http://terapix.iap.fr

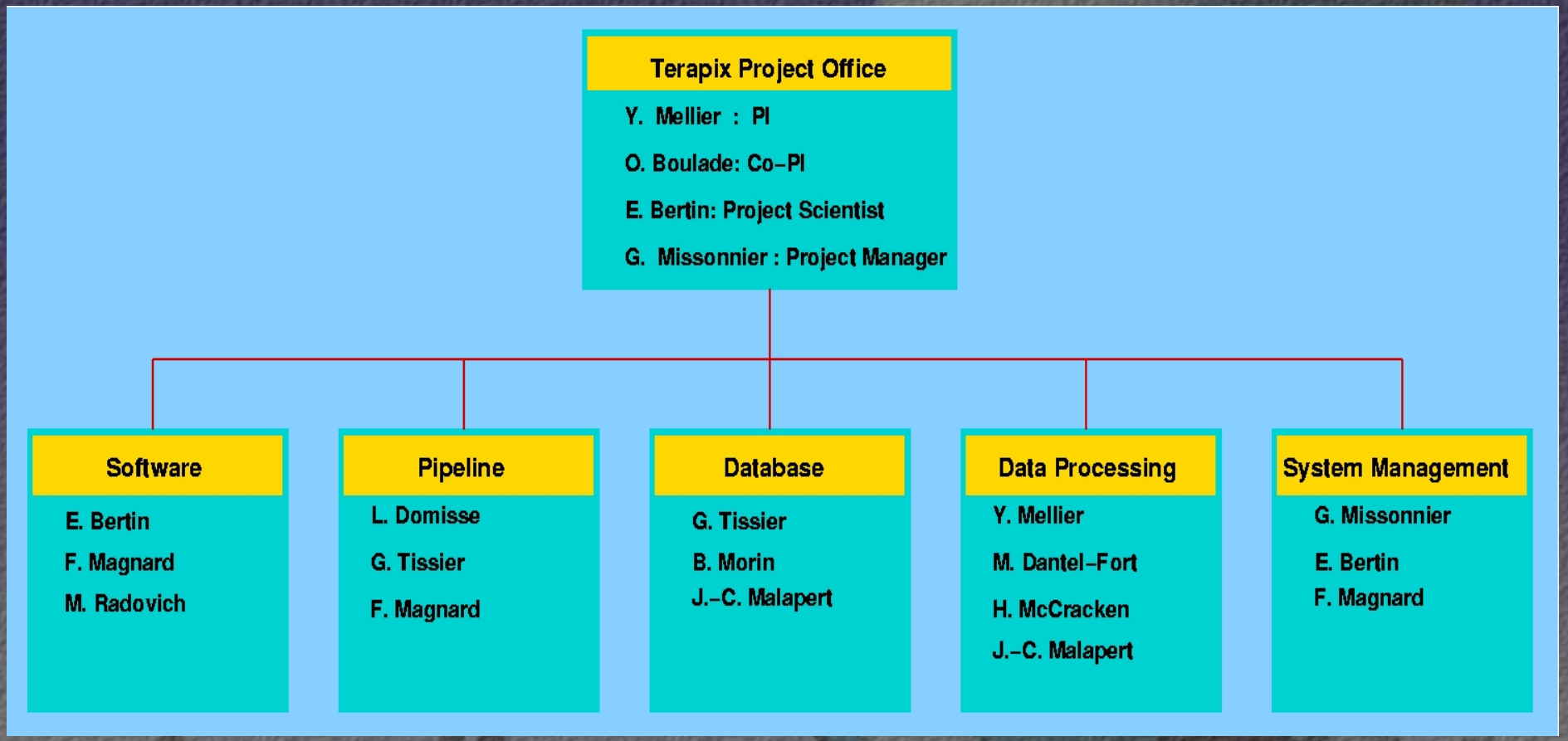
TERAPIX

Meudon, le 27 novembre 2003

TERAPIX

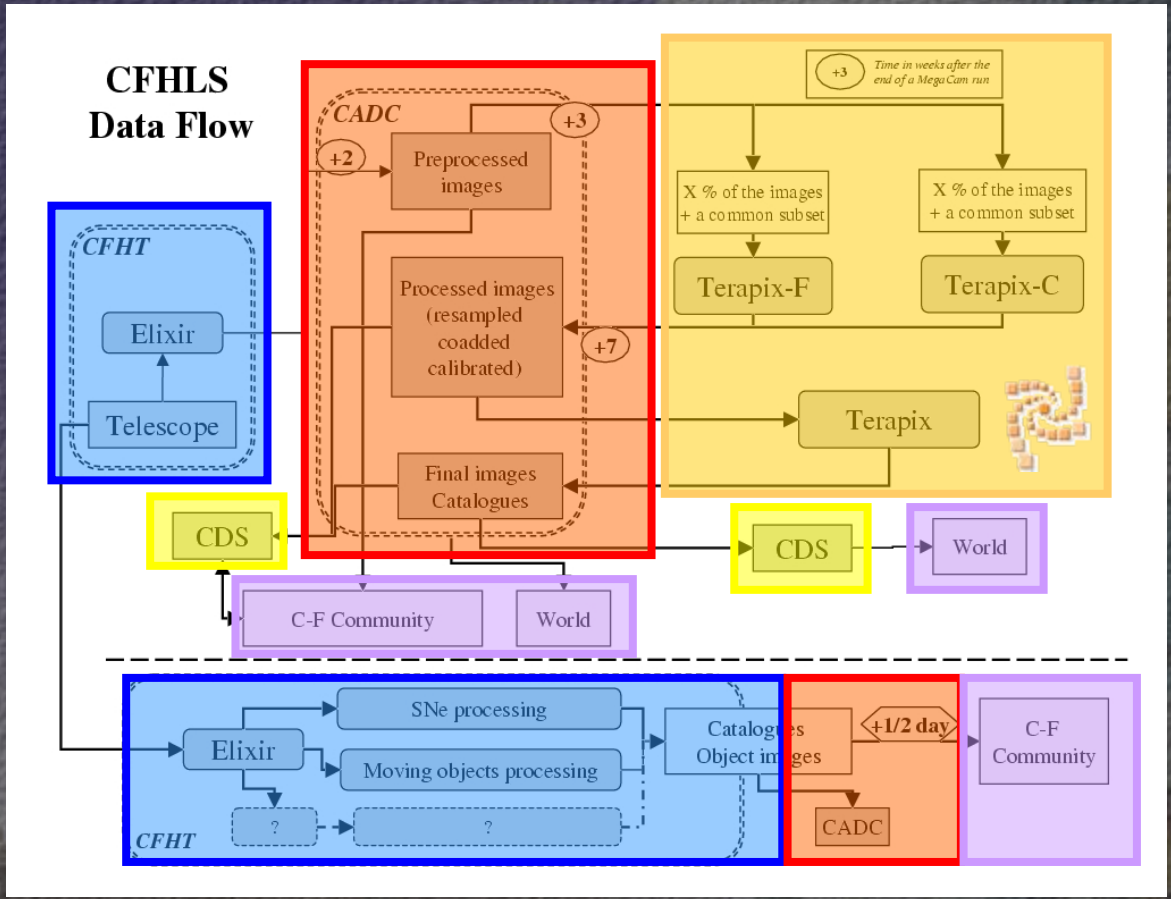
- Production of large, “clean” and well-calibrated science images
  - Production of calibration/data-description images (weight+flag maps)
  - Astrometric and photometric solution
  - Image warping
  - Image homogenization
  - Image co-addition
  - Quality assessments
- Production of “Final” source catalogs
  - Detection
  - Measurement
  - Classification
- Users tools:
  - Automatic pipeline / *data base with remote user access*
  - vizualisation,
  - survey follow-up, etc...
- User assistance:
  - PI images processed by Terapix
  - or PI does their own at Terapix remotely.
- Funding:
  - INSU + PNC + EC-FP5-AVO + EC-FP5-AstroWise + IAP + CEA

