The Gaia mission and the variable objects

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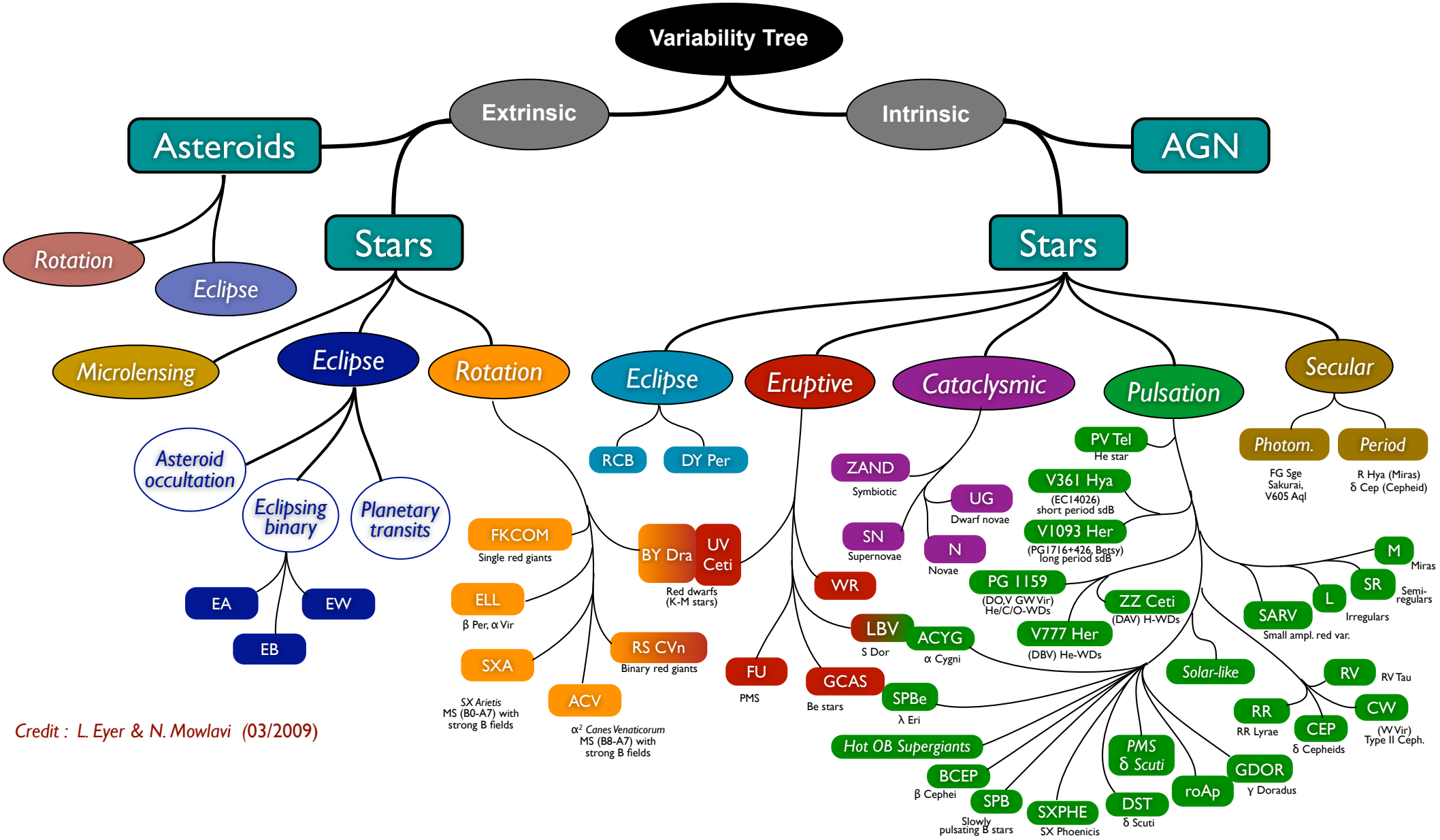
Kursaal Besançon, France

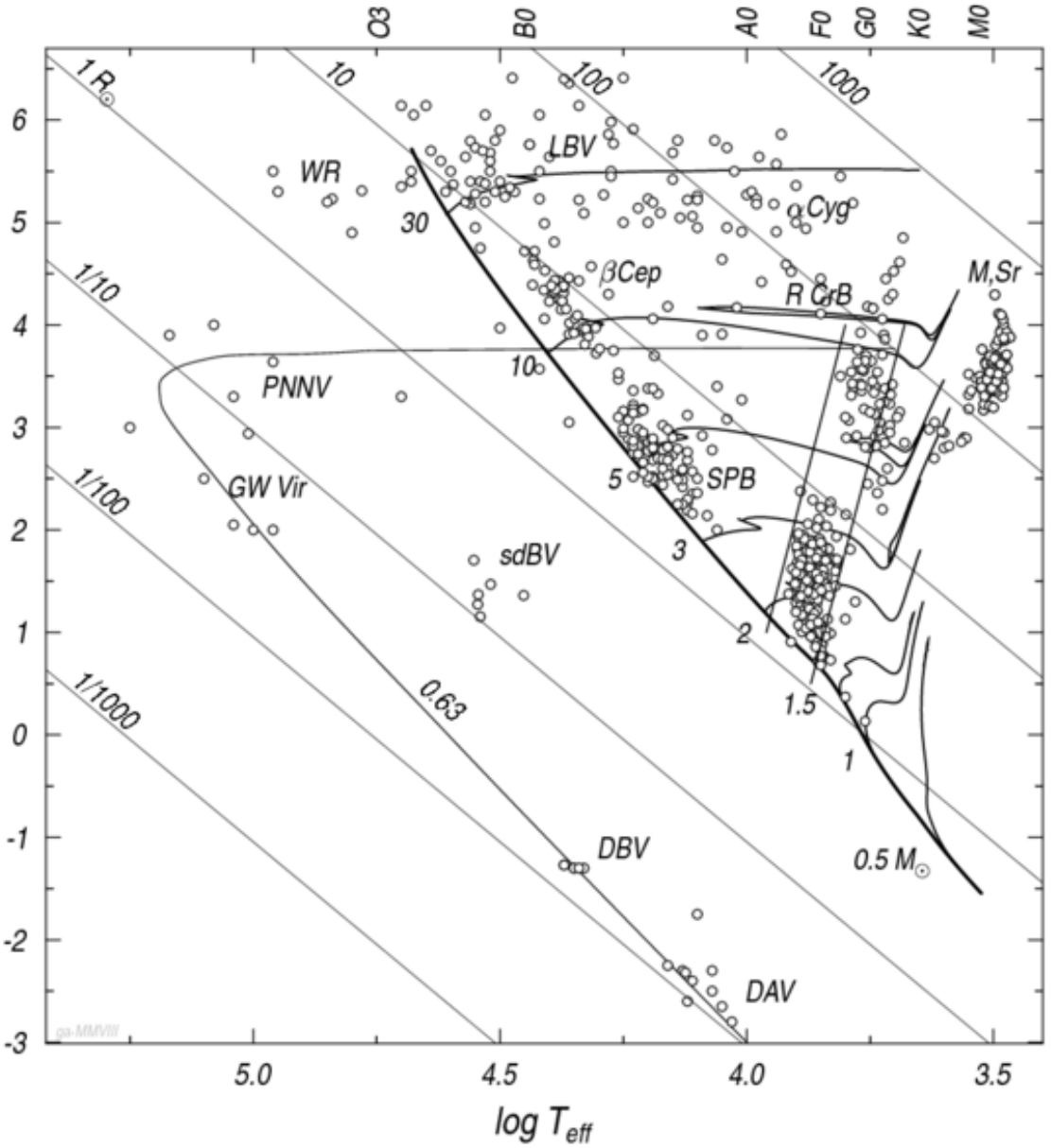
An attempt to organise the variable celestial objects



Credit : L. Eyer & N. Mowlavi (03/2009)

