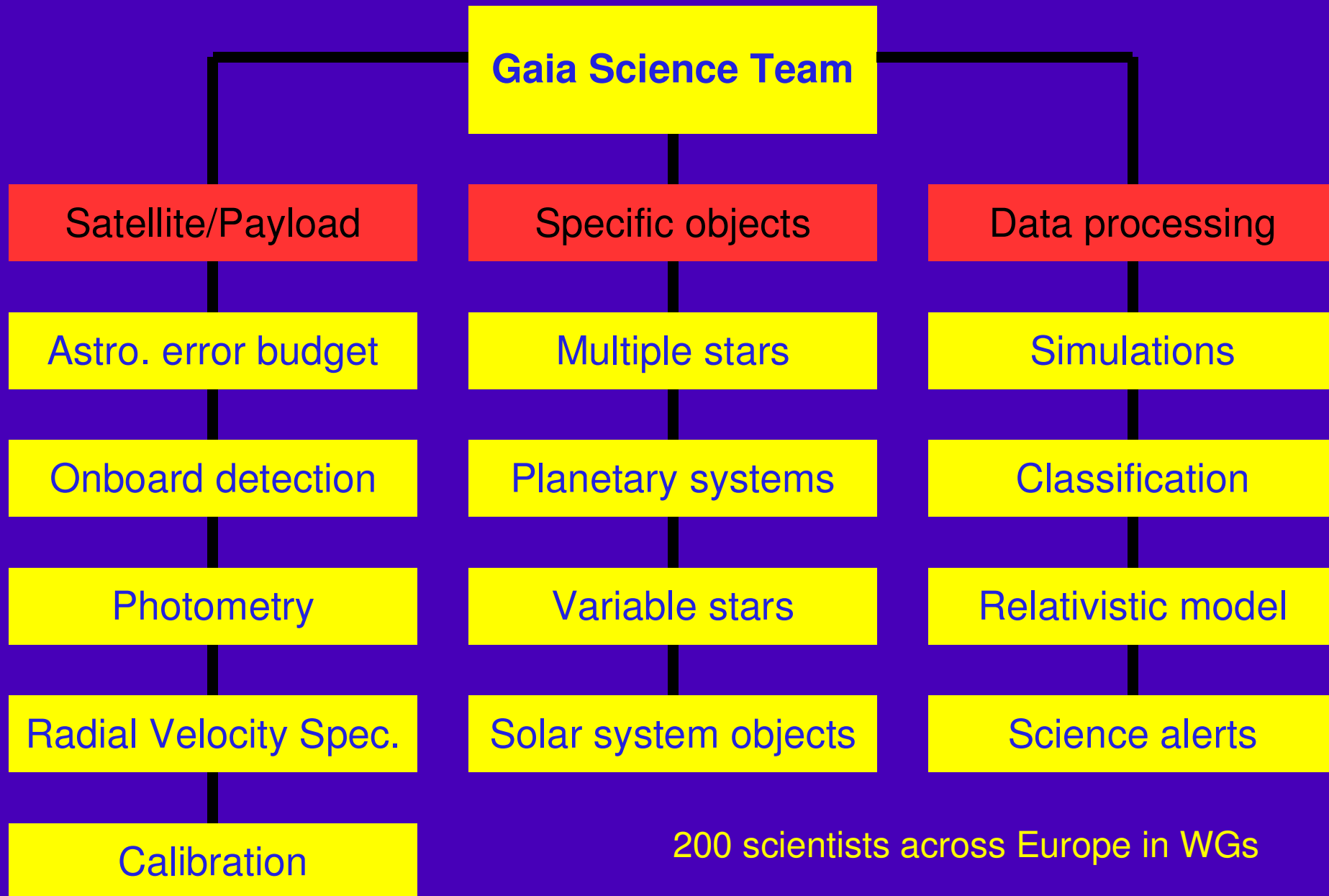


Gaia Science Team (13 members)

Michael Perryman (chair) ESA-ESTEC

Frédéric Arenou	Paris Observatory, Meudon	France
Coryn Bailer-Jones	MPI Astronomie, Heidelberg	Germany
Ulrich Bastian	ARI, Heidelberg	Germany
Erik Hoeg	U. Copenhagen	Denmark
Andrew Holland	Brunel University	United Kingdom
Carme Jordi	U. Barcelona	Spain
David Katz	Paris Observatory, Meudon	France
Mario Lattanzi	Astronomical Observatory, Torino	Italy
Floor van Leeuwen	U. Cambridge	United Kingdom
Lennart Lindegren	Lund University	Sweden
Xavier Luri	U. Barcelona	Spain
François Mignard	Observatoire de la Côte d'Azur	France

Gaia working groups



WG members in Germany

Hans-Martin Adorf	Garching
Coryn Bailer-Jones	Heidelberg
Ulrich Bastian	Heidelberg
Hans-Heinrich Bernstein	Heidelberg
Norbert Christlieb	Hamburg
Sonja Hirte	Heidelberg
Torsten Kaempf	Bonn
Sergei Klioner	Dresden
Peter Kroll	Sonneberg
Karl-Heinz Marien	Heidelberg
Piotr Popowski	Garching
Siegfried Roeser	Heidelberg
Elena Schilbach	Heidelberg
Ralf Scholz	Potsdam
Michael Soffel	Dresden
Stephan Theil	Bremen
Stefan Wagner	Heidelberg
Philip Willemsen	Bonn
Hans Zinnecker	Potsdam

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Data processing is a community task

- ESA pays for: satellite, payload, launch, ground-segment
- ESA will *not* pay for the data processing (DP)
 - funding from national agencies (in Germany primarily DLR)
- DP study (GDAAS) has been running since 2001
 - objective: assess feasibility of DP approach
 - system, hardware, database, integration (UB, GMV, CESCA)
 - algorithms (working groups)
- Replaced by data processing consortium from 2006
 - develop, implement and manage DP system until ca. 2019
- Organization of community at two levels
 1. thematic (DP consortium, working groups)
 2. funding (national)

Possible data processing concept

- Pan-European, distributed data processing consortium
- Single core data processing centre
 - ESAC (Villafranca, Spain)
 - hosts hardware, primary database and maintenance staff
 - executes core data processing tasks (GIS etc.)
 - algorithms provided by data processing consortium
- Distributed shell processing
 - either at ESAC or remote
 - possible GRID application
 - algorithms provided by data processing consortium
- Independent verification
- No proprietary data phase or data rights

Summary

Astrometry, RVs, spectroscopy, 15-band photometry
⇒ astrometric *and* astrophysical properties

The Galaxy, Solar system objects,
exoplanets, binaries, galaxies,
quasars, fundamental physics

5 year mission
~ 85 observations per object

All sky survey to $V=20$ (10^9 stars)
Real-time onboard detection
5D phase space (6D to $V\sim 17$)

Accuracy = $10 \mu\text{as}$ @ $V=15$:
⇒ distances to $<1\%$ for 20 million stars
⇒ transverse velocities to 1km/s at 20 kpc

Launch 2011; DP consortium from 2006–2019
Data processing preparations underway