Another way to explore the sky: HEALPix usage in Aladin full sky mode
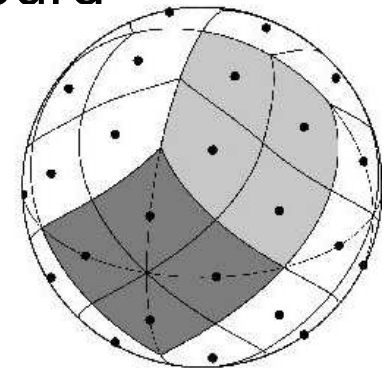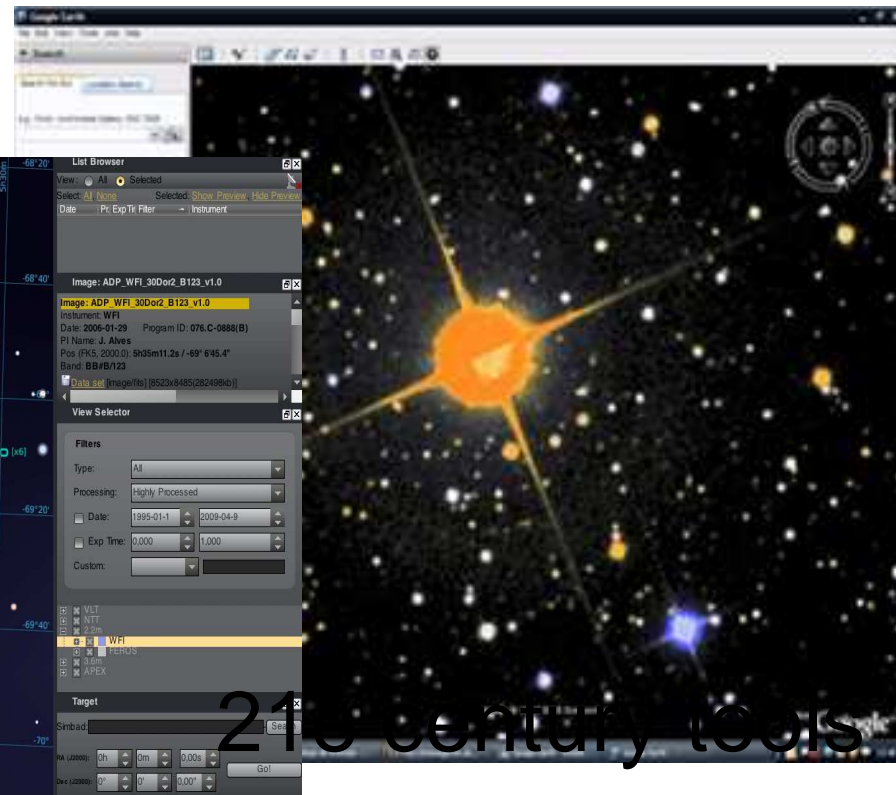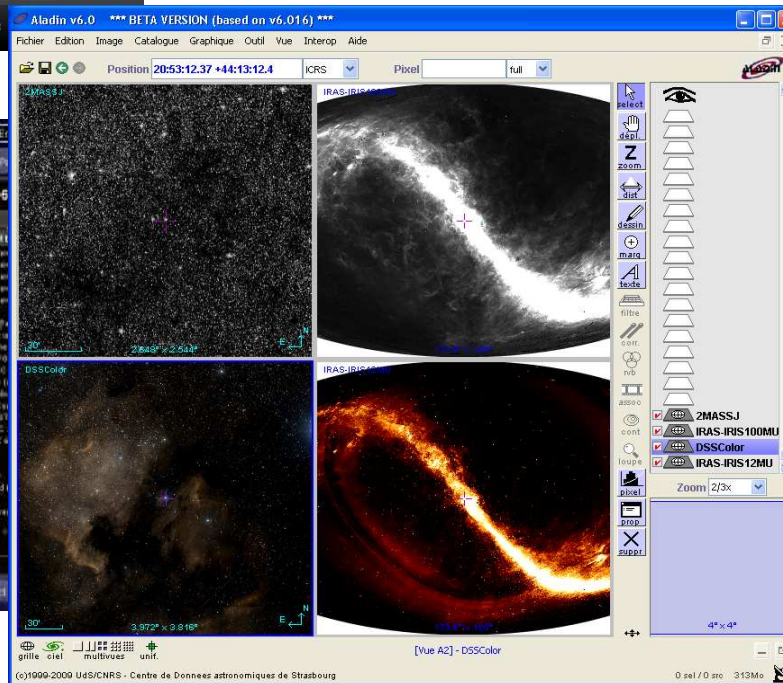
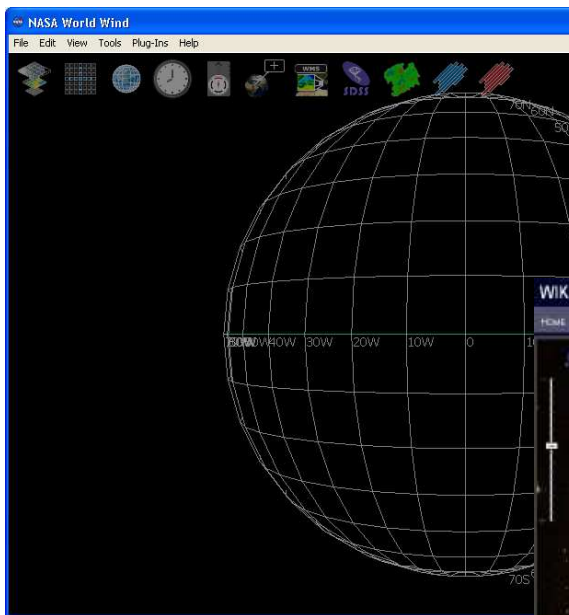Pierre Fernique, Thomas Boch,
Anaïs Oberto, François Bonnarel

