Antarctic Research, a European Network for Astrophysics

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(ARENA coordinator)

- A 4-year (2006-2009) EC FP6 network to foster an Antarctic Research Infrastructure for Astrophysics [mainly] at Dome C
- EC: « Research Infrastructures » ; European Research Area (ERA)
- « No science, no R&D », but « coordination»
- *Critical mass and added value*
- 22 partners (incl. Agencies) , 7 countries (6 from Europe and Australia)
- Budget: 1.35 MEURO

* read by Hans Zinnecker (ARENA NA5 leader)

Antarctic Research, a European Network for Astrophysics

- Aims:
  - ✓ prepare the ground (*roadmap*) for a new Research Infrastructure
  - ✓ collect site testing data and give open access to them
  - ✓ identify most compelling science cases
  - ✓ propose adequate *polar-certified* mesoscale instruments & instrumentation (concept studies)
  - ✓ send appropriate requests to the Polar Agencies to upgrade the logistics resources (transport, power supply, communications, health, environment)

  3 ARENA conferences: Roscoff 2006, Potsdam 2007, Frascati 2009

- http://arena.unice.fr

European Antarctic Astronomy at a crossroads

- **Cosmic visions**
  - ESA Cosmic Vision (2007), ASTRONET (2008)
  - US: Astro2010 decadal survey (in progress)
  - French INSU «*prospective*» (in progress, 2009) …
  - European Astronomy in Antarctica : ARENA (2009)
- **An Antarctic astronomy «*roadmap* »**
  - tasks, NA, achievements ; '*deliverables'*
  - projects proposed by 6 dedicated working groups (WG)
- Ambitious, but realistic medium-scale projects (PLT, AST) as first steps toward larger projects
- Open discussion → recommendations
- **Recommendations, but no priority list**
- How to get further support from EU after ARENA?