Terapix organisation

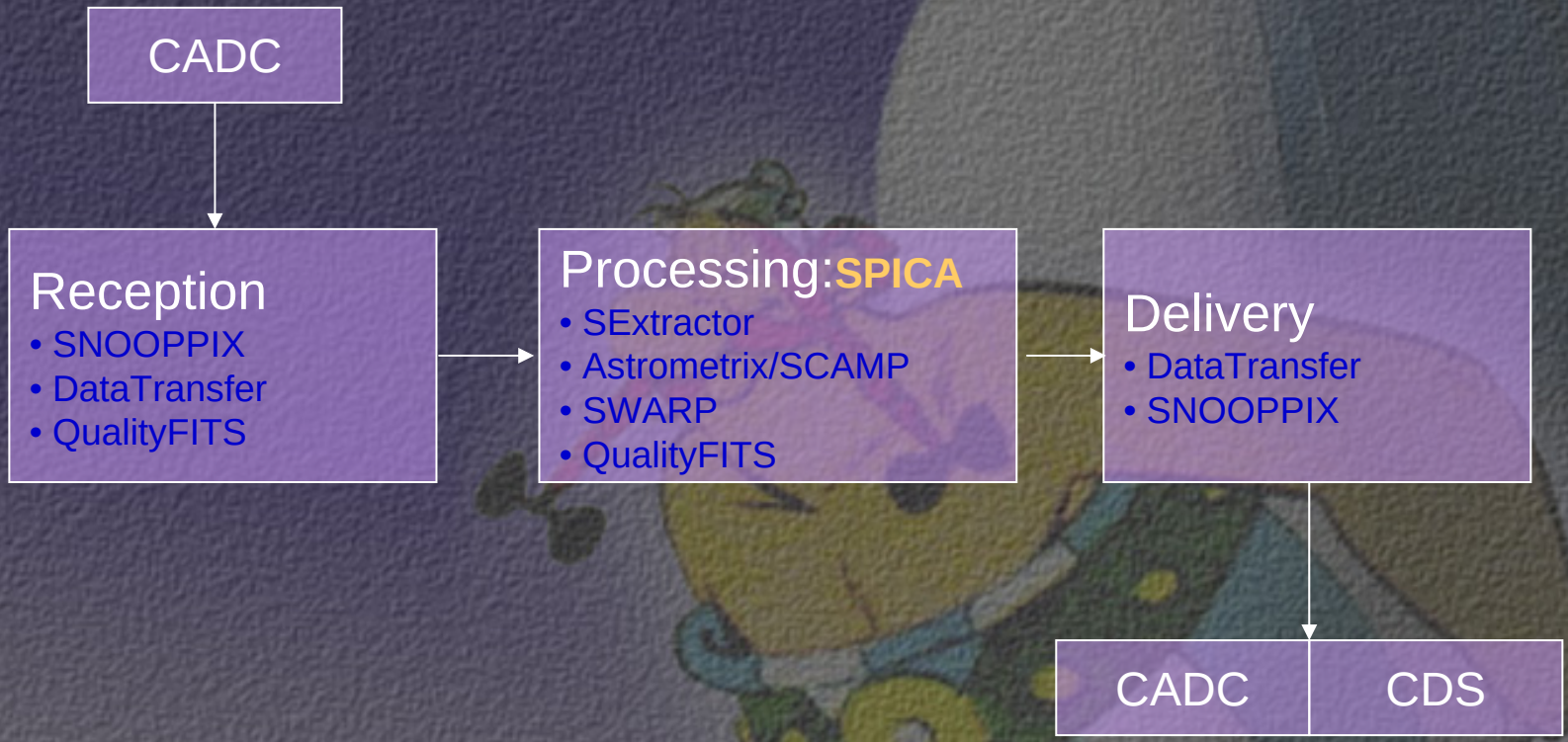


Data Flow

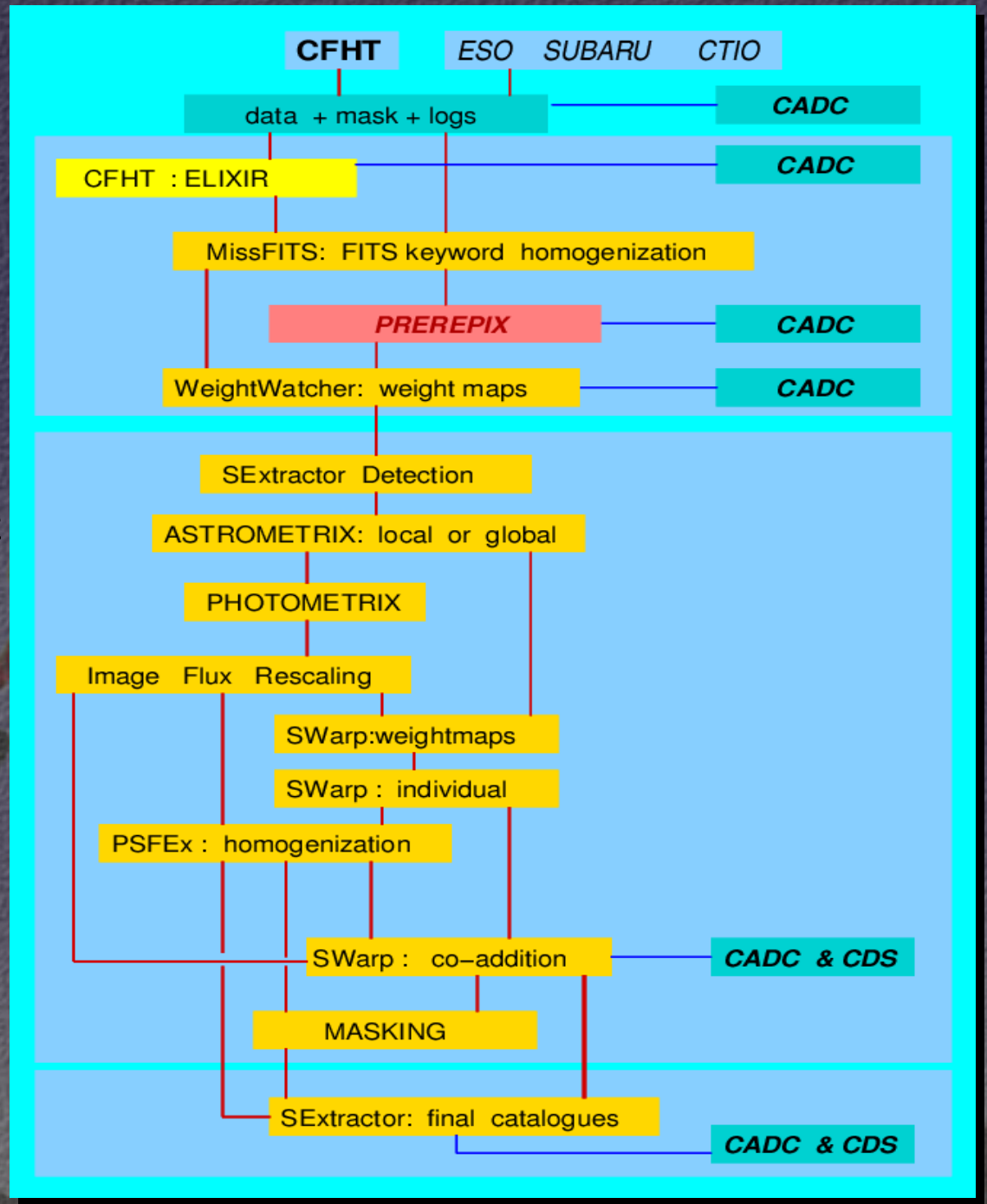
- Terapix reception: 2000-3000 images/run (2.1 TB, maximum) ,
- Terapix production : Weight+Flag images + stacked images (~ 4.5 TB)
- Goals: 300 Kpixel/sec, 100 object/sec (real working time: 8hrs/24)



Overview of the TERAPIX pipeline



Overview of the TERAPIX pipeline



Software

- Data reduction modules:
  POSIX-compliant C/C++ and/or PDL+PERL-Tk
  - Most of them are being developed and are maintained *on-site* :
    - Perfectly matched to MEGACAM images
    - Perfect control; fast response in case of problems
    - Many tasks are performed within each module
      - Efficiency (minimizes inputs/outputs)
      - Simplifies the pipeline at higher levels
      - Possible thanks to permanent, dedicated, team members
  - Distributed to the general community A.S.A.D
    - Tremendously improves robustness and portability (code, instruments, file formats)
    - Brings up new ideas
    - ☺ Helps in forcing people to write a detailed documentation
    - Source packages now comply with GNU standard (Autoconf); binary packages are Linux RPMs
    - Released under GPL

Software (cont.)

- Pipeline: stand-alone programs **+ SPICA + DBclient**
  - SNOOPPIX: spots data at CADC
  - Datatransfer: send data to Terapix/CADC and organise data on disks
  - QualityFITS: input/output quality assessments tools + metadata
  - MissFITS: manage FITS files
  - WeightWatcher: Create weight-maps for images
  - SWarp: Resample and co-add images
  - SExtractor: Source extraction
  - PSFEx: Build a PSF model of a field
  - ASTROmetrix/PHOTOmetrix: local and global astrometry + photometric normalization/calibration
  - SCAMP: New Astrometric/photometric software
- Simulation+visualisation tools: C/C++ stand-alone programs
  - Stuff: Simulation of galaxy populations
  - SkyMaker: Image simulation
  - Panorapix: Large image visualisation
  - Stiff: image compositing and conversion to TIFF
  - SExBench: hardware benchmarking software
  - SkyWatcher: Survey/data sky follow up

Software distribution

TERAPIX

Home » 1.Activities » 1.Software » SWarp

- 1.Activities
  - 1.Software
    - Spica
    - Database
    - CVS access
    - News
    - Download
    - SWarp
    - Links
  - 2.Hardware
    - News
    - The Terapix cluster
    - Legacy hardware
    - Links
  - 3.Documentation
    - Reports
    - Meetings
    - Press
- 2.Agenda
  - 1.Calendar
  - 2.Meetings
- 3.Locations
- 4.Tools
  - 1.Instruments
    - MegaCam
    - MegaPrime
  - 2.Archives
    - CADC
    - CDS
  - 3.Data reduction
    - Spica access
- 5.Participants
  - 1.Human resources
    - People
    - Project vacancies
  - 2.Funding agencies
  - 3.Contracts
    - AVO
    - ASTRO-WISE
    - CADC-Terapix
    - STAR TAP
- 6.Science
  - 1.CFHTLS
  - 2.DESCART
    - News

SWarp

Updated November 22nd, 2003

SWarp is a program that resamples and co-adds together FITS images using any arbitrary astrometric projection defined in the WCS standard.

The author
- Emmanuel BERTIN

What's new?

