- Planck extremely brief presentation
- Extended emission in general
- HEALPix pixelization scheme
- All-sky extended emission viewer (PISTOU)
- Planck needs related to VO

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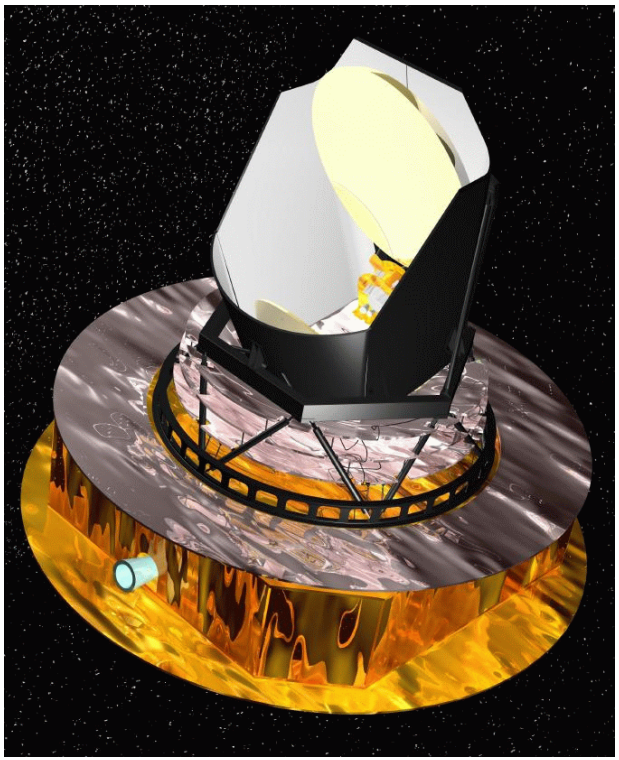
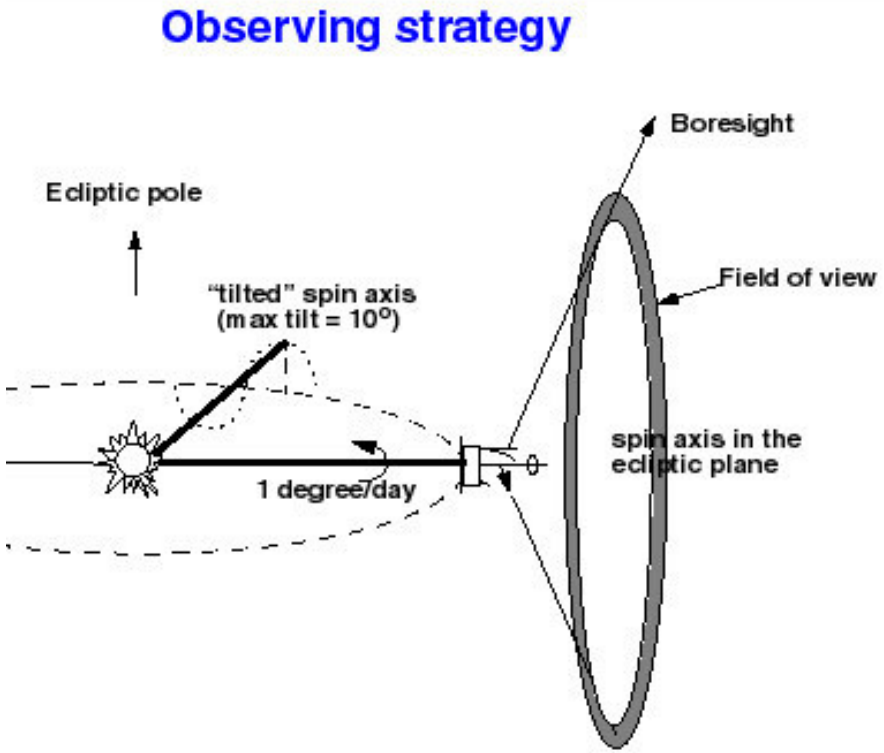
Planck

- Spinning satellite at L2 point: will observe all sky along big circles on the sky (1rpm)
- 9 freq. Channels, resolution 5-30’