ARENA network

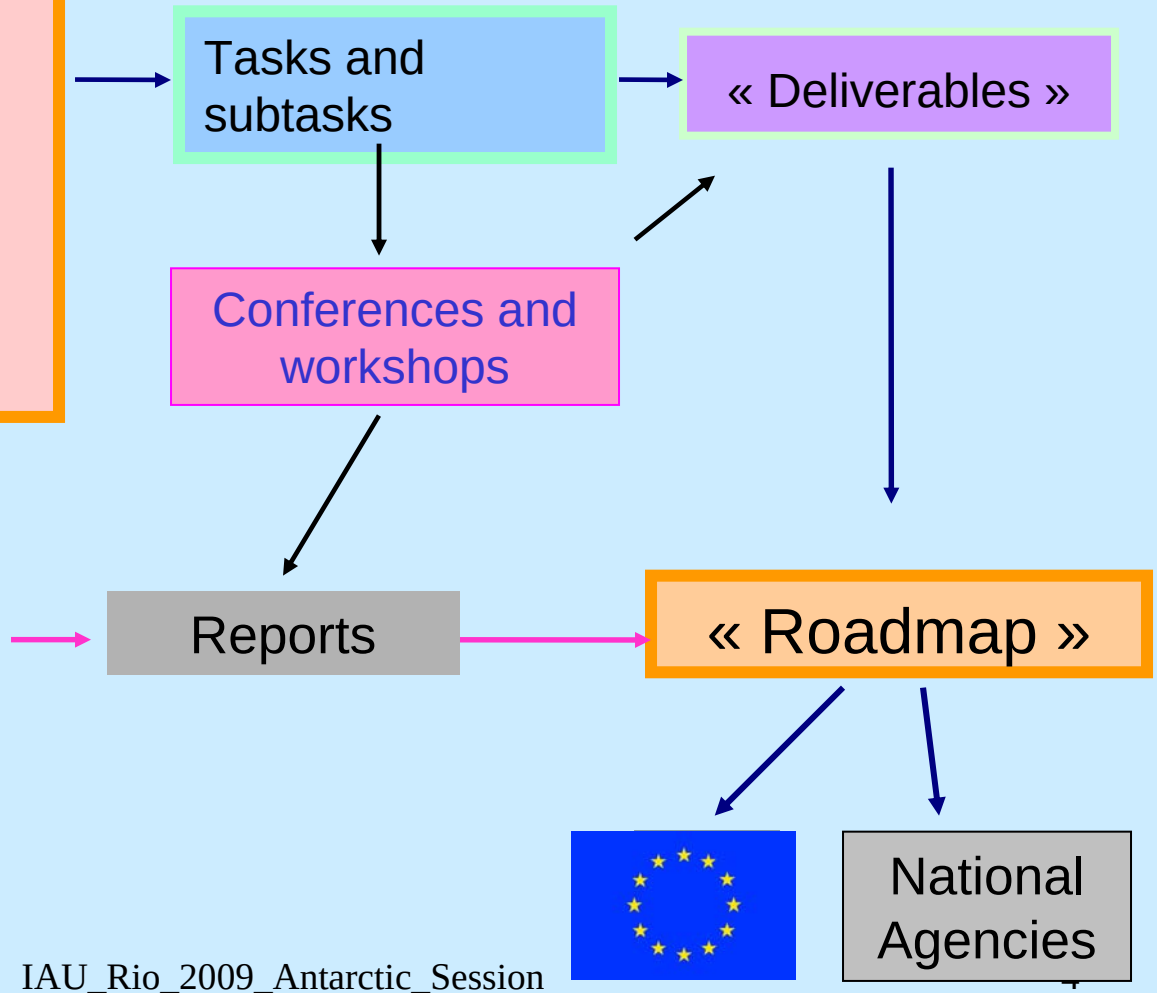
How we work

5 Networking Activities

- Management (incl. Outreach) **(NA1)**
- Site qualification **(NA2)**
- Instrumentation **(NA3)**
- Logistics (**NA4)**
- Key science cases **(NA5)**

6 Working groups

- optical/IR Wide Field imaging
- Submillimetre wave
- Optical/IR interferometry
- Long time series
- CMB (polarization)
- Solar physics (HAR)