- *11/24/2003*: A *huge bug* has been found in V**2.07**. This is now fixed in V**2.08**. Sorry for the mess.
- *11/23/2003*: Version **2.07** of SWarp is finally available!! Release highlights:
  - Resampling is 2 - 10 (!) times faster than in V1.xx
  - Multi-threading and co-addition more efficient (code rewritten from scratch)
  - Support for BLANK pixels

Download the latest version (V2.08)

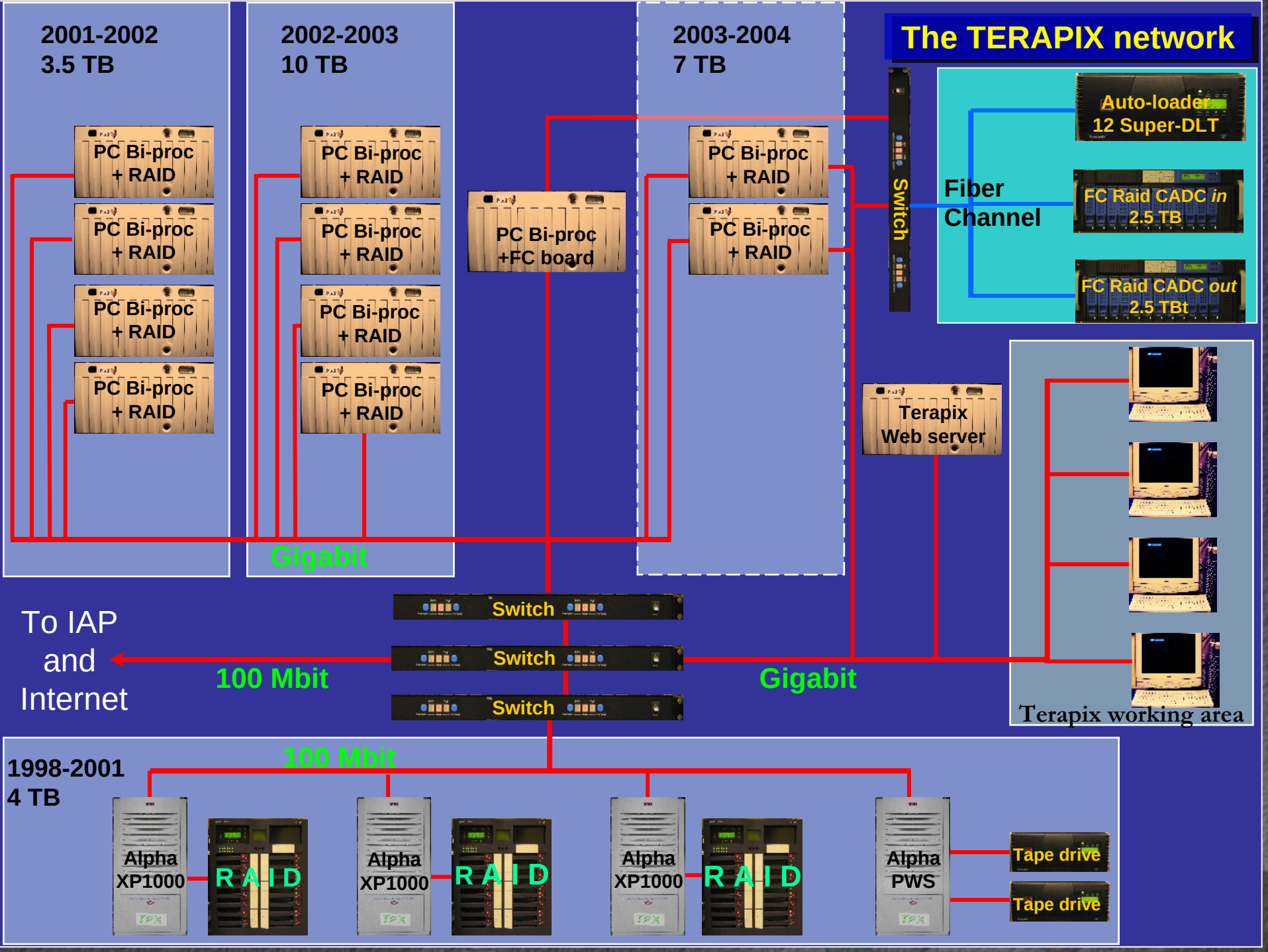
Both the autoconfigurable source archive and Linux RPM packages for x86 are available below. The RPM versions have been optimized to provide the best possible performance on Linux PCs.