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Visualization Tools

- Projection of any dataset onto any other, towards any direction of the sky
- Reading accurate sky brightness values (e.g Mjy/sr, brightness temperatures, …) @ each pix.
- Reading sky coordinates @ each pix.
- Contour overlays
- Point sources overlays
- Coordinate grids overlays
- Color Tables + color stretching (min,max,lin/log, equalization, …)
- Compare different extended emission data-sets

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Basic Data processing

- Estimate noise properties
- Integrate or average with error propagation
- Extract (1D) signal (e.g. along cuts, according to distance to a given point, coordinates, within contours of another image, …)
- Fit 1D profiles (Spectral fits, Gaussian fits, power-law fits, …)
- Compute power-spectra in specific regions (FFT, Ylm, …)
- Structure detection (Point-sources, wavelets, edges enhancement,
- Identify/mask given regions of the image (e.g. Point-sources, defects, …)
- Compare different data-sets / handle data-cubes (e.g. color maps, difference maps, excess maps, …)
- Map convolution/smoothing (enhance low contrast regions, bring effective resolution to that of another dataset, …)

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Specific requirements

- Re-projection of the data (e.g. comparison of different data-sets)
- Preserve photometric accuracy in the above
- Use of Regions-Of-Interest (ROI) in which data processing is performed
- (Often) process large amounts of data (large CCD formats, all-sky analysis, …)
- (Often) handle undefined values and/or take individual pixel errors into account

FITS beauty and limitations

- FITS=Flexible Image Transport System
  images are associated to a fits header describing image size (naxis), projection type (ctype, equinox), astrometry of each pixel (crpix,crval,cdelt,crot,) and sometimes other useful information (bunits, origin, telescop, …)
- Using these parameters allows to compute sky-coordinates transformation (pixel <-> sky coordinates), which is the basis to any visualization and data processing activity.
- There are many projection types possible (CAR, TAN, SIN, MOL, SCS, …) to represent a single object, the celestial sphere
- Various data-sets are generally provided in different projection types (e.g. IRAS, Vis.: TAN, COBE: CSC, molecular: CAR)
- Comparing different data-sets therefore requires re-projection and re-griding of the data, which
  - is (very) time consuming
  - can affect data accuracy (photometry), if not done properly.
- FITS representation is not well adapted to handling all-sky data
  Finding neighbor pixels in a fits image is generally a pain.