Centre de Données astronomiques de Strasbourg

21th century tools

P.Fernique – T.Boch – A.Oberto – F.Bonnarel – ADASS 2009/Sapporo

Browsing the sky...

2001   Virtual Sky   http://www.virtualsky.org

2006   Wikisky/sky-map http://sky-map.org

2006   World wind http://worldwind.arc.nasa.gov

2007   Google sky http://earth.google.com

2008   WWT   http://www.worldwidetelescope.org

2008   VIRGO http://archive.eso.org

2009   Aladin http://aladin.u-strasbg.fr

=> *21st century tools*

The 4 main issues

1) The size of data (server-side, via internet, client-side)

2) The client display performances

3) The data base structure (storage and retrieval)

4) The sky projection/distorsion

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1) Data size...

- DSS2: 1 arcsec/pixel resolution survey
  - => 500 billions pixels => 1 TB in 16 bits/pixel

    => 70 GB in JPEG

- Resampling whole DSS2 takes now 2 months of elapsed time for computation on a basic machine

- A few MB in a few seconds via internet

« *Traditional* » surveys seem *not so big today* !

2) Client display performances...

- Current graphics cards require ~1ms for projecting 1million pixels (bilinear method)

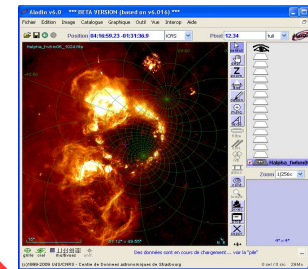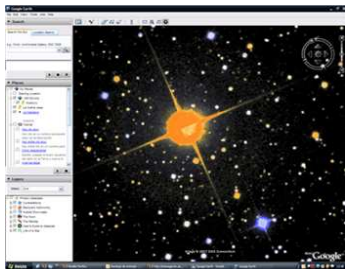=> 20 ms for redrawing an all sky view
with one thousand (64x64) mosaic images
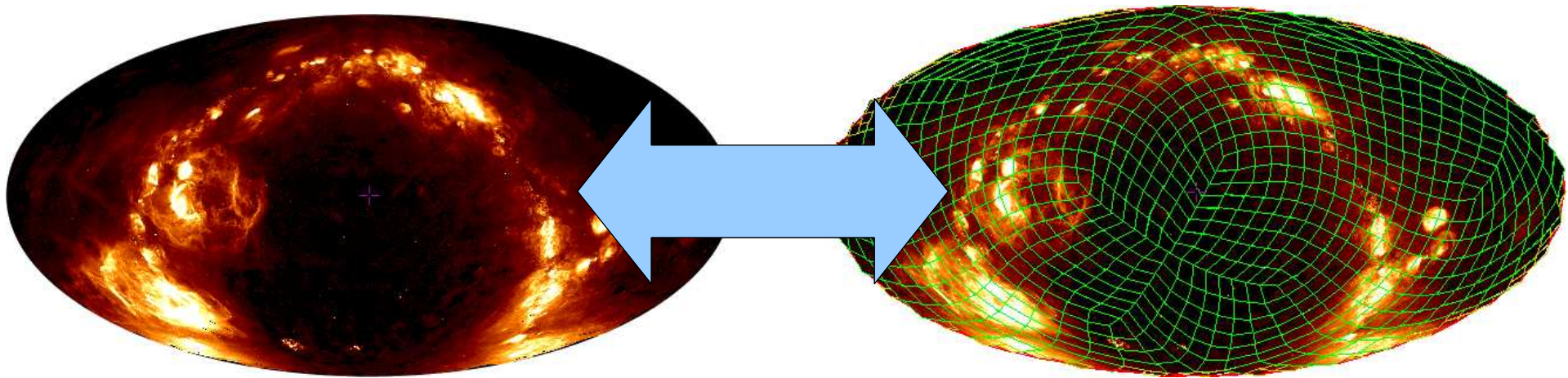
=>*You can* **drag&drop the sky** *with the mouse*
=> Thanks to computer games

3 & 4) How to « divide » the sky ?

- Server database => get a good spatial index

- Client => get an efficient display (poles ?, pixel value ?...)
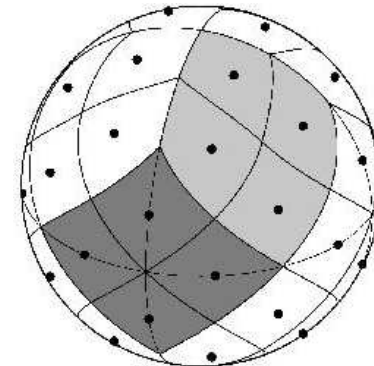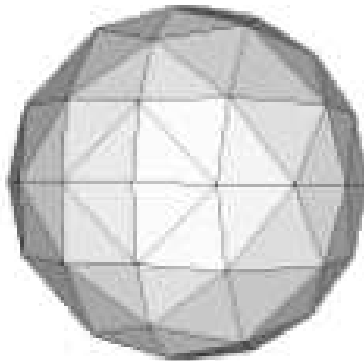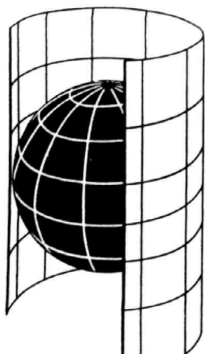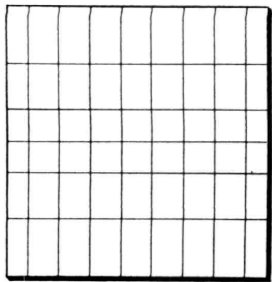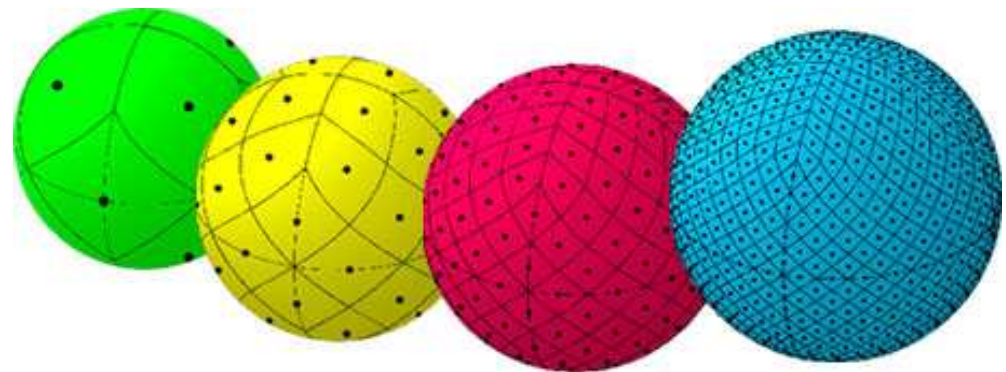