Source archive | Monoprocessor | Multiprocessor

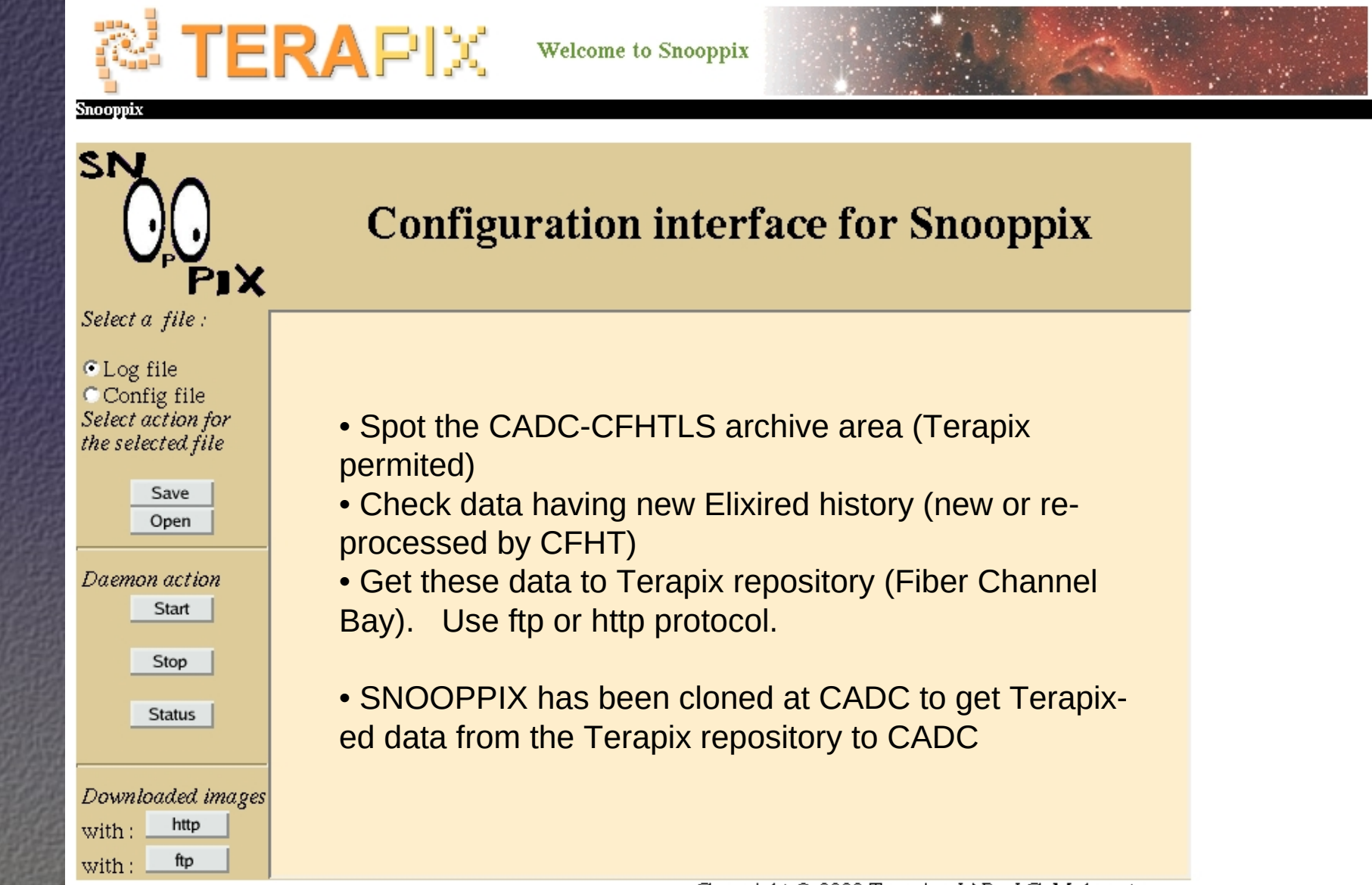
Subsections

- SWarp Mailing List
- Bulletin Board

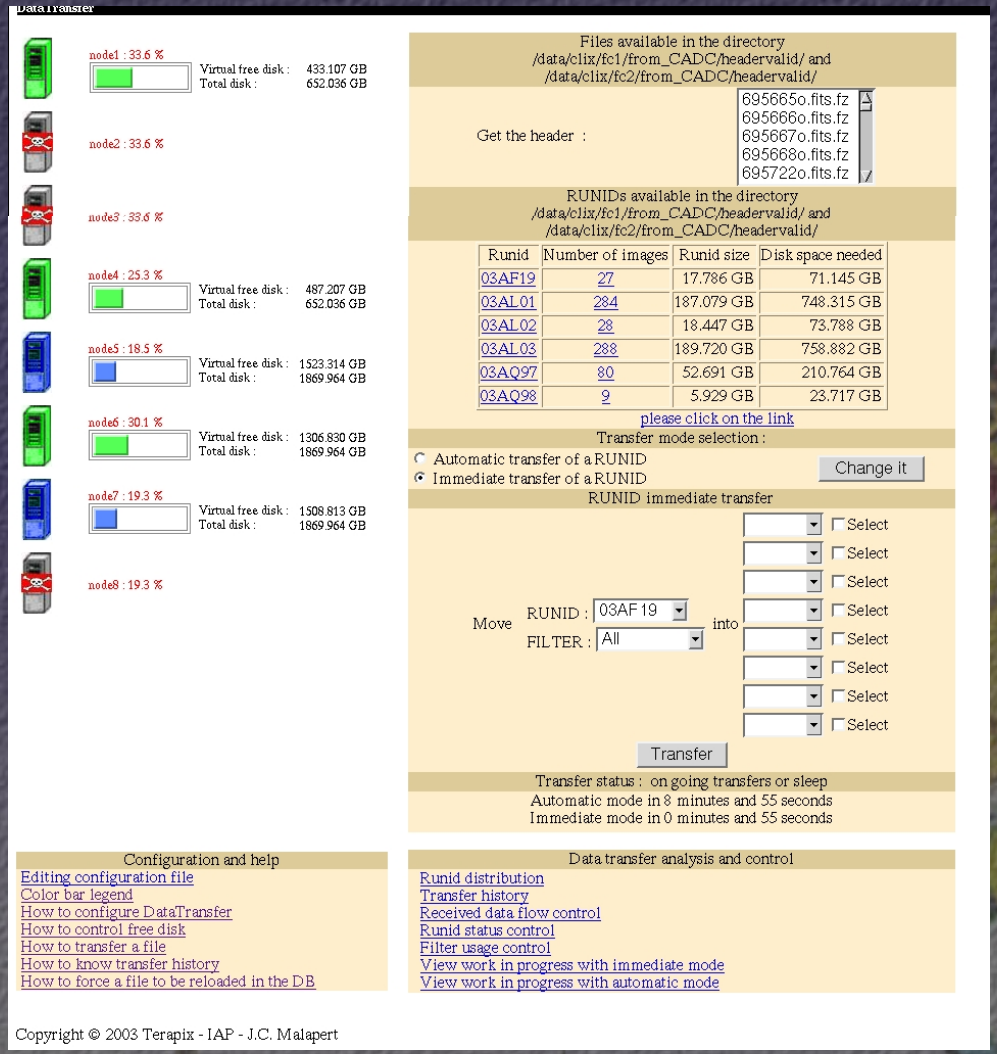
http://terapix.iap.fr/soft/swarp


2001-2002
3.5 TB
2002-2003
10 TB
2003-2004
7 TB
The TERAPIX network
PC Bi-proc
+ RAID
PC Bi-proc
+FC board
Switch
Fiber
Channel
Auto-loader
12 Super-DLT
FC Raid CADC in
2.5 TB
FC Raid CADC out
2.5 TBt
Terapix
Web server
Gigabit
To IAP
and
Internet
100 Mbit
Switch
Terapix working area
1998-2001
4 TB
Alpha
XP1000
RAID
Alpha
PWS
Tape drive

Snooppix

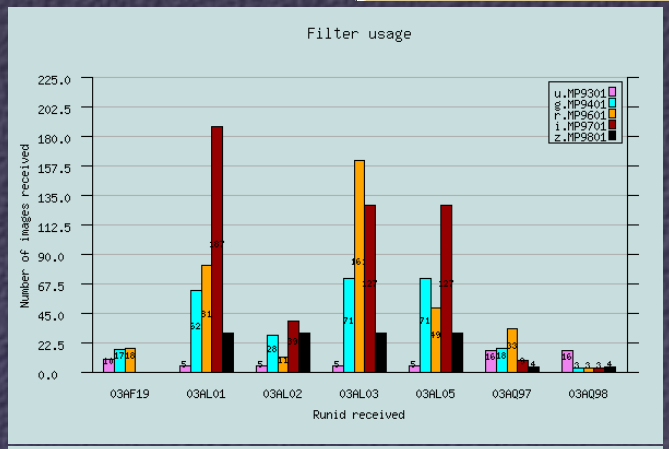

TERAPIX
Welcome to Snooppix
Snooppix
SN OP PIX
Configuration interface for Snooppix
Select a file :
Log file
Config file
Select action for the selected file
Save
Open
Daemon action
Start
Stop
Status
Downloaded images
with : http
with : ftp
• Spot the CADC-CFHTLS archive area (Terapix permited)
• Check data having new Elixired history (new or re-processed by CFHT)
• Get these data to Terapix repository (Fiber Channel Bay). Use ftp or http protocol.
• SNOOPPIX has been cloned at CADC to get Terapix-ed data from the Terapix repository to CADC
Copyright © 2003 Terapix - IAP - J.C. Malapert

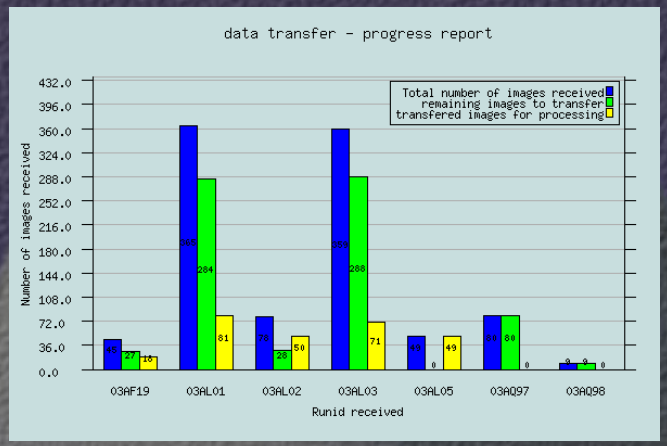
Datatransfer

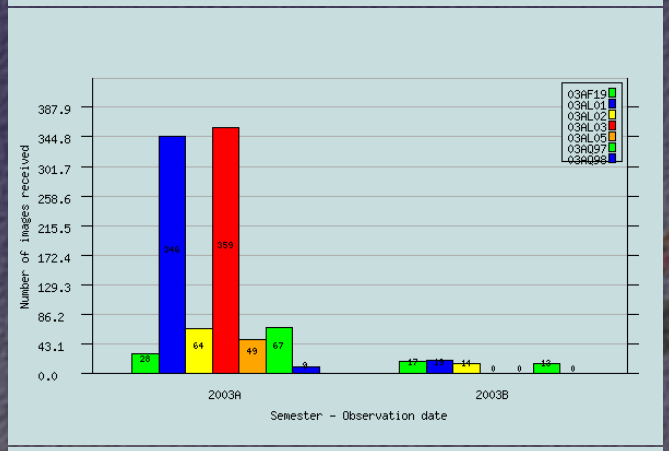


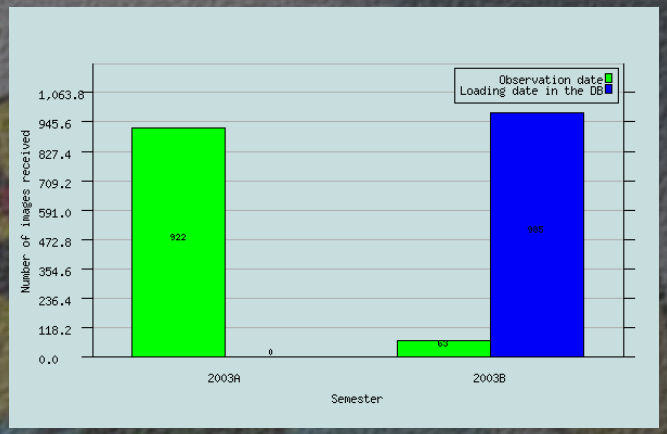
- Transfer the data snooped by SNOOPPIX from the data transfer repository disks to Terapix processing disks
- Check the disk space available on each node and send the data on disks that still have enough space to produce weight + flag map images
- Make statistics on images (period, RunID, filter, etc…) and store meta-data on local DB
- Can run automatically or manually