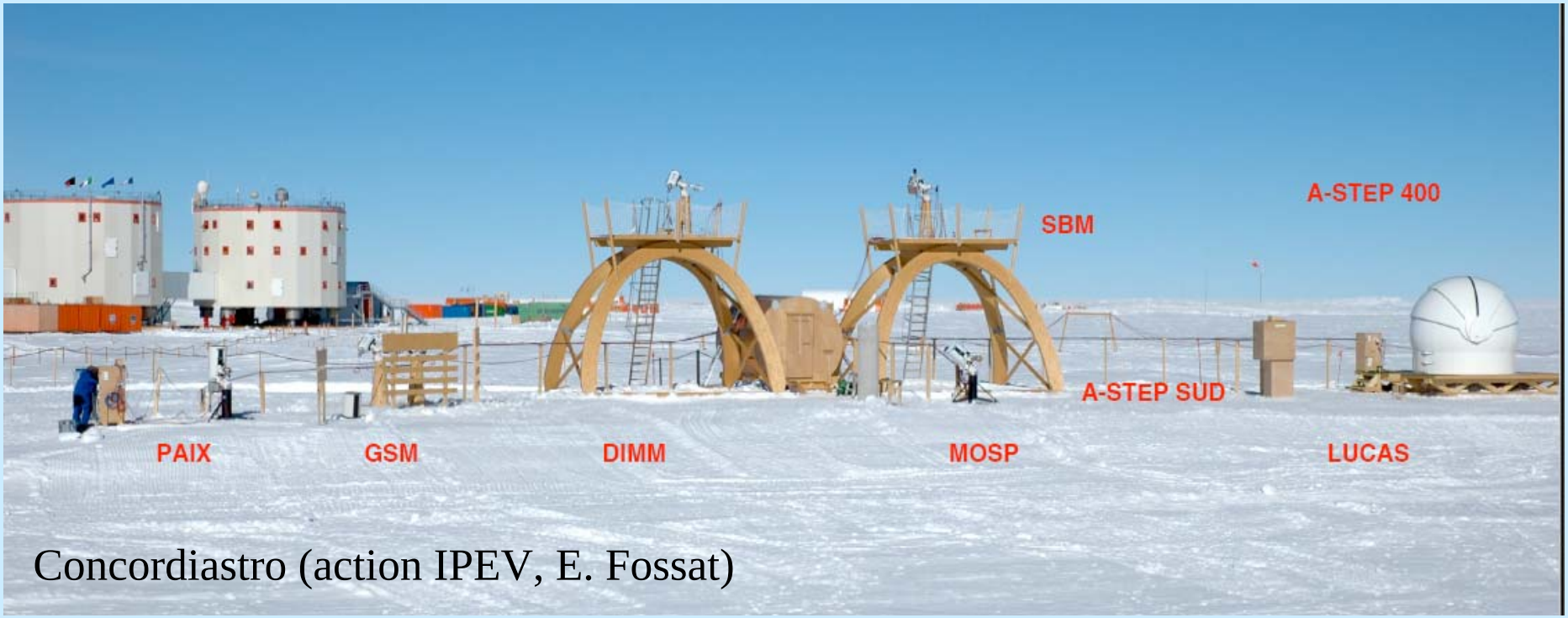
Concordia a unique site for astronomy

- Concordia at Dome C is one of the few year round operated Antarctic stations suitable for astronomy (from the optical to the mm wavelength range)
  - 70-80% of clear photometric time
  - Lowest PWV content *(Submillimetre wave) 0.25 mm*
  - Low sky brightness *(infrared) 3 magnitudes below other sites*
  - Unique air turbulence properties *(HAR, stability) seeing etc.*
  - Tested logistics *(IPEV/PNRA) 5th winterover (15 persons)*

- Compelling science cases (defined at ARENA2/Potsdam)

Synthesis of site qualification *from*

Aristidi, Fossat, Ziad, Gredel, Trinquet, Storey, Valenziano, Argentini, Ashley, Burton, Lawrence ...



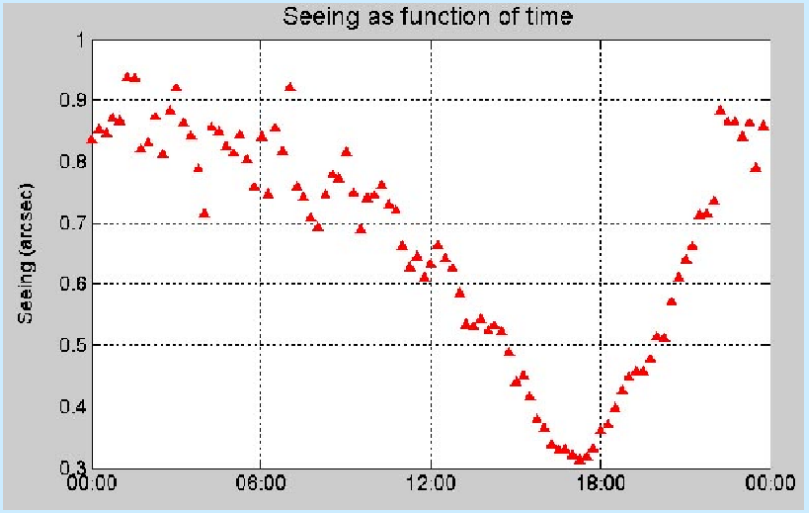
Concordiastro (action IPEV, E. Fossat)

