Calibration

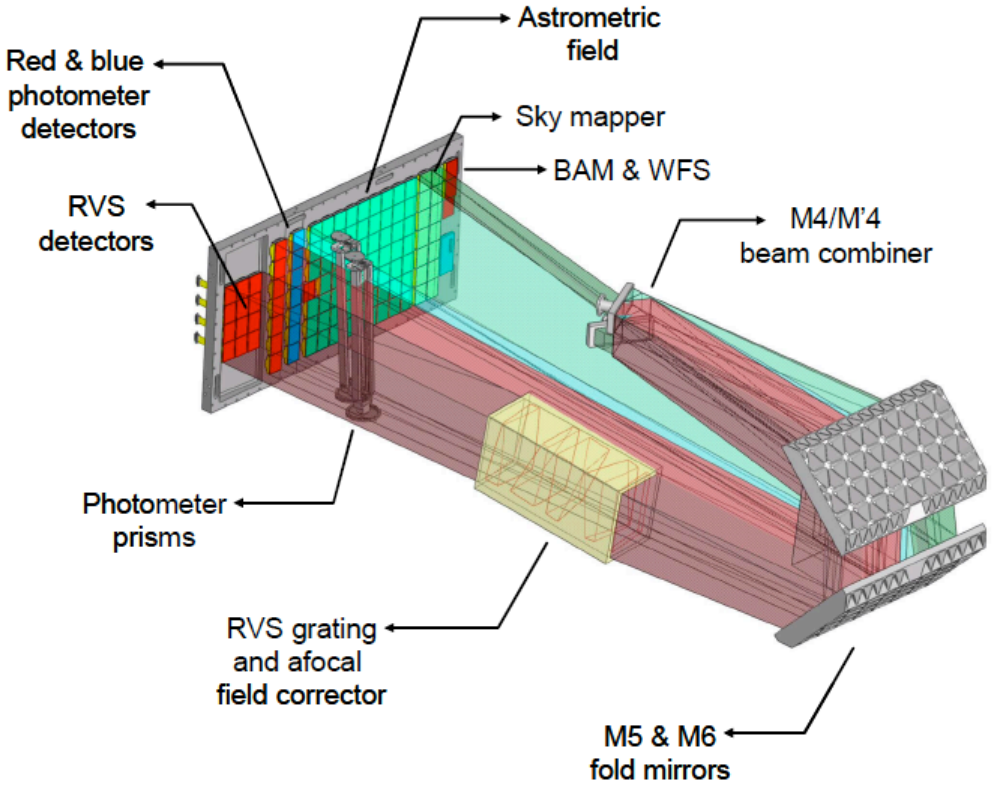
CU6 Workshop, IAP, 6/7 March 2006

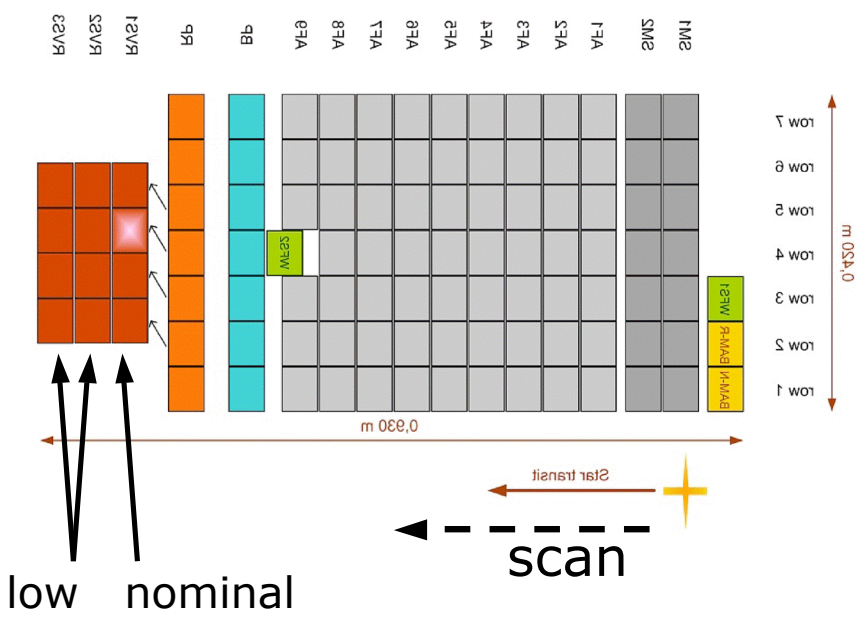
Calibration: overview

- The RVS calibration occurs at two main levels:
  1. CCD level – bias, gain, cosmetic defects *etc*.
  2. astronomical – photometric throughput, wavelength scale *etc.*
- The *Gaia*3 design provides visibility of data from each CCD individually: not combined on board (better)
  - no on-board software and software logs
  - no diagnostic mode data
  - no uploading of lookup tables and parameters for on-board software (this used to be a required output from the ground system → satellite)
- But, note that TDI operation prevents 2-D information from CCDs being obtained

Calibration: overview (ctd)

