Extraction

CU6 Workshop, IAP, 6/7 March 2006

Extraction: overview

- The *Gaia*3 design selects windows on the CCD as for the astrometry and photometry – but not like the ESA Study Contract design.
- Data from individual CCDs are available directly – no combination on board; this is helpful for cosmic rays *etc.*
- Data are collapsed spatially during the CCD readout, so no 2-dimensional information is retained or available for the ground processing (except for very bright stars V<?? where full 2-d information is available).
- Crowding is less of a problem with the *Gaia*3 design because of the larger image scale ⇒ factor ~250 less crowded – this is very helpful.
- Nevertheless, above 10000 stars/sq degree (occupation factor 1/25) crowding will remain a problem.

Extraction: crowded windows

- *Gaia*3 design allows for overlapping windows, but not clear how the data will be treated – still under discussion:

- Also, *Gaia*3 design has two resolution modes
  - nominal resolution mode $\lambda/\Delta\Lambda$~11500 for stars down to V<15 (TBC) first strip of CCDs only
  - low resolution mode $\lambda/\Delta\Lambda$~5000 for fainter stars to reduce readout noise

Extraction: mixed resolution

- Low resolution mode will operate on first strip of CCDs if no bright (V<15) stars are being read out for that line ⇒ some spectra will have a mix of low and nominal resolution mode (details TBC)

as follows: 

- Faint object spectra or parts of spectra which are on the nominal resolving power sampling must be rebinned onto the coarser sampling for the radial velocity calculations
- Since this leads to the discarding of information, eg for emission line objects, the original spectra could also be retained…
  but, implications for the later processing – too complex?
- All of this leads to calibration issues.

Extraction: modelling

- Extraction will be a complex process in the *Gaia*3 design because of the absence of 2-d information
- In non-overlapped windows, the situation will be simple.
- For overlapped windows, much greater attention will be required to modelling the data than in the ESA Study design
  - information will be needed from the RP and astrometry
  - the overlapped flux profiles will need to be predicted
  - the prediction and observed RVS fluxes will be compared
  - some iteration will be required, at later phases using the radial velocity derived from earlier scans
  - some quality of fit parameters (eg χ_ν^2) will need to be derived

Extraction: background

- CCD bias and any charge-injection will be removed
- All backgrounds are lower due to the larger image scale
- The diffuse background may be available from unused windows (maintained to ensure constant heat load) – the number of these is still TBD
- The background due to
  - point sources and
  - extended sources
- will be modelled, using information from RP and astro (BP?).
- This information needs to be transformed backwards into instrument space from the calibrated astro and RP data

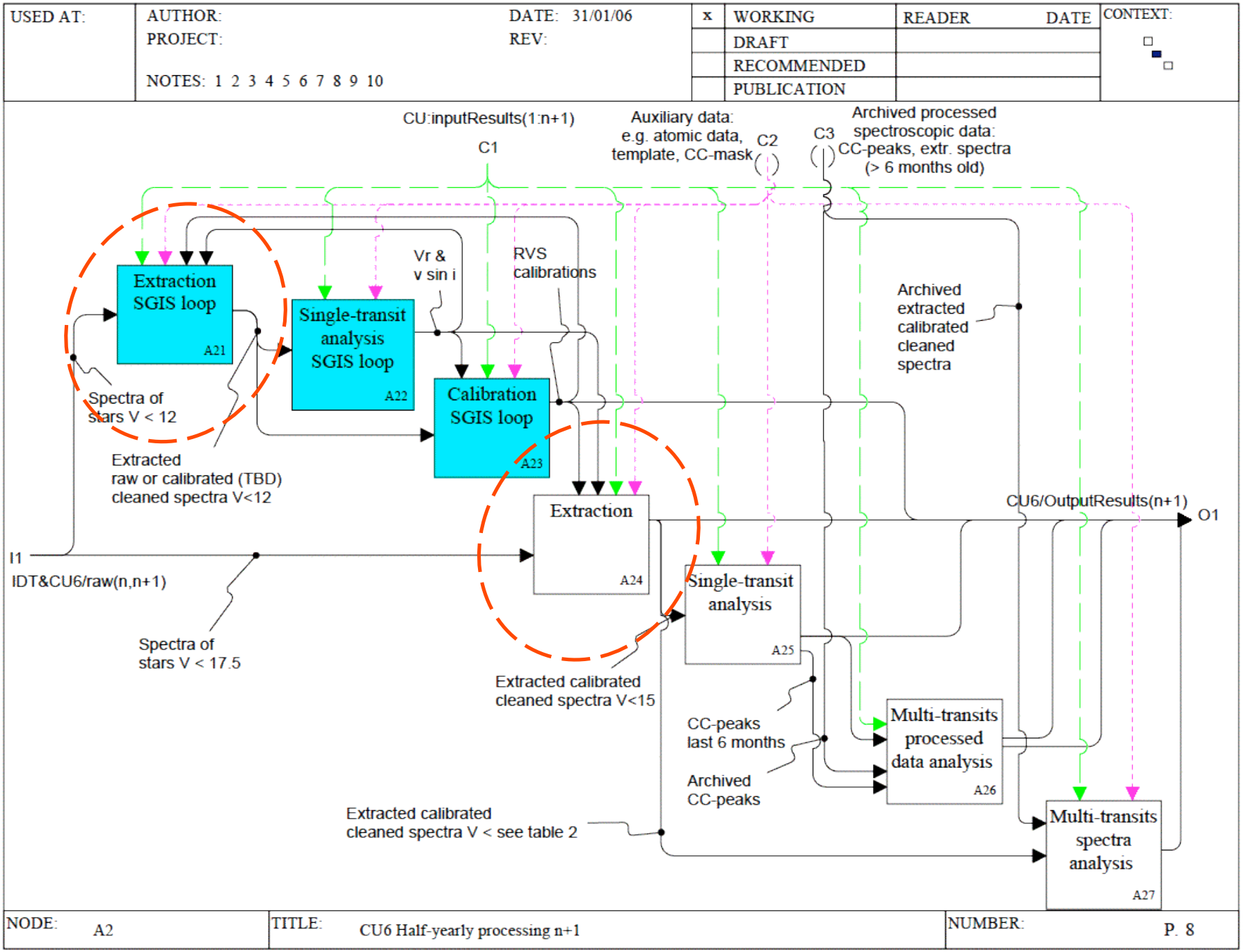
  ⇒ 1 forward and 1 reverse calibration
- May need velocity shifts to be applied – will use past RVS measurements

Extraction: cosmic rays & calibration

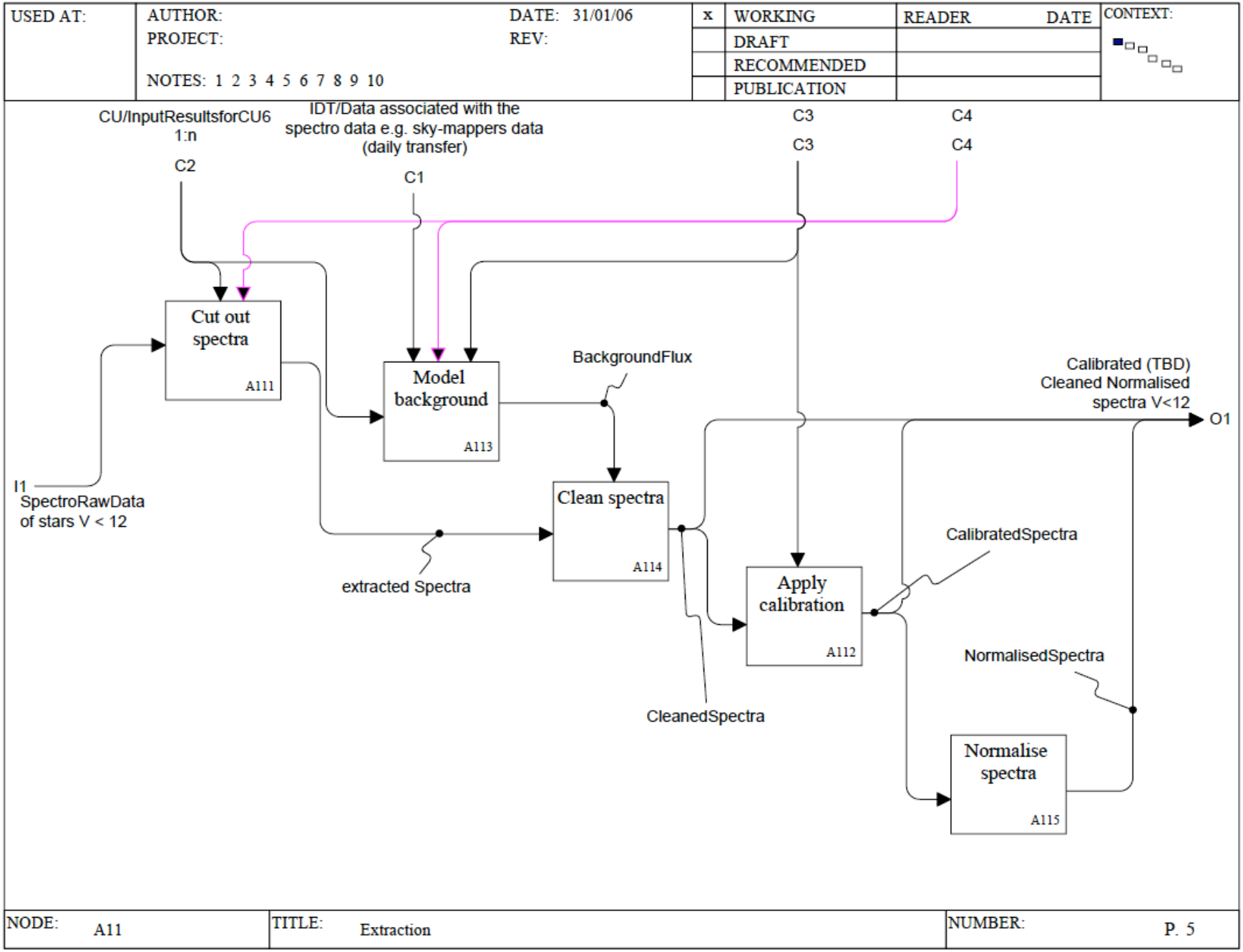
- After modelling for overlapping windows, and background modelling (diffuse, point-source and extended object), spectra can be extracted and background subtracted.
- The extraction process is responsible for applying the calibrations
  - photometric throughput
  - wavelength scale
  - cosmetic defects on CCD

  … propagation of error/uncertainty information, quality flags
- Also, a spectrum normalised to the local continuum will be generated
- Cosmic ray removal is required using some TBD algorithm:
  - cosmic ray flux for *Gaia*3 design is more problematic than ESA Study design (number of pixels/spectrum is larger)
  - no 2-D information

Half-yearly processing



Functional Analysis: current state



Workpackage 620

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

GWP-S-620-00000 Spectra extraction
GWP-C-620-01000 Management, configuration management & interf. of spe. extrac.
GWP-C-620-02000 Detailed functional analysis of the spectra extraction
GWP-S-620-03000 Extract spectra from raw images
GWP-S-620-04000 Apply calibration
GWP-S-620-05000 Model background generated by extended sources
GWP-S-620-06000 Model background generated by point-like sources
GWP-S-620-07000 Clean spectra
GWP-S-620-08000 Normalization to the continuum

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
  - 7.9 FTE in Oct 2007/Mar 2012 [4.5 yr = 1.8 FTE/yr]
- Staff effort made up of
  - 0.25 Senior Researcher and
  - 1.5 Senior Developer/Developer