Gaia will detect most variable types on this tree

HR diagram for variable stars



Gaia:
Imagine 10-20 million variable stars in this HR-diagram

Precise statistical description of variable types

Precise position of instability strips

A.Gautschy 2008

Variable stars in Colour-Magnitude Diagram

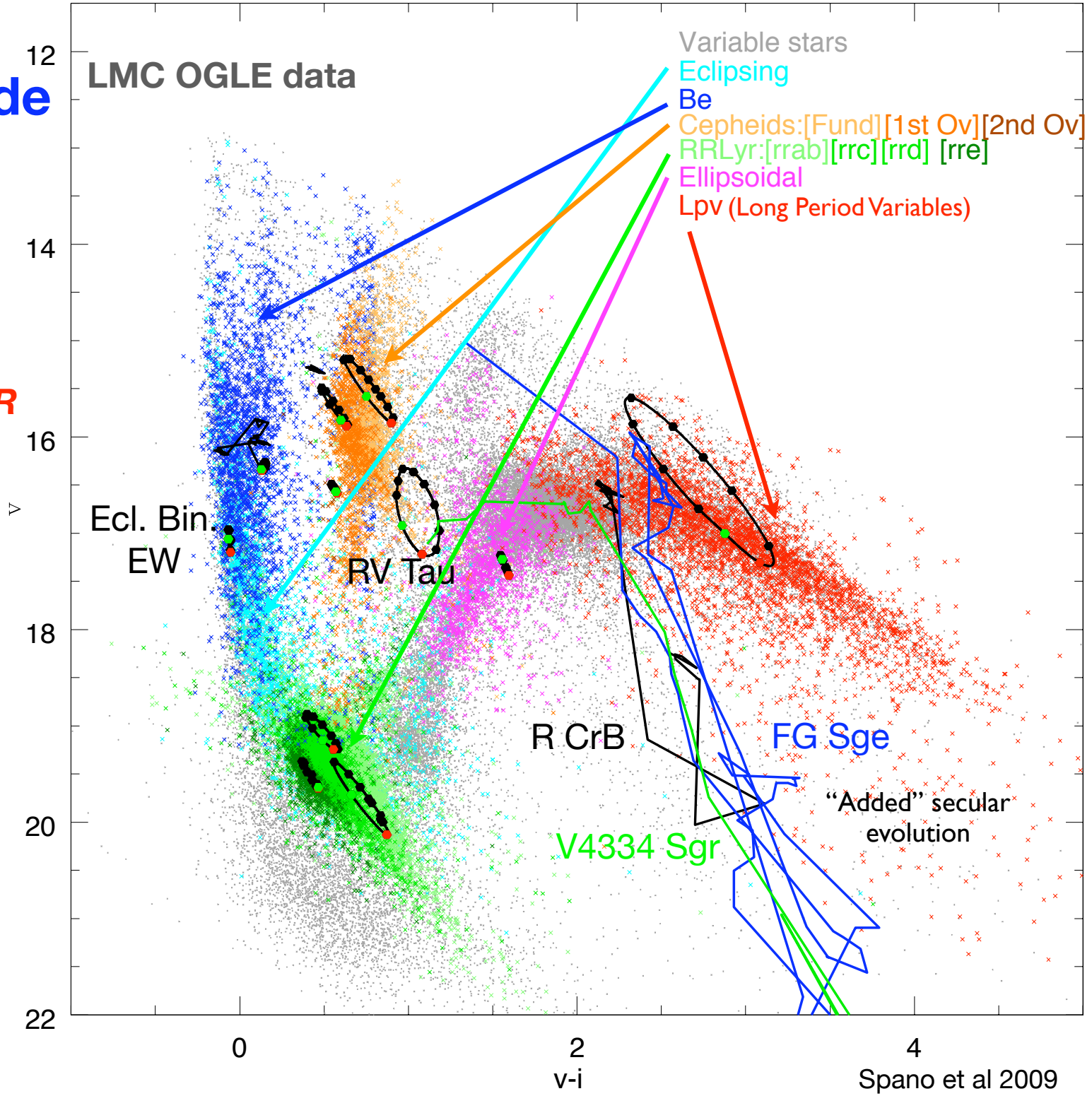
Gaia:

1) Full description of HR diagram (parallax)

2) better precision (detection of many additional types)

3) simultaneous data in G, BP, RP

4) Radial Velocities



Fraction of variables from some surveys

- Hipparcos satellite: 3.3 years, 118,204 stars

  9.7 % variable stars

- ASAS 1-2: 3 years, 140,000 stars

  2.9 % variable stars

- OGLE-II: ~3-4 years, 40 million stars

  0.7 % variable stars

- MOST satellite (J.Matthews, private communication)

  20 % variable stars

- CoRoT satellite, 2.5 years, “120,000” stars (Debosscher’s PhD Thesis)

  40 % variable stars

- Kepler satellite, 3.5 years, 100,000 stars

  ? % variable stars (a majority of variable stars?)

Gaia:
10% ?
=100 million variables!

The Gaia mission: Observed Objets

- 1 billion stars (~100 million variable objets)
- 1 million galaxies
- 0.5 million QSO
- 0.3 million asteroids of our solar system

-astrometry, photometry
-spectro-photometry

-Radial Velocity Spectrometer

mostly main belt asteroids

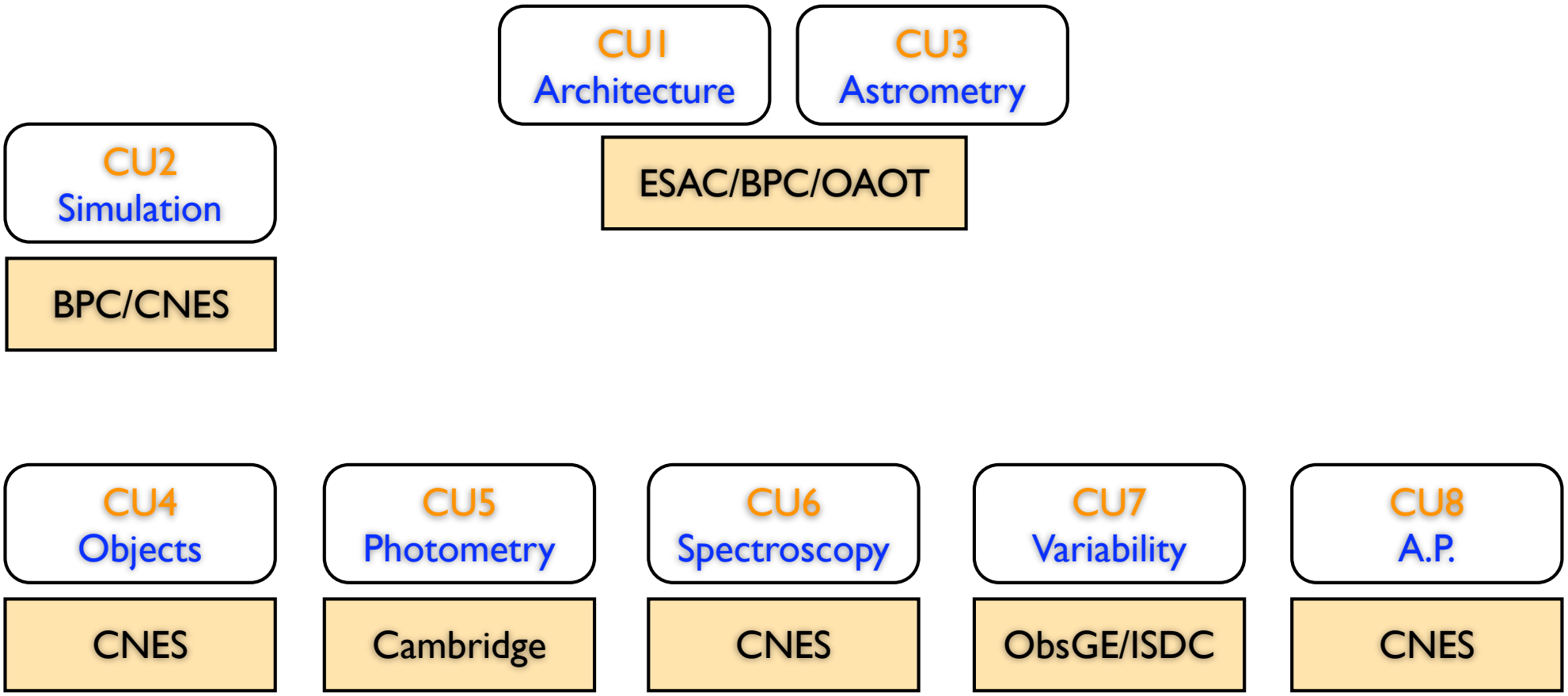
~80 (40-250) measurements over 5 years

~40 (20-120) measurements over 5 years for objects brighter than G=14-15

The DPAConsortium: the global view

Two main concepts:

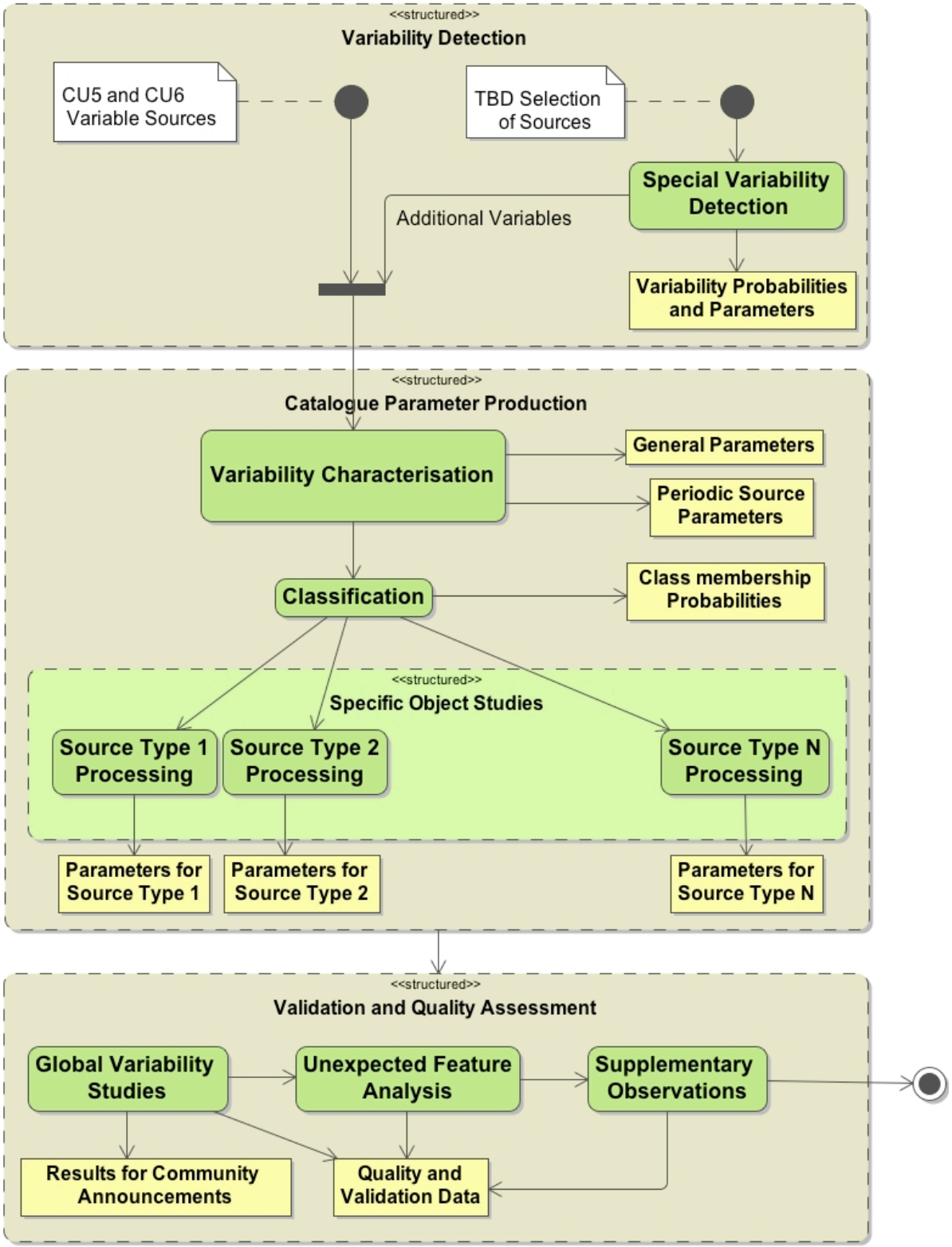
1. Coordination Units
2. Data Processing Centres