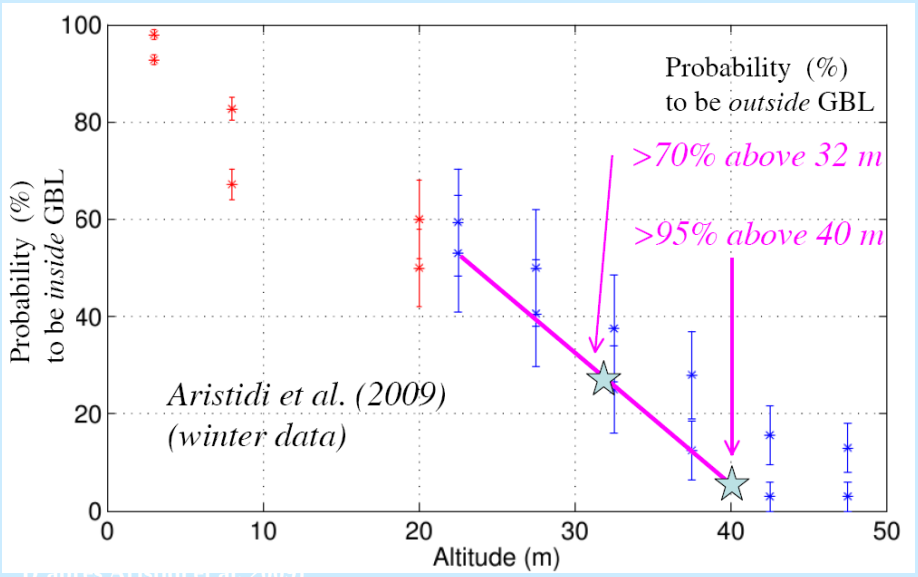
Atmospheric conditions at Dome C

Time % for clear sky > 0.9	78%
> 0.85	80%
> 0.5	91%
# of consecutive clear days (fraction >0.9)	
Average :	5.3
Max :	14.9
# of consecutive bad days (fraction <0.25)	
Average :	0.5
Max :	1.6

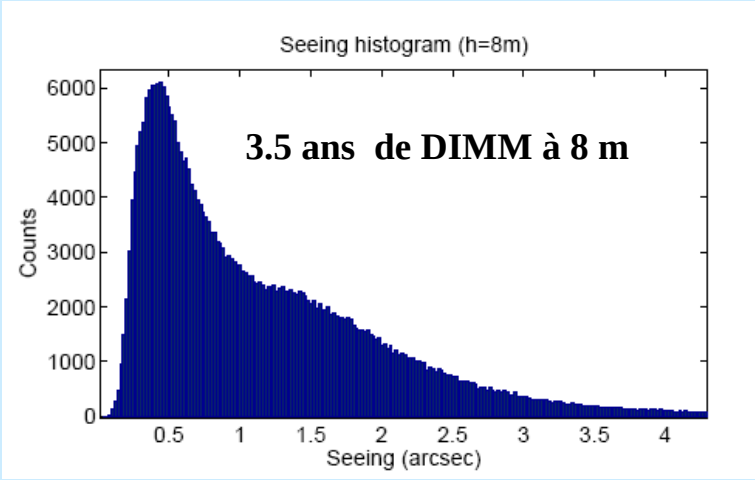
% of time

From visual observations (4-5 points per day) by E. Aristidi during the period Jan 1 – Oct 31, 2006





D'après Aristidi et al. 2009)



How much better?

	Dome C	Best site	Gain
IR brightness @K **@L'**	16.5 8.6	13.4 (Mauna Kea) 5.3 (Mauna Kea)	**3 mag**
Transmission @350 μm **@200 μm**	60 % 20 %	45 % (Chajnantor) <10% (*ibid*)	**25 %** **50 %**
Seeing **(arcsec)**	1.6 0.3 (30m)	0.7 (Mauna Kea)	**factor 2**
Coherence time (sec)	7 (ground) 11.2 (30m)	3 (Paranal) 2.9 (Mauna Kea)	**>factor 2**
Outer scale Lo (m)	<10		