- *Gaia3* design has the concept of
  - nominal $\lambda/\Delta\lambda \sim 11500$ resolving power, in first strip of CCDs
  - low $\lambda/\Delta\lambda \sim 5000$ resolving power, in other strips (and perhaps 1st strip)
- (see extraction section)
- This means that two sets of calibrations need to be obtained
  ⇒ systematic effects will need to be dealt with (ground standards?)





Calibration: CCD level

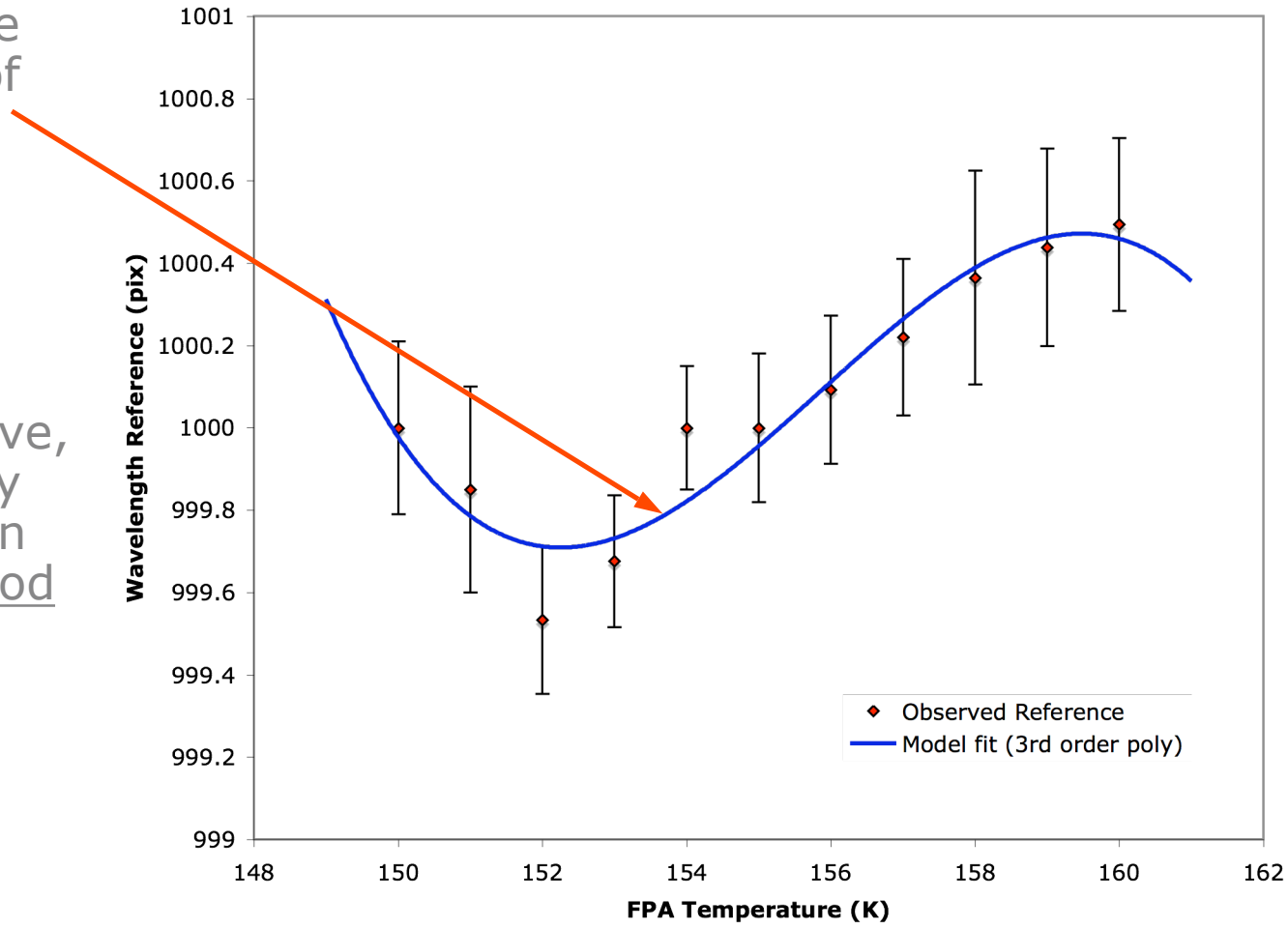
- Calibration at CCD level includes
  - CCD bias as f(CCD#)
  - CCD gain as f(CCD#) [both for classical and L3CCDs]
  - CCD readout and dark noise as f(CCD#,y)
  - CCD TDI flat field as f(CCD#,y,λ)
  - CCD blemishes as f(CCD#,y)
  - signal linearity as f(CCD#)
  - saturation level as f(CCD#)
  - scattered light/ghosts as f(CCD#,y)