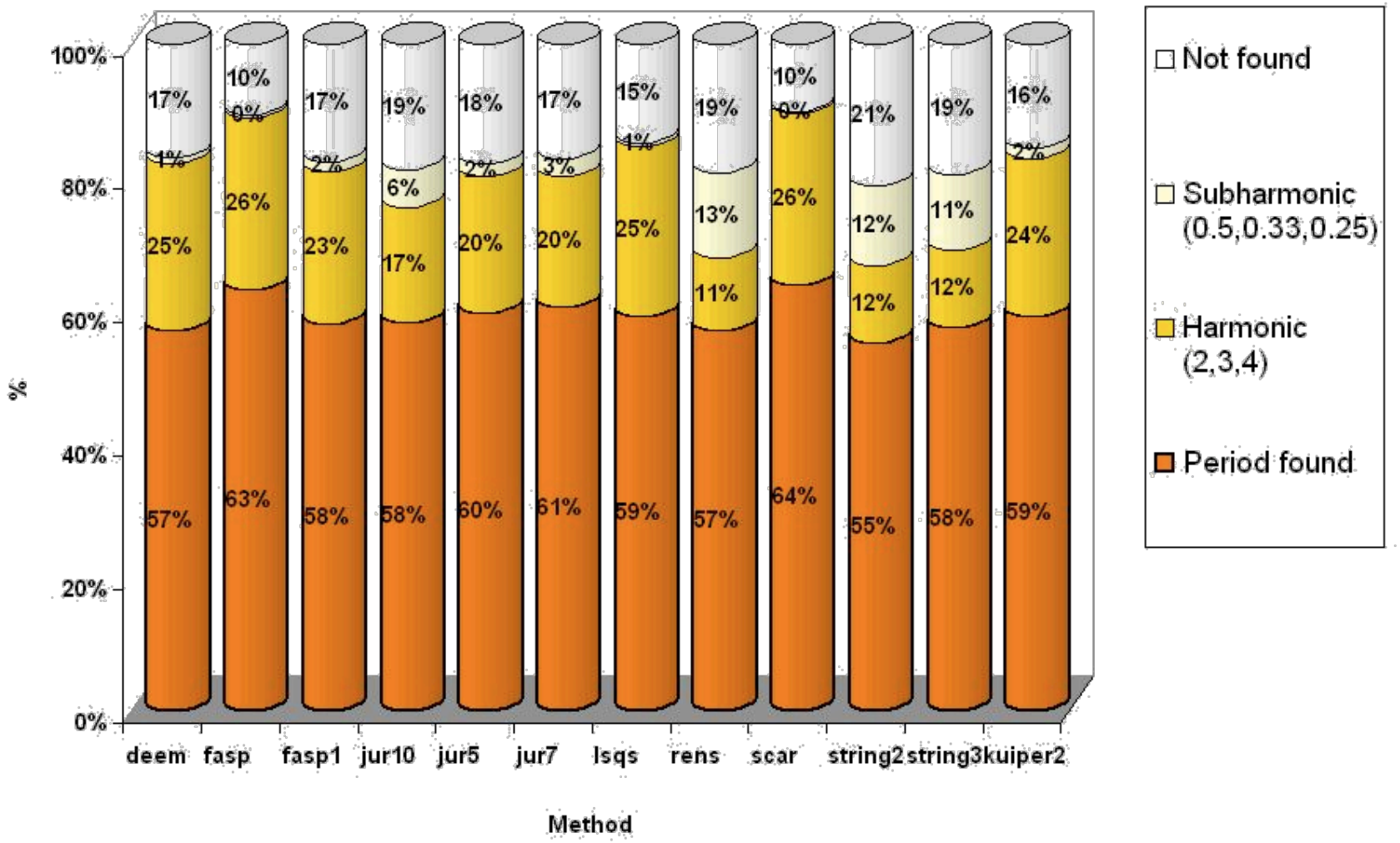
385 people

CU7
Variability Analysis

functional analysis



Study of Period search algorithm (J.Cuypers) Hipparcos data



CU7