« *The ARENA CMC* » recommendations

1. Supports Concordia as a site for a future astronomical observatory
2. Encourages international collaborations to study and build a set of *facilities (such as PLT, Alladin, AST, solar instrument)*
3. Emphasizes the need for meso-scale facilities (pathfinders)
4. Recommends that the site qualification continues and that the collected data be widely accessible to the community
5. Endorses the science cases proposed by the 6 dedicated working groups
6. Recommends to carry out dedicated technical studies related to the polar environment
7. Recommends upgrades of logistics (transport, communication, energy)
8. Suggests to continue to seek further funding from the EC
9. Gives support to a set of instrumental projects proposed by the WGs (in progress)

WG Projects review and recommendations

- WG1- Wide field: PLT
- WG2 – Submillimetre : AST
- WG3 – Interferometry: Alladin, alternatives?
- WG4- Time series:
  - On going: IRAIT, a-STEP → message
  - ICE-T (photometric)
  - SIAMOIS (spectroscopic)
- WG5 - CMB projects: BRAIN→ QUBIC (US)
- WG6 – Solar: EFSIIC, and other solar projects

WG1 proposal

- PLT concept basically agreed
  - Based on phase A PILOT study (Aus) (*see Burton's presentation*)
  - Emphasis on NIR imaging and specto-imaging surveys
  - Distant Universe, Exo-planets (transit + µlensing)
  - Galactic Ecology
- Basically Australian (~15 persons) + French (>15 persons) interest, but no clear message from Italy, Spain, Germany
- Iniatate a phase B study for a 2.5m PLT in

WG2 – Submm THz

- COCHISE first radiotelescope at Dome C (2007)
- Main project: AST 25m single dish radiotelescope
- Essentially dedicated to 200-350 μm range
- No smaller (12m) telescope proposed
- Basically collaboration France (CEA), Italy (INAF) + TAS/EIE
- CMC recommends a phase A study
- Dome A perhaps a better site?

AST = 25m single dish telescope top level requirements

- 25m single dish
- 200, 350, 450 μm (up to 2 mm ?)
- Extension to the mid-IR/FIR ?
- Best angular resolution in submm: ~2"
  - Surface RMS < 12 micron
  - FOV: 5 – 20 arcmin
  - Pointing accuracy: < 0.3 arcsec
- Optical design
  - Ritchey-Chrétien (CCAT-like)
  - Shaped surfaces (SRT-like)
  - Offset configuration (SPT-like)
  - Spherical primary?
- Instruments location
  - **Bent Cassegrain focus, in rotating RX room**
  - **Nasmyth foci, stationary**
- Bolometer array
- Heterodyne multi-beam array
- Study with EIE and TAS
  - active surface / active primary mirror
  - big secondary (3 m)

From Minier, Proc. ARENA3, May 2009

WG3- Interferometry

- Aladdin (exozodi « machine », cf. Darwin)

  (see talk V. Coudé du Foresto)
- No clear consensus of IR/optical interferometric community
- Kilometric array ?
- Which pathfinder ?
- PLTI (interest to use PLT as first element)
- Mykerinos (3 small telescopes, phase closure)

