ESCS

(**E**nhanced **S**ingle-dish **C**ontrol **S**ystem)

New facilities for the Medicina 32-m dish

Simona Righini – INAF Dipartimento di Astronomia – PhD Student

INAF-IRA Working group

The people taking care of the ESCS development are:

- Alessandro Orfei
- Ettore Carretti
- Giuseppe Maccaferri
- Karl-Heinz Mack
- Franco Mantovani
- Andrea Orlati
- Alessandra Zanichelli

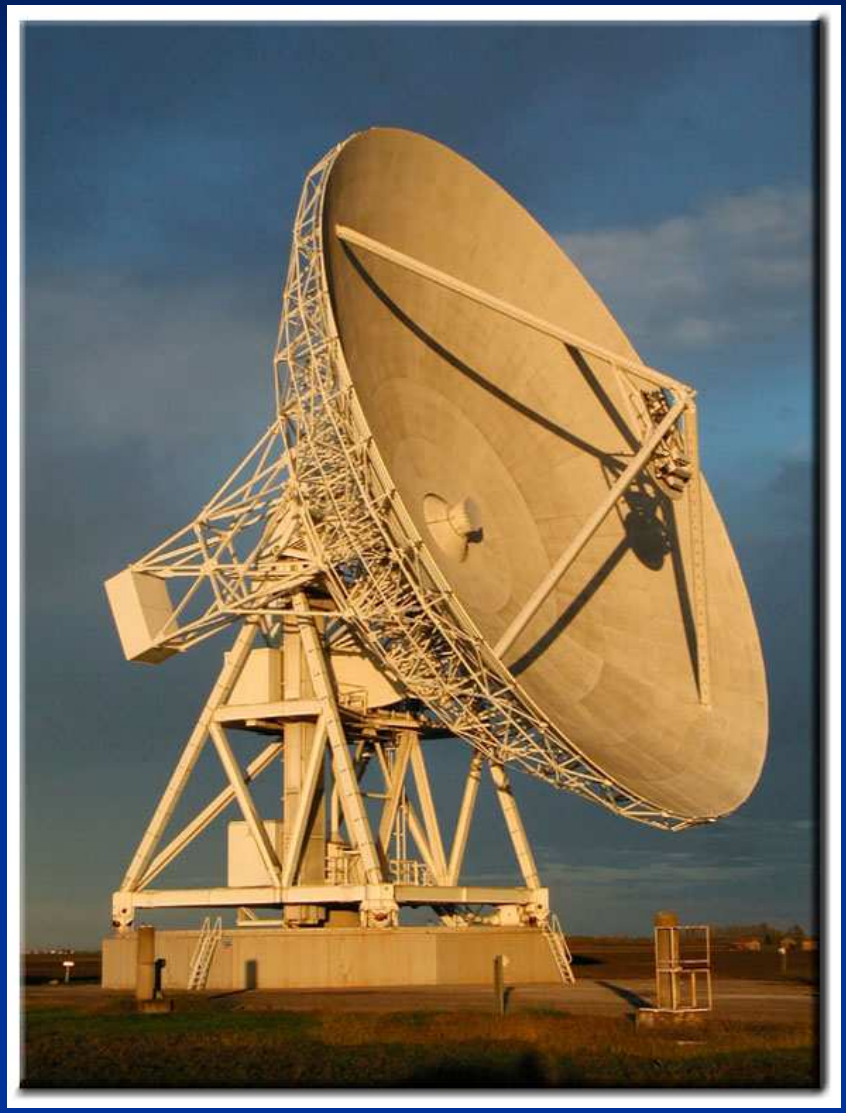
Two PhD students have been recruited:

- Simona Righini (Mar.2007 – Tutors: D.Dallacasa, A.Orfei, E.Carretti)
- Rashmi Verma (Sep.2007 – ESTRELA fellowship – Tutors: L.Gregorini I.Prandoni A.Orfei)

Once upon a time…

1983 – The 32-m dish under construction

Present antenna facilities



More than 50% of antenna time devoted to interferometry (VLBI) – development of tools and systems mainly for this task.