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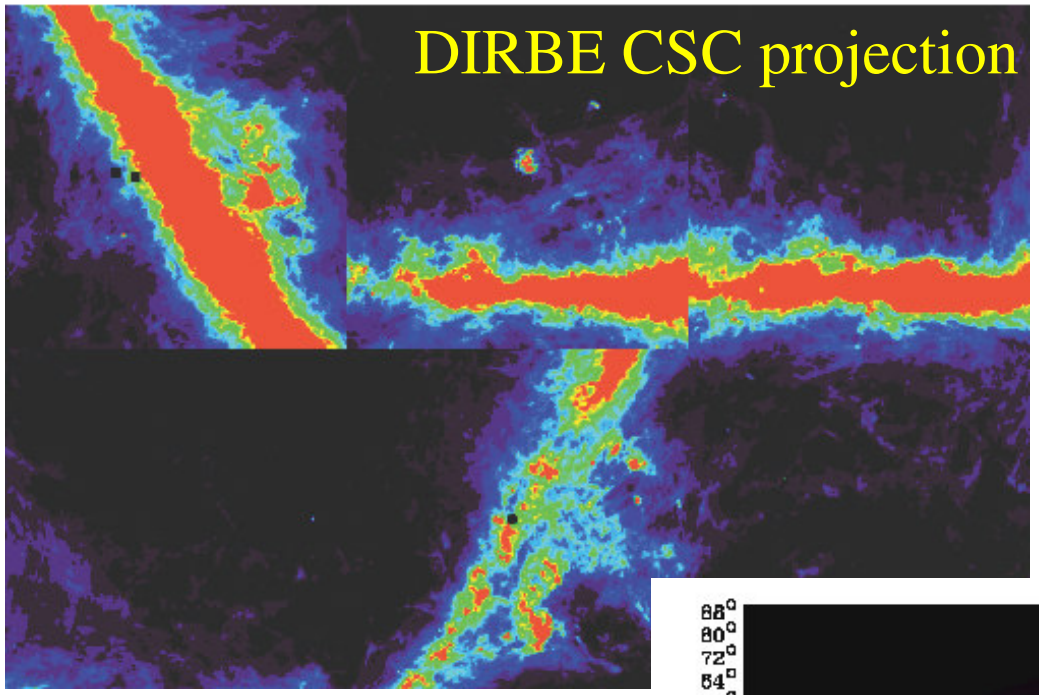
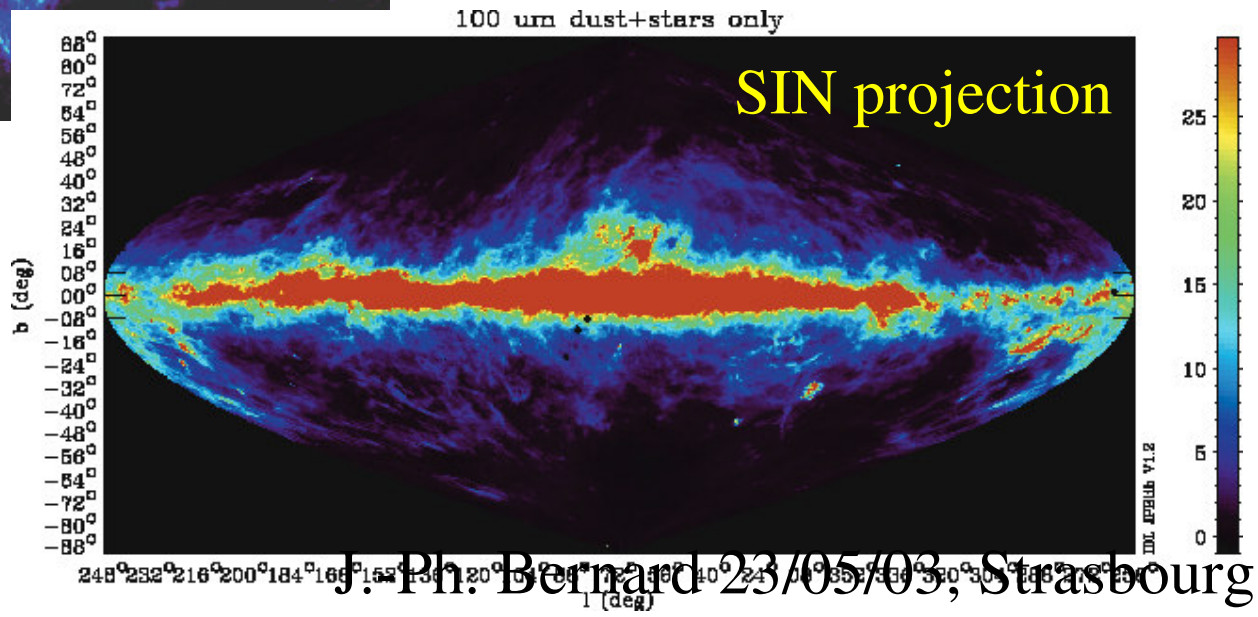
Example



DIRBE 100 μm



HEALPix

- HEALPix=Hierarchical Equal Area iso Latitude Pixelisation (http://www.eso.org/science/HEALPix/)
- Allows fast harmonics calculations (Cl for CMB cosmology)
- Well adapted to handling all-sky data
- Adopted as a standard for WMAP, Planck, and probably others to come
- Sphere is devided into 12 square equal area zones (Nside=1), then divided in 4 (Npix=12*Nside^2)
- Data values stored into a fits table. Header only gives Nside, coordsys (GAL, ECL, EQU)
- Fast calculation of pixel <-> sky-coordinates(θ,φ) through Fortran (and C ?), IDL Library.
- Includes neighbor pixels identifications (calculated or stored)
- Now in 64 bits -> allow to store large files and high angular resolution
- Partial HEALPix is possible at the cost of increasing the file size by a factor <2 (store pixel numbers as well as data values)
- When necessary, healpix data can be re-projected to standard FITS local projection (e.g. to produce standard FITS files, figures, …)
  Fast tools (healp2fits, fits2healp) is being developed within Planck HFI DPC to and from the most common FITS projections (TAN, MOL, CAR, CSC, ZEA)

