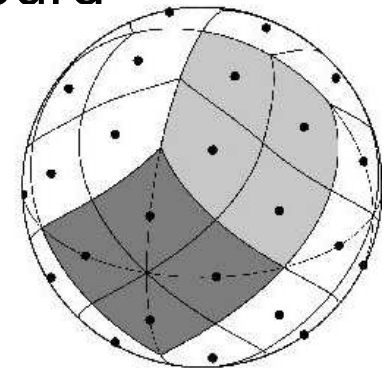


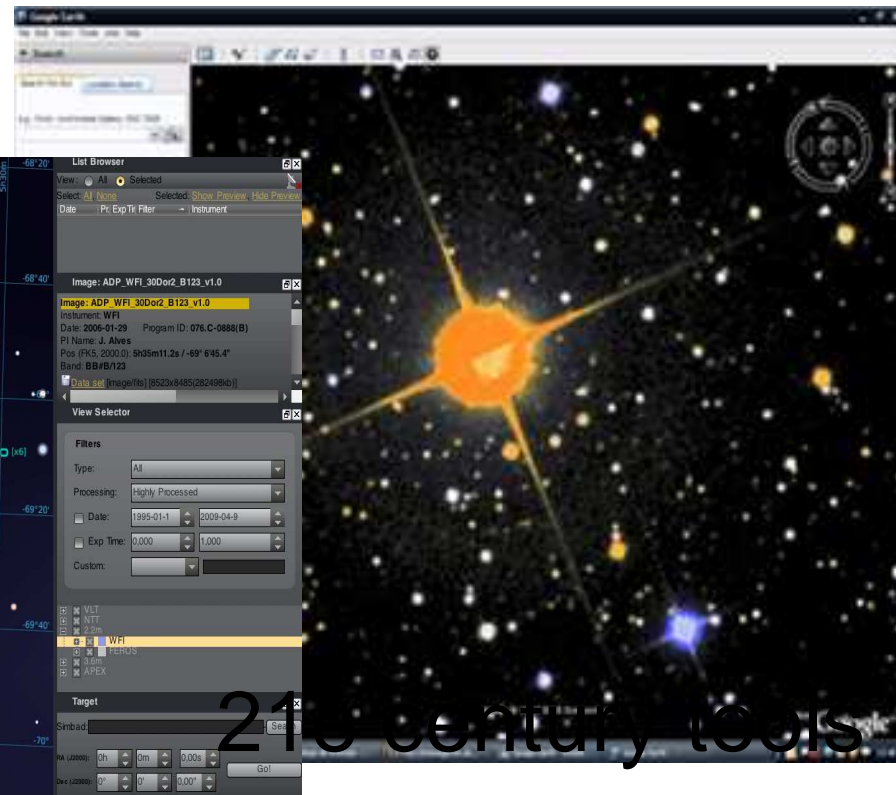


*Another way to explore the sky:
HEALPix usage in Aladin full sky mode*

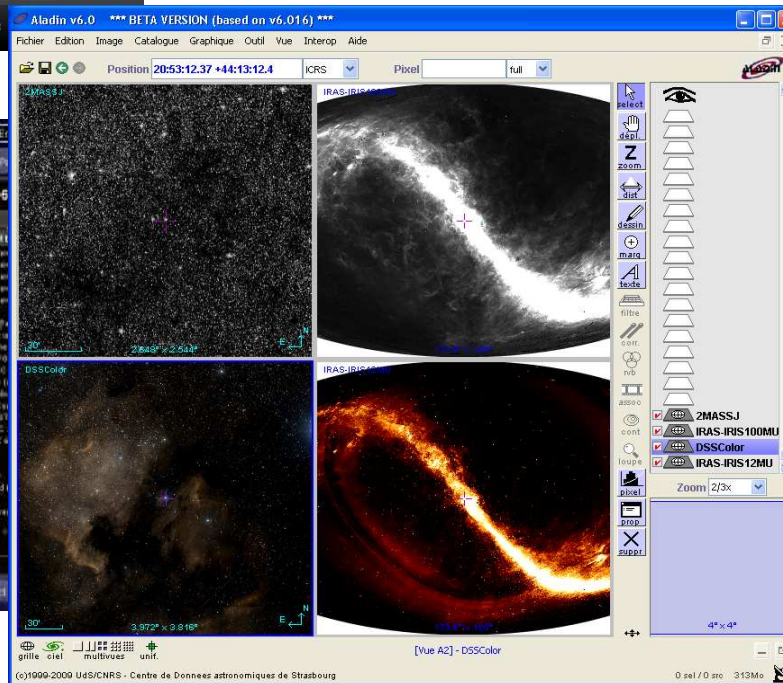
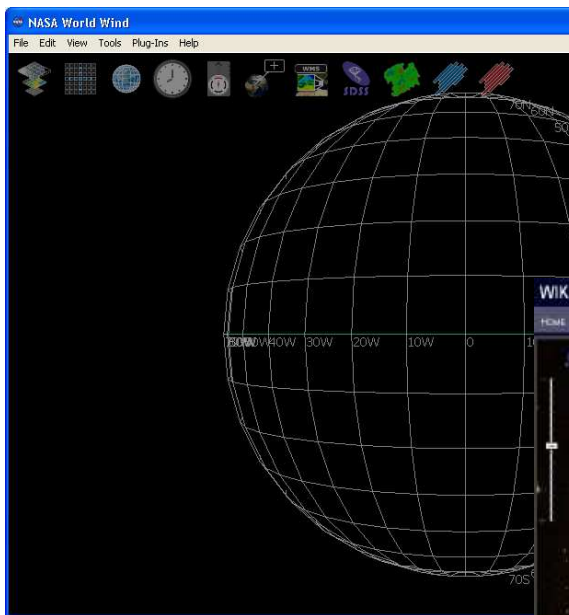