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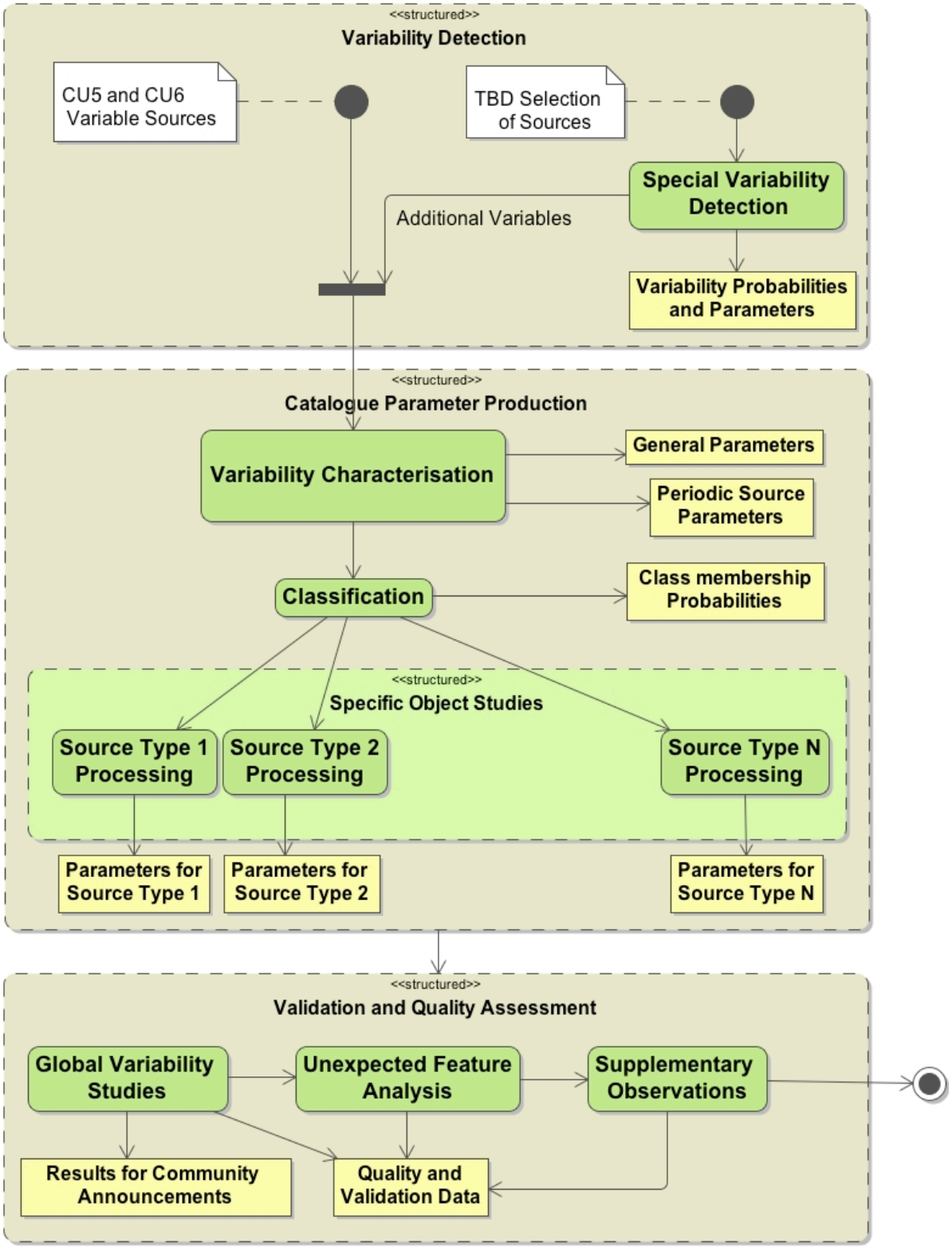
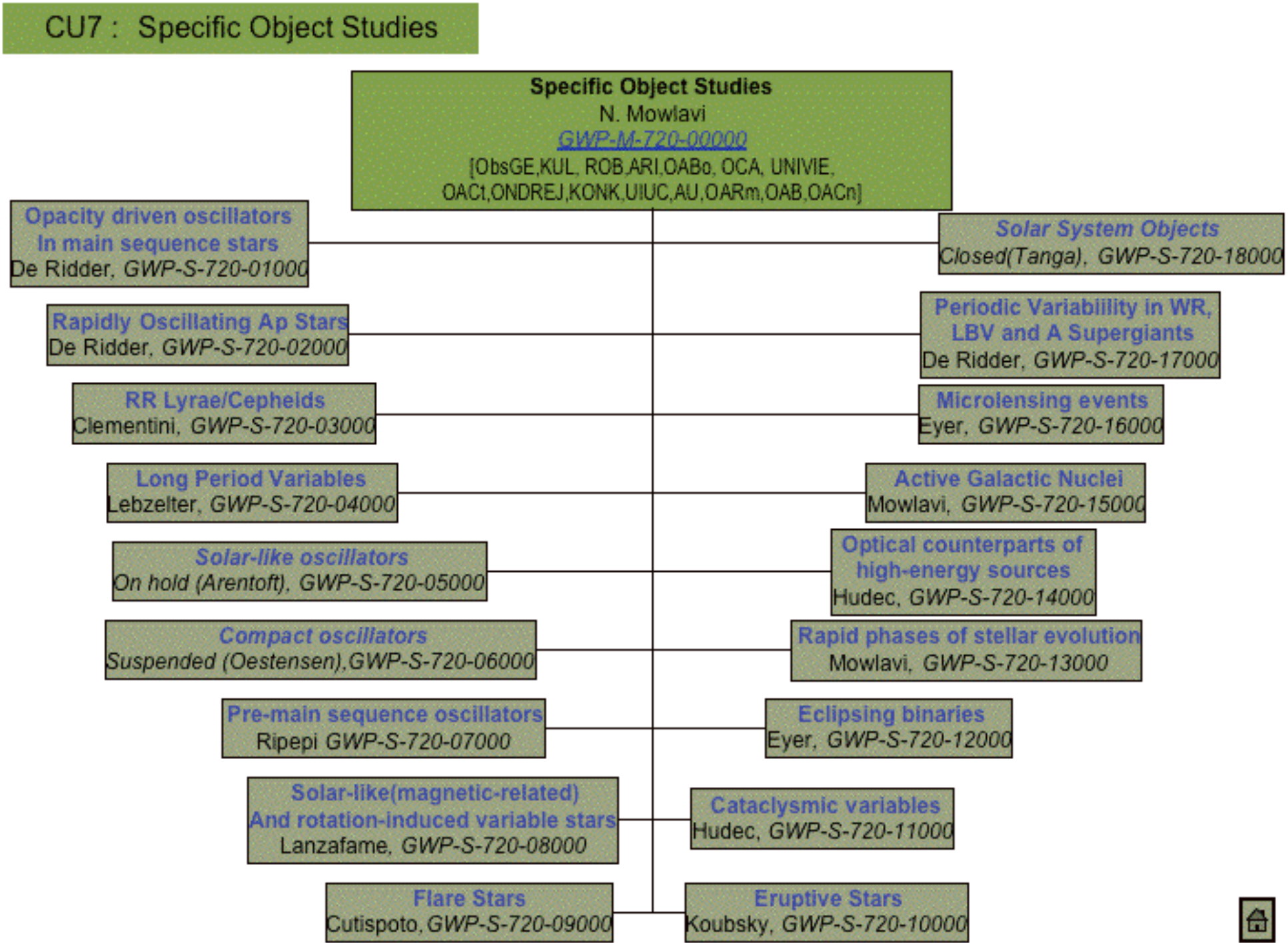
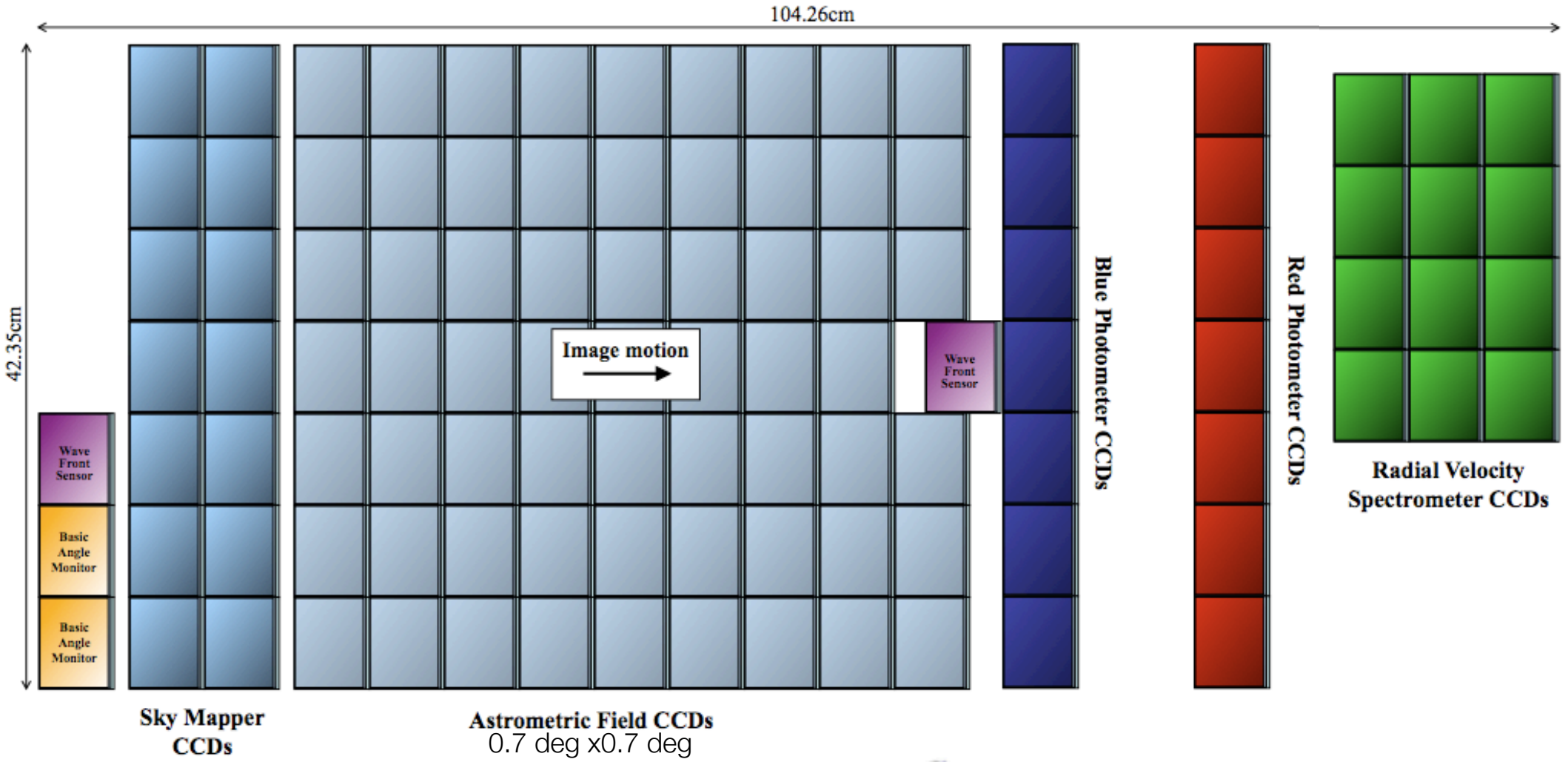


Specific Object Studies N.Mowlavi (ObsGe/ISDC)