The antenna is managed using the standard VLBI software called "Field System" (FS)

Available receivers – all single-beam:

- 1.35 – 1.45 GHz (p)
- 1.515 – 1.715 GHz (p)
- 2.20 – 2.36 GHz (p)
- 4.30 – 5.80 GHz (c)
- 5.90 – 7.10 GHz (c)
- 8.18 – 8.98 GHz (p)
- 21.86 – 24.14 GHz (p)

The new 18-26 GHz multi-beam receiver

T_{sys} (El=45°) = 70 K (with τ = 0.1)

Gain (El=45°) = 0.12 K/Jy (predicted) for the central beam

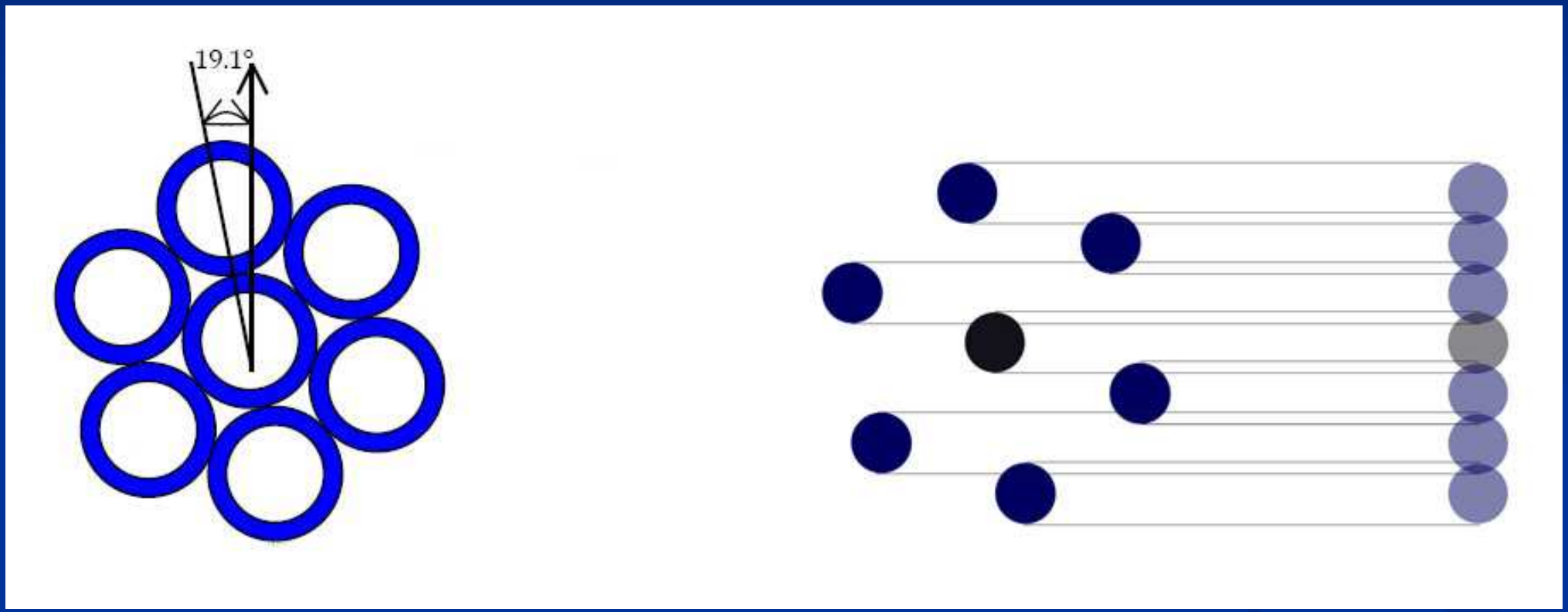
Gain (El=45°) = 0.11 K/Jy (predicted) for lateral beams

HPBW = 92” for every beam, at 22 GHz

Sky distance between beam couples = 215”

14 output channels (7 LCP + 7 RCP) with 2 GHz-wide IF bands

Multi-beam orientation



Present antenna facilities: backends

Spectrometers: ARCOS, MSpec0, Spectra-1 (almost done)

Continuum backend: MarkV (VLBI acquisition system)

Polarimeter

Other: SPEX (SRT Pulsar EXperiment)

Every backend runs a proprietary software.