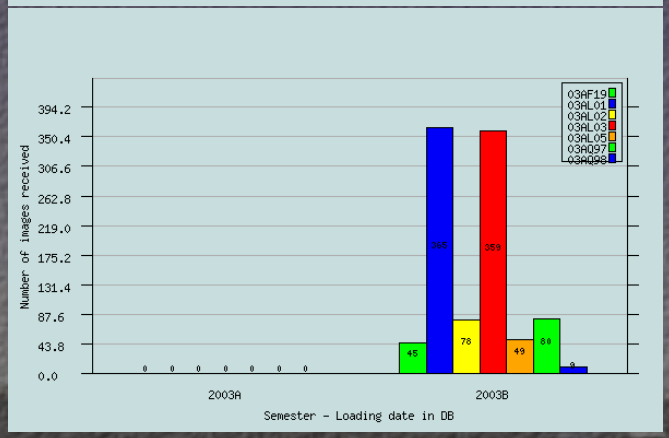
Data transfer - progress report

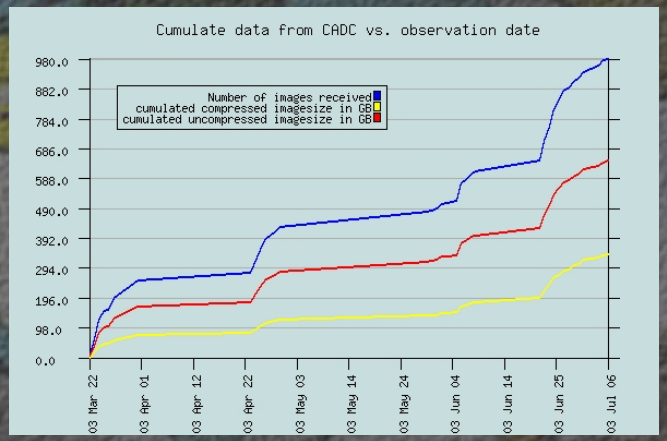






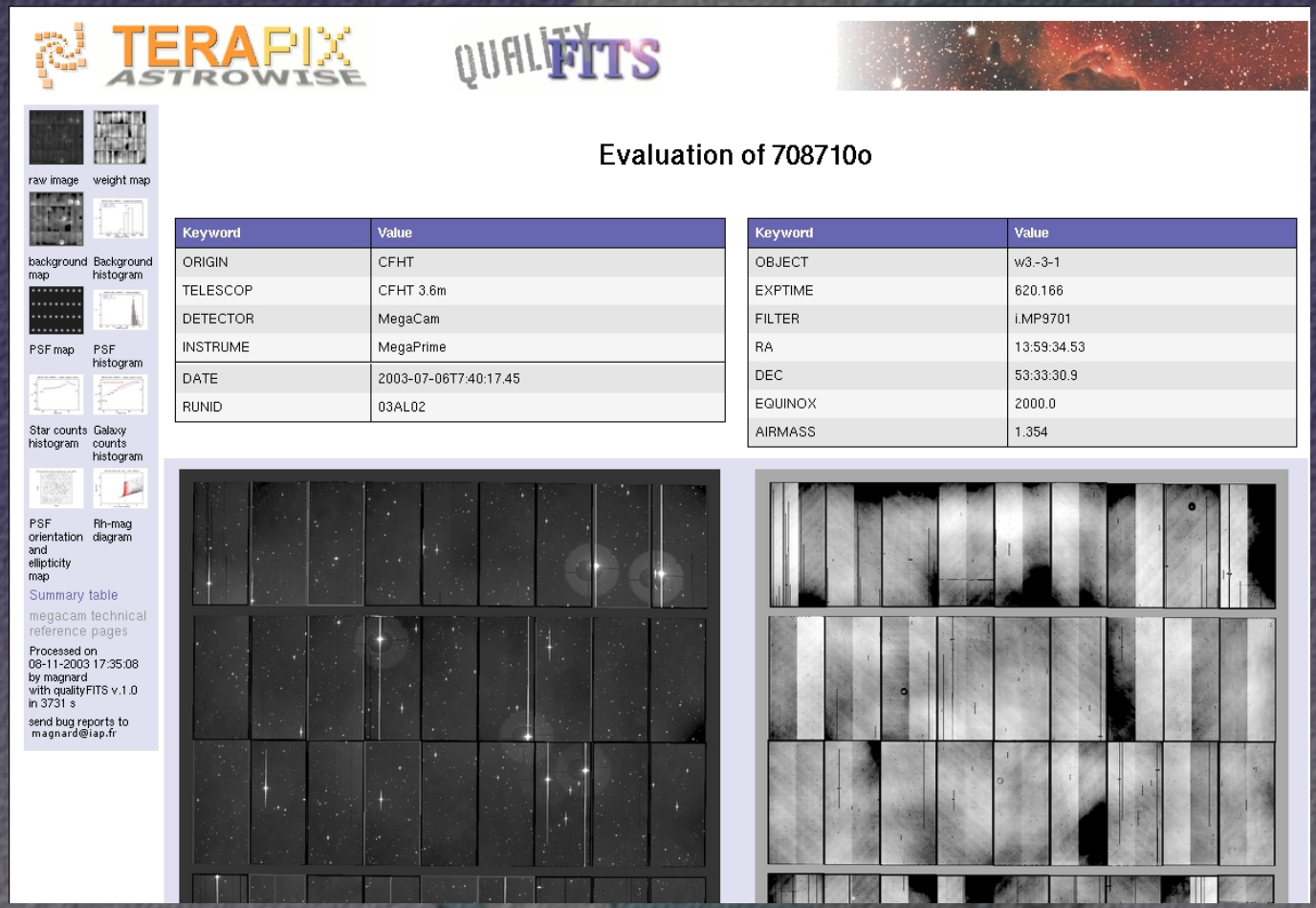






QualityFITS

- Delivered by Terapix to the AstroWISE consortium
- Provides a complete image analysis of all images
  - Check background
  - Maps the PSF
  - Checks star and galaxy counts
  - Produces weight/flag maps
- Quality assessment for in/out images
- QualityFITS uses:
  - SExtractor
  - PSFex
  - SWARP
  - PLplot library tools
  - Weightwatcher

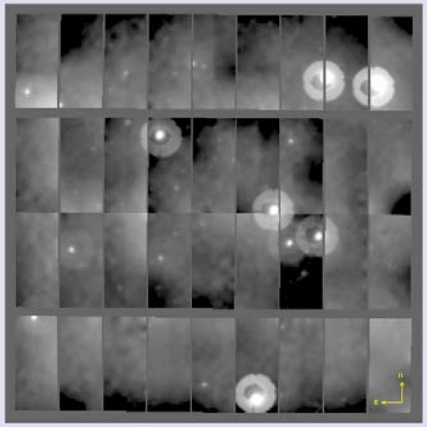


QualityFITS (cont.)

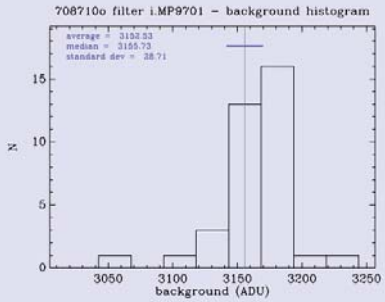
Raw mosaic image

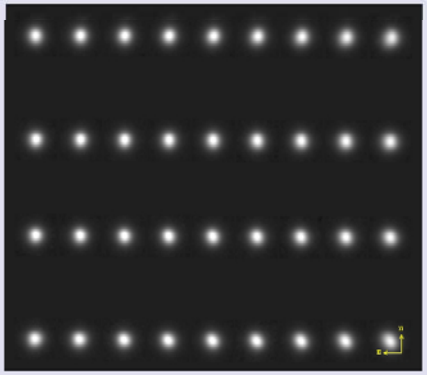
Mosaic of weightmap

Note to **Internet Explorer** users: IE is unable to render properly the transparency in PNG images. Prefer mozilla. Cf. test.

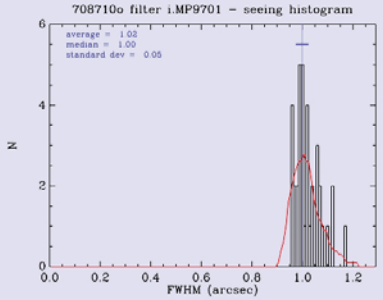


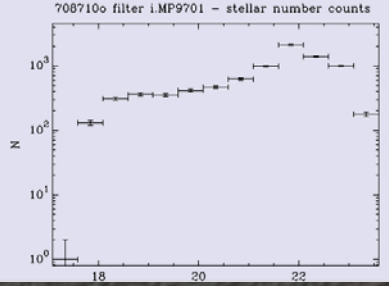
mosaic of backgrounds (gamma=2.2)
mesh size = 64 pixels