Pierre Fernique, Thomas Boch,
Anaïs Oberto, François Bonnarel

Centre de Données astronomiques de Strasbourg





21st century tools



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



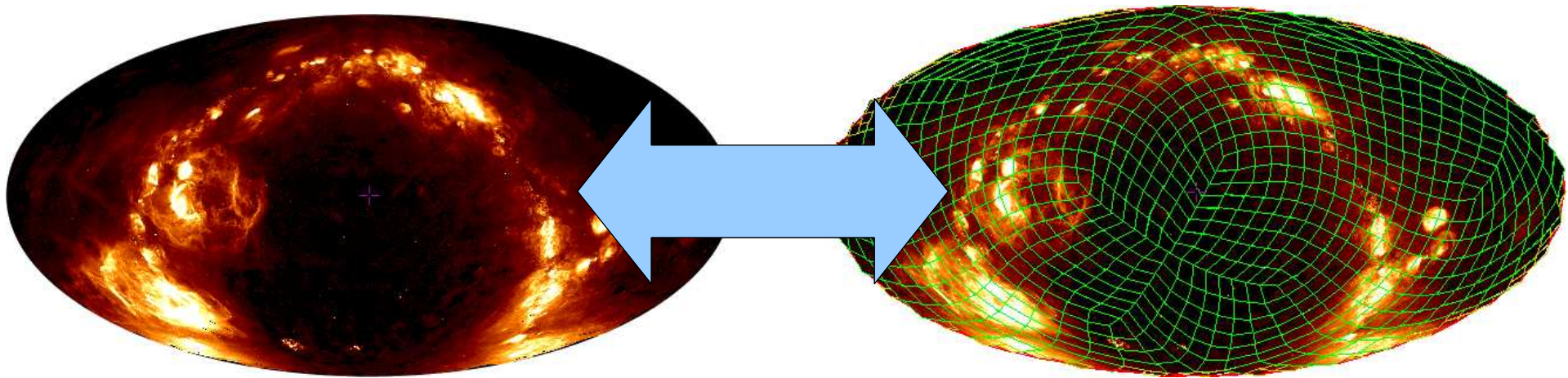
1) Data size...