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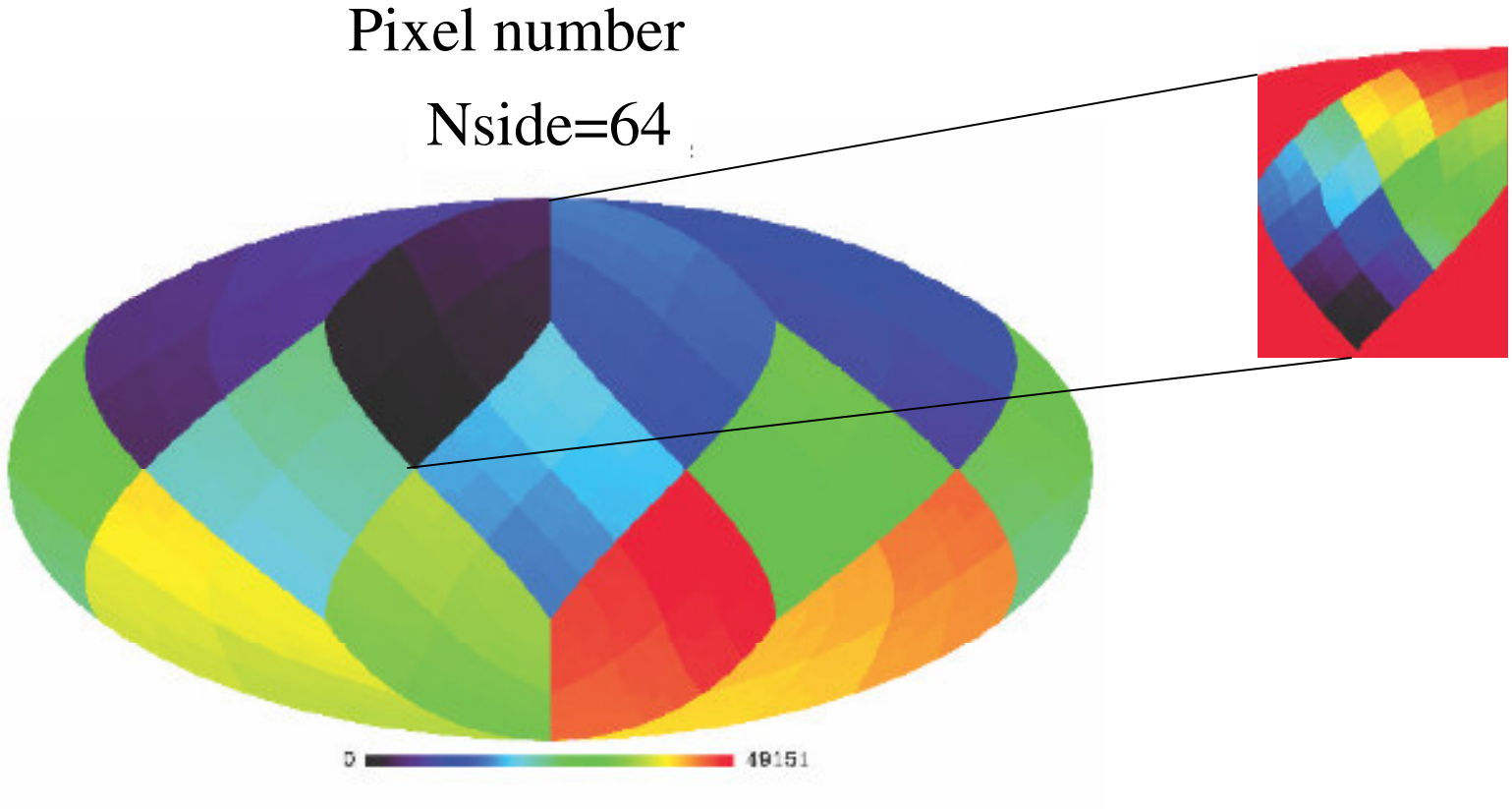
Example



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Ingesting Ancillary data

- HEALPix=Hierarchical Equal Area iso Latitude Pixelisation (http://www.eso.org/science/HEALPix/)
- Ancillary data necessary to planck data analysis will have to be transformed to the HEALPix scheme.
  - NANTEN (CO survey from Nagoya, Japan)
  - Av maps (L. Cambresy, K. Dobashi)
  - HI from Dwingeloo + Argentina, HI GPS (CGPS, …)
  - IR data (IRAS, DIRBE, FIRAS, DMR)
  - Some Herschel Data ?
  - Some SIRTF data ?