Gaia Focal Plane

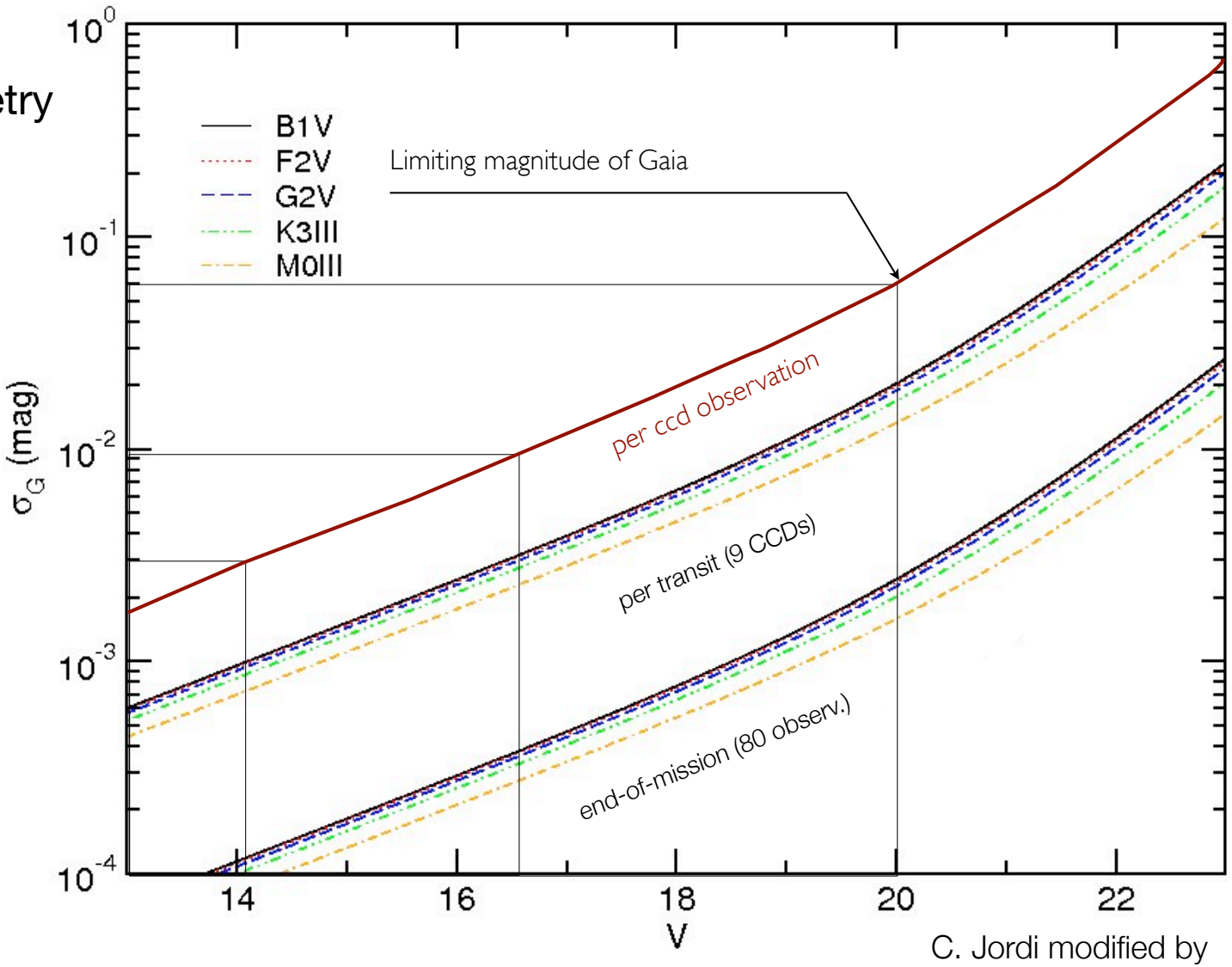


The Gaia photometric precision G-band

In the G band transit photometry

20 mmag at G=20

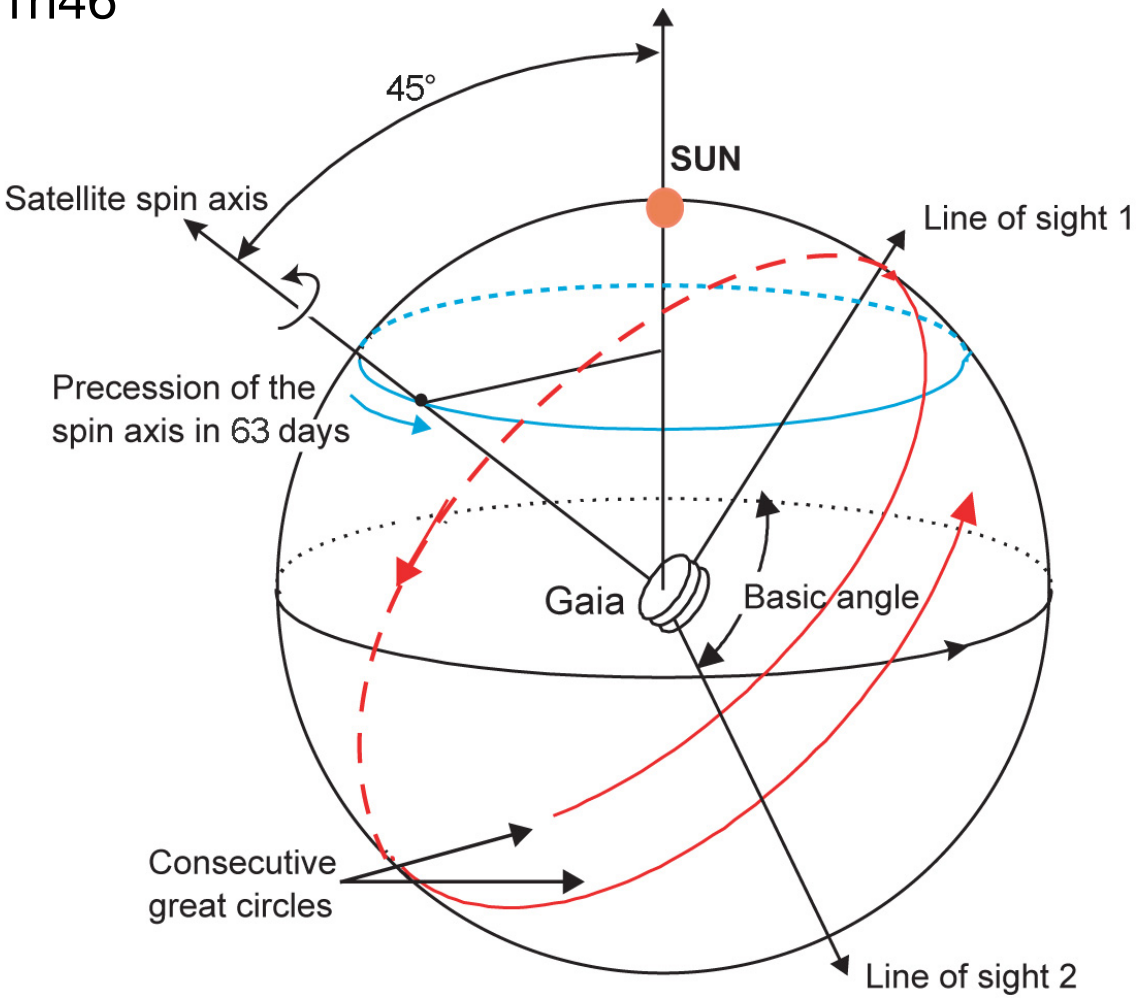
~1 mmag at 10<G<14



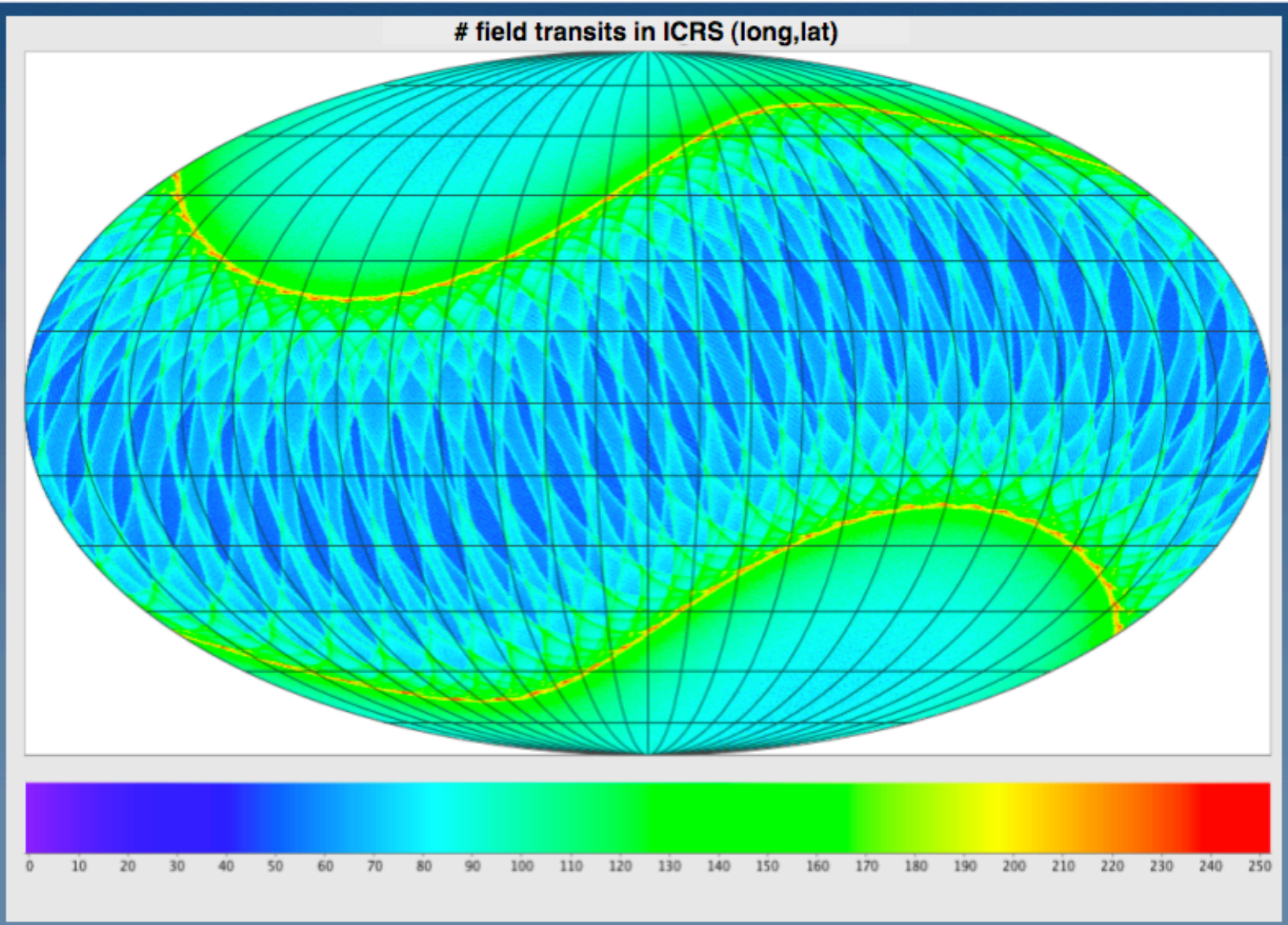
C. Jordi modified by M.Varadi

The Gaia mission sampling properties

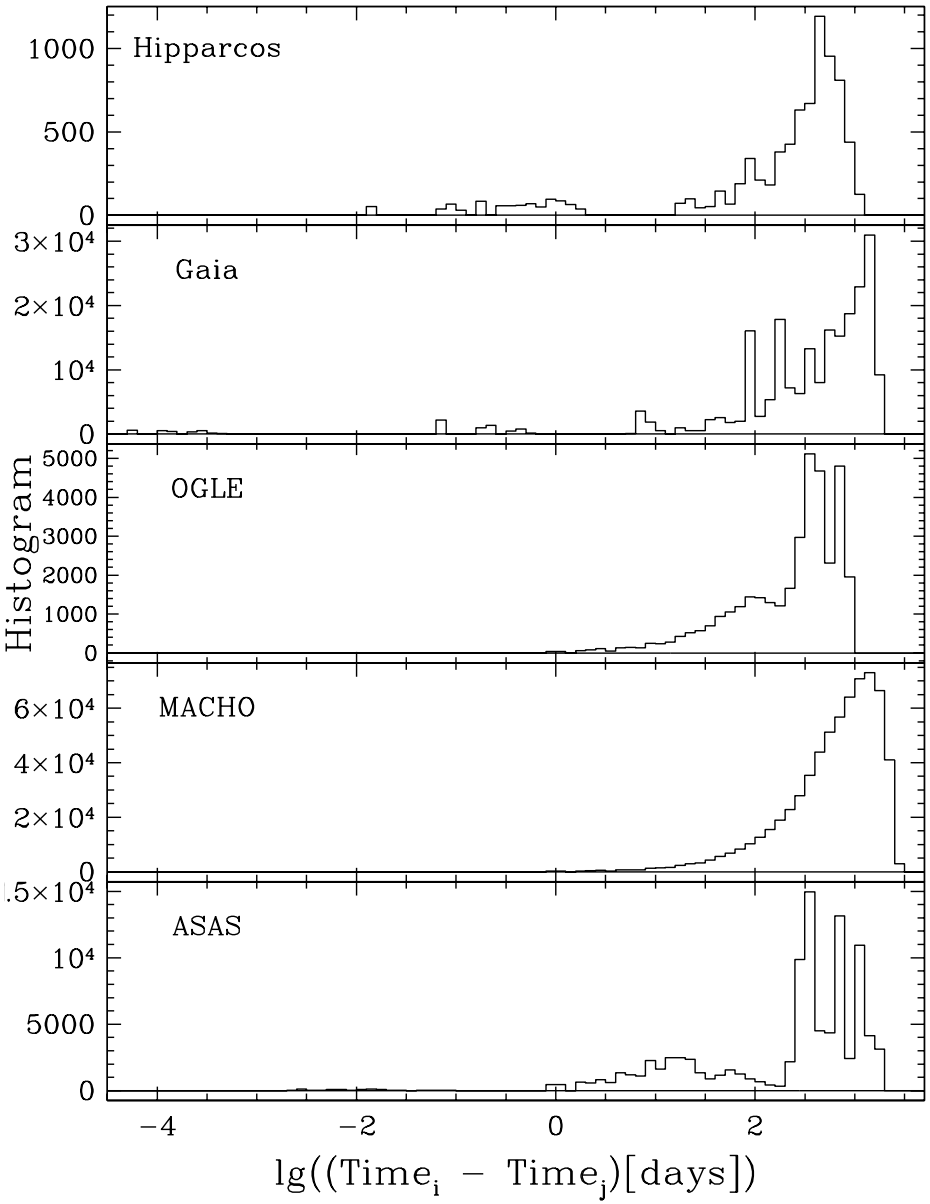
- Rotation of the satellite 6 hours, precession in 63 days
- Preceding-Following Field of View: 1h46
- Following to Preceding FoV: 4h14
- Gaps of about 30 days