All these devices are interfaced with the Field System to perform the antenna pointing.

Most of them produce output files in a custom format.

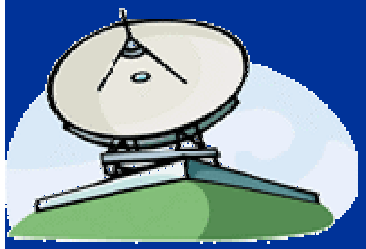
Present observing modes

- Sidereal tracking
- Accelerated tracking (constant RA and Dec rates applied)
- ON-OFF
- FIVEPT (FS raster cross-scan for antenna pointing calibration)
- OTF mapping (FS script to map a given sky area, developed for polarimetric observations)

ESCS improvements:

Possibility to implement new modes

Restyling of the system operating software



ESCS: enhancing the single-dish potential

The ESCS system will include all the necessary tools to effectively employ the 32-m antenna as a single-dish telescope:

- Antenna pointing and setup for old and new observing modes in continuum, spectrometry and polarimetry
- Comprehensive user-friendly interface to guide novice and expert users along the observation scheduling and execution. Absentee and remotely accessed sessions will then be easier to perform
- Standard calibration procedures and real-time quick-look of the data being acquired
- Production, for all the station backends, of standard-output files (MBFITS format)
- Open “back-door” to guest backends

ESCS: other features

- Improved monitoring of the site conditions (weather, RFI…) and of the antenna performance
- Dynamical antenna time allocation
- New data archive and data access policy
- User's feedback

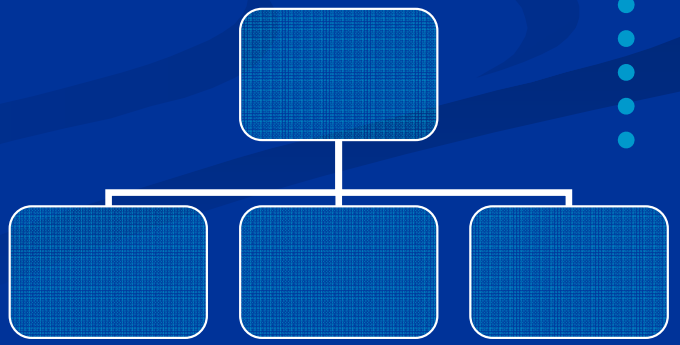
Eligibility to join the TransNational Access




ESCS design and development instruments

The main software/hardware instruments to develop the ESCS system have been identified in:

- Unix-Linux platform
- ACS (ALMA Common Software) framework
- PCs - other machines
- TCP/IP and CORBA communication protocols
- C++ as programming language, Python for scripting
- QT libraries and JAVA for GUI
- Doxygen as automatic documentation tool
- UML (Unified Modelling Language) to schematise the system architecture



ALMA and ACS

The Atacama Large Millimeter/submillimeter Array (ALMA), an international astronomy facility, is a partnership of Europe, Japan and North America in cooperation with the Republic of Chile.

ALMA is funded in Europe by the European Organisation for Astronomical Research in the Southern Hemisphere , in Japan by the National Institutes of Natural Sciences (NINS) in cooperation with the Academia Sinica in Taiwan and in North America by the U.S. National Science Foundation (NSF) in cooperation with the National Research Council of Canada (NRC).

ALMA construction and operations are led on behalf of Europe by ESO, on behalf of Japan by the National Astronomical Observatory of Japan (NAOJ) and on behalf of North America by the National Radio Astronomy Observatory (NRAO), which is managed by Associated Universities, Inc. (AUI).