- A preliminary IDL program has been written which allows to convert a set of fits files (any projection type) to HEALPix, allowing
  - on the fly convolution of the original data
  - “real time” addition of new data.
  - uses the optimized code developed within DPC.

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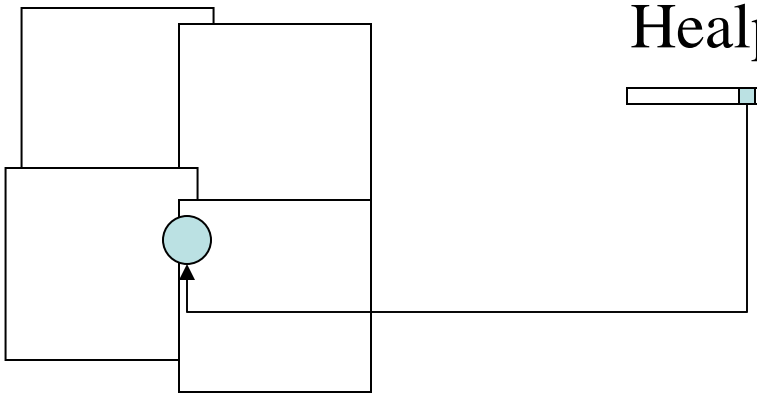
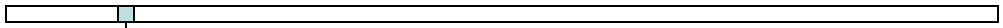
Example

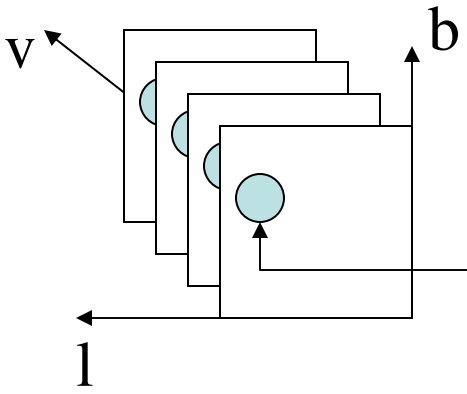
Fits mosaic



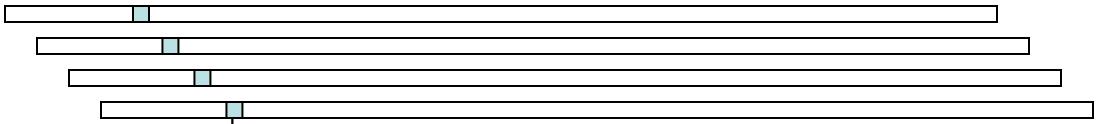
Healpix Fits file



Fits cube



Collection of Healpix Fits files



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PISToU

- PISToU=Planck Interactive Software TOols and Utility
- Basic Idea: Take advantage of hardware in video cards to perform the projection of the sky (Sphere) onto computer screen (Plane).
- Accuracy is not an issue to human eye (as long as precise coordinates can be read), but speed is (same as for video games)
- PISToU is coded in C++ and QT, allowing to use OpenGL functionalities
- PISToU is developed through a contract with Noveltis in Toulouse, under the supervision of HFI DPC.
- It will serve as the main real-time assessment tool for Planck-HFI 2D data, and will be made available (free) to the Planck (and maybe more) community. License type under discussion.
- A similar tool for 1D data (QLA) is under development. Also based on C++/QT allowing future merging/interaction.

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PISToU Functionalities

- PISToU allows visualization of Healpix fits files trough a view of the sphere from the outside (longitude axis inverted to conform with Astronomer convention)
- Sphere can be moved/zoomed interactively. Zooming uses multi-scale capabilities of Healpix.
- When fully zoomed, the view is “equivalent” to a TAN projection on the screen
- Allows PS location/property (from input catalogs), contours, Grid overlays
- Representation of vector fields (polarization)
- Representation of several data-sets simultaneously, in slave windows or multi-layers
- Definition of complex Regions Of Interest (ROI) equivalent to IDL “where” function
- Various processing applied to ROIs through module plug-ins (also used in pipe-line and QLA) with I/O defined through XML description
- Jpeg, Gif, postcript outputs