Aladin choice

Our goal

Offer an All sky mode providing the same functionalities that the classical « image » mode (catalog overlays, survey comparison, all projections, constrast adjustement, pixel manipulation, local data...)

Halpha all sky

IRAS-IRIS 100 all sky

HEALPix

- Sky splitted in 12 diamonds divided in 4 sub-diamonds recursively

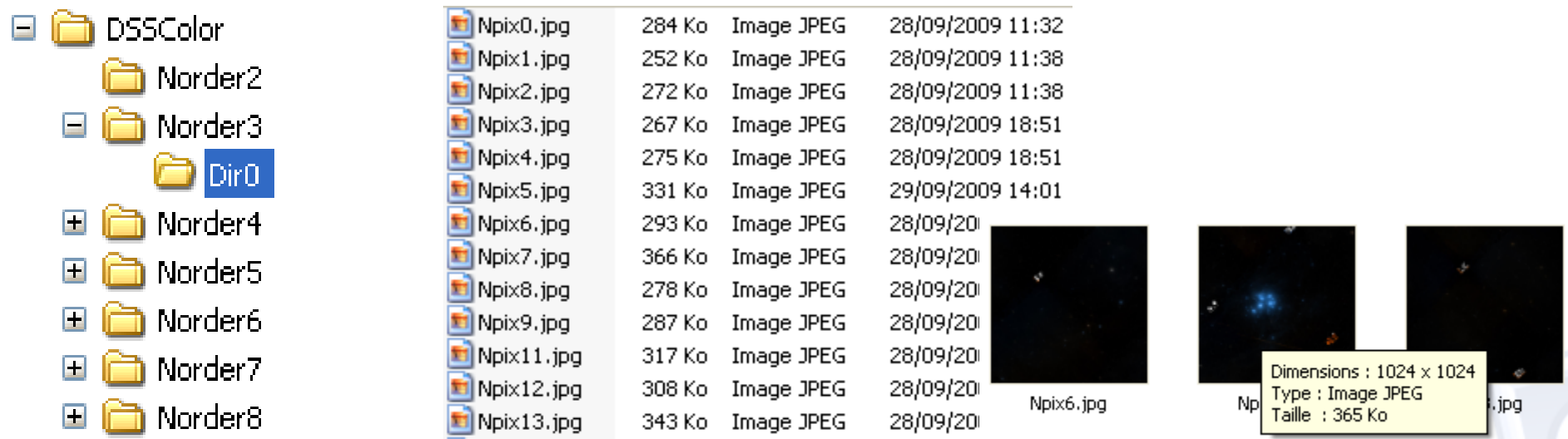| Norder	pixels	16bits	JPEG	Pix res	Missions
0	12	24B		58,63°	
1	48	96B		29,32°	
:	:	:		:	
6	49152	96KB	6KB	54,97'	COBE
:	:	:		:	
8	786432	1,5MB	100KB	13,74'	WMAP
9	3145728	6MB	400KB	6,87'	PLANCK
:	:	:		:	
12	201326592	384MB	25MB	51,53"	IRAS, ROSAT
:	:	:		:	
18	8,25E+011	1,5TB	100GB	0,255"	DSS, 2MASS, SDSS
:	:	:		:	
29	3,46E+018	6HB	410PB	124mas	*Healpix 64 bits limit*