- 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...

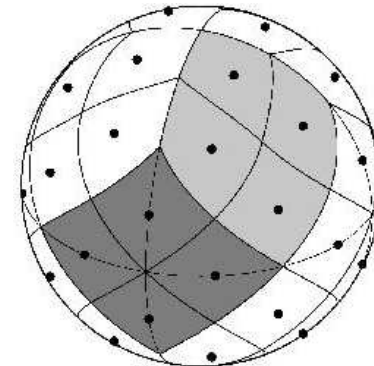
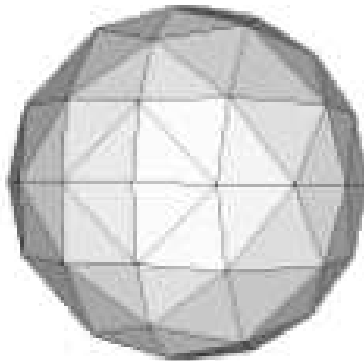
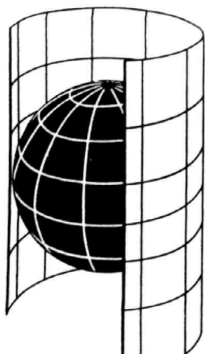
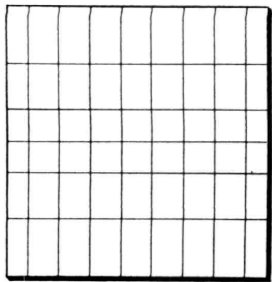
- Current graphics cards require ~1ms for projecting 1million pixels (bilinear method)
 - => 20 ms for redrawing an all sky view with one thousand (64x64) mosaic images



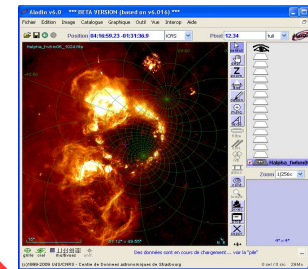
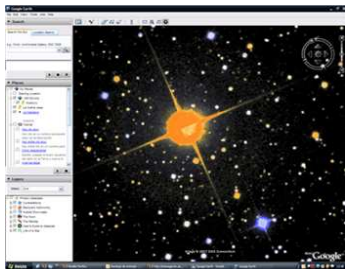
=> You can *drag&drop the sky with the mouse*
=> Thanks to computer games

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

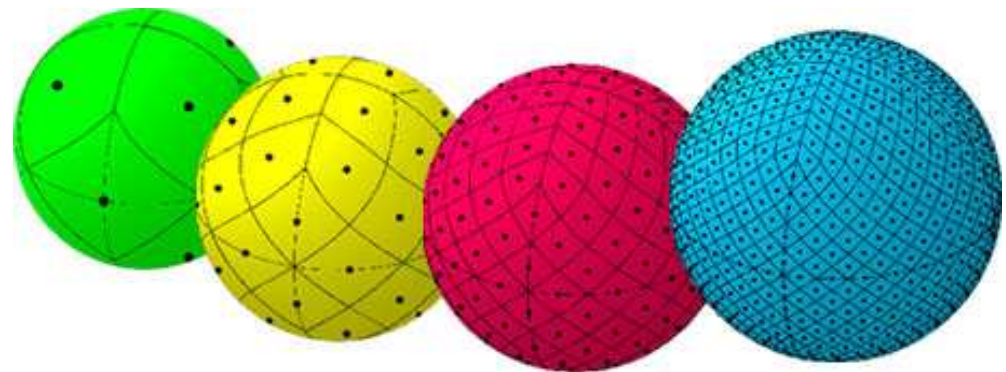
*Offer an All sky mode providing **the same functionalities** that the classical « image » mode*
(catalog overlays, survey comparison, all projections, contrast adjustment, pixel manipulation, local data...)