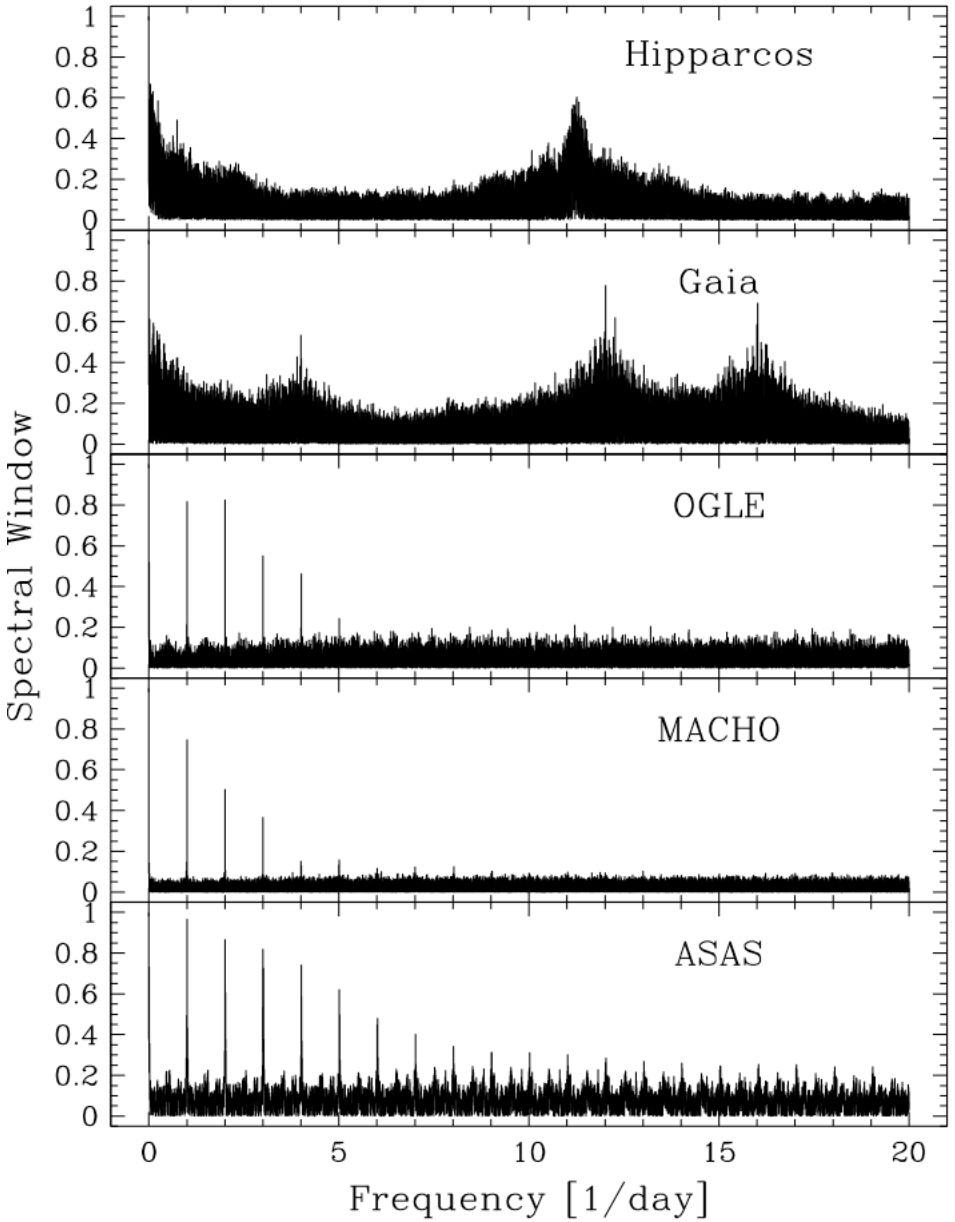


Number of field transits over 5 years
time differences and spectral windows



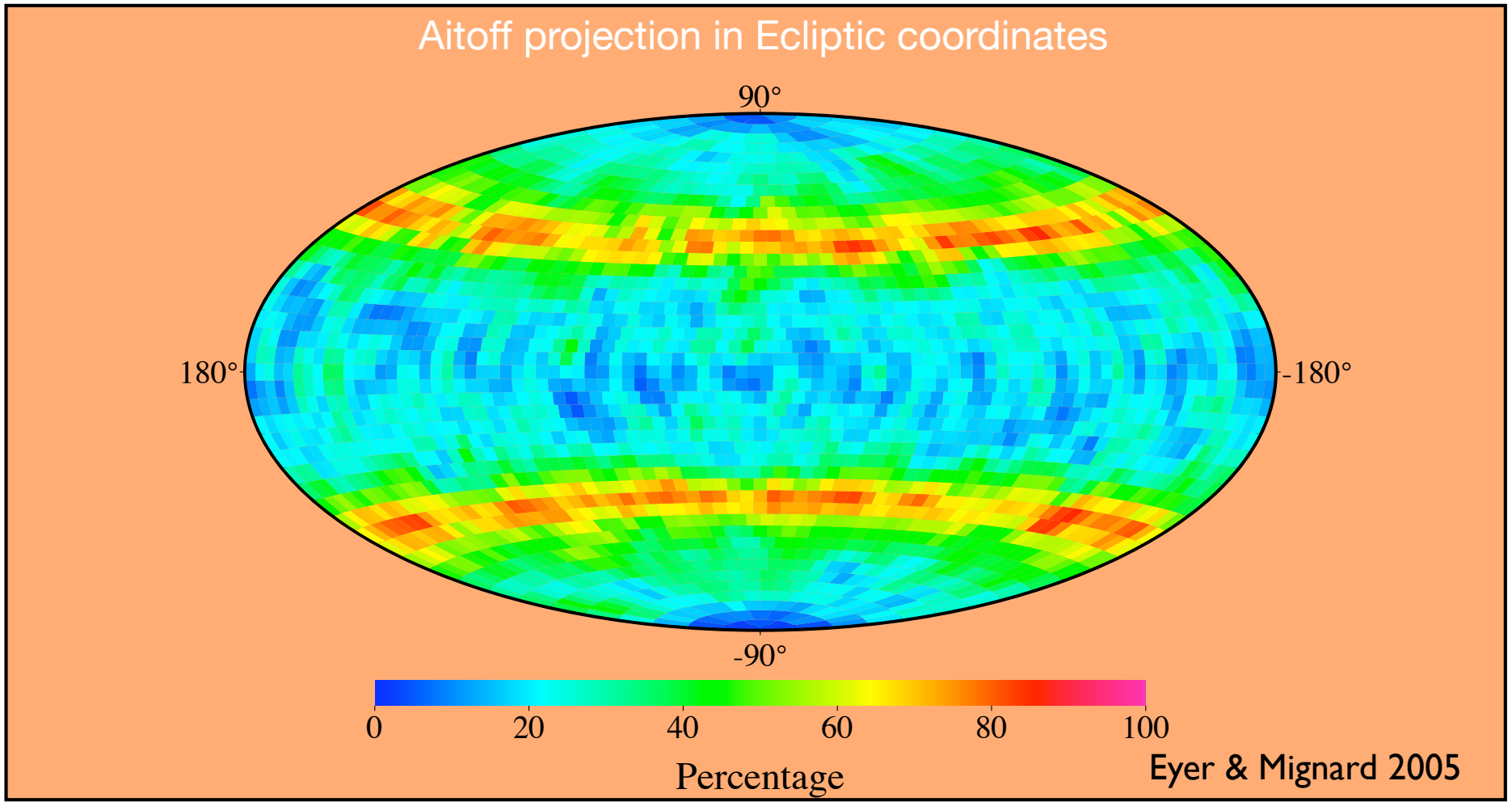
A comparison of time differences and spectral windows