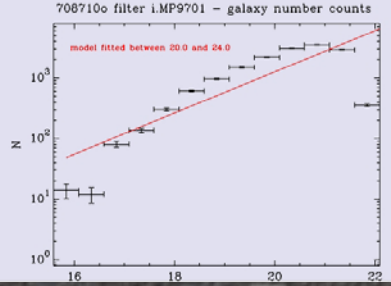


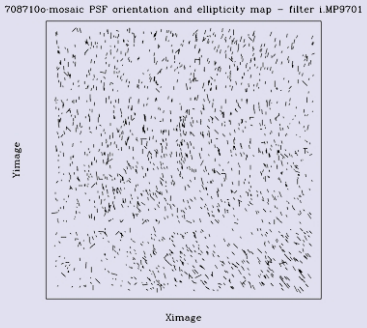


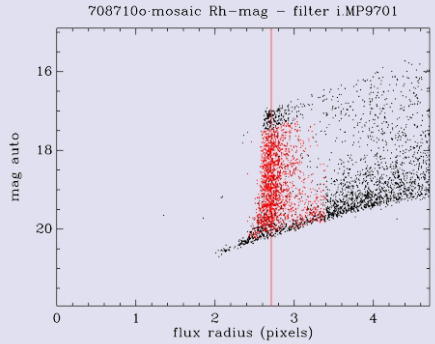
mosaic of PSF









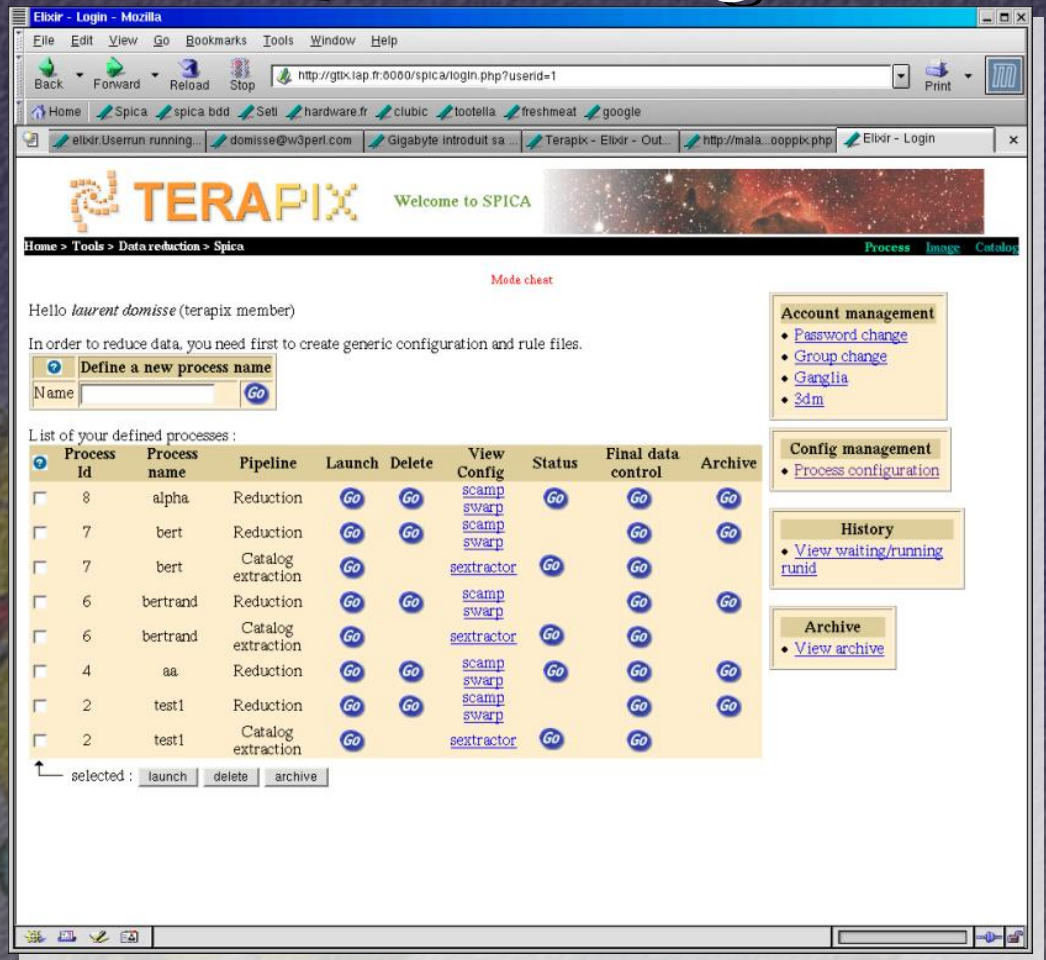


PSF orientation and ellipticity map

4x4 binned chip pixel (1,1) is at lower left	background (ADU)	sigma_bkg (ADU)	background (mag/arcsec^2)	nsexdet	seeing (pix)	seeing (arcsec)	sloaded	saccepted	schi2
ccd00	3160.4	123.7	20.28	754	5.72	1.05	29	27	1.65
ccd01	3125.0	125.8	20.30	606	5.35	0.99	52	45	1.30
ccd02	3142.8	117.9	20.30	662	5.34	0.99	48	40	1.26
ccd03	3139.8	126.1	20.31	685	5.39	1.00	43	37	1.27
ccd04	3127.3	120.3	20.31	649	5.49	1.02	52	42	1.27
ccd05	3108.6	122.7	20.32	681	5.69	1.06	52	41	1.32
ccd06	3178.4	123.4	20.29	768	5.79	1.07	60	55	1.48
ccd07	3104.9	128.5	20.31	762	6.04	1.12	38	38	1.57
ccd08	3166.2	141.7	20.28	727	6.34	1.17	29	27	1.85
ccd09	3172.6	119.3	20.29	701	5.26	0.98	50	39	1.19
ccd10	3152.0	132.7	20.31	755	5.19	0.97	39	36	1.26
ccd11	3164.8	134.0	20.31	654	5.20	0.97	45	40	1.24
ccd12	3152.7	125.7	20.31	703	5.35	1.00	50	39	1.25
ccd13	3172.2	122.2	20.31	850	5.42	1.01	67	59	1.22
ccd14	3157.3	136.5	20.31	826	5.50	1.03	43	37	1.15
ccd15	3136.5	129.3	20.32	817	5.55	1.04	51	42	1.21
ccd16	3136.6	126.4	20.31	828	5.70	1.06	53	46	1.22
ccd17	3165.0	124.2	20.29	848	5.92	1.10	43	33	1.29

Pipeline SPICA : PHP/SQL technologies

- « web » interface
  - Fully portable, used remotely
  - Users accounts
  - Selection criteria included for user selection of images and configuration files
  - Fully automated mode (all images)



SPICA: output

TERAPIX

Home > Tools > Data reduction > Spica

Server Admin Spica - Automatic Image Mode

Input Qualityfits - Spica - Output Qualityfits

Warning : node2 is down

Images available		269
Input quality assessment	231	85 %
Spica	0	0 %
Output quality assessment	0	0 %

Image	RunID	Filter	Exp time	Date	RA	Dec	Input Quality Assesment	Spica processing	Output Quality Assessment	Sent to CADC
707440o	03AF19	r.MP9601	560	2003-06-24	15:08:30.00	5:00:00.0	Y	N	N	N
707441o	03AF19	r.MP9601	560	2003-06-24	15:08:28.9	4:59:55.3	Y	N	N	N
707442o	03AF19	r.MP9601	560	2003-06-24	15:08:30.30	4:59:45.0	Y	N	N	N
707443o	03AF19	r.MP9601	560	2003-06-24	15:08:31.00	5:00:04.4	Y	N	N	N
707444o	03AF19	r.MP9601	560	2003-06-24	15:08:29.69	5:00:14.9	Y	N	N	N
707445o	03AF19	r.MP9601	560	2003-06-24	15:08:29.29	5:00:10.4	Y	N	N	N

yfits Processed data

RunId	Number	%
	18	10 %
	20	11 %
	50	28 %
03AL03	37	21 %
03AL05	49	28 %

Filter	Number	%
g.MP9401	37	21 %
i.MP9701	39	22 %
r.MP9601	98	56 %

Node	Number	%
Node1	49	28 %
Node5	18	10 %
Node6	37	21 %
Node7	59	33 %
Node8	11	6 %

Search	Display	RunId	Filter	Node	Exp_time (min/max)	Airmass (min/max)	Mseeing (min/max)	Mbkg (min/max)
Go	20	---	---	---	140.03 / 63.943	1.053 / 1.561	0.7336 / 1.9881	18.45 / 21.83

All 20 images displayed. Use the form to select more or less

Warning : node2 is down

Warning : node3 is down

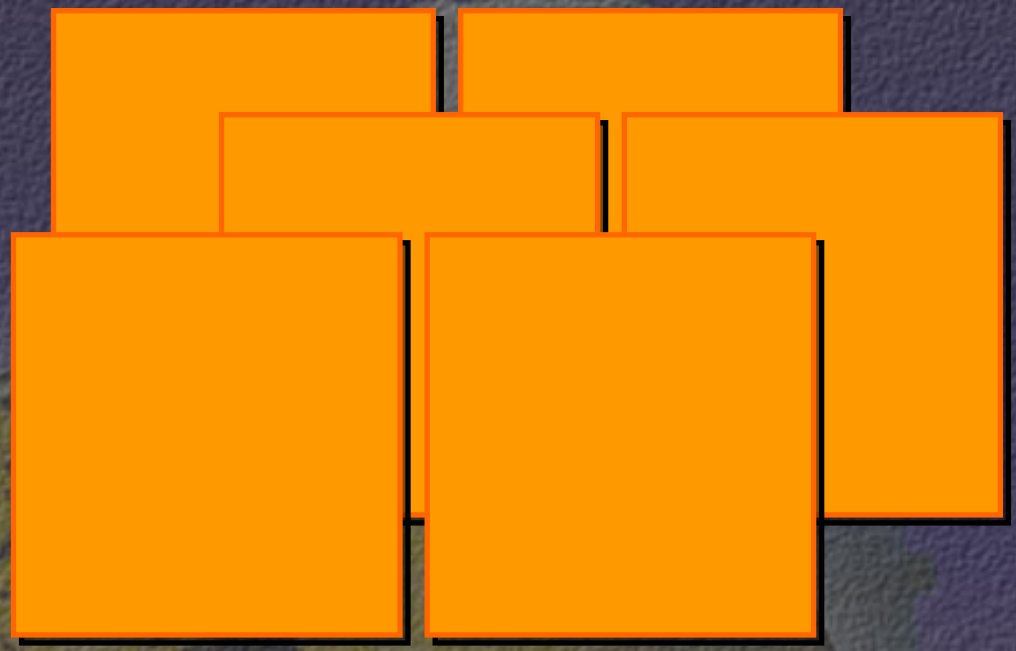
Warning : node8 is down

	Image	RunID	Filter	ExpTime (s)	Date Obs	RA	Dec	Equinox	Airmass	Mseeing (')	Mbkg (mag)	Node
☐	695703o	03AL05	r	180	2003-03-22	14:08:43.70	53:35:30.9	2000	1.234	0.9009	19.97	Node1
☐	695704o	03AL05	r	180	2003-03-22	14:08:37.98	54:02:30.8	2000	1.246	1.0193	19.96	Node1
☐	695705o	03AL05	r	180	2003-03-22	14:08:32.09	54:30:30.8	2000	1.258	1.0097	19.95	Node1
☐	695706o	03AL05	r	180	2003-03-22	14:08:26.05	54:58:30.9	2000	1.27	1.2213	19.94	Node1
☐	695707o	03AL05	r	180	2003-03-22	14:08:19.83	55:26:30.9	2000	1.283	0.9702	19.93	Node1
☐	695708o	03AL05	r	5	2003-03-22	14:08:13.43	55:54:30.9	2000	1.296	1.2161	19.94	Node1
☐	695818o	03AL05	r	180	2003-03-23	8:40:39.80	-3:18:25.0	2000	1.089	0.9715	20.92	Node1
☐	695819o	03AL05	r	180	2003-03-23	8:40:39.80	-2:51:00.0	2000	1.087	0.9972	20.91	Node1
☐	695820o	03AL05	r	180	2003-03-23	8:40:39.80	-2:23:00.1	2000	1.085	1.0641	20.9	Node1