ALMA project

ALMA project

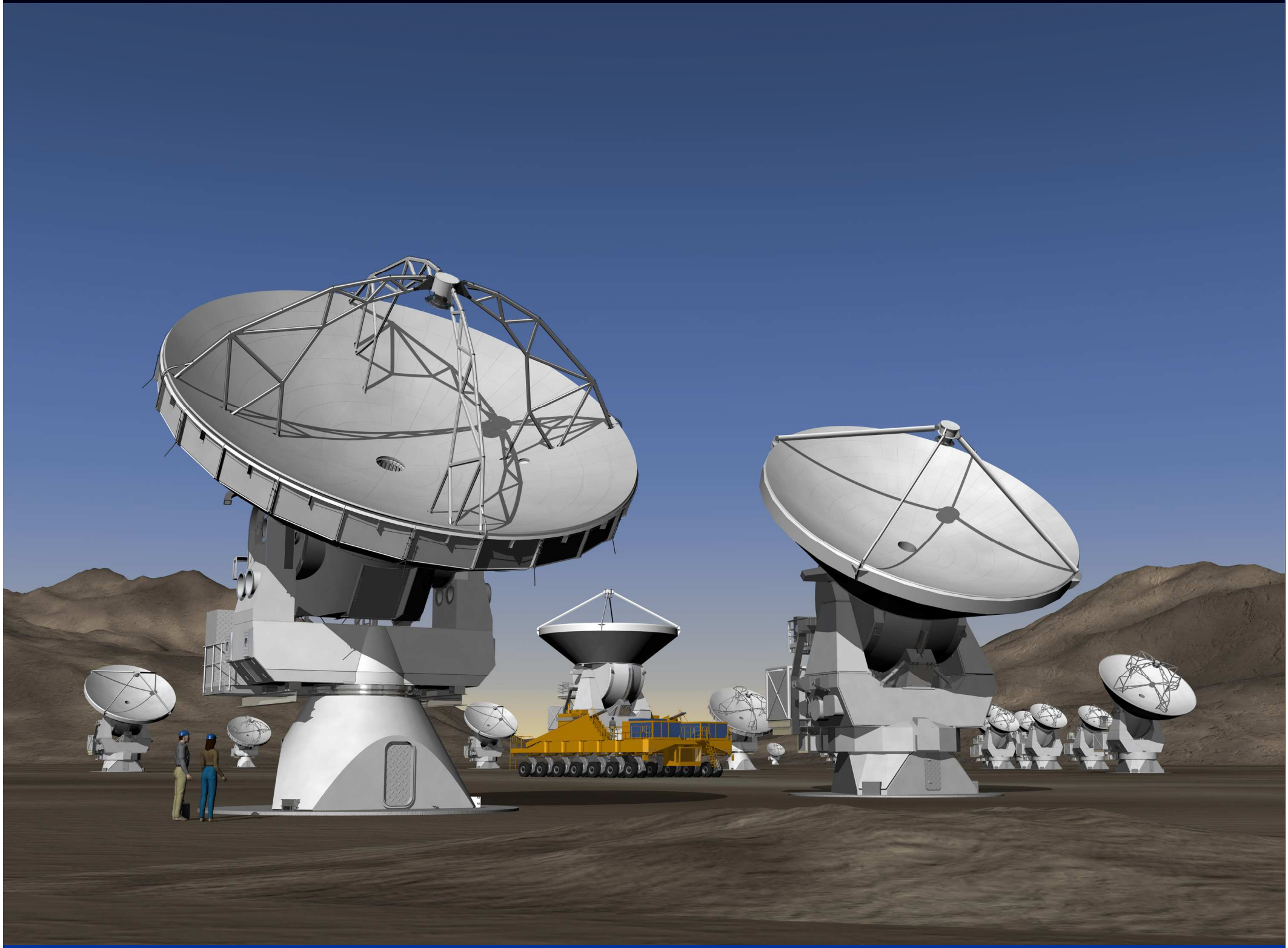
- Europe (ESO) + North America (NRAO+Canada) + Chile
- Up to 64 12-m antennas at 5000-m in the Atacama desert in Chile
- antenna baselines = 150 m to 10 km (reconfigurable)
- 4 receiver bands around 100, 250, 325, and 650 GHz (first light)
  - DSB/2SB receivers
  - Dual polarization
  - Wide band IF (4-12 GHz)
  - Cryogenic temperatures