Halpha all sky

IRAS-IRIS 100 all sky

MAIN ID	OTYPE	RA	DEC	COO ...	COO ...	C...	PMRA	PMDEC	B
<input type="checkbox"/> NGC 1788	RfNeb	05 06 54	-03 20.5						5,8
<input type="checkbox"/> NGC 1999	HII	05 36 27	-06 43.3	18000	18000	174			9,5
<input type="checkbox"/> M 78	RfNeb	05 46 46,7	+00 00 50	3000	3000	176			8,0
<input type="checkbox"/> NGC 2064									
<input type="checkbox"/> NGC 2067									
<input type="checkbox"/> NGC 2071	RfNeb	05 47 04.4	+00 21 19	3000	3000	176			

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	<i>Healpix 64 bits limit</i>

Why did Aladin choose HEALpix ?

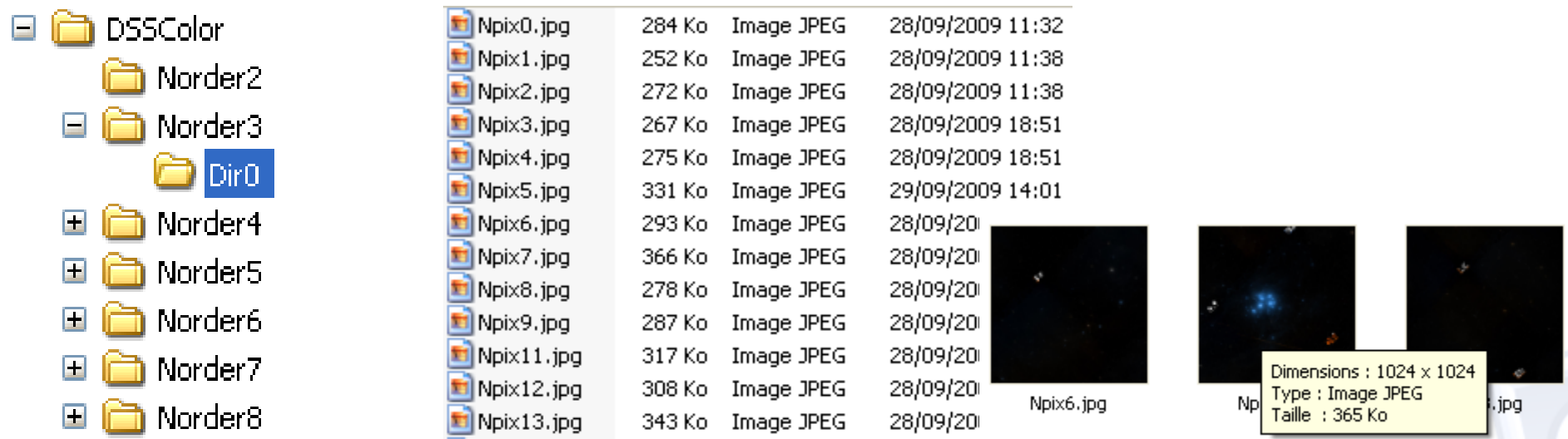
- Regular **hierachical sky division** (easy server implementation – no pole problem)