SPICA uses and feeds the local Terapix data base DBclient

Global astrometric solution

- Uses both overlapping detections and a reference astrometric catalog (**USNO**) : automatic access to CADC catalogs
- Works best with a wide dithering pattern
- Current method (**Astrometrix**): iterative solution… SCAMP used for Megacam images
  - No need to bring coordinates to a common projection



Megacam CFHTLS Wide: Pre-survey

$$\chi^2 = \sum_{i<j,k\in\Omega_i\cap\Omega_j} \frac{(x_{ik}-x_{jk})^2+(y_{ik}-y_{jk})^2}{\sigma_{ik}^2+\sigma_{jk}^2}$$

$$+\lambda \sum_{i,k\in\Omega_0} \frac{(x_{ik}-x_{0k})^2+(y_{ik}-y_{0k})^2}{\sigma_{ik}^2+\sigma_{0k}^2}$$

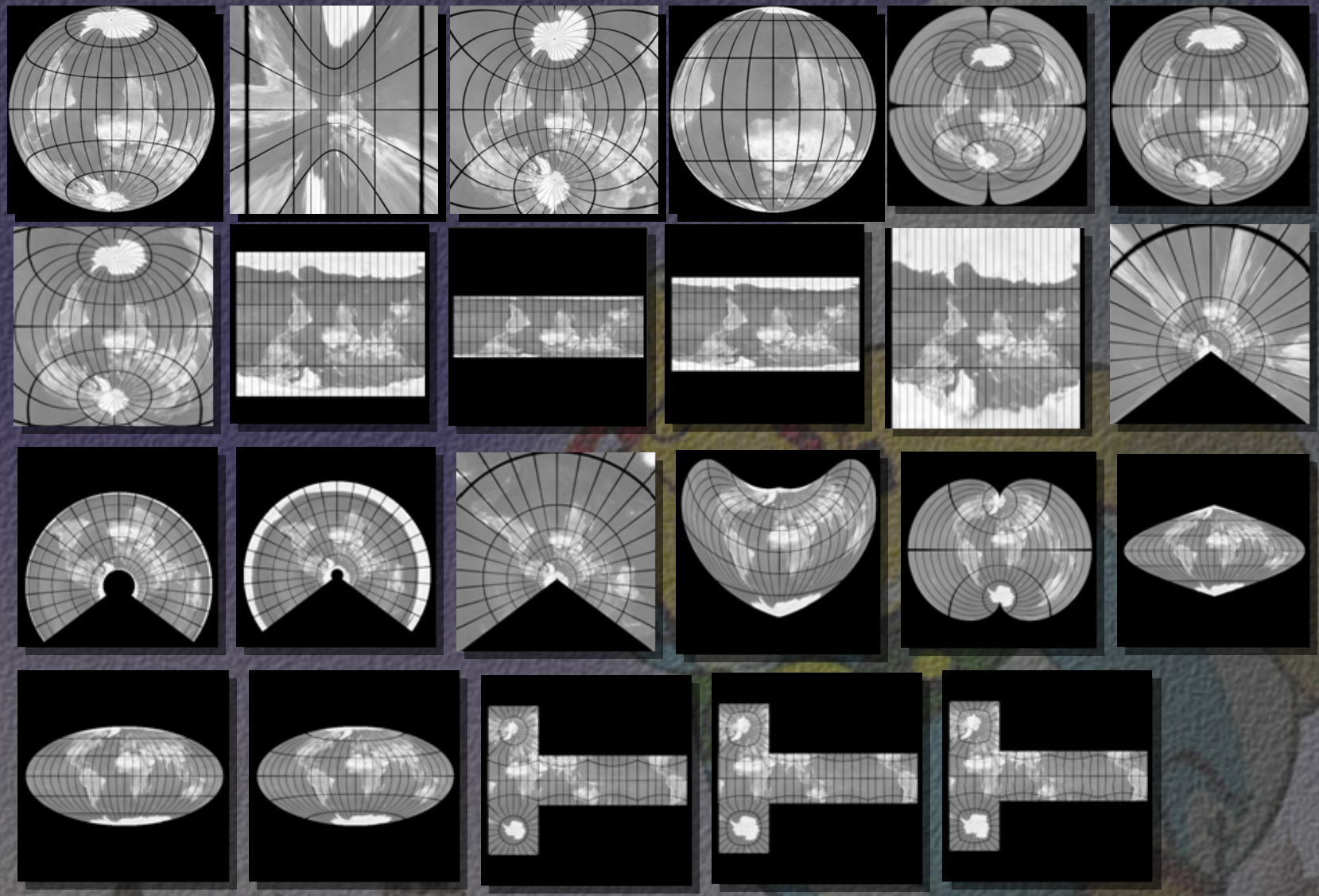
Image resampling and co-addition: SWarp

- **FITS/WCS/TNX** in input and output (thanks to a modified version of **M.Calabretta**'s **WCSLib v2.6**)

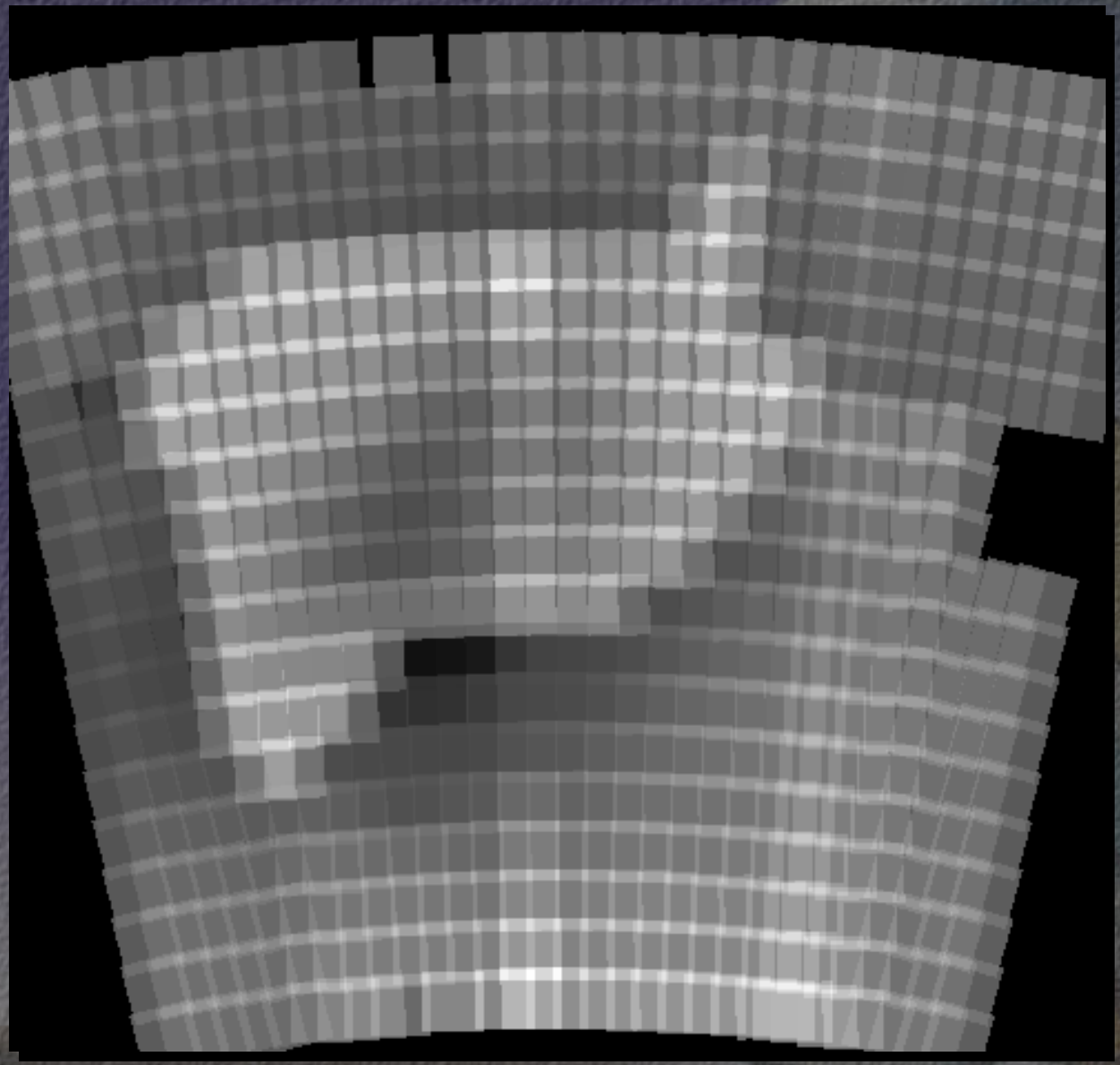
- Full handling of weight-maps
- Work with arbitrarily large images
- Up to 9 dimensions (including a maximum of 2 spherical coordinates)
- Choice of interpolation functions (kernels up to 8^n taps)
- Equatorial/Galactic/Ecliptic coordinates
- Built-in background subtraction and noise-level measurement for automatic pixel weighting
- Automatic centering/sizing of the output field