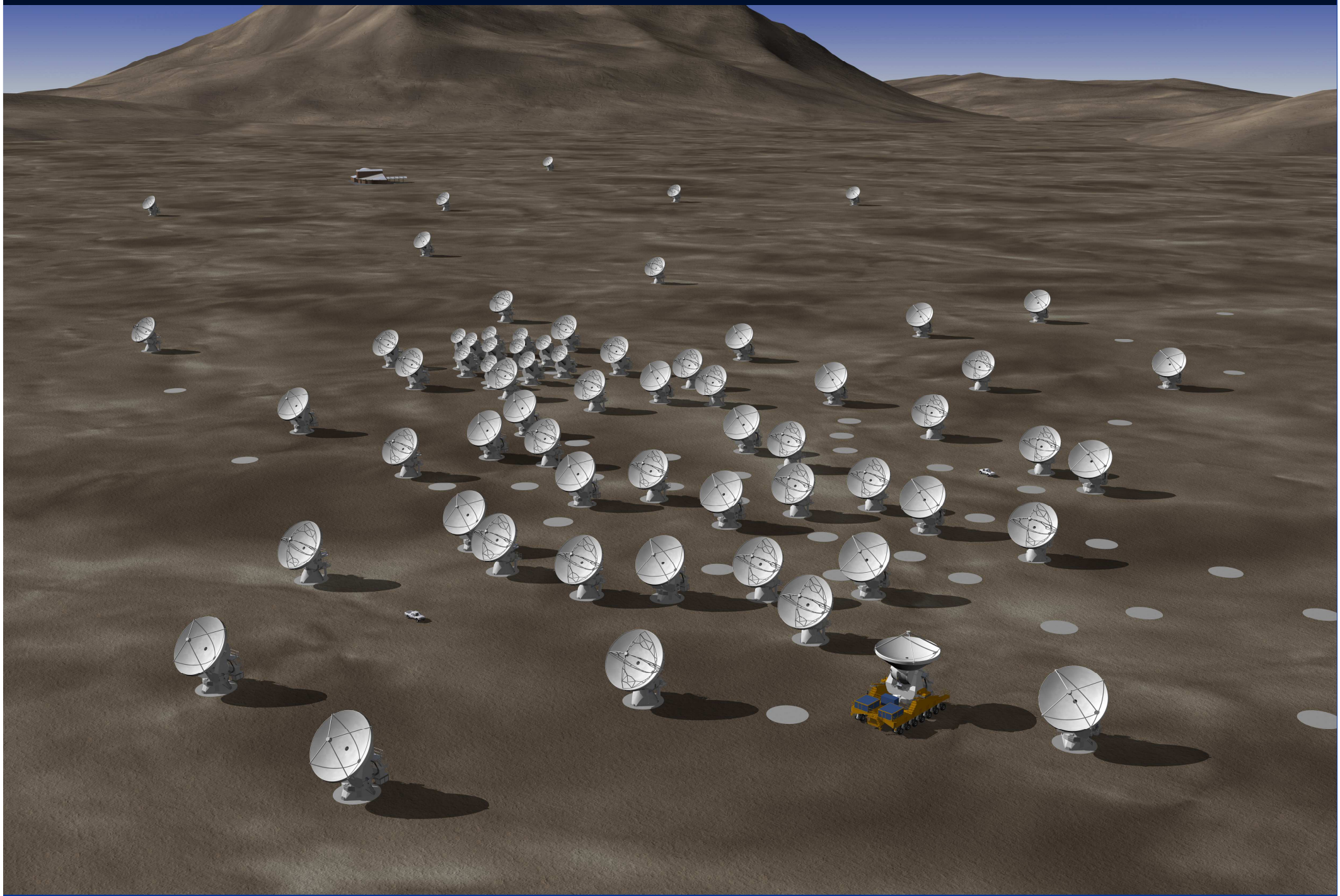
1300 M$ (2006)