Calibration: normal calibrations

- The set of calibration stars is made up of
  - external standards (flux standards, radial velocity standards *etc.*)
  - an internal set of stars with consistent characteristics from scan to scan, and appropriate spectra
- Have in the calibration database
  - observations of the set of calibration stars
  - the calibration model
- The set of calibration stars is continually updated by eliminating unsuitable stars (outliers) as calibration improves
- A model fit is made to the set of calibration stars as a function of the parameters of interest (eg temperature, Sun angle *etc*.)
- The model is updated in the daily calibration cycle.
- New observations are then calibrated with the most recent model.

Calibration: Modelling

- Example of wavelength reference dependence on the temperature of the FPA
- In general the model will be multi-dimensional f(T_i,CCD#,y…)
- Calibration will improve, but will be affected by stars in the calibration set with early less good calibrations.
- Need some sort of weighting kernel to emphasise recent observations
- Then - SGIS…



Calibration: SGIS

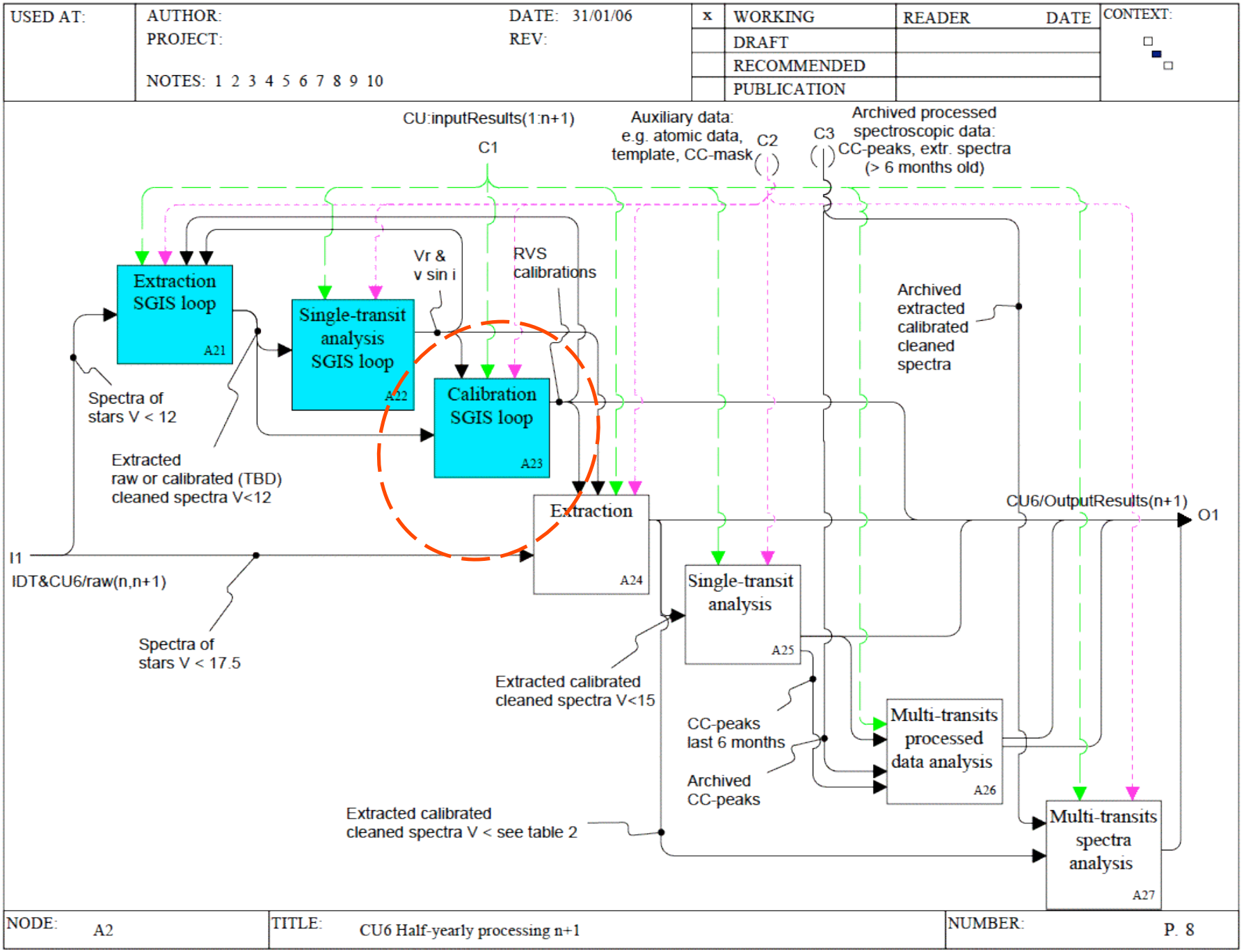
- The SGIS (Spectroscopic Global Iterative Solution) occurs in an outer loop, where the calibration parameters from the instrument are re-derived by refining both
  - the calibration applied to the calibration star observations (from a reanalysis of the observations) and
  - the model
- at the same time, iteratively
- Past work at Meudon (Guerrier & Katz) has simulated this and checked for convergence (*c.f.* next talk)
- The size of the sample to be used for SGIS will affect the frequency with which it is possible to re-run SGIS (6 months nominally).
- It will in any case be necessary to have observations separated by a sufficient duration in order to correct for/model all significant systematic effects using SGIS.

Calibrations: SGIS (ctd)

- SGIS will determine the main instrument calibration
  - wavelength scale and zero reference as f(y,λ,T)
  - photometric throughput as f(CCD#,y,λ)
  - AC line spread function as f(CCD#,y,λ,scan_law)
  - AL line spread function as f(CCD#,y,λ,T)
  - distortion map as f(CCD#,y,λ,T)
  - scattered light/ghosts as f(CCD#,y)