- Multithreaded
- Speed: typically 500kpix/s on a bi-proc Athlon @1.5GHz

Some projections supported in Swarp



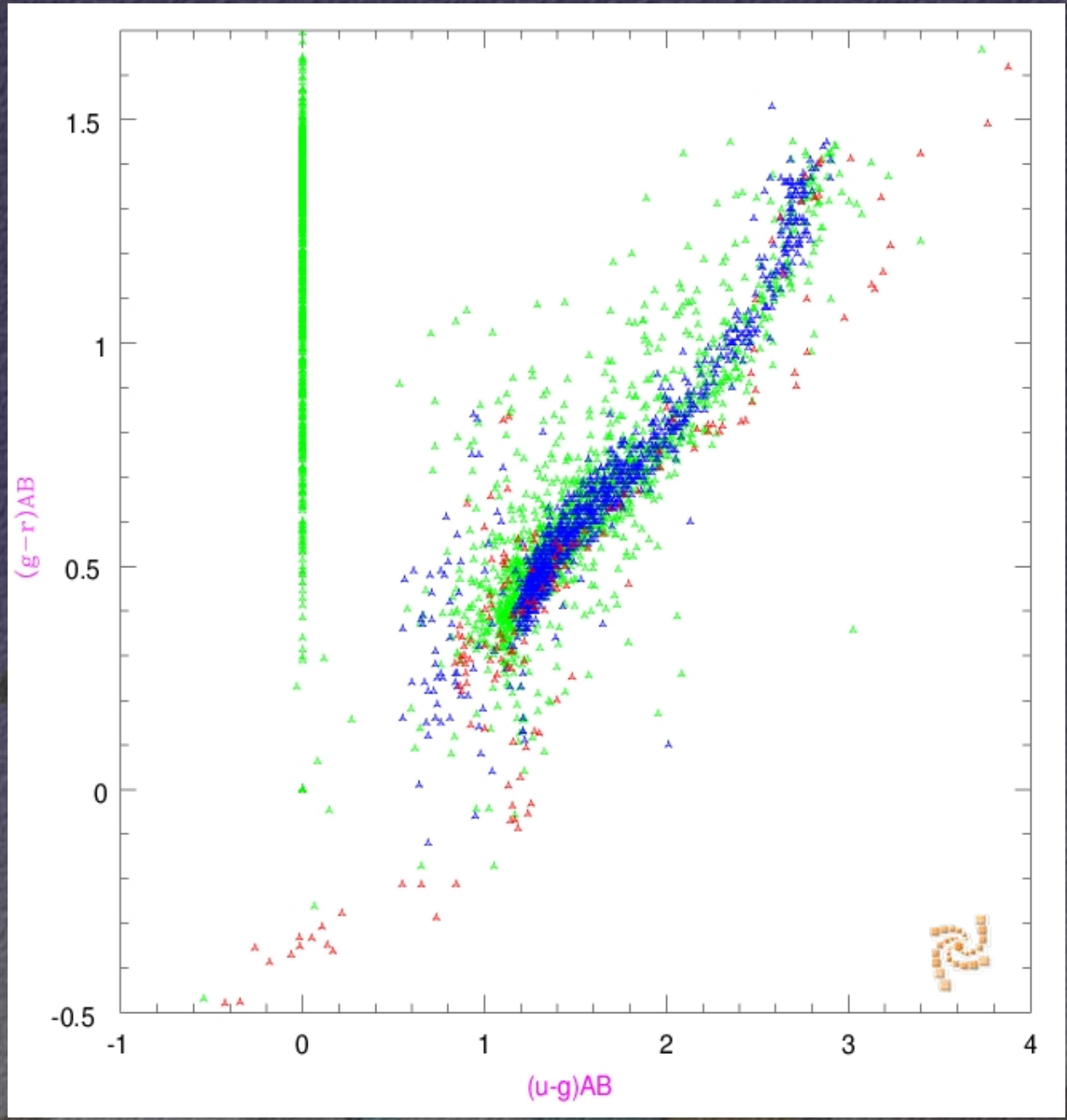
Weighted co-addition



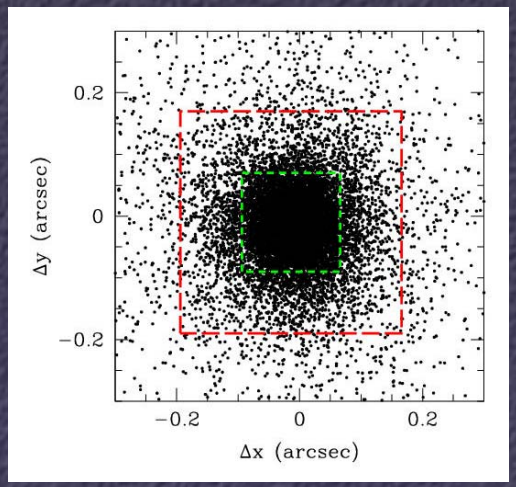
Application to Megacam:

SDDS vs. Megacam star color-color diagram

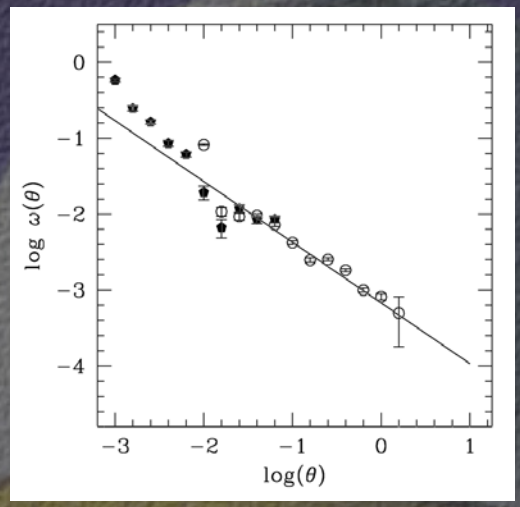
18 x 560 sec. r' + 17 x 560 g' + 13 x 700 sec. u* Megacam data



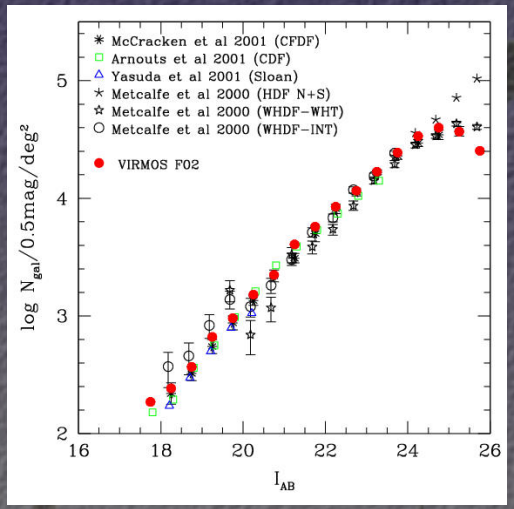
Scientific applications as test bench for Terapix



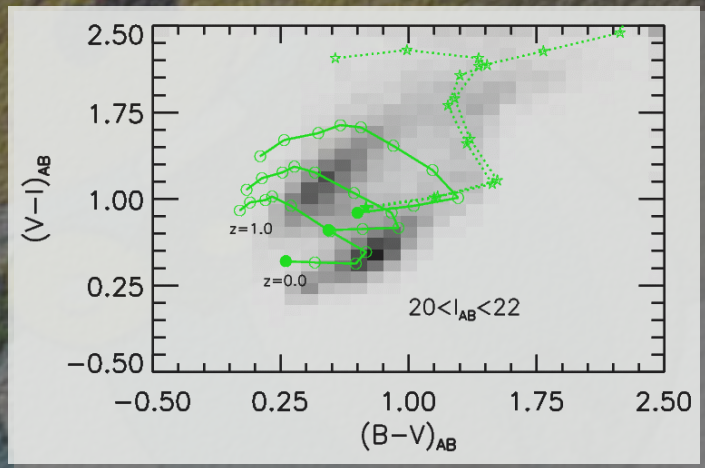
Astrometry



Photometry: 2-pt galaxy correlation function



Photometry: galaxy counts



Photometry: galaxy color-color tracks

VIRMOS/TERAPIX teams: McCracken et al. 2003

Performances

Configuration

- Datatransfer + QualityFITS + SPICA (detection, astrometry, warping, co-addition, QualityFITS-out) + DB storage
- 10 Bi-proc nodes working

Performance

- Data transfer CADC to Terapix: ftp : 20 Megacam (compressed) images/hr
- 1000 Megacam images Nov. 2003: 250 hrs (expected soon: 200 hrs): 30 working days (~ 8hrs/day)

Expected input flow

- Big Megacam run: 10 hrs/night; 15 nights, 5min. Exp. Time: 1800 images

- We are almost ok, but we must think about re-processing: better software tools; faster and more reliable nodes and CPUs; more optimised compilation options

On going developments and prospects

- Image masking
- PSF homogenization
- Improve/increase quality assessment tools
- Image visualisation: Panorapix
- Survey follow up tools: skywatcher
- Prepare WIRCAM tools, if needed

- More complex and precise galaxy morphology analysis

End