Why did Aladin choose HEALpix ?

- Regular hierachical sky division (easy server implementation – no pole problem)

- Pixel equal area => fast pixel algorithms

- Immediate conversion (pixel number to coordinates) with no recursion => constant time

```
double[] pix2ang(long nside, long ipix)
```

- FITS format for recording HEALPix allsky map => direct usage for current mission data such as Planck

- HEALPIX libraries in FORTRAN, C, C++, IDL, Java (in our case N. Kuropatkin code)
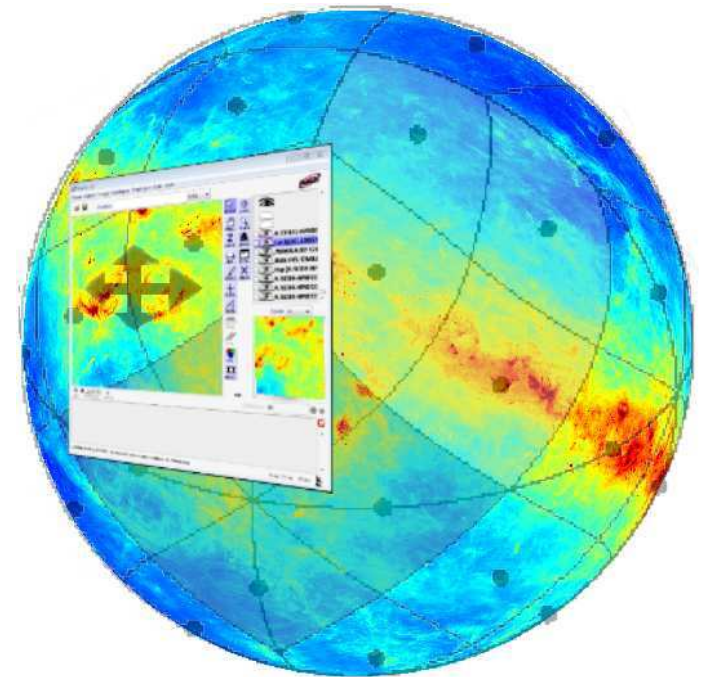
On server side...

- Actually no data base, just directories and files (1024x1024 square « tiles » in FITS or JPEG => 786432 files for DSS/order18, 768 files for IRIS/order3)