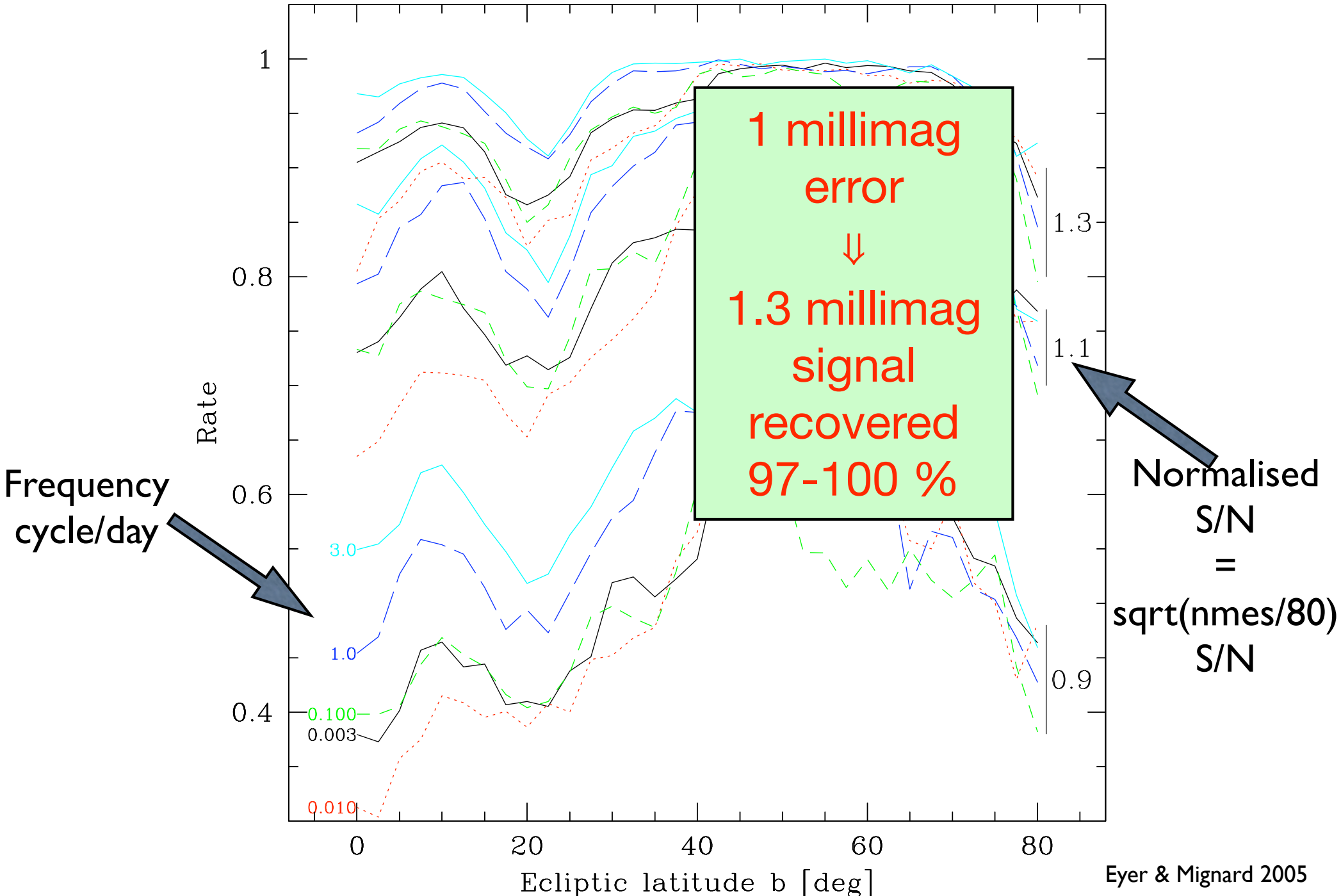


Period recovery rate for strictly period signals

1. Signal(t)= A sin(2 π ν t + φ) + noise
2. Two parameters: a) S/N ratio = 0.75 (very defavorable case)
   b) Period = 1/ν = 0.2 day
3. Gaia sampling
4. Period search algorithm ➔ determine the success rate



Period recovery rate: exploring the parameter space

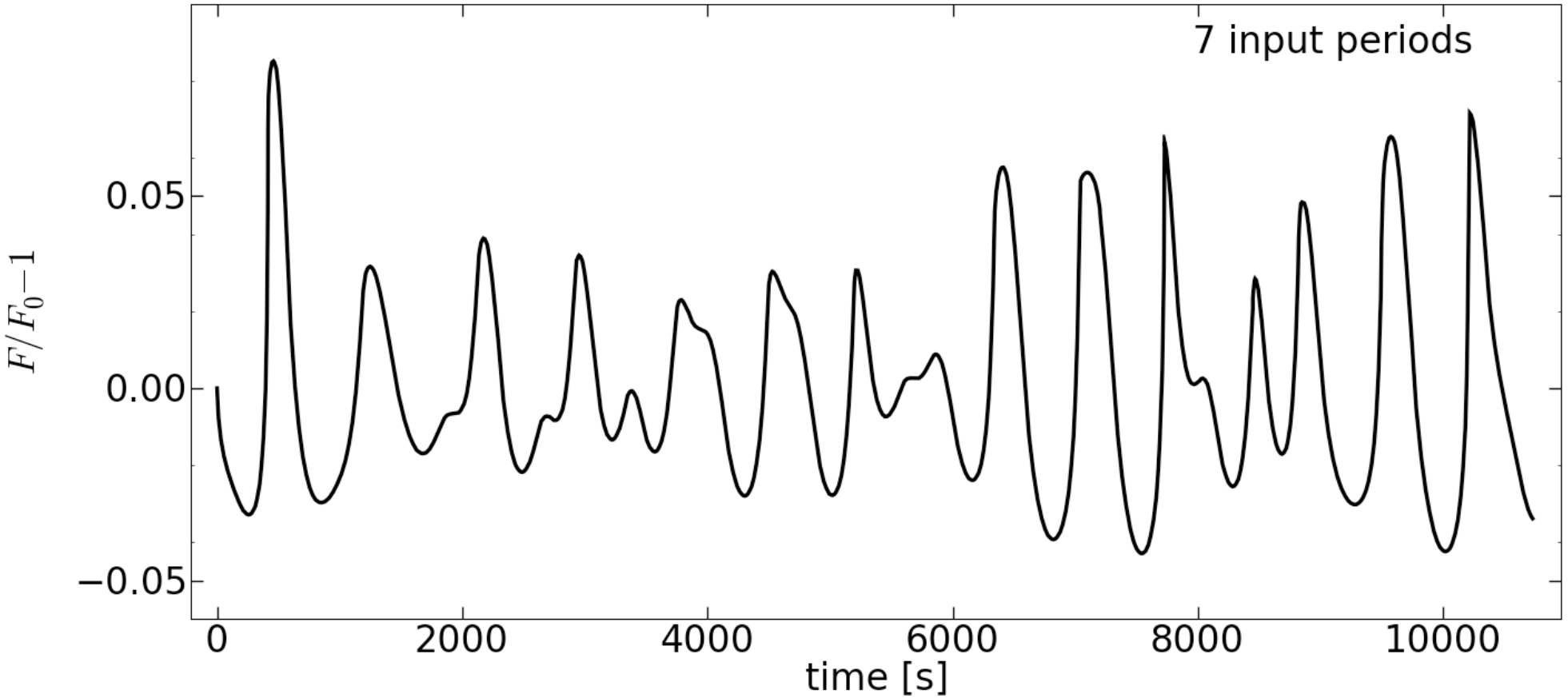


Eyer & Mignard 2005

More complex light curves: Simulated ZZ Ceti stars (pulsating white dwarfs)

Simulation of a typical ZZ Ceti star (properties derived from the star GD29-38)

Work done with Stefan Jordan (Heidelberg), code re-written by M.Varadi



Analysis of simulated time series of GD29-38

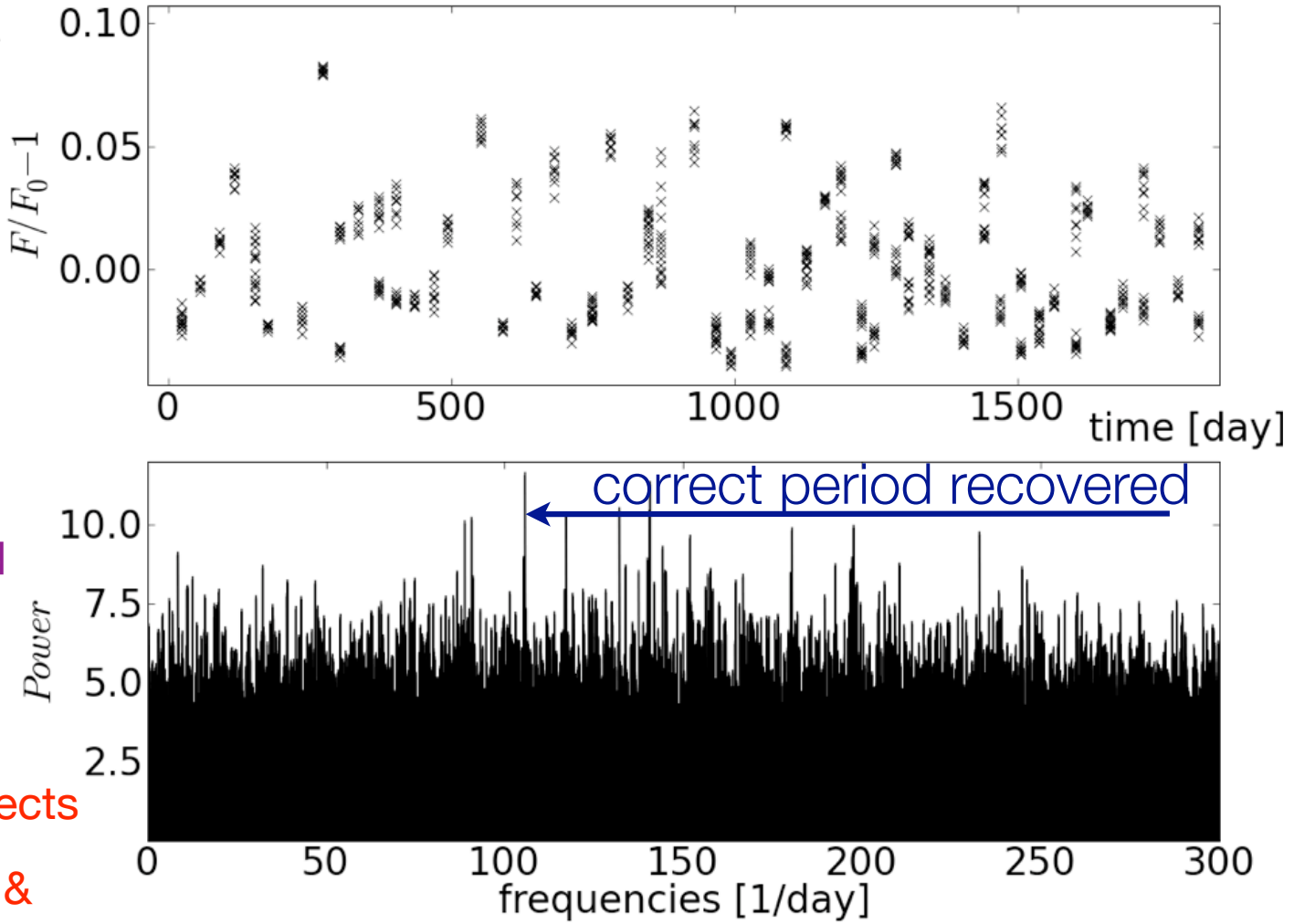
- multiperiodic signal + noise
- 5 year long data set
- Gaia sampling (AGISLab)