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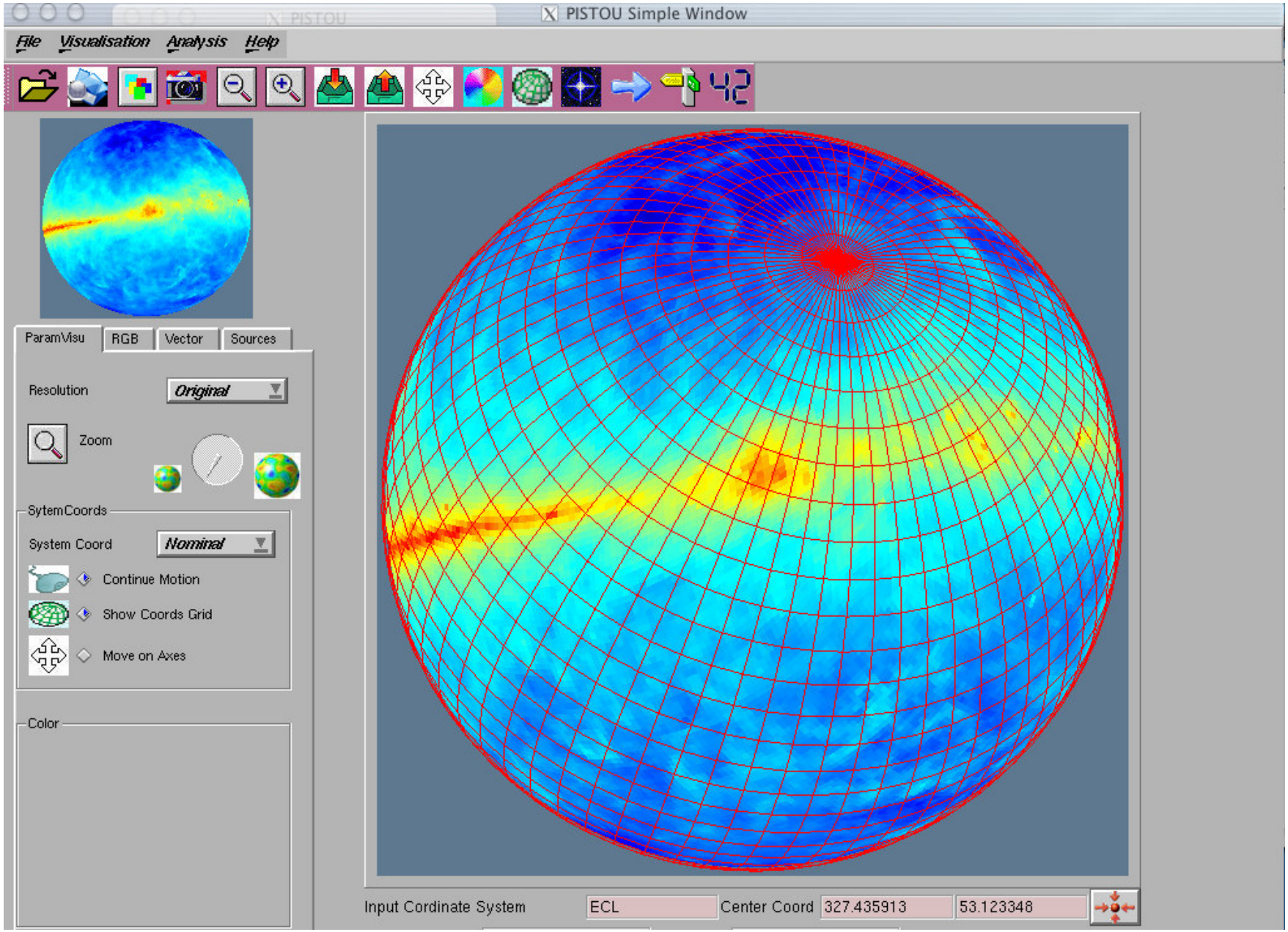

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VO / Planck (suggestions only)

- What VO could bring to Planck

(assuming VO can accommodate HEALPix)

- Help ingest ancillary data into HEALPix
- Store/Retrieve Ancillary data in HEALPix format
- Allow on-line visualization/analysis and distribution of Planck data
- Use of intensive GRID calculations for analysis purposes

- What Planck could bring to VO
- Concept/Help for developing an all-sky visualization and analysis tool for extended emission
- Specific analysis plugins developed within DPC

Question: When will all-sky arc-second data be possible to handle, given constant increase in computer performances ?

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