- possibility to expand to 10 bands over 30 GHz to 1 THz
- Wide band IF (4-12 GHz) 6 Mb/s average data rates (60 Mb/s peak)

After Japan has joined in 2004

- additional 4 12-m + 12 7-m antennas (compact array)
- additional correlator
- receiver bands around 150 and 450 GHz (+ possibly 850 GHz)



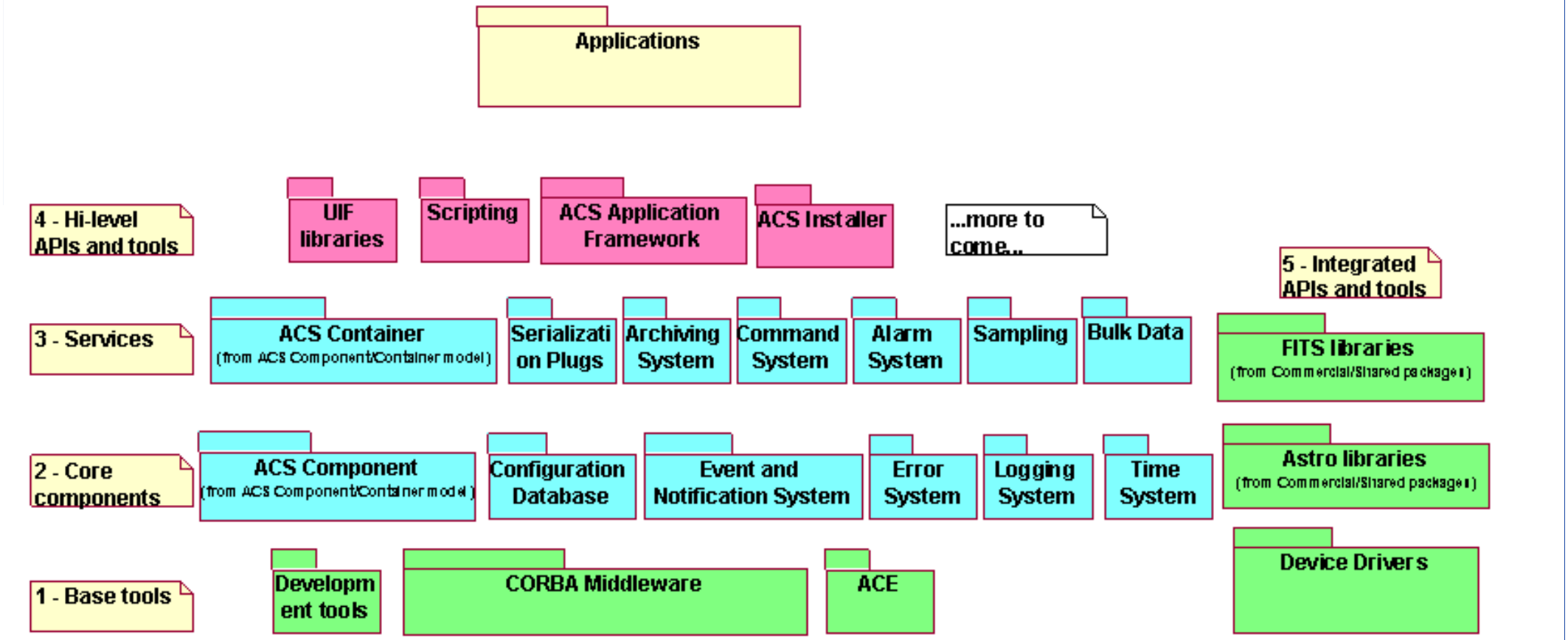


ALMA Common Software