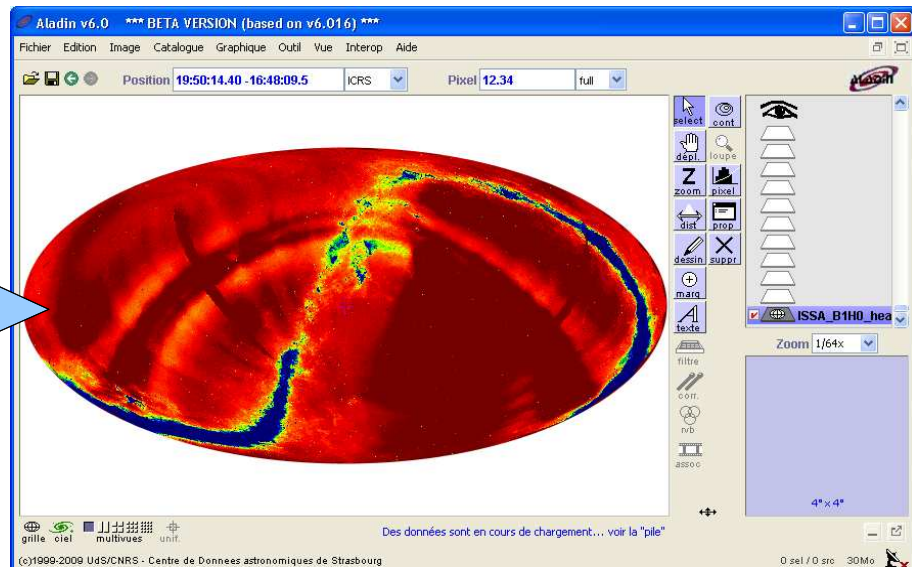- From a HTTP server or directly on the client machine
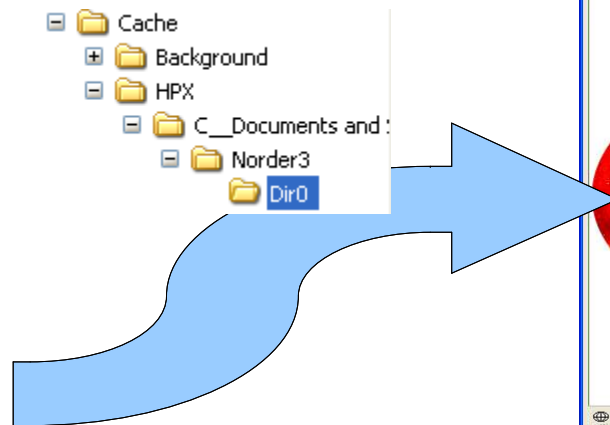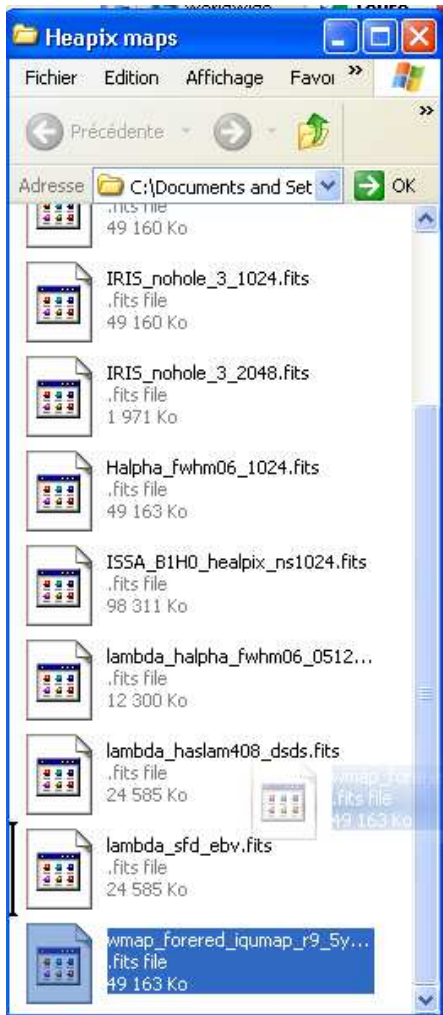
- Full and compressed pixels supported

On client side...