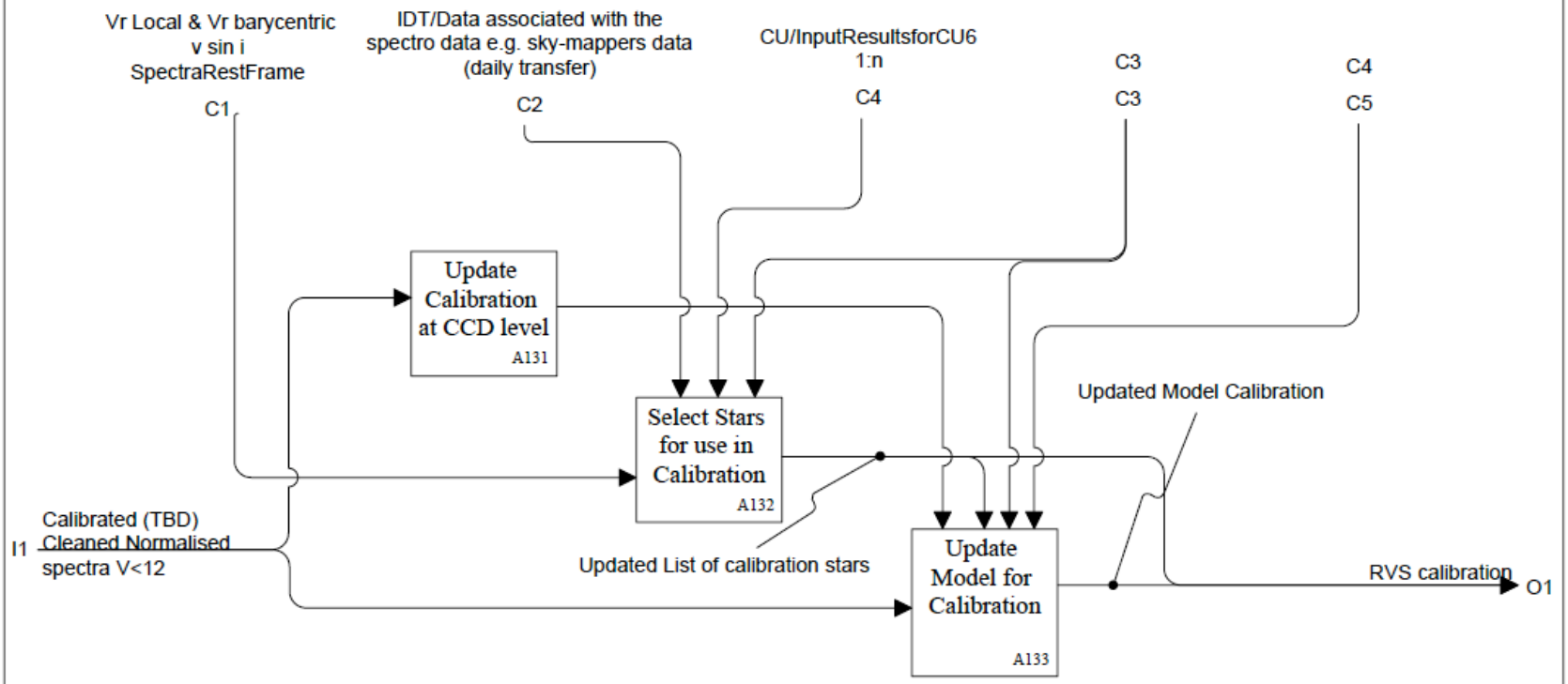
- Have to learn how to reconstruct the focal plane imaging in absence of 2-d imaging (*eg* for scattered light/ghosts analysis)

Half-yearly processing



Functional Analysis: current state

USED AT:	AUTHOR:	DATE: 31/01/06	x	WORKING	READER DATE	CONTEXT:
	PROJECT:	REV:		DRAFT		
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED		
				PUBLICATION		



NODE: A13	TITLE: Calibration	NUMBER: P. 7

Workpackage 630

- The top level WBS is given in GAIA-C6-SP-OPM-DK-002-1

GWP-S-630-00000 Calibration of the spectroscopic instrument
GWP-C-630-01000 Management, configuration management & interf. of calibrations
GWP-C-630-02000 Detailed functional analysis of the calibrations
GWP-S-630-03000 Implementation of SGIS
GWP-S-630-04000 CCD bias, CCD readout and dark noises, CCD blemishes
GWP-S-630-05000 Photometric throughput, CCD flat field, linearity, saturation level
GWP-S-630-06000 AL & AC LSF
GWP-S-630-07000 Wavelength scale, Distortion map
GWP-S-630-08000 Scattered light & ghosts

Development

- First year will be dedicated to exploration of the different alternatives and methodologies (scientific algorithms)
- Code prototyping and development will occur after that
- Java will be used to keep in alignment with CU6 standards
- eXtreme Programming methods are being considered (*cf* CU1 AGIS):
  - ⇒ rapid development cycles
  - ⇒ tight control on what is really needed
  - ⇒ concurrent requirements development
- Total effort assigned (PPARC bid):
  - 0.25 FTE in Oct 2006/Oct 2007
  - 6.4 FTE in Oct 2007/Mar 2012 [4.5 yr = 1.5 FTE/yr]
- Staff effort made up of
  - 0.25 Senior Researcher and
  - 1.25 Senior Developer/Developer