- Pixel **equal area** => fast pixel algorithms
- **Immediate conversion** (pixel number to coordinates) with no recursion => constant time

```
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...

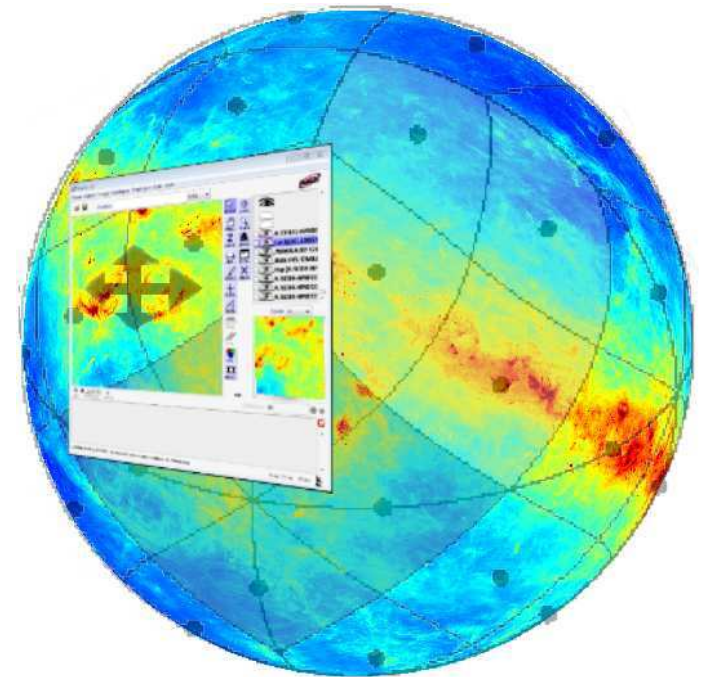
- Actually no data base, just directories and files (1024x1024 square « tiles » in FITS or JPEG => 786432 files for DSS/order18, 768 files for IRIS/order3)
- From a HTTP server or directly on the client machine
- Full and compressed pixels supported



The screenshot displays a file explorer window. On the left, a tree view shows a folder named 'DSSColor' containing subfolders 'Norder2' through 'Norder8'. The 'Norder3' folder is expanded to show a subfolder 'Dir0'. The main pane shows a list of files named 'Npix0.jpg' through 