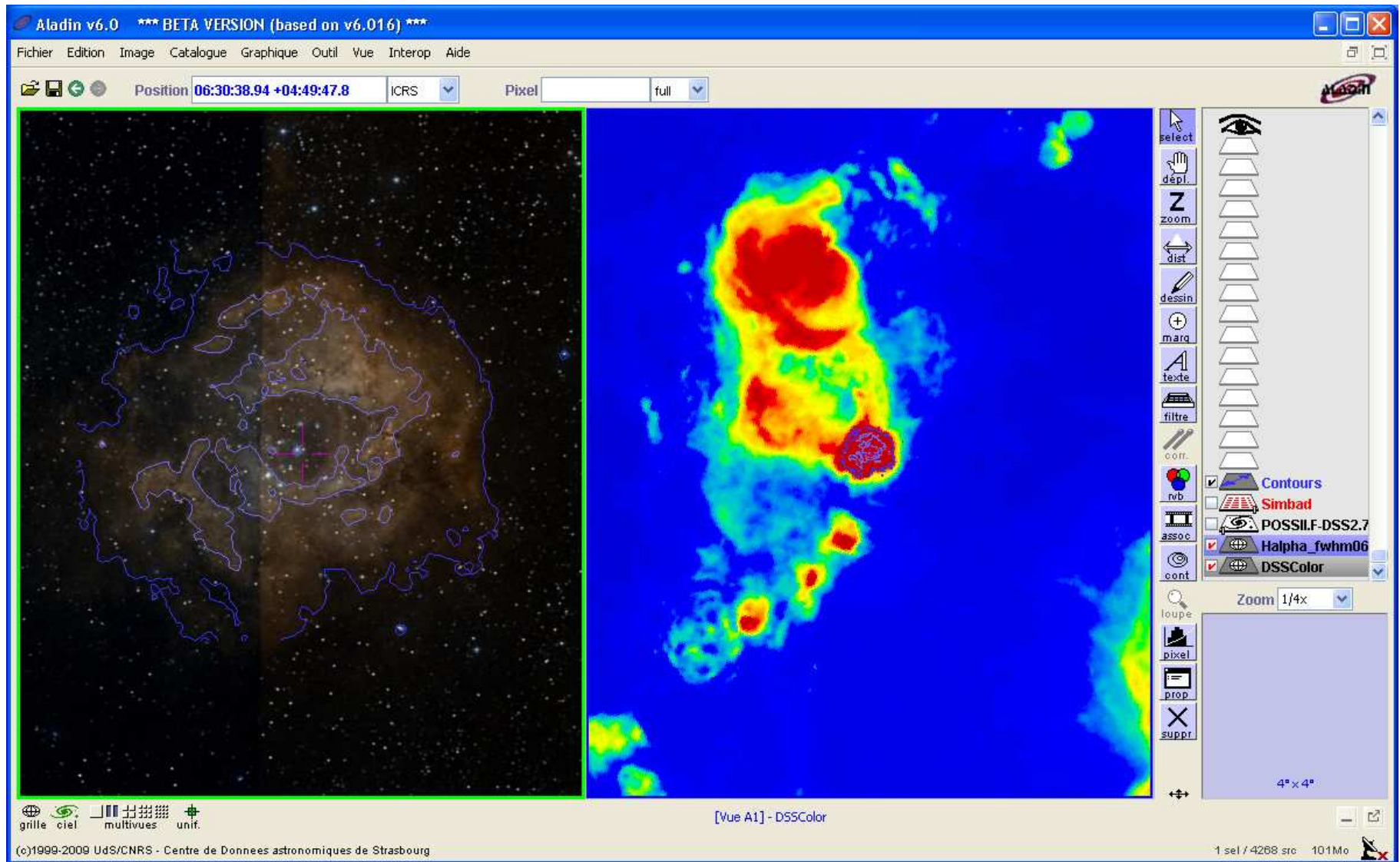

- Retrieving Healpix diamonds corresponding to the current user view and resolution

  - Immediate Healpix computation for determining which healpix pixels are in a sky region for a given depth order,

  - Filepath/url immediately built from survey/order/pixelNumber triplet => no «localisation» query required)

- Drawing each diamond for fully covering the 4 projected polygon corners (according to the user-defined projection – Sinus, Tangential, Arc, Aitoff, ZET, Stereographic, Cartesian...)

Local full sky file feature

- HEALPix FITS map file automatically recognized by Aladin

- Directory tree (= virtual « Data base ») built locally at first loading and kept for next usage
  => ex : WMAP - 50MB process in 12s

2 mn demo...

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