  82*9=738 per-ccd data

2 frequencies with highest amplitude can be recovered

Gaia Goal:

Correct detection of such objects with possibilty main period & determination of luminosity



Caveat: Pulsation assumed stable

Transient variable: Microlensing and Supernovae

1) **Microlensing**:

L. Wyrzykowski

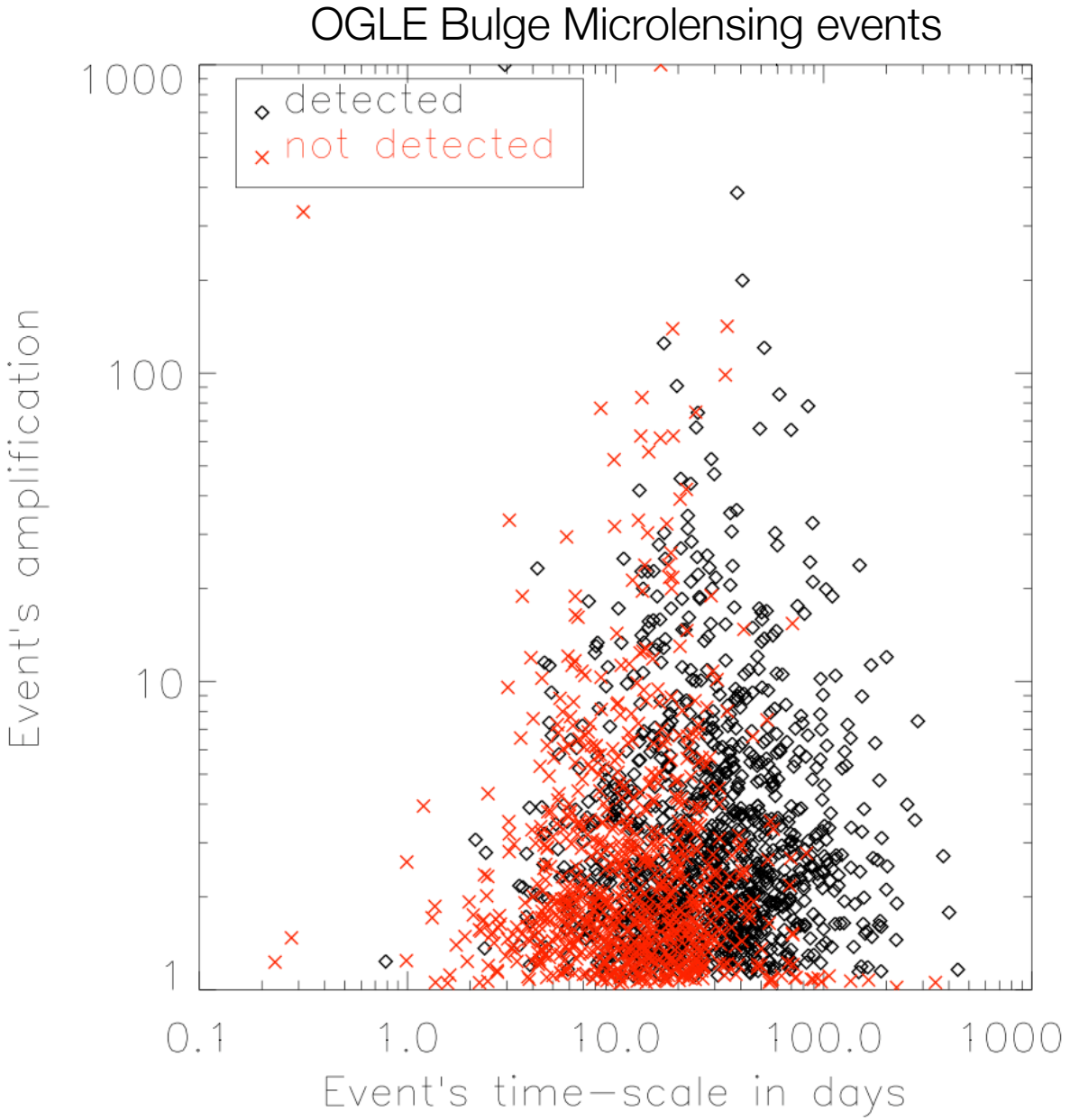
- 1324 out of 1988 microlensing events from OGLE with at least one measurement within lensing event
- event duration > 30 days: rate is 93%

D.Evans, I.Lecoeur, L.Eyer

- Algorithm of microlensing detection, high recovery rate on OGLE-II data

2) **Supernovae** (Gilmore & Belokurov):

- 6,000 to G=19 about 1/3 before maximum light



Ground based Observations

Within Gaia Data Processing and Analysis Consortium (DPAC):

- Help the data reduction GBOG (Ground-Based Observations for Gaia, Caroline Soubiran)
- Verify-Val is
  - CU5 for th
  - CU7

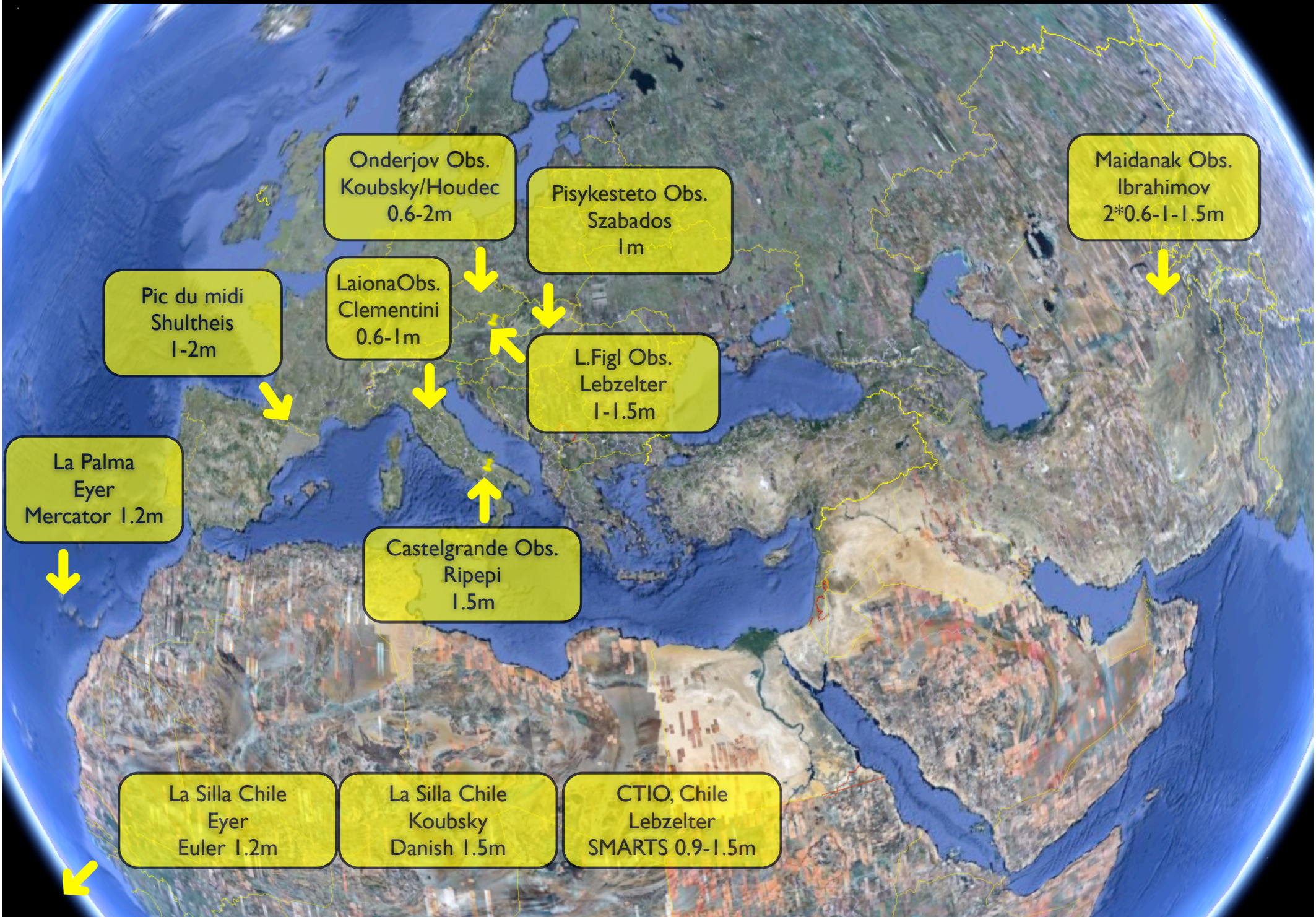
CU7: Use of HAT, SDSS, Hipparcos, OGLE, CU2; Super-Macho, CoRoT, ...

Telescopes of 1m-2m, 2m-4m are valuable for the Gaia validation & science

Scientific Community:

- Scientific exploitation (for exam rch for European Astronomy Training), following
  - Scientific follow-up of alerts, announc
  - Catalogue releases

Telescopes that could be used for CU7 Validation



Ground based observations

- Establish:
    - List of (planned) instruments attached to the telescope
    - the relevance for Gaia validation and science
- Importance for the future of telescopes

FIN !

Merci pour votre intérêt