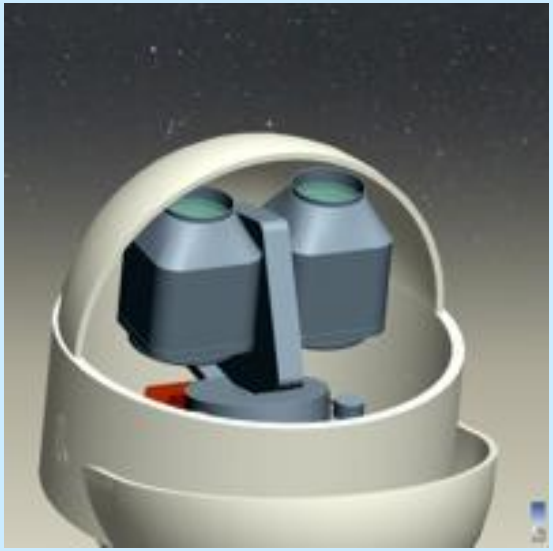
WG4- long time series

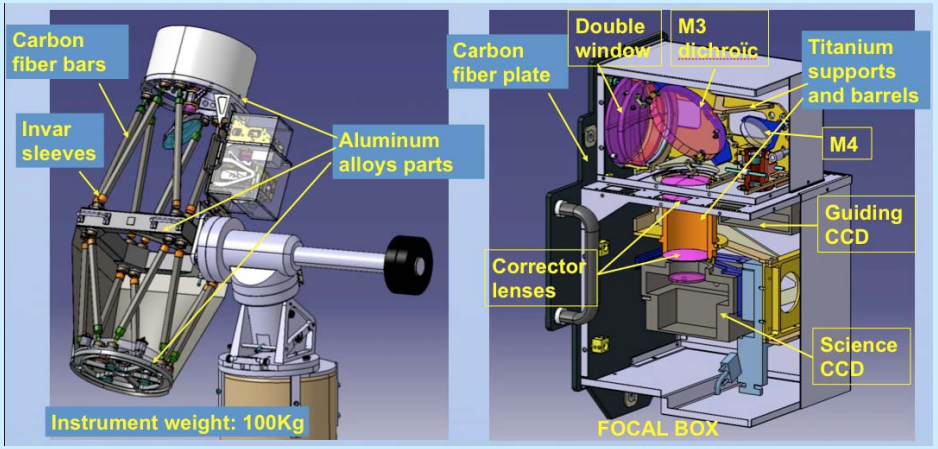
- **IRAIT(80 cm IR)** must be set up next season.
  - AMICA camera status → Dome C 2010
  - First light winter 2010?
- **A-Step** (small A-Step and A-Step400)
  - Set up next Summer First light winter 2010
- **ICE-T** strongly recommended, but status?
- **SIAMOIS** recommended but single team project
- **PLT** interest in transits, µlensing, …

WG4 long time series

		Method	FOV	Aperture	Time resolution	Time duration	Possible project
Exoplanets	Exoplanet transit search (detection)	CCD phot, IR Phot	Wide-Ultra Wide	All	10 min	Months-Years	A-STEP ICE-T, PILOT
	Exoplanet characterization	IR phot	Small	Mid-Large	1 min	Hours	IRAIT, PILOT
	Exoplanet timing (detection)	CCD phot	Wide	Mid	30 sec	Months	ICE-T, A-STEP
	Microlensing (detections)	CCD phot	Ultra Wide	Mid	2 min	Months	ICE-T
	Microlensing (tracking)	CCD phot	Small	Mid	10 sec	Days	PILOT
Stellar physics	Asteroseismology	CCD phot	Wide	All	10 sec	Months	ICE-T
		HiRes spec	Small	All	1 min	Months	SIAMOIS
	Long-period pulsation variables	CCD phot	Wide	All	10 min	Months-Years	A-STEP ICE-T
		HiRes spec	Small	All	10 min	Months	SIAMOIS
	Stellar activity (detection)	CCD phot	Wide	Small	10 min	Days-Months	A-STEP ICE-T
	Stellar activity (characterization)	CCD phot w bandpasses	Wide	Mid	10 min	Months	ICE-T IRAIT
		HiRes spec	Small	Large	20 min	Months	PILOT SIAMOIS
Solar Science	Solar science						

Small instruments at CONCORDIA, IRAIT, A-STEP, ICE-T, SIAMOIS





WG5 CMB

- A major topic for antarctic astronomy
- BRAIN
- New collaboration with US: QUBIC
- Interest in AST

WG6- Solar physics

- Dome C is an excellent solar observing site.
- Excellent science cases for solar high angular resolution
  - Good seeing + coronal (unique according to O. van der Lühe)
- Site testing in progress (sky background in visible/Arnaud)
- Coronograph?
- Interferometer (AFSIIC)?

ARENA Roadmap

- Release in Fall 2009

  → EC, National Agencies, ESO…
- Content:
  - the work done in fulfillment of the ARENA work programme (deliverables)
  - reports of the 6 working groups
  - status of logistics and proposed upgrade
  - final statements and recommendation to the EC and National Agencies