'Npix13.jpg'. Each file entry includes its size (e.g., 284 Ko), type (Image JPEG), and date (e.g., 28/09/2009 11:32). Below the list, three image thumbnails are visible. A tooltip is shown over the middle thumbnail, labeled 'Npix6.jpg', with the following text: 'Dimensions : 1024 x 1024', 'Type : Image JPEG', and 'Taille : 365 Ko'.

File Name	Size	Type	Date
Npix0.jpg	284 Ko	Image JPEG	28/09/2009 11:32
Npix1.jpg	252 Ko	Image JPEG	28/09/2009 11:38
Npix2.jpg	272 Ko	Image JPEG	28/09/2009 11:38
Npix3.jpg	267 Ko	Image JPEG	28/09/2009 18:51
Npix4.jpg	275 Ko	Image JPEG	28/09/2009 18:51
Npix5.jpg	331 Ko	Image JPEG	29/09/2009 14:01
Npix6.jpg	293 Ko	Image JPEG	28/09/2009 11:32
Npix7.jpg	366 Ko	Image JPEG	28/09/2009 11:38
Npix8.jpg	278 Ko	Image JPEG	28/09/2009 18:51
Npix9.jpg	287 Ko	Image JPEG	28/09/2009 18:51
Npix11.jpg	317 Ko	Image JPEG	28/09/2009 18:51
Npix12.jpg	308 Ko	Image JPEG	28/09/2009 18:51
Npix13.jpg	343 Ko	Image JPEG	28/09/2009 18:51

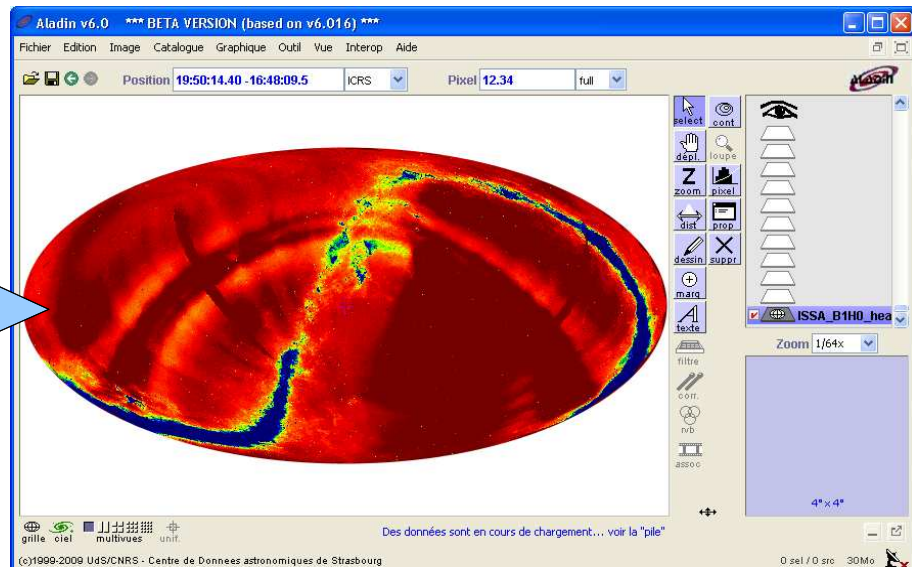
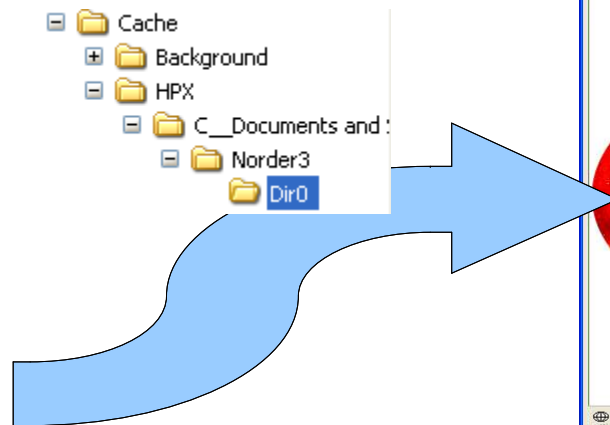
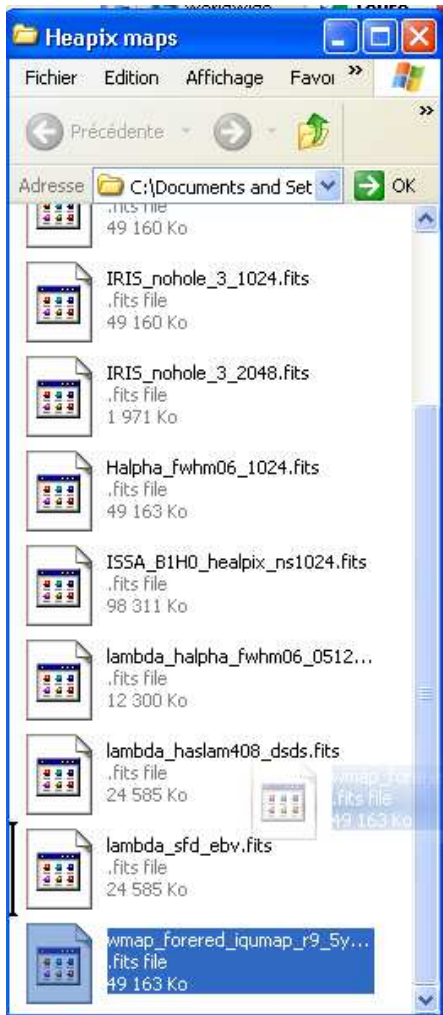
On client side...

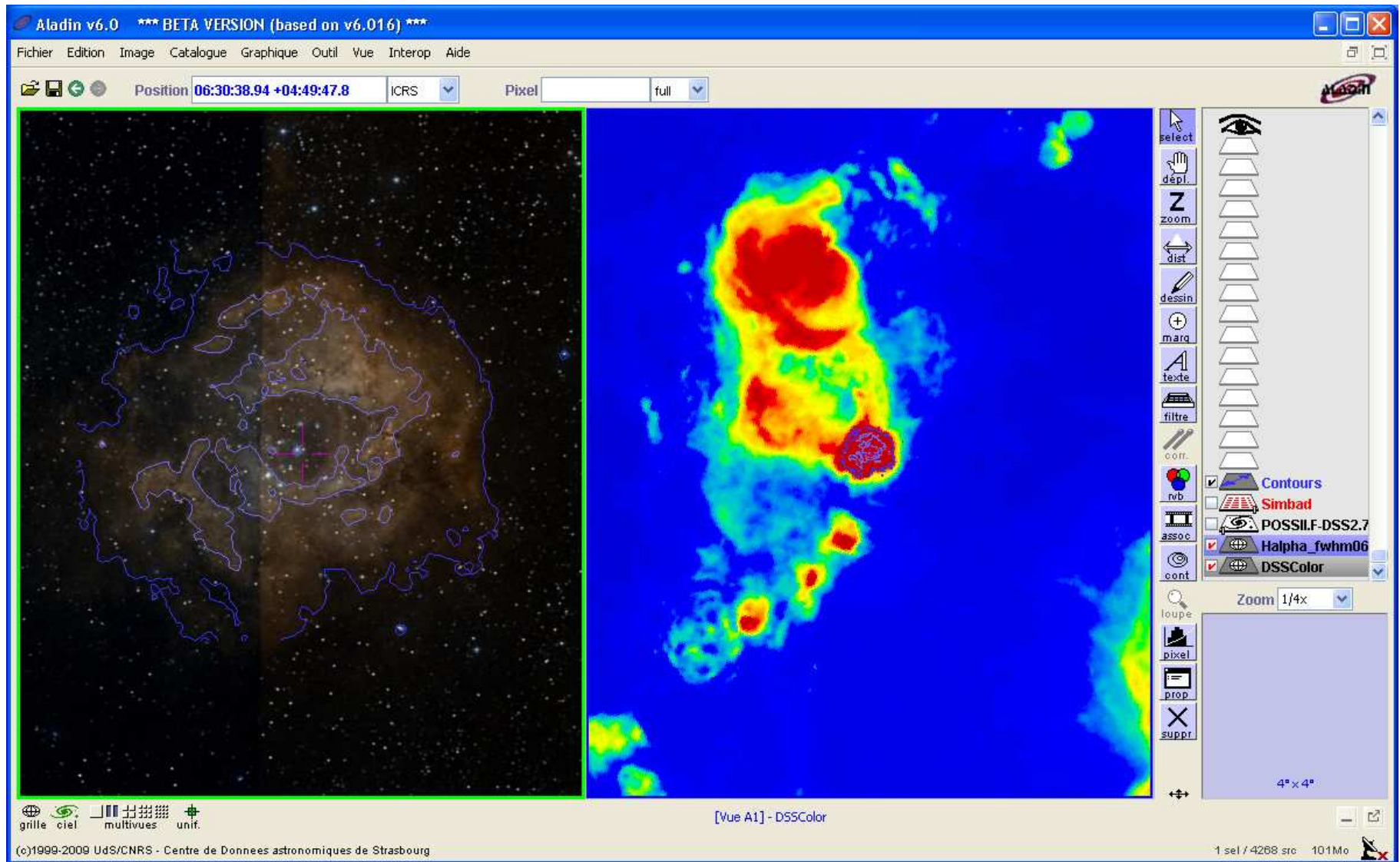


- **Retrieving Healpix diamonds** corresponding to the current user view and resolution
 - Immediate Healpix computation for determining which healpix pixels are in a sky region for a given depth order,
 - Filepath/url immediately built from survey/order/pixelNumber triplet => no «localisation» query 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...