SPIRE-UCF-MHO-002484

ICC Status

Ken King

Overview of Herschel Science Ground Segment Status

Current status of activities

Issues

Future work

Overview of Herschel Science Ground Segment

Herschel Science Ground Segment

- **Review (part of Mission CDR)**
  - **Kick-off 19-20 Jan '05, Report: SD/2005.035**
    - **Acceptance Review of HCSS and ICCs for ILT and IST activities**
    - **Implementation review for items planned in 2005/6**
    - **Design Review of elements necessary to complete the operational SGS**
  - **Good points**
    - **'Smooth transition' is working well**
      - ILT testing has been achieved with a system very similar to the operational SGS
      - Transition to IST has been relatively painless and transition to operations is expected to also be smooth
      - System well ahead of normal at this time (both implementation and testing)
    - **HCSS**
      - Common development, 'owned' and accepted by all teams
      - Relatively stable, incremental releases – adaptable to users needs
      - Most major systems have been implemented or prototyped
      - QA OK, but needs more resources

Herschel Science Ground Segment

- **Concerns**
  - **Database**
    - Performance problems (data size, searching, complexity of distributed databases) – **under assessment by Herschel Archive RRF**
    - Licensing – **Versant deal**
    - Security, proprietary rights – **Herschel Archive RRF**
  - **IA (now Data Processing, DP)**
    - User interaction/feedback important –
      - » ***encourage more use by potential observers***
      - » ***documentation effort under way***
  - **Mission Planning**
    - AOTs: schedule is becoming critical, S/C pointing problem
      - » ***AOT RRF***
    - Need to freeze HSPOT-User and HSPOT-CUS interfaces
  - **Data Products**
    - Need defining in more detail – **Data Products WG**
    - Assessment of adequacy for general astronomer
      - » ***Planned products known to be processed to minimal level (Level-1)***
      - » ***Improvement only possible with additional resources***
      - » ***Successful bid made in SPC paper for resources to cover DP extension WPs to go to level-2 products***
      - » ***SPMP (Herschel/HSC/Doc/0555) produced***
      - » ***Contracts under discussion***

Current status of activities

Test Preparations

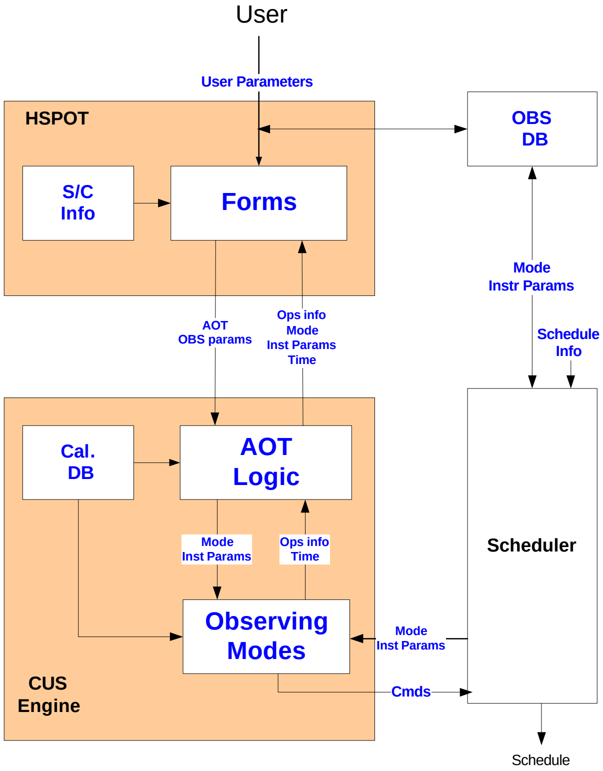
- EGSE Hardware
  - Has been available for Instrument-level tests since start of CQM testing (Jan 2004)
  - IEGSE for use at Astrium has been purchased and integrated at Ottobrun. This has been used to test the warm electronics after integration and ,this week, will be used to test the warm instrument.
  - A second database machine has been purchased to allow distribution of the test data to those in the consortium processing data. Uses data replication mechanism.
  - Still operating with workaround solution for SCOS problems
- EGSE Software
  - EGSE software has been updated in line with HCSS releases before each new test (no change in software during test)
- Instrument Databases (MIBs) have been updated to conform to stringent Alcatel HPSDB interface
  - Still problems with HPSDB – modification of MIB contents – affects IST

The system operation for ILT now mirrors the way in which the system will operate in flight giving us increased confidence in the ability of the system to work correctly during the mission.

- On-Board Software
  - Version 2 of the OBS is now available for use. This includes some of the autonomy functions, although it is unlikely that they will be used in the next test
- Data Processing
  - We have been getting more interest from the consortium in using DP to do their analysis, following the IA demonstration in September
  - Lethbridge have used part of the FTS pipeline in for processing spectrometer data
  - Still able to export to FITS for those 'stuck in the mud'

AOT Definition

- **ESA schedule to meet dates for input of Key Programmes**
- **End May: delivery of ICD describing HSPOT I/F to user and CUS**
  - ICD issued on time (SPIRE-RAL-DOC-002387, version 1.1)
- **Mid August: delivery of set of AOts to allow acceptance testing of the mission planning tools of HCSS**
  - Requires realistic AOT definition (not calibration) and ability to generate commands
  - AOTs now defined in CUS language, not in java
  - Preliminary logic and code for Photometric Single Point and Small Map modes have been produced
  - Waiting for S/C composite pointing modes to be defined (due before end June, now due this week?) **– therefore unlikely to be able to deliver all modes on time**
- **Mid October: delivery of all AOTs**
  - Still some questions about detailed inputs for some modes
- **Mid December: delivery of calibration files to be used for Key Programme input**
  - **This will not be possible as calibration of the FM will not have taken place**
  - **Use of results of PFM2 testing?**



Data Processing Pipeline

- **Spectrometer Processing**
  - **Processing modules were successfully used to process data from the PFM1 tests into spectra**
- **Pipeline Definition revisited**
  - **based on new knowledge of observing modes and instrument capabilities**
  - **Additional steps to take data products to level-2**
  - **Requires more work on defining the final products**
- **Plan**
  - **Now: specification of 'qualitative' steps and agreement on the their data products (input, output and calibration)**
    - **Problem with S/C pointing information**
  - **Mid August: Workshop to put together 'qualitative' pipeline**
  - **September: Meeting to agree responsibilities for 'quantitative' steps**
  - **January: Workshop to put together full pipeline, with basic 'qualitative' steps**
  - **July: Workshop to put together initial full pipeline**

Common Software Development

- **HCSS**
  - HCSS is now reaching maturity with much of the ICC required functionality already implemented
  - It has been used extensively in Instrument-Level Testing (ILT) and integration tests prior to Integrated System Testing (IST)
  - Major area of discussion is database usage in operations
    - Observer access to data from HSC Respecting access rights
    - Database replication between ICCs and HSC (reda/write access)
    - Local database or local store
      - Versant licences
    - Browsing of the database to find/access data

- **Data Processing, DP (Incorporates Interactive Analysis and pipelines)**
  - Major work has been put into improving the documentation for users
    - Development of system for generating the documentation automatically (manuals and on-line help)
    - Users Manual now available with each release (reference manual soon)
    - Many 'how-to's and demo scripts
  - We really need use of IA by the consortium to provide feedback to the developers
    - User Group representatives: Mattia and Sarah
  - Recent work has involved defining extra functionality required for extension to allow processing to level-2 products, both within common DP and SPIRE specific DP
    - Map production
    - Source extraction
    - Datacube analysis

Issues

Issues

- Staffing changes
  - We (will) have lost significant effort due to people leaving (3), becoming unavailable (1)and not starting on time (1).
  - Makes it difficult to keep continuity of development
  - Requires changes in WP responsibilities
- Launch delay to August 2007 (6 months delay)
  - Affected UK effort
    - Prompted bid to PPARC for additional funds, which was successful, but expected savings in the ICC area
    - Use of ICC staff to support instrument testing has led to reduction in effort available for ICC development in UK
  - Other countries not affected
- Consortium input
  - Significant effort is being expended on AOT definition and Pipeline definition over the next year and on ICC operations definition and we need input from the consortium on our proposals.
    - Subscribe to ICC Bulletin Board for the area(s) of interest
    - Read the documentation sent out
    - Participate in reviews

Future Activities

Future activities

- AOT definition completion (by end of year)
- Pipeline development
  - ‘Initial’ for mid 2006 – End to End test
  - ‘Final’ for early 2007 – Launch Readiness
  - Updates during PV phase
- DP development
  - tools for SPIRE-specific analysis
- Calibration
  - Update of Calibration Plan
  - Provision of calibration scripts/modules/tools
- Definition of ICC operational scenario
  - ICC operations
  - DAPSAS centres
  - Consortium access to data

Observing with SPIRE: AORs

Dave Clements, Mattia Vaccari, Imperial College

Ken King, Tanya Lim, Bruce Swinyard, Sunil Sidher, RAL

Marc Sauvage, Herve Aussel, Frederique Mott, CEA Saclay

Matt Griffin, Cardiff University

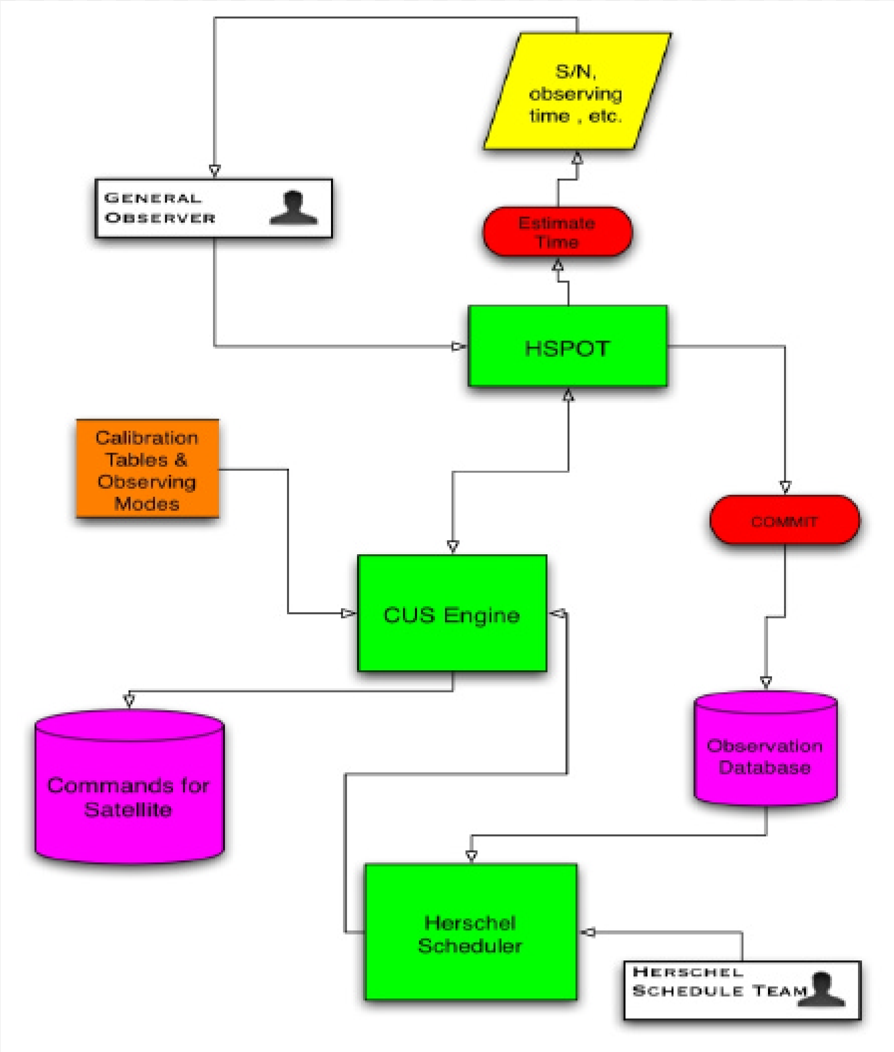
AORs and Herschel

- Astronomical Observation Requests are how observers specify their observations
- The definition of AORs are important for several reasons
  - Its how the observers will interface with the instruments
  - It will be our first main contact point with them
  - The AOR specifications define how SPIRE will be used, what calibrations are needed, and how the data will be reduced

Observing modes and AORs

- There are many potential ways that SPIRE can be used
- In producing AORs we go from the infinite range of possibilities to a small number of specific options
  - The fewer options the simpler the calibration, verification and data reduction tasks will be
  - BUT at the same time do not want to limit the observing possibilities

SPIRE AOR operation



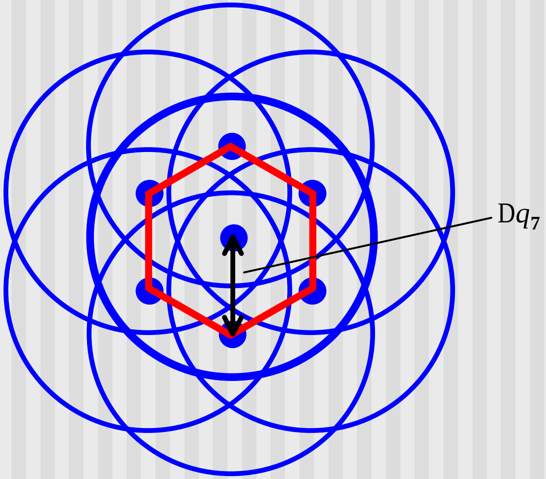
- Observer enters observations into HSPOT
- HSPOT calls CUS Engine to get integration times etc. which are reported to Observer
- When happy, observer commits observations to database
- Later, the Scheduler uses the scheduling tool to get an observation out of database
- This calls CUS Engine, which generates commands for spacecraft

HSPOT for SPIRE

- SPOT - Spitzer observation entry tool
- Modified by HSC for Herschel AOR entry
  - HSPOT - demo later on
- Working AOR entry system for whole of SPIRE
  - Still in development though, so some rough edges - comments appreciated!
  - Can download it for yourselves from Herschel HSCDT site
    - http://www.rssd.esa.int/SD-general/Projects/Herschel/hscdt/

Point Source Photometry

- Nominally uses a 7-point jiggle map
  - ?? $_7$ = 6”
  - Coverage is > APE
  - Loss in sensitivity < 20% c.f. chopping
- *Fixed point chopping is available if the telescope pointing is good enough and source position accurately known, or a peak-up operation can be performed*
  - *Peak-up time reduces the effective sensitivity*
  - *This is not currently selectable in HSPOT*
- Note: this mode produces a ‘sparse map’ of the 4’ x 4’ area around the source as a by-product

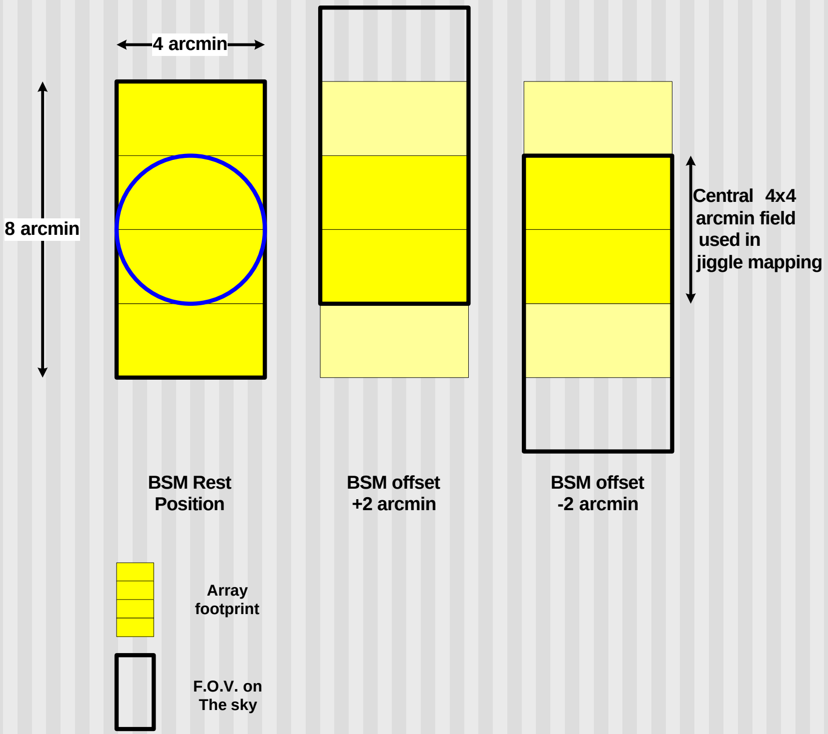


Photometry Status and Issues

- Do we use 7-point jiggle for all photometry?
- Can now enter 7-point observations in HSPOT and get sensitivity/observing time estimate
- Range of chopping exclusion angles allowed
  - Will make scheduling harder, so best avoided!

Small Maps - Jiggle Mapping

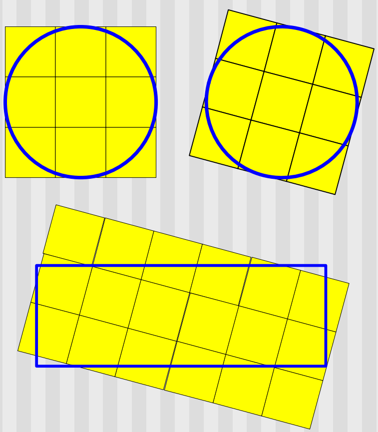
- Small Map Photometry
  - Provides 4’ x 4’ area fully sampled by
    - Chopping by ± 2’
    - 64 point jiggle map to give full sampling
  - Because of unknown angle on sky at time of observation only coverage of 4’ circular area is guaranteed



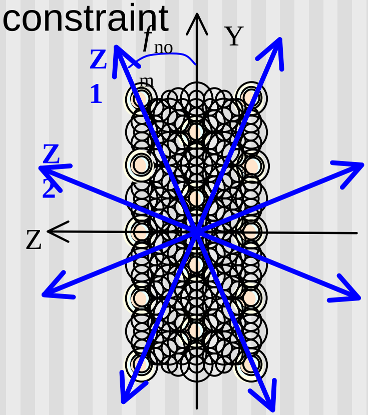
Large Maps

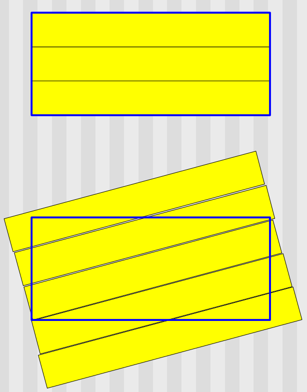
- Can be covered in two ways: determined by minimising observing time

- Raster pattern of small maps
- Raster pattern fixed to lie along chop to ensure maps ‘join’ correctly. Therefore angle of raster on sky is determined by scheduled date
- To avoid sky rotation affecting coverage
  - Define square field but assume circular coverage - inefficient
  - define allowable range of orientation on sky - implies scheduling constraint



- Scan Map
- Default is no chopping
- Scan angle, relative to telescope, optimised to provide complete even coverage across scan using multiple pixels.
- Scan direction is therefore fixed wrt telescope axes
- User can provide allowable range of orientation on sky – implies scheduling constraint





Mapping Status and Issues

- User input definition to HSPOT complete
- We expect to make an automated decision between raster and scan mapping based on the most efficient mode given map size and sensitivity
- There will be minimal choice in definition of maps
  - There will be a standard overlap size in rasters
  - Scan maps will be done at an optimal scan speed with multiple passes to increase sensitivity
    - Without scheduling constraints we can only guarantee a circular region to required sensitivity
    - Non-standard scan geometries precluded by spacecraft pointing
- Keeps data reduction, mode verification, and spacecraft control as simple as possible

Spectrometer Status and Issues

- Use inputs for HSPOT complete
- Now offering two resolutions:
  - High resolution & Low resolution (and a combined mode if both needed)
  - Medium resolution - is it needed?
- Small jiggle maps offered
- Larger maps achieved by rastering jiggle maps
  - Sparsely sampled maps allowed
- The possibility of using step & integrate for low resolution spectra is available

SPIRE/PACS Parallel Mode

- It is taken as a constraint that the SPIRE BSM should not be moved during this mode
- Mapping is achieved by scanning the telescope
- The only operation needed by SPIRE is to start detector sampling (at an appropriate rate)
  - Sample slower – implies scanning slower than nominal rate
  - Sample at normal speed and discard redundant pixel data

CUS Conversion

- Go from HSPOT to commands in CUS language which tell telescope/instrument how to do observation
- Some preliminary versions of these conversions are now available (POF2, 3)
- Main job of conversion of observation descriptions to telescope commands will come later this summer, once spacecraft pointing commanding is clarified

CUS Sequences

- CUS gets user input from HSPOT and performs two steps
- AOT Logic
  - Checks input
  - Calculates integration times and operation length
  - Calculates the timing parameters for the pointing mode
  - Calculates number of ‘cycles’ of operations and positions of calibration activities
- AOT Generation
  - Generates pointing command
  - Generates Serendipity operation, if possible
  - Generates configuration and initialisation commands
  - Iterates through each cycle generating instrument commands for each operation and inserts calibrations
  - Generates reconfiguration commands

Default Parameters

- CUS conversion will use the SPIRE Observing Mode descriptions as basis for defining commands to instrument
- Some decisions about which mode to use will be taken automatically
  - Rastered Jiggles or Scanmap - based on optimisation for mapping speed
  - Line & continuum spectrum based on whether continuum is detectable in high res. scan

Current CUS Status

- 7-point jiggle and 64-point jiggle Photometer modes have been implemented using ‘example’ pointing modes. Early versions of these (no command generation) are available in HSPOT at present
- Scan and Serendipity operations have been defined
- No spectrometer operations have been defined in CUS, but they have been exercised in ILT, so we know how to do it
- We are now waiting for the composite pointing modes (or at least an API and dummy versions) before we can implement the sequencing of these

AOT Status: Conclusions

- Observing modes are approaching full definition
- HSPOT observation request system nearing first full release
- System to go from HSPOT observation descriptions to S/C & SPIRE commands well advanced
- Acceptance testing for HSPOT/CUS Engine system at end of summer

HSpot

The tool for planning Herschel observations and submitting proposals

SPIRE Consortium Meeting

Caltech, 21 July 2005

Sarah Leeks

HSpot essential functionalities

- Entering Astronomical Observation Requests (AORs) via Astronomical Observation Templates
- Target definition
- Instrument performance and observing time estimation
- AOR replication
- AOR visualization
- Proposal submission
- Entering timing and grouping constraints

To be implemented

- Timing and grouping constraints
- Homogenization between instrument front-ends
- Herschel Confusion Noise Estimator
- Proposal printing
- Auto update
- Versioning of AOTs
- Background for moving targets
- Shadow measurement and footprint for SSOs
- More detailed footprint images
- AOT front-end updates induced by AOT logic development

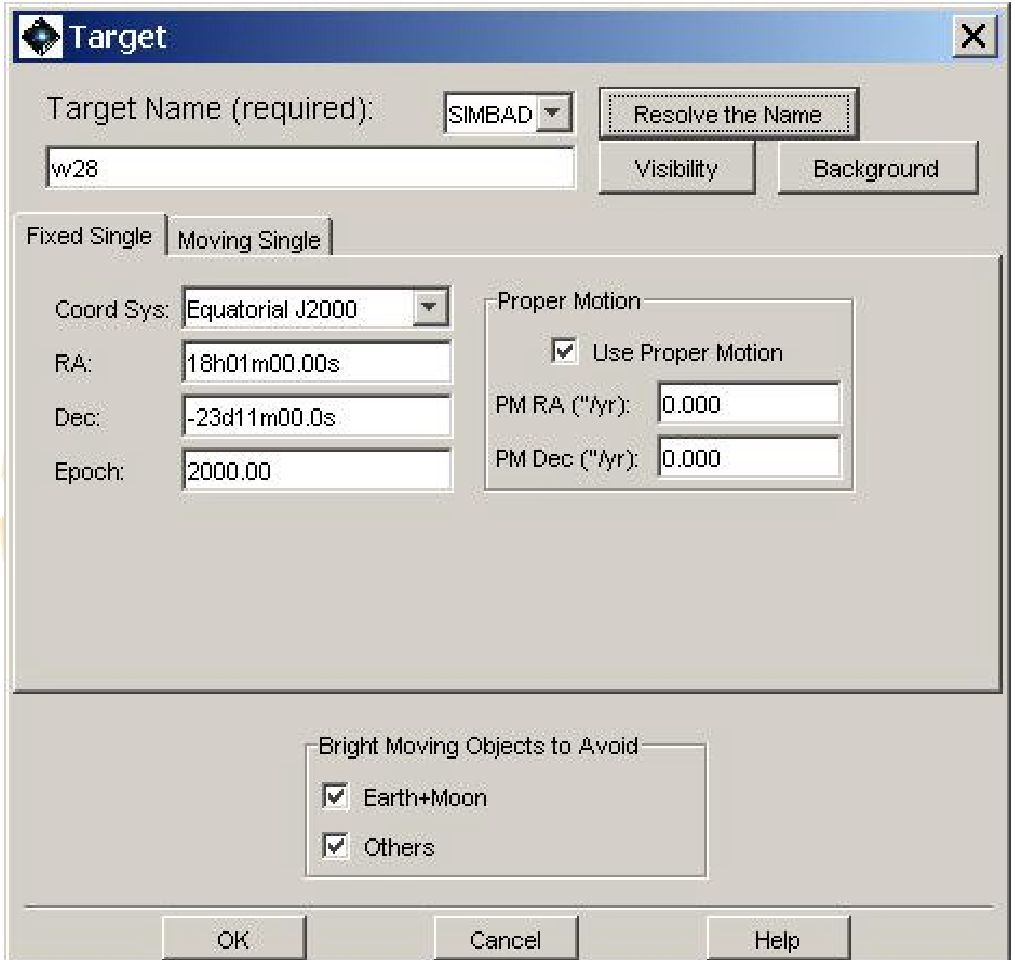
HERSCHEL SPACE OBSERVATORY

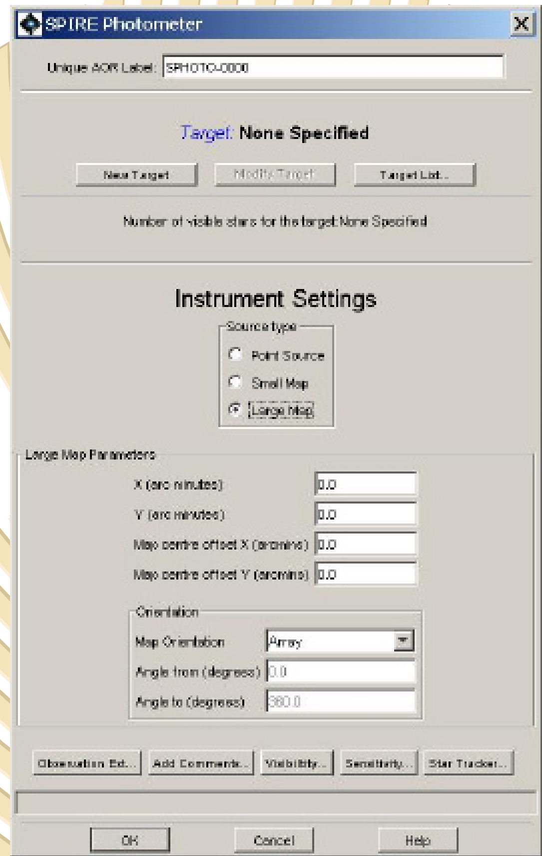
How to get the software

- From web page:
- ftp://ftp.rssd.esa.int/pub/HERSCHEL/csdt/phs/

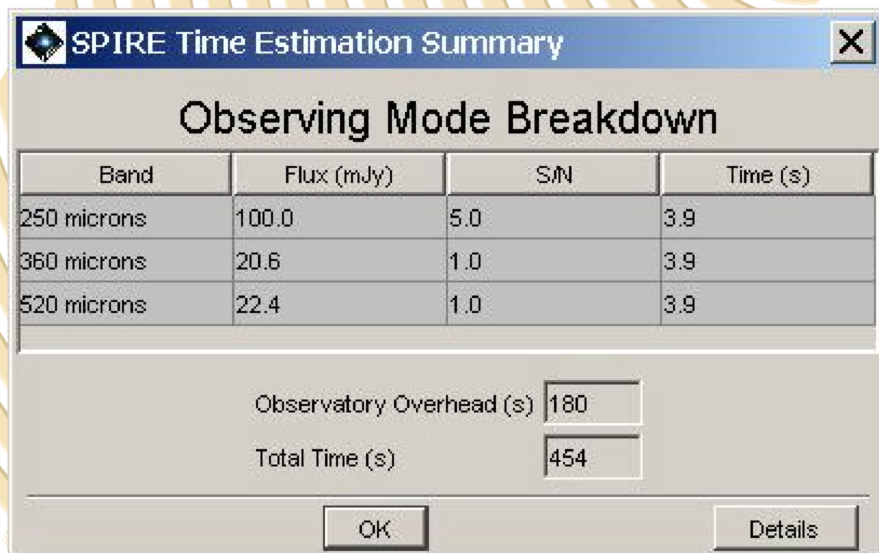
- Take build with highest number for the relevant platform
- Look at README file for notes on releases and installation instructions

HERSCHEL SPACE OBSERVATORY


Target
Target Name (required):
SIMBAD
Resolve the Name
w28
Visibility
Background
Fixed Single
Moving Single
Coord Sys:
Equatorial J2000
RA:
18h01m00.00s
Dec:
-23d11m00.0s
Epoch:
2000.00
Proper Motion
Use Proper Motion
PM RA ("/yr):
0.000
PM Dec ("/yr):
0.000
Bright Moving Objects to Avoid
Earth+Moon
Others
OK
Cancel
Help



HERSCHEL SPACE OBSERVATORY



HERSCHEL SPACE OBSERVATORY

SPIRE Time Estimation Summary

Observing Mode Breakdown

Band	Flux (mJy)	S/N	Time (s)
250 microns	10.0	5.0	392.0
360 microns	2.1	1.0	392.0
520 microns	2.2	1.0	392.0

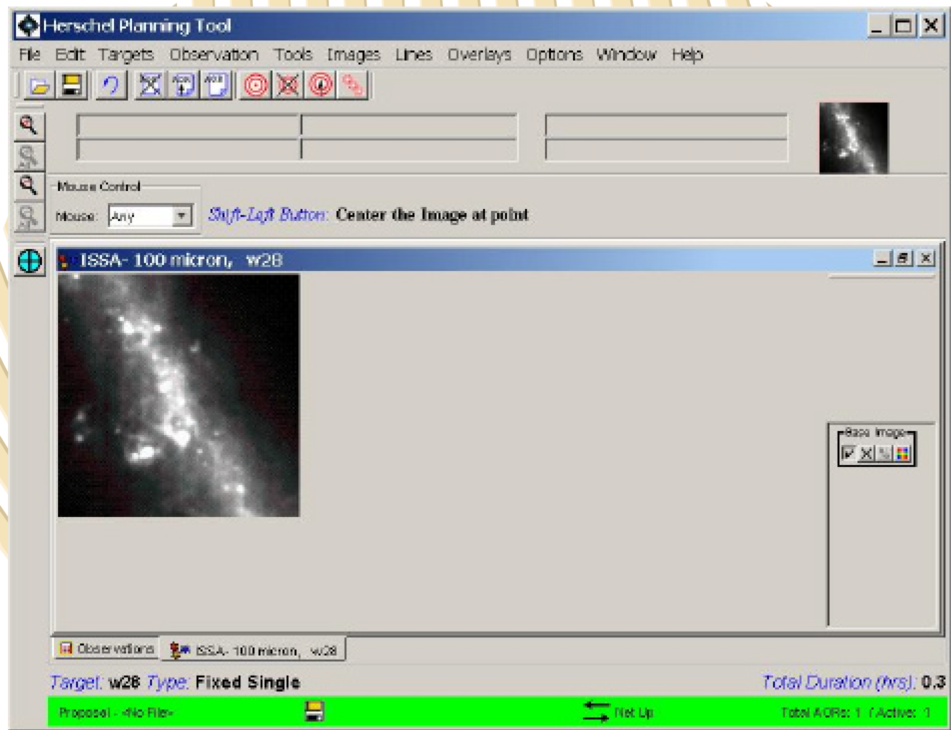
Warning: The confusion limit has been reached in one or more of the flux bands.

Observatory Overhead (s) 180

Total Time (s) 910

OK   Details

HERSCHEL SPACE OBSERVATORY

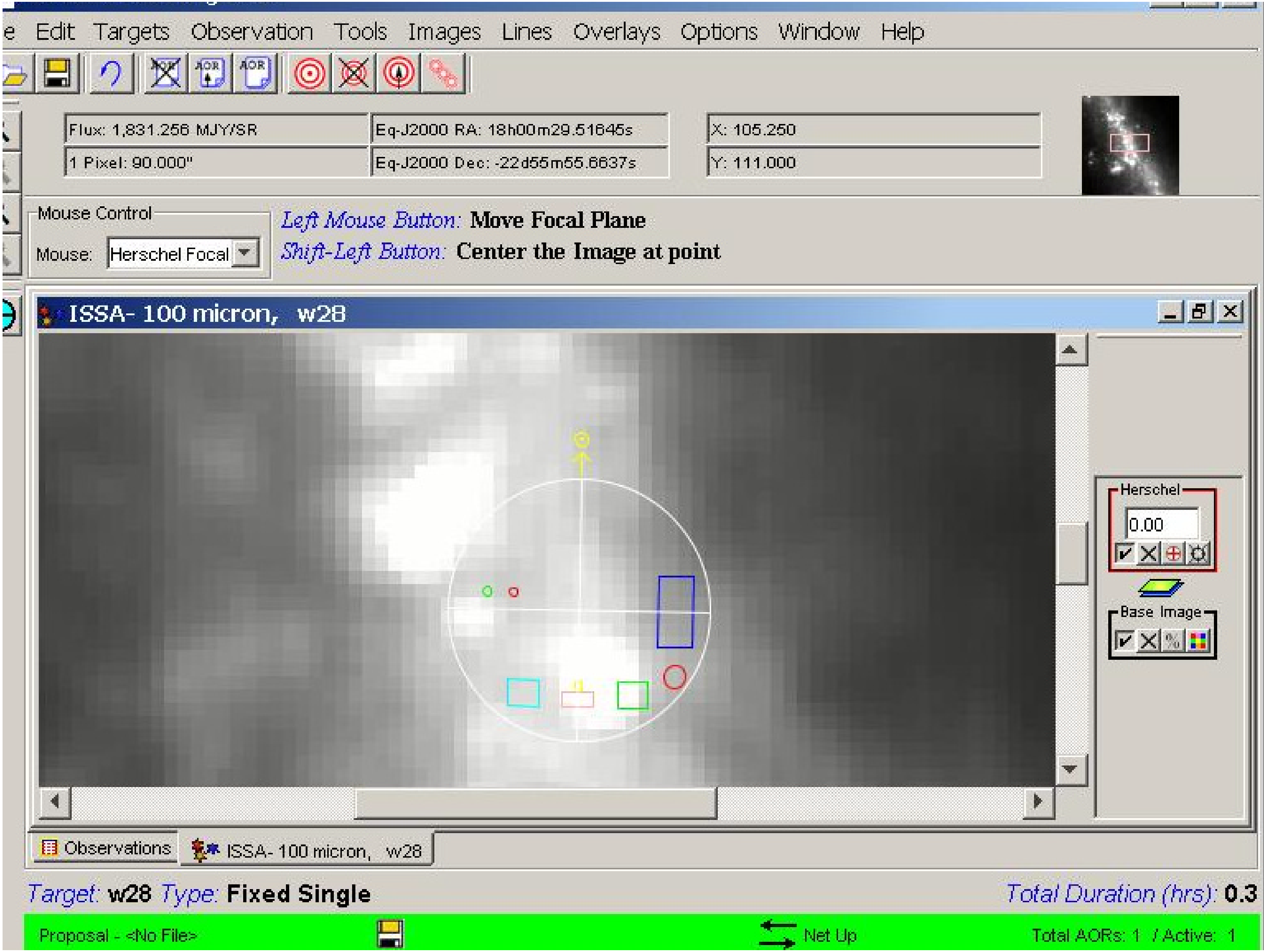

Herschel Planning Tool
File Edit Targets Observation Tools Images Lines Overlays Options Window Help
Mouse Control
Mouse: Any
Shift-Left Button: Center the Image at point
ISSA- 100 micron, w28
Base Image
Observations
ISSA- 100 micron, w28
Target: w28 Type: Fixed Single
Total Duration (hrs): 0.3
Proposal - <No File>
Net Up
Total AORs: 1 / Active: 1

Visibility Windows

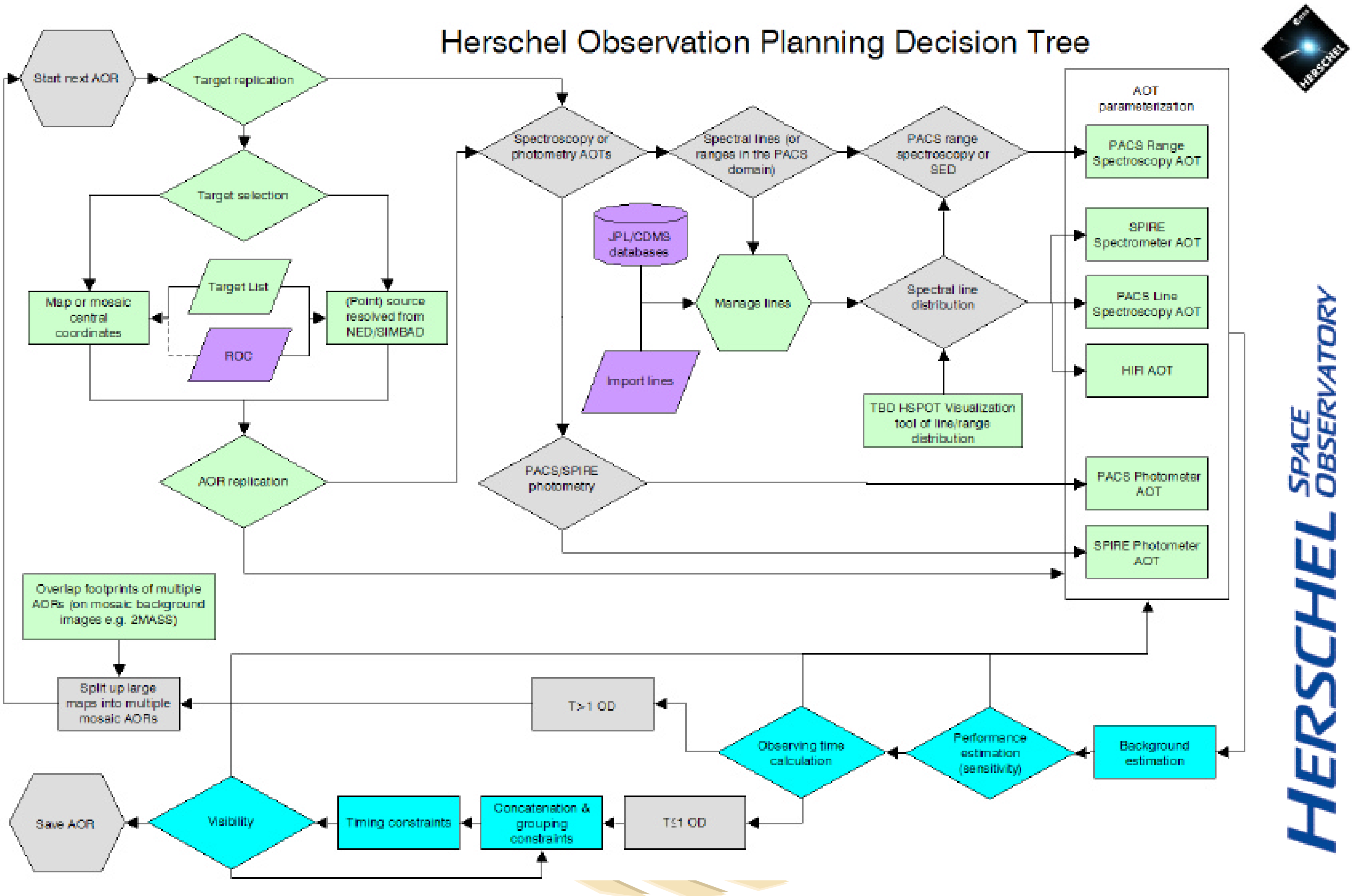
Herschel visibility windows for target w28

Window Open	Window Close	Duration(days)
2007 Aug 23 21:05:00	2007 Oct 24 09:54:00	61.5
2008 Feb 19 14:35:00	2008 Apr 20 07:35:00	60.7
2008 Aug 23 03:20:00	2008 Oct 23 15:00:00	61.5
2009 Feb 18 22:19:00	2009 Apr 20 12:42:00	60.6
2009 Aug 23 11:01:00	2009 Oct 23 19:44:00	61.4
2010 Feb 19 06:10:00	2010 Apr 20 17:30:00	60.5
2010 Aug 23 18:47:00	2010 Oct 24 00:23:00	61.2
2011 Feb 19 13:47:00	2011 Apr 20 22:02:00	60.3
2011 Aug 24 02:21:00	2011 Oct 24 05:05:00	61.1
2012 Feb 19 21:09:00	2012 Apr 20 02:32:00	60.2

Done


e Edit Targets Observation Tools Images Lines Overlays Options Window Help
Flux: 1,831.256 MJY/SR
Eq-J2000 RA: 18h00m29.51645s
X: 105.250
1 Pixel: 90.000"
Eq-J2000 Dec: -22d55m55.6637s
Y: 111.000
Mouse Control
Mouse: Herschel Focal
Left Mouse Button: Move Focal Plane
Shift-Left Button: Center the Image at point
ISSA- 100 micron, w28
Herschel
0.00
Base Image
Observations
ISSA- 100 micron, w28
Target: w28 Type: Fixed Single
Total Duration (hrs): 0.3
Proposal - <No File>
Net Up
Total AORs: 1 / Active: 1

Herschel Observation Planning Decision Tree



HERSCHEL SPACE OBSERVATORY

SPIRE Data Products

Mattia Vaccari - Imperial College

(Thanks to Matt, Ken & Dave)

SPIRE and the Community

- **Emphasis at this stage is rightfully on test data analysis**

However

- **Many "casual" users will look at the whole of SPIRE through the lens of the automatically generated data products they will be delivered after pipeline data processing**

Therefore

- **We must ensure that the definition of data products**
  - takes into account indications from testing
  - parallels AOTs and pipeline development
  - is supported by Herschel Common DP system data structures
  - is insofar as possible homogeneous within Herschel context

Various Data Products Levels

- **According to previous agreements, ICCs committed to provide Level 0 ("calibrated timelines") and Level 1 ("calibrated timelines in which instrument effects have been removed") data products**
- **Through the *Extended Data Processing* scheme, in partnership with the HSC, SPIRE (and Herschel) will now be able to provide Level 2 data products, i.e. "suitable for science analysis and interpretation"**
- **While such automatically generated data products are all very well and might eventually be enough for most observers, expert users will need straightforward ways to retrieve raw data or to interactively visualize / modify data at intermediate pipeline stages**
- **Actual processing level of delivered data products is expected to evolve over mission lifetime**

Users and Pipeline / IA Use

- **All data products shall be made available to the users**
  - **For all observing programmes**
  - **Via standard processing**
  - **Including robustly defined history and versioning information**
  - **Based on a standard calibration scheme**
    - **Some elements SPIRE-specific**
    - **Some common with other instruments**
- **Expert users may go back to the raw data and reprocess using new pipeline versions, IA or their own software and/or different calibration assumptions**
- **Pipeline and IA data processing modules will allow alternative algorithms to be applied and/or interactive visual inspection through tools jointly developed by HSC and SPIRE**

Generic Calibration Information

- Absolute calibration scheme (models, uncertainties)
- Spectral passbands
- Calibration source(s) used, assumed flux densities and nominal spectral indices
- Flux-weighted effective wavelengths for nominal source spectral index
- Flux-weighted effective wavelengths as a function of source spectral index
  - Observers can then choose appropriate wavelength given their beliefs concerning the actual source spectral index
- Beam profiles
- Focal plane geometry
  - Relative positions of all detectors with respect to a fiducial detector in each array
- Fitting methods for use in flux density and position determination
- FTS instrument response and apodisation functions

Point Source Photometry

Level 1 Products

- All detector photometric timelines with astrometry based on telescope pointing and SPIRE BSM position
  - Deglitched
  - Corrected for baseline drifts
  - Calibrated in physical units
- All nod position A and B signal values for all detectors, with statistical errors and astrometric information (position and uncertainty)
- Identification of prime detectors

Level 2 Products

- Fitted source flux density with statistical, calibration and total uncertainties (with fit quality indication)
- Fitted source position offsets wrt commanded astrometry and corresponding uncertainties (with fit quality indication)

Photometer Jiggle Mapping

Level 1 Products

- As for point source photometry except that no prime detector set is identified

Level 2 Products

- Co-added and re-gridded map based on all data
  - Regular grid of positions with flux density (Jy/beam at l_{eff} for nominal spectral index) and statistical error
  - Astrometric position and uncertainty for the map centre

Level 2 IA Capabilities (TBC)

- Capability to transform to surface brightness (Jy/sr) – requires deconvolution using beam profile information and/or some knowledge of the source brightness distribution

Photometer Scan Mapping

Level 1 Products

- **Deglitched time-ordered data for each detector (signal vs. position)**
  - **Telescope turn-around periods flagged (may be usable)**
- **Bolometer and instrument thermal drift timelines (from dark pixels and H/K thermometry)**

Level 2 Products

- **Same as for Jiggle Map**
- **Detailed handling of astrometric errors is TBC (depends on pointing characteristics)**

Level 2 IA Capabilities

- **Conversion to surface brightness – as for Jiggle map**
- **Simple and robust point source extraction routine**
  - **Producing a point source list: flux densities at l_{eff}(i) , and astrometric position with corresponding uncertainties and quality indicator**
- **Basic toolkit for characterisation of extended emission (details TBC)**
- **More sophisticated point source extraction methods (TBC)**

FTS Observations

Level 1 Products

- **Individual interferograms**
  - Deglitched timelines for each detector (signal vs. mirror position)
  - Astrometric data (positions and uncertainties)

- **Identification of prime detectors**

- **Spectral data cube**
  - Flux density vs. wavelength or frequency (e.g., W m^{-2} cm^{-1} in beam vs. wavenumber) for each detector position
  - Based on a standard calibration and apodisation scheme

- **These basic products are already at the level of "scientific usability"**

FTS Line Spectroscopy
Point Source or Sparse Map

Level 2 IA Capabilities

- **Simple and robust unresolved line extraction routine**
  - **Producing a line list**
  - **Line flux (W m^{-2}) and wavelength with corresponding uncertainties**
- **Resolved line fitting routines**
  - **Line profile fitting / characterisation routine based on instrument response function**
- **Line identification routines**
  - **Database of known lines and ability to correct for VLSR to overlay on measured spectrum**
- **Background subtraction routines**
  - **To assist the astronomer in removing the background using adjacent detectors and/or offset observation with central pixel**
- **Spectrophotometry : SED fitting routines**

FTS Mapping

- **Multiple pointings will be treated separately and not combined into a single data cube**
  - **All observations to be reduced and calibrated as point sources**
  - **Extended source observations encouraged for expert users in the first instance**

- **Residual telescope emission will not be removed – to be done by the astronomer using adjacent pixels or observation of adjacent patch of sky with the central pixel**

SPIRE / PACS Commonality

- **Calibration Scheme**
  - **Must be based on same standards and assumptions**
  - **Should have similar methodology and terminology (definition of effective wavelengths, assumptions about nominal spectral indices, etc.)**
- **Photometer Level 2 Products**
  - **They should be very similar**
  - **Ensuring their common look and feel will greatly benefit users which might then use PACS+SPIRE as a single instrument**
- **Spectrometer Calibration and Level 2 Products Definition**

Current Status

- **SPIRE Data Products Specification collects current definitions**

2.14.1 SDT Product Format

product (type="SDT", description="Spectrometer Detector Timeline")		
metadata:		
String	creator	(description="Creator", quantity="")
Date	creationDate	(description="Creation Date", quantity="UTC")
String	instrument	(description="Instrument", quantity="")
String	modelName	(description="Instrument Model Name", quantity="")
Date	startDate	(description="Start Date", quantity="UTC")
Date	endDate	(description="End Date", quantity="UTC")
long	obsid	(description="Observation Identifier", quantity="")
long	bbid	(description="Building Block Identifier", quantity="")
long	bbtype	(description="Building Block Type", quantity="")
long	bbcount	(description="Building Block Count", quantity="")
String	subsystem	(description="Instrument Subsystem", quantity="")
String	aot	(description="AOT Identifier", quantity="")
composite dataset	(description="Detector Timeline", key=*source, as defined in* Table 2-3*)*	
metadata:		
String	source	(description="Source packet", quantity="")
Table dataset	(description="Pixel Timeline", key="SSWR1")	
metadata:		
String	pixelName	(description="Pixel Name", quantity="")
long	pixelId	(description="Pixel Identifier", quantity="")
string	status	(description="Channel Status", quantity="")
Column Double1d	sampleTime	(description="Sample Time", quantity="Seconds")
Column Double1d	signal	(description="Detector Signal", quantity="Volts")
Column Double1d	error	(description="Error on Signal", quantity="Volts")
Column Integer1d	mask	(description="Data Mask", quantity="")

Current Status

- **Level 0 and Level 1 products definition essentially complete**
  - defined and (being) implemented in pipeline development
  - follows AOTs both in implementation and priority

- **Spectrometer calibration products and Photometer Level 2 products definition well underway**

What's Next?

- **Photometer calibration products definition (if provisional) is needed soon following indications from testing and shaping pipeline development**

- **Level 2 products must be (better) defined in consultation with other instruments (and possibly with SPIRE astronomers)**

ICC On-Line Resources

- RSSD - Herschel and SPIRE Software/Doc Repository and Mailing Lists
  - Herschel-wide and SPIRE-specific DP software
  - Livelink documentation database
  - HSPOT Proposal Handling System
  - Herschel-wide Mailing Lists
- IC - Information Dissemination
  - Bulletin Board (permanent record of messages and documents)
  - Document Repository (SPIRE Livelink "patch")
  - SPIRE for Dummies (including quick links to most resources)
- RAL - Test Data Database & Repository and SPIRE Mailing Lists
  - HTTP database to access data through SPIRE QLA
  - Test data FITS file output
  - SPIRE Mailing Lists where astronomers' involvement is most needed
    - AOT (AOTs Development)
    - OBST (Pipeline Development)
    - SDPUG (Data Processing Users)
    - SPSWG (Photometer Simulator)

SPIRE Pipeline

Tanya Lim
RAL

Introduction

- The SPIRE interactive analysis is a set of software that allows the processing of SPIRE data from its raw state to astronomically usable products
- The aim of IA is to allow users to run it either interactively or in ‘pipeline’ mode or a combination of both
- The pipeline mode (Standard Product Generation) consists of data being passed through a set of processing stages.
  - For early pipeline stages data is processed on a building block level e.g. 7 jiggle positions and for later pipeline stages on a per observation level e.g. combining nod positions
  - Before the observation processing, the building block processing must be complete for every building block in the observation e.g. all the 7 jiggle positions per nod must be processed before nods are combined
- The processing steps in the data flow have been designed to add clarity to the processing i.e. not put too many changes to data in a black box
- The reason for this as the minimum expectation for running the IA interactively is that data inspection will be possible between each processing stage

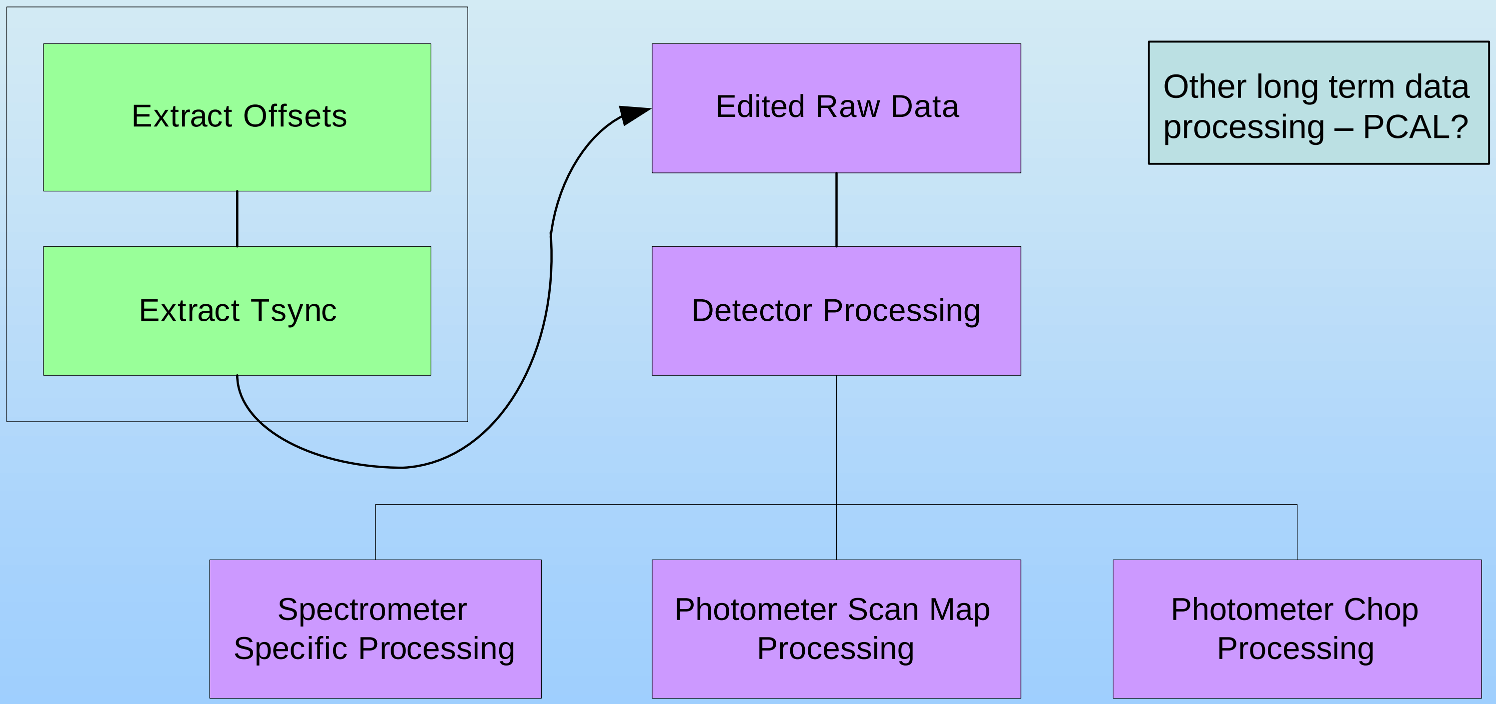
Status

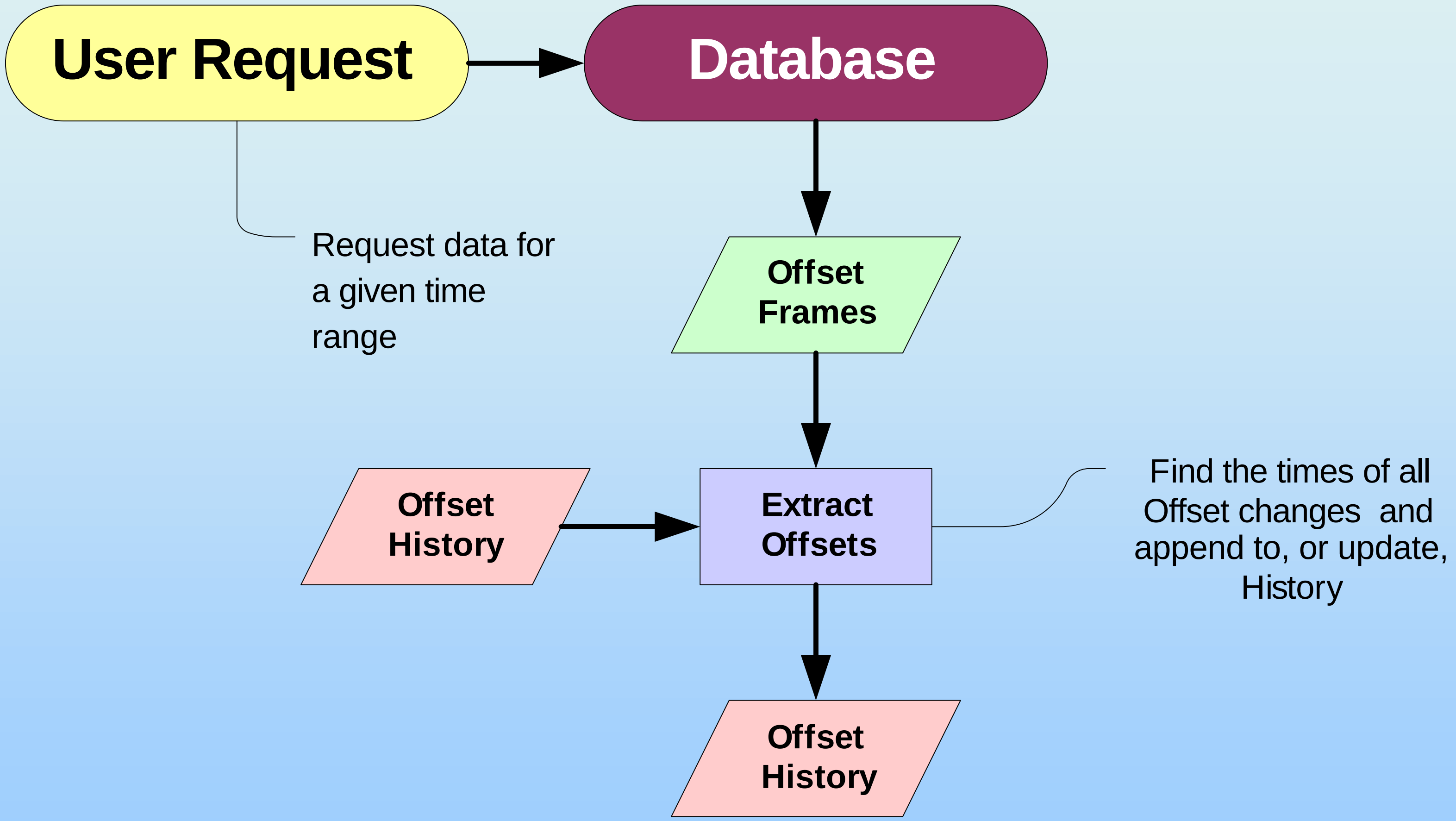
- A document describing the pipeline is being prepared and is almost ready for circulation but…
- The document is not complete
  - the pointing processing probably needs to be described as a separate data flow
  - a data flow is required for PCAL processing
  - I haven’t yet designed the spectrometer step and look mode data flow

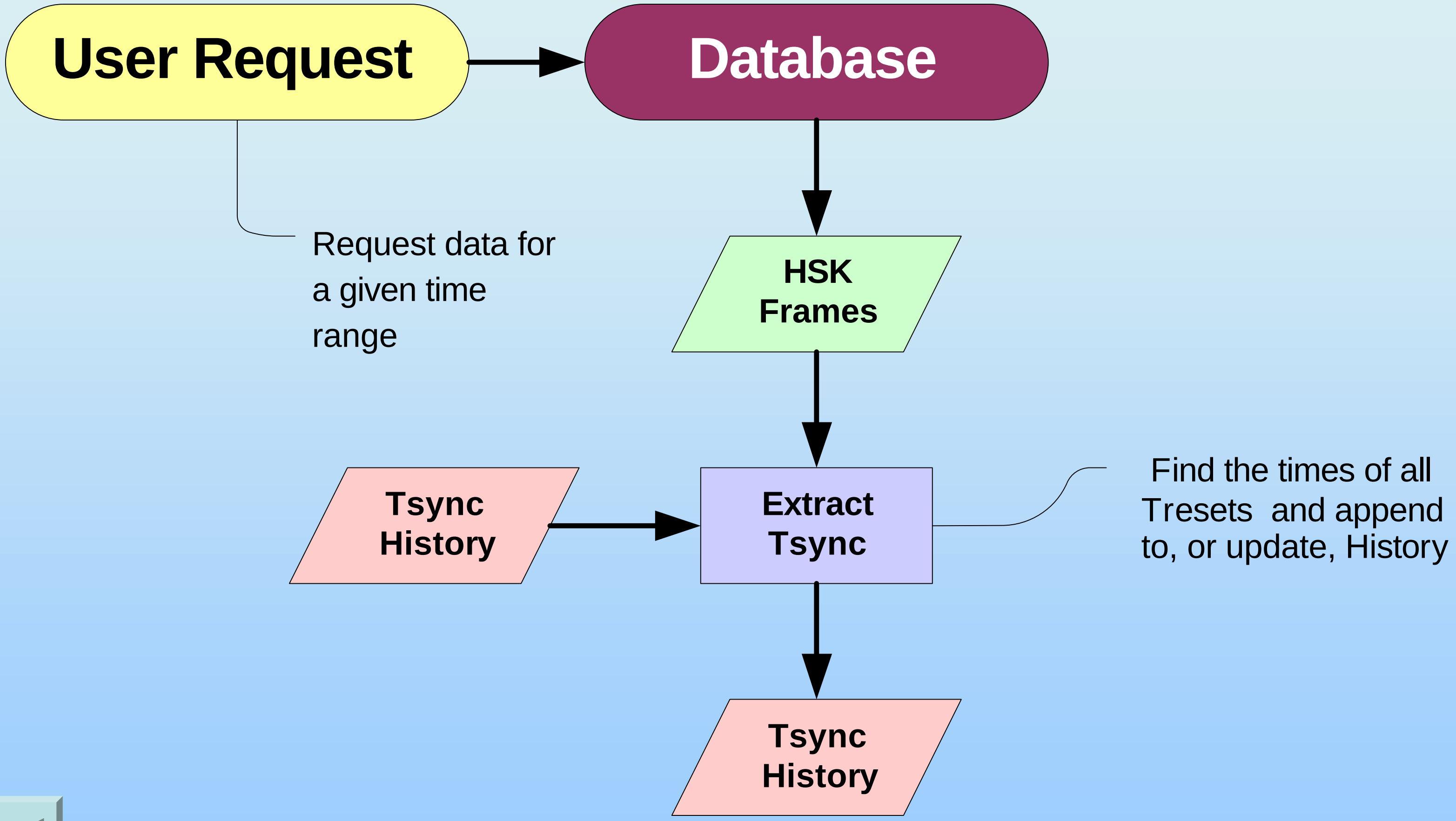
- The data flow is being used by the ICC to design the empty pipeline as it indicates where data changes format but…
  - In many places there are still details to be worked through concerning the passage of data through the pipeline
  - A lot of work is needed to agree the implementation of the calibration data (file formats)

Run for a time period e.g. 48 hours

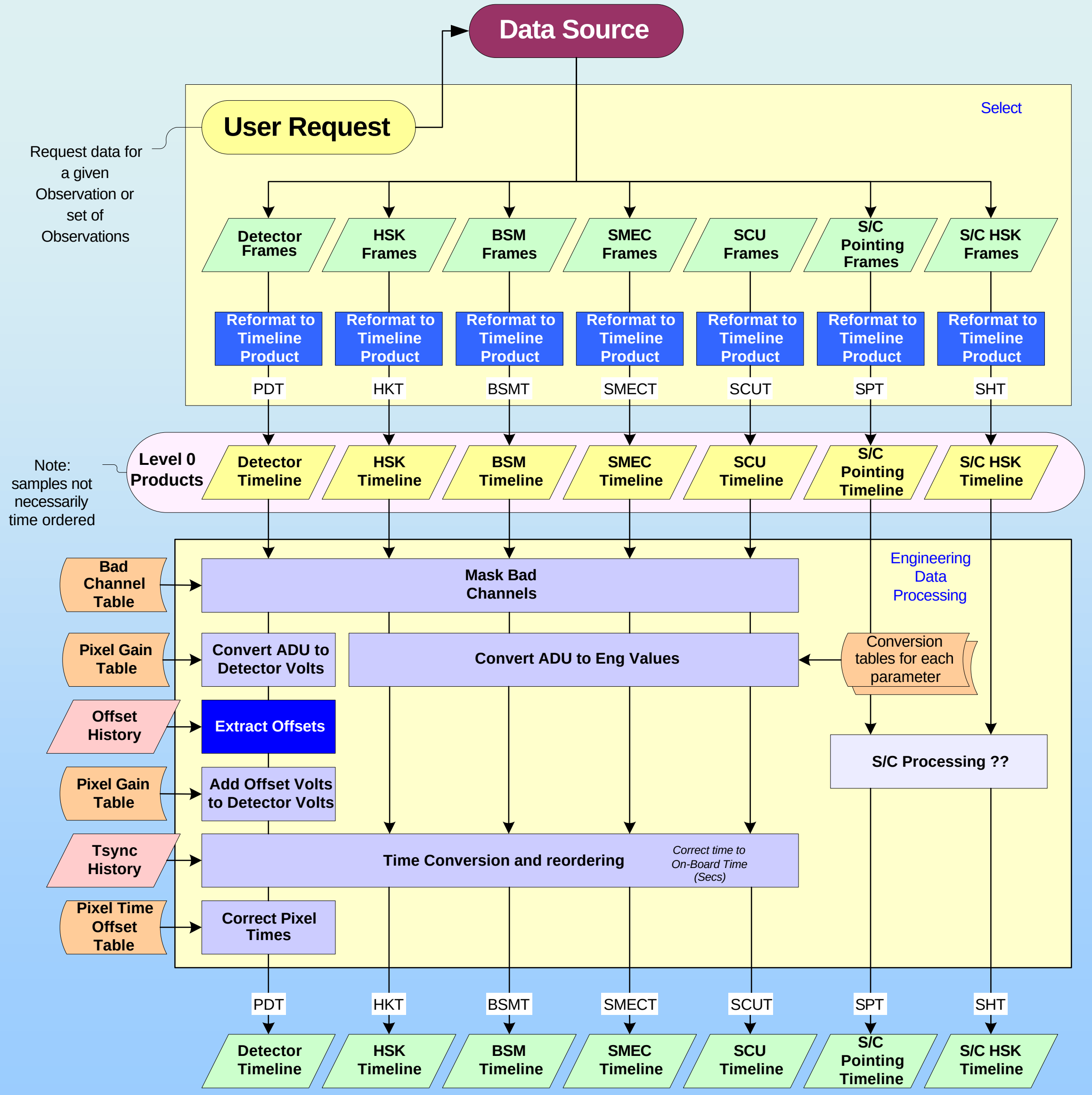
Run on a building block/observation



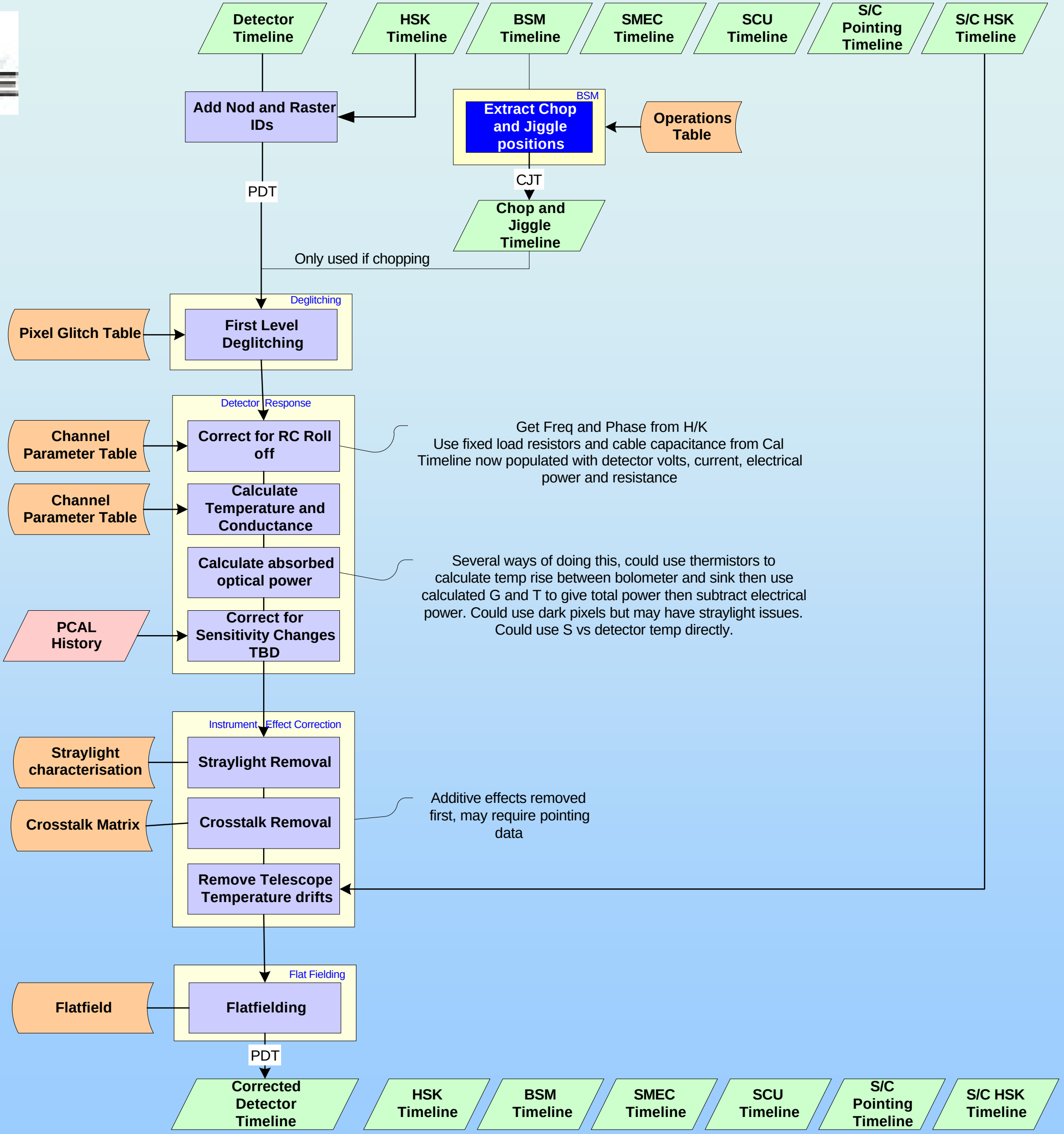

User Request
Database
Request data for a given time range
Offset Frames
Offset History
Extract Offsets
Find the times of all Offset changes and append to, or update, History
Offset History

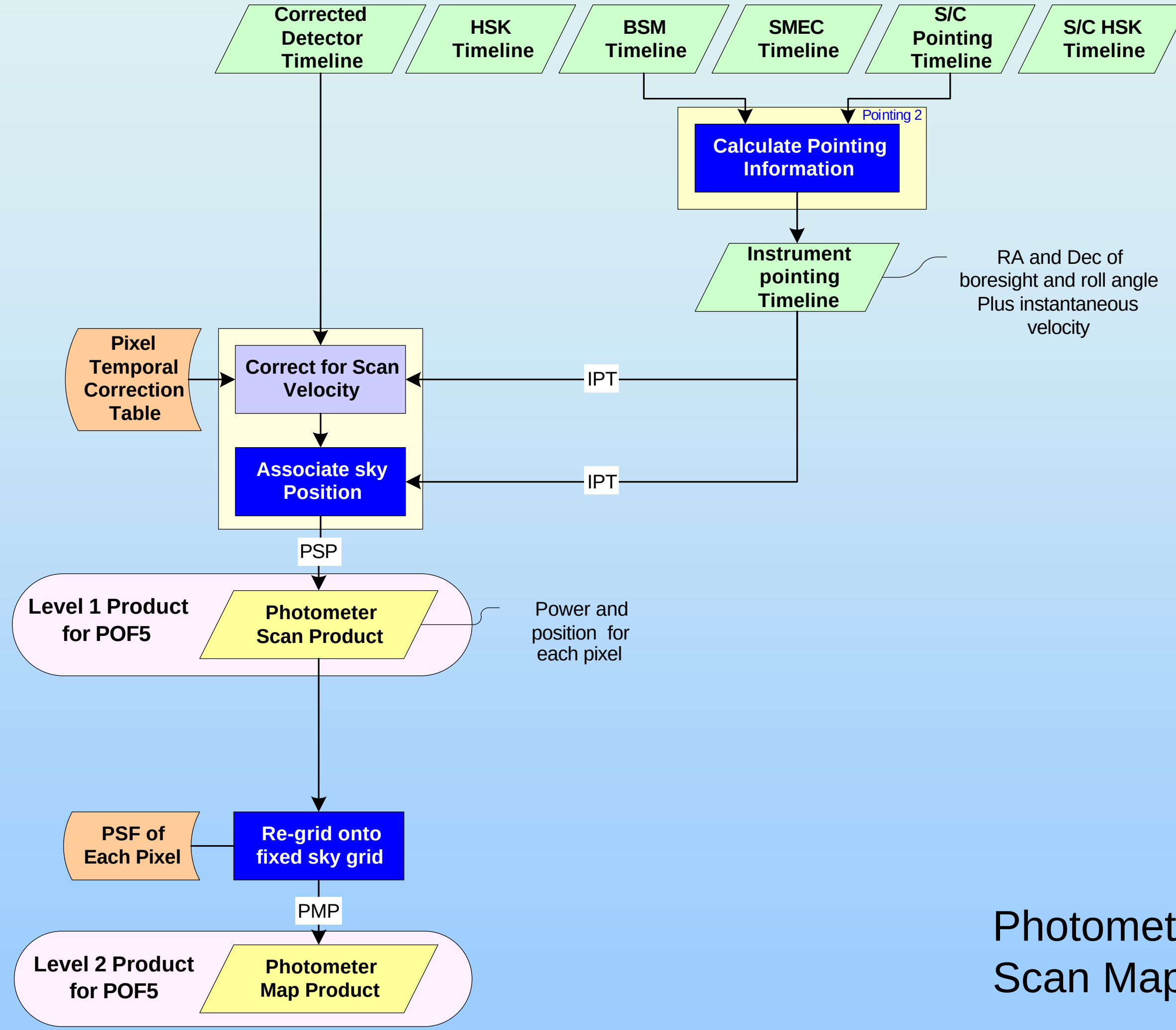

User Request
Database
Request data for
a given time
range
HSK
Frames
Tsync
History
Extract
Tsync
Find the times of all
Tresets and append
to, or update, History
Tsync
History

Generic Steps

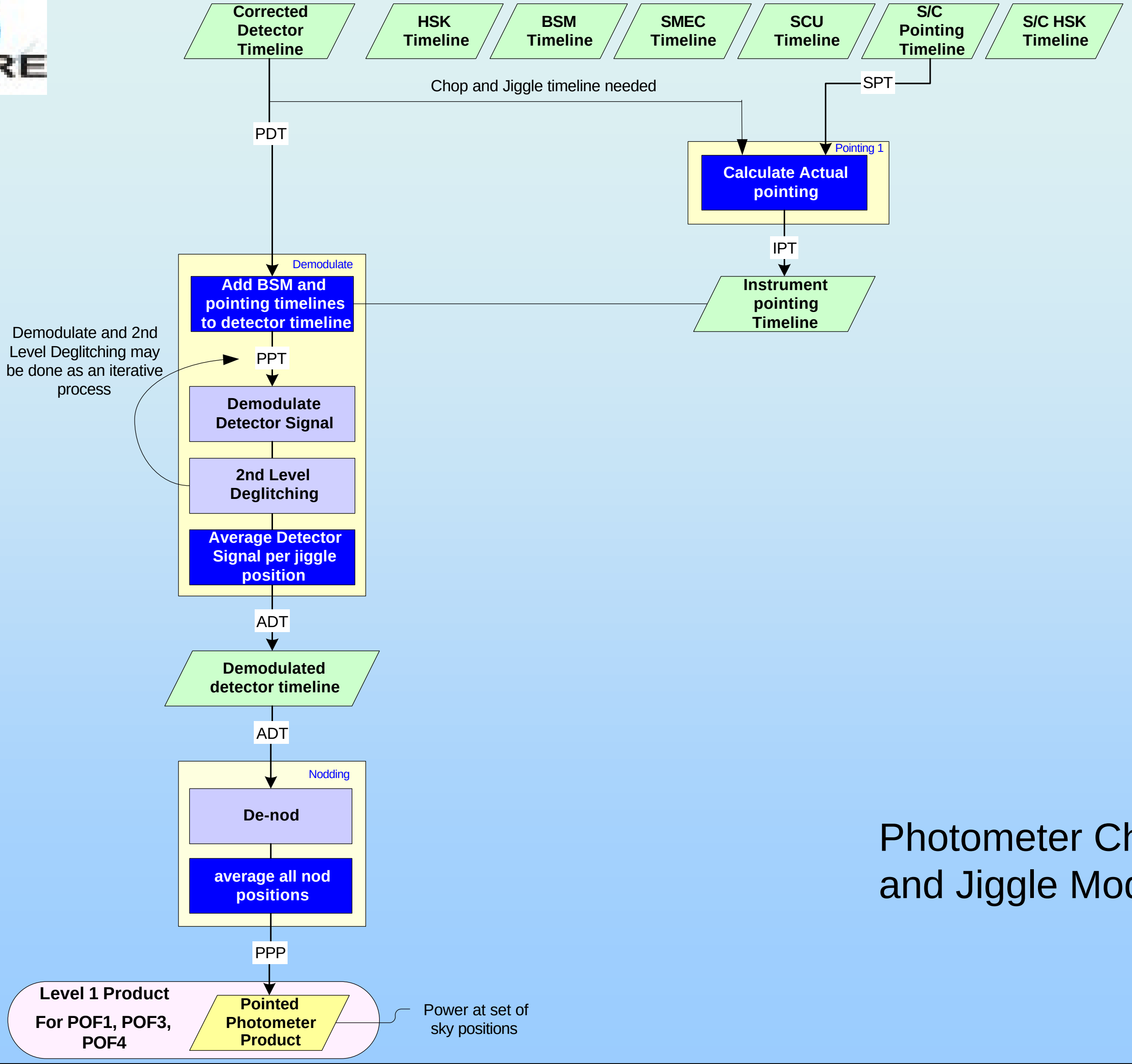


Generic Steps



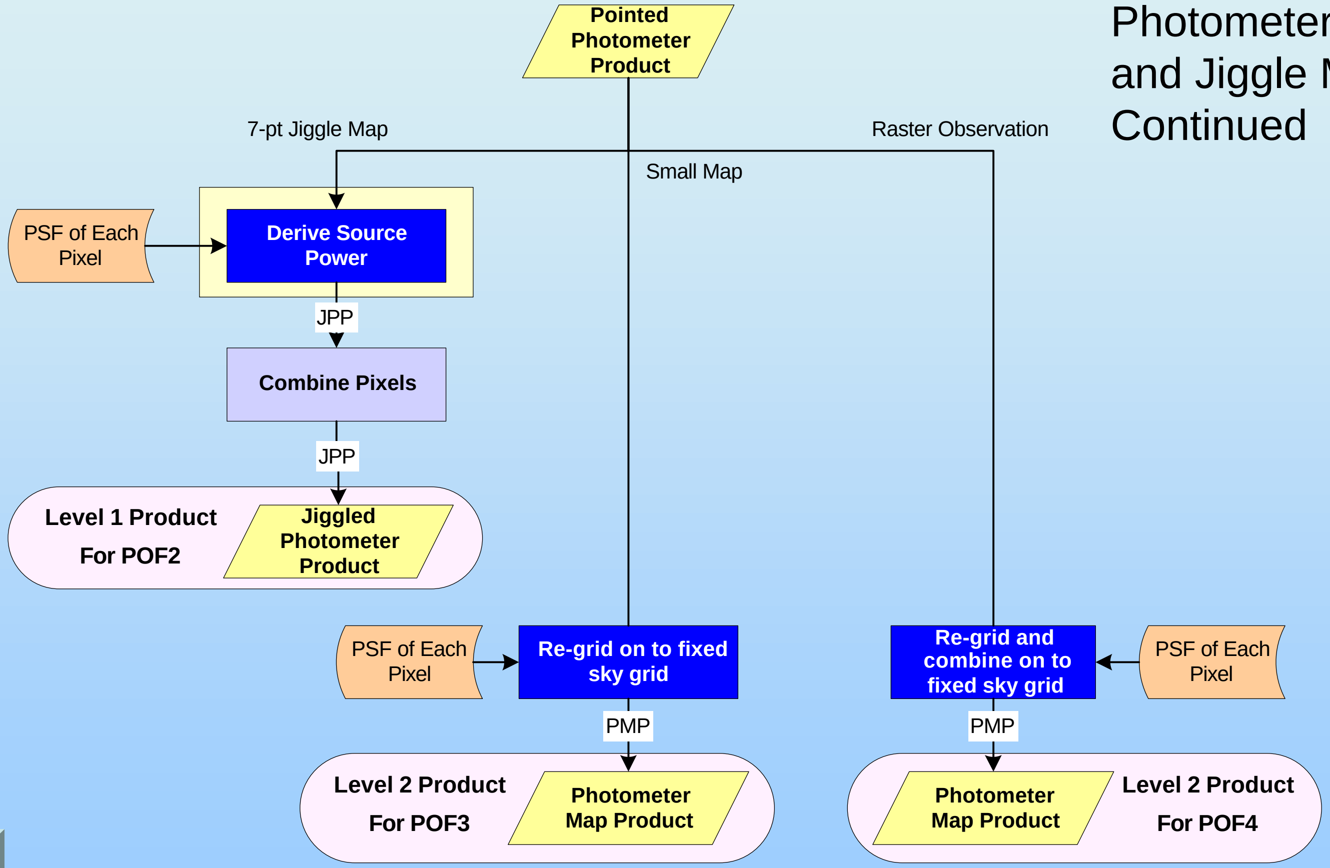


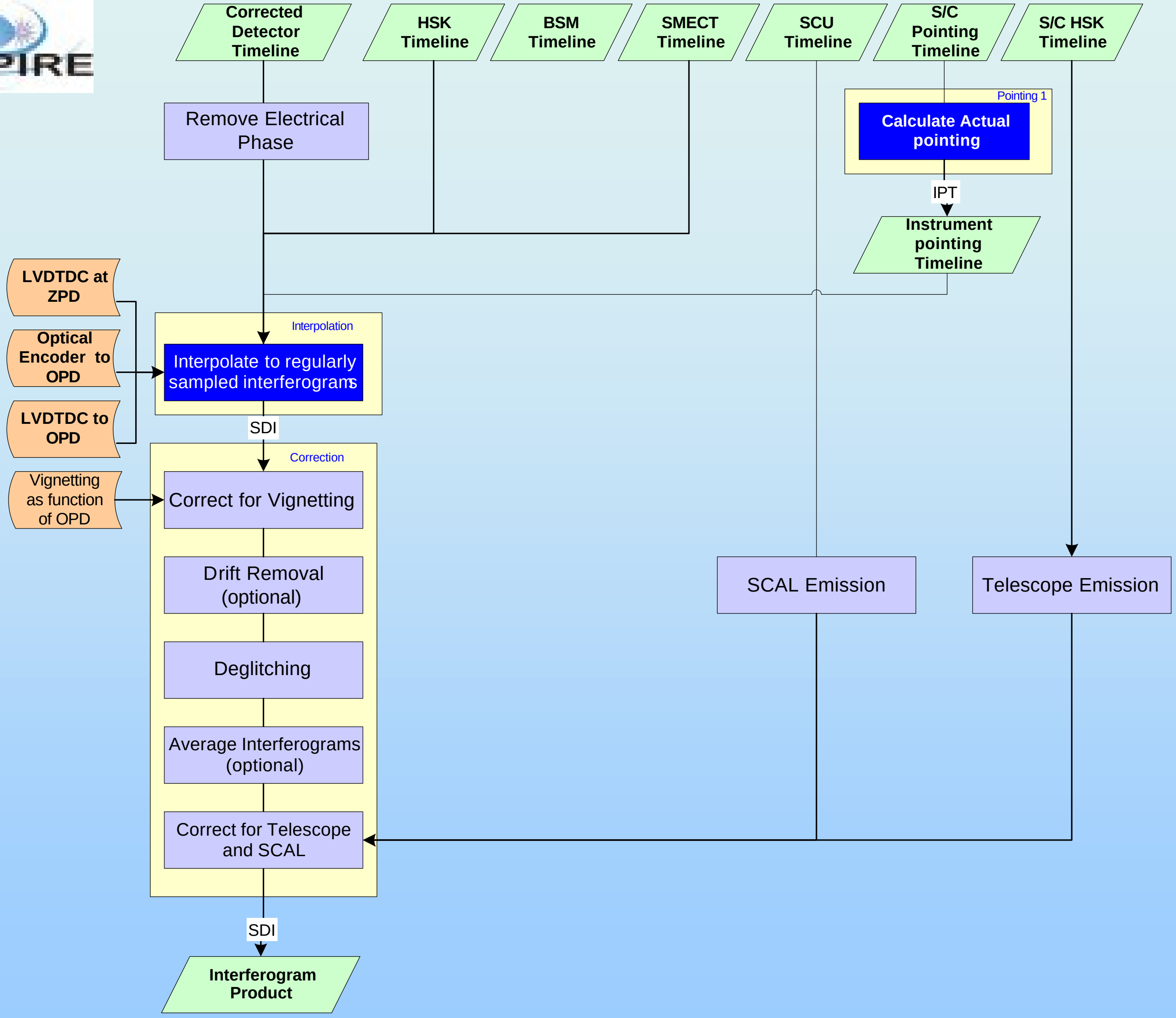
Photometer Scan Mapping

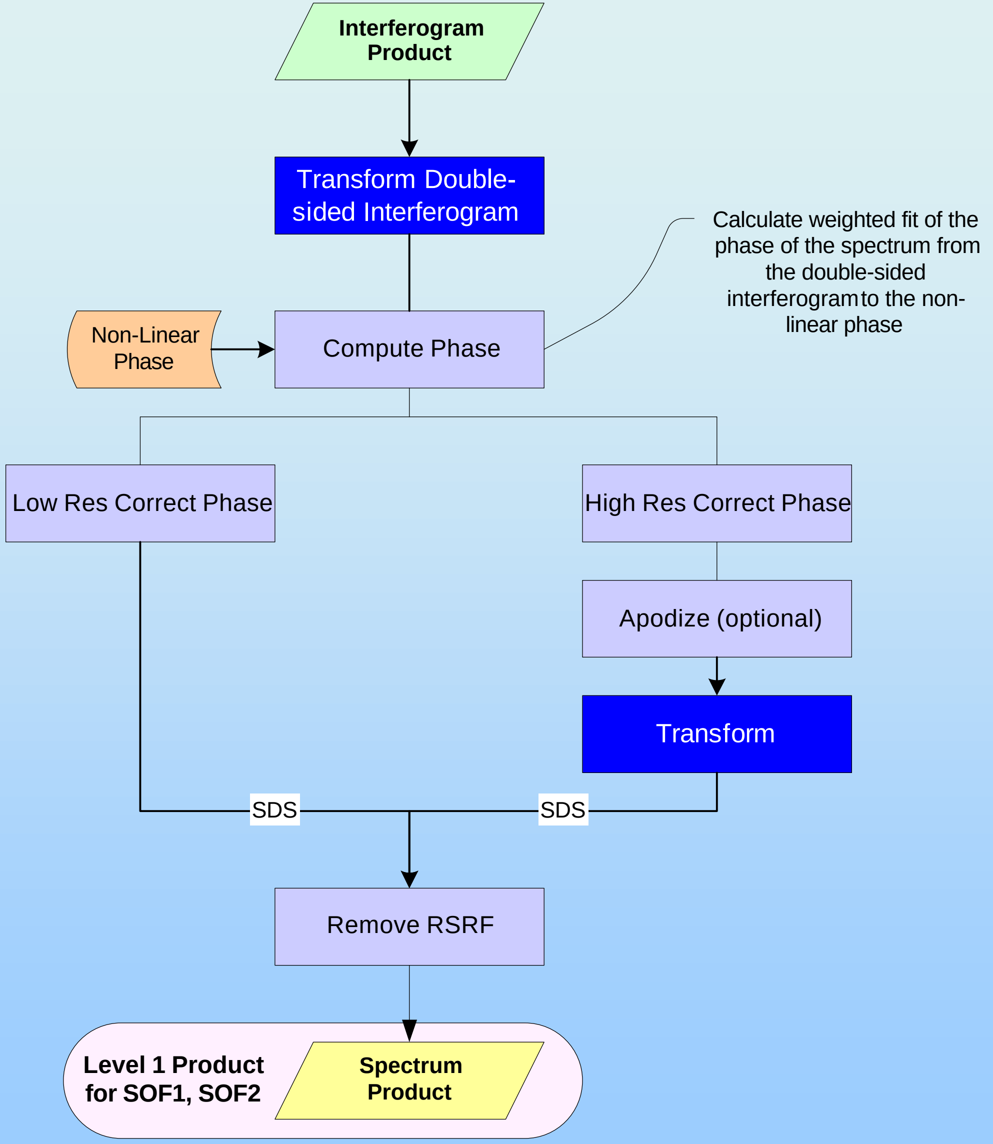


Photometer Chop and Jiggle Modes

Photometer Chop and Jiggle Modes Continued




Corrected Detector Timeline
HSK Timeline
BSM Timeline
SMECT Timeline
SCU Timeline
S/C Pointing Timeline
S/C HSK Timeline
Remove Electrical Phase
Pointing 1
Calculate Actual pointing
IPT
Instrument pointing Timeline
LVDTDC at ZPD
Optical Encoder to OPD
LVDTDC to OPD
Interpolation
Interpolate to regularly sampled interferograms
SDI
Correction
Vignetting as function of OPD
Correct for Vignetting
Drift Removal (optional)
Deglitching
Average Interferograms (optional)
Correct for Telescope and SCAL
SCAL Emission
Telescope Emission
SDI
Interferogram Product


Interferogram Product
Transform Double-sided Interferogram
Calculate weighted fit of the phase of the spectrum from the double-sided interferogram to the non-linear phase
Non-Linear Phase
Compute Phase
Low Res Correct Phase
High Res Correct Phase
Apodize (optional)
Transform
SDS
SDS
Remove RSRF
Level 1 Product for SOF1, SOF2
Spectrum Product

Conversion of Detector Output to Volts

$$V_{\mathrm{det}} = \frac{Range.ADU}{\left(2^{16}-1\right).12.Gain_{LIA}.Gain_{JFET}}$$

- The combination of electronic filter, JFET and LIA gain terms may be different for individual pixels and this should be taken into consideration for pipeline development.
- Currently the individual values for the photometer and spectrometer are applied for all detectors in each sub-instrument. These parameters should reside in a separate 'pixel gain table' calibration file.
- It is TBD how this file is structured i.e. whether a single conversion number is stored per channel or whether the separate components are stored individually. It is not yet known whether this table will be time dependent although this is unlikely.

Offset Conversion to Volts

$$V_{off} = \frac{Range.\left(ADU.\frac{2^{19}}{10} - \left(2^{14} - 1\right)\right)}{\left(2^{16} - 1\right).12.Gain_{LIA}.Gain_{JFET}}$$

Correct for RC Rolloff

Initial value of bolometer resistance guessed using circuit as voltage divider then initial gain correction calculated

$$gain_{RC} = \frac{V_{out}}{V_{in}} = \frac{1}{\sqrt{1+\left(wR_{bolo}C\right)^2}}$$

There is another gain term (gain$_{CAP}$) due to a drop in impedance caused by a phase shift T induced in the cable between the bolometers and JFETS. The phase is calculated using

$$\Theta = \tan^{-1}\left(-wR_{total}C\right).\frac{180}{\Pi}$$

The estimated the gain loss is currently calculated empirically i.e. an arbitrary square wave is generated representing the LIA output and a sine wave is also generated with the same frequency but with phase shift T . The two waveforms are then multiplied together and integrated. The gain loss is then given by the difference between the current phase and zero phase difference. For the pipeline this method could be replaced with either the correct mathematical formulation or a gain-phase calibration table.

Correct for RC Rolloff

- The two gain terms $gain_{RC}$ and $gain_{CAP}$ are then multiplied to give a total estimated gain loss.
- Once this gain loss is estimated a new value V'_{bolo} is generated by correcting V_{bolo} with the gain term.
- V'_{bolo} is then fed back into the voltage divider to obtain a new estimate of R_{bolo}.
- This in turn generates new estimates of gain loss.
- Eventually this iterative process converges.
- For the pipeline it may be sufficient to only go through this process once however this is still under investigation.

Calculate Temperature and Conductance

This is theory dependant but for these detectors the following is adopted:

Once R is known the temperature T can be calculated from

$$R = R_0 \exp\left(\frac{\Delta}{T}\right)^{\frac{1}{2}}$$

where R0 and ? will be parameters per bolometer taken from a calibration file.
The conductance GT is then calculated from

$$G_T = G_0\left(\frac{T}{T_0}\right)^{b}$$

with G0, T0 and ß being supplied from a calibration file

Pointing Calculation

- This is done by calculating the pixel offset to the telescope and is based in instrument coordinates
  1. Start with the pixel offset table which will be defined as angular offsets in instrument coordinates
  2. If the scan map uses chopping, the chop and jiggle positions are used to calculate the angular offset in instrument coordinates of the BSM from the BSM home position.
  3. These are then added to the offsets for each pixel.
  4. The offset of the BSM home from the SPIRE boresight then needs to be added in.
  5. This angular offset of each pixel in instrument coordinates is now referred to the SPIRE boresight.
  6. The offset beween the SPIRE boresight and the telescope boresight is also known in instrument coordinates and this offset is then applied to each pixel.
  7. What we now have is an offset in instrument coordinates of each pixel from the telescope boresight.
  8. This can then be translated into sky coordinates using the spacecraft roll angle.

Pointing Calculation – Other considerations

- We should consider that the pixel offsets from the boresight assume a stationary telescope.
- The fact that not all pixels are read out at the same time means that the time difference between readouts should also be folded in to the pointing correction. I'm assuming for now that this correction is so small we don't need to worry about it.
- Once the position is calculated, this step also needs to calculate the telescope slew velocity, the easiest way to do this is probably to calculate angular distance moved between each step

De-Nodding

- This step is the first pipeline step that cannot work on a single building block of detector data but instead must work on an observation.
- Each averaged pixel output at a nod position will contain the source minus a reference sky/telescope position for that nod position.
- The simplest way of de-nodding is to add the two positions i.e. if A1 B2 B3 A4 are the nodding positions then the signal is given by:

$$Signal = \frac{1}{2}\left(\left(A1 - B3\right) + \left(A4 - B2\right)\right)$$

(*Note For 7-point jiggling only do we only de-nod the central pixel as when we combine pixels the two either side will need to contribute just the demodulated data at one nod position?. For mapping modes I assume we de-nod all pixels.)*

Herschel Archive and Data Access

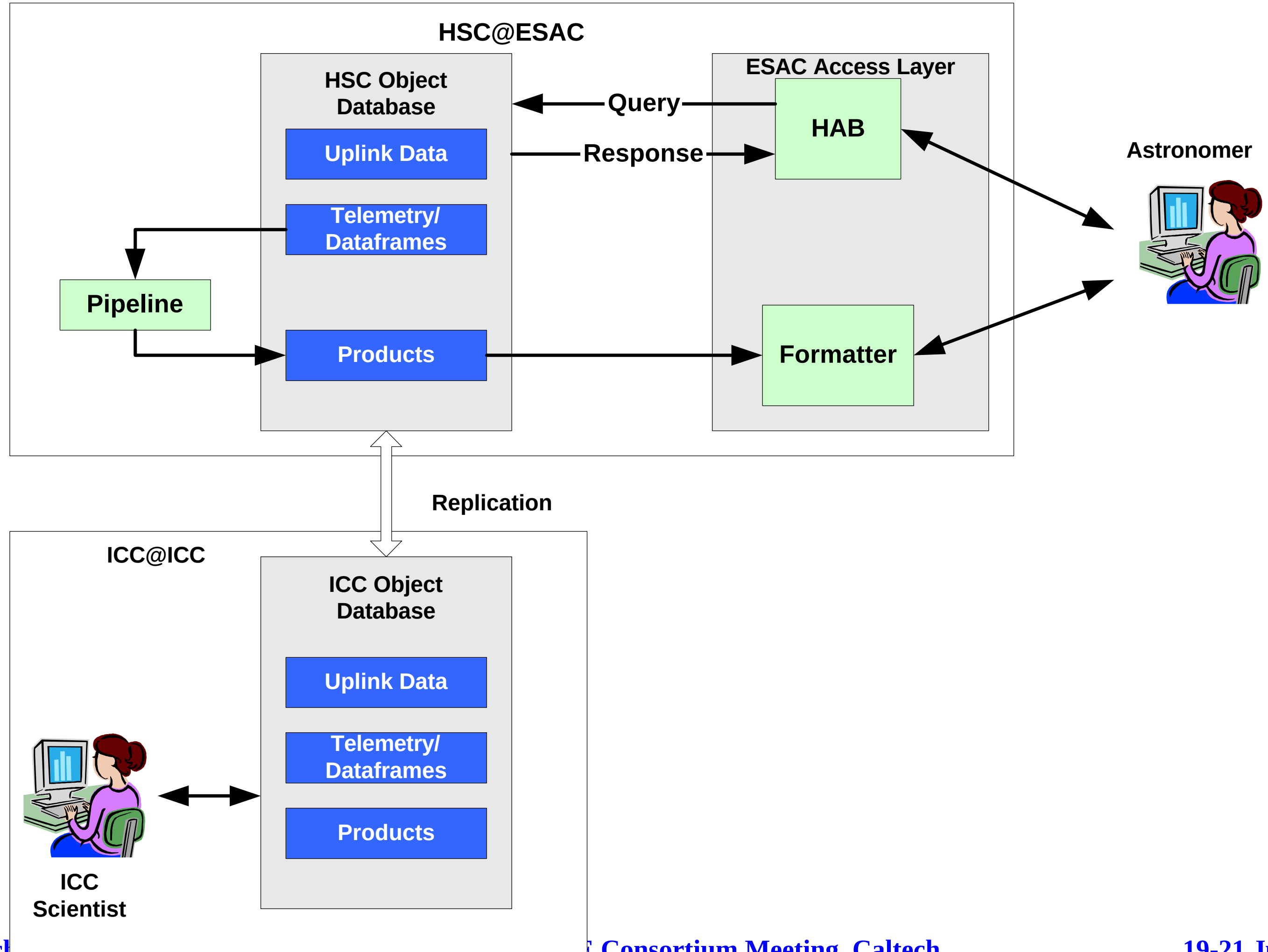
Ken King

Based on (preliminary version of) Herschel Database and Archive RRF Report

(HERSCHEL-HSC-REP-0609)

This is intended as an introduction to likely operation of the Herschel Archive and Database for information and comment

Original Concept



Database Issues

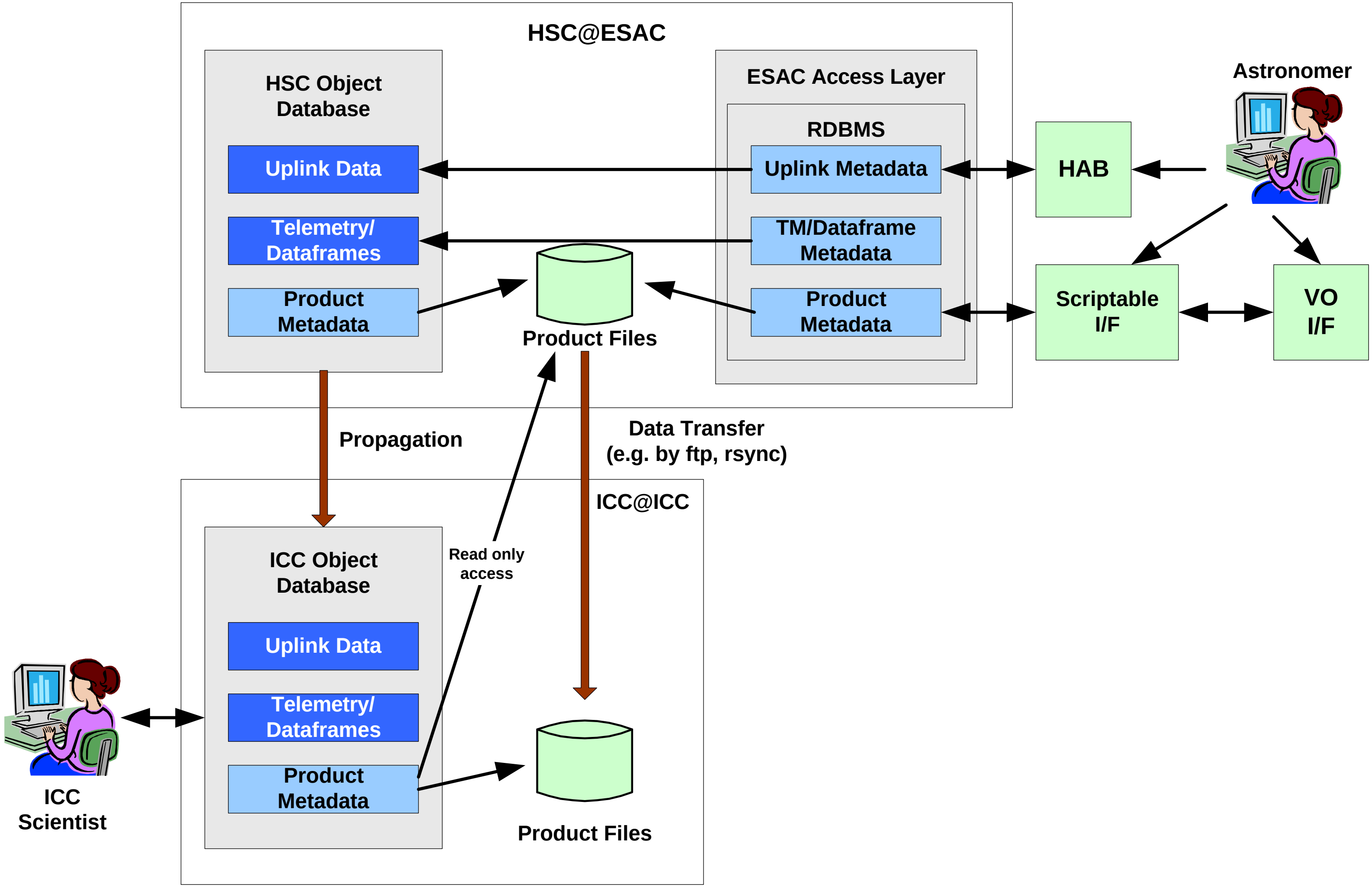
– **Data size**
  - **Total data now estimated to be ~50-70 TB (c.f. 10TB)**
  - **Database System consists of a set of ‘nodes’, which should be limited in size to less than ~250 GB to allow backup in a reasonable time => many servers => high hardware costs, high license costs?**

– **Querying**
  - **Querying performance is not good for non-metadata searches**
  - **Querying capability not adequate – unable to sort query output**
  - **Expected to be solved with new release of Versant in Jan 05 but due to non-ratification of international standard (JDO) this has not been fully addressed.**

Data Replication to ICCs

- Implies only one Herschel DB, accessible to everyone in the HSGS.
- This gives powerful access to the DB internal structure for everyone but makes it possible to bring the operational DB to an inconsistent state
- There will be many simultaneous connections to the database therefore a possibility of someone ‘locking’ part of the database required for operations
- Replication is transparent to data contents – temporary ICC data, test data and other ‘restricted’ information will be replicated to the Herschel system
- Very difficult to restrict access to data - need to protect each object at the individual user level
- Distributed DB requires many open TCP/IP ports which could compromise security
- Requires shared DB administration

Proposed Concept



Features

- HSC Database has restricted access
  - Updates will go through CCB (or other controlled process)
- Data is copied to ICCs database (not replicated)
  - Possible to exclude ‘restricted’ or confidential data being copied
  - Nevertheless ICC personnel will retain to all data necessary for their instrument calibration or health assessment in the ICC database. They also are able to perform ‘unrestricted’ low-level operations and searching on the telemetry data and metadata
- Data products are stored separately from object database (and cached)
  - Can be handled with single server as no need to backup products – cache can be cleared and started again
  - ICC object database is much smaller (<5TB and even smaller if TM and dataframes are store outside the database also). This will reduce cost of ICC implementation
- HSC database protected from astronomers!
  - Access only through three tier interfaces (HAB, VO i/f)

Open Issues

- Pipeline to be run by Observer and ICC scientist
  - ICC members may use the DB for access to calibration/data products and for storage.
  - Observers can only use file system .
  - It may be possible to write the pipeline framework to make this transparent
- ICC has to handle Access rights to proprietary data
  - Only ICC members will have be able to use ICC database
  - Consortium will get data through ESAC
  - Is this acceptable? Need to define ICC ‘role’ for consortium members working on Performance verification
- Consortium scientists do not have access to data other than products.
  - Do Key Programme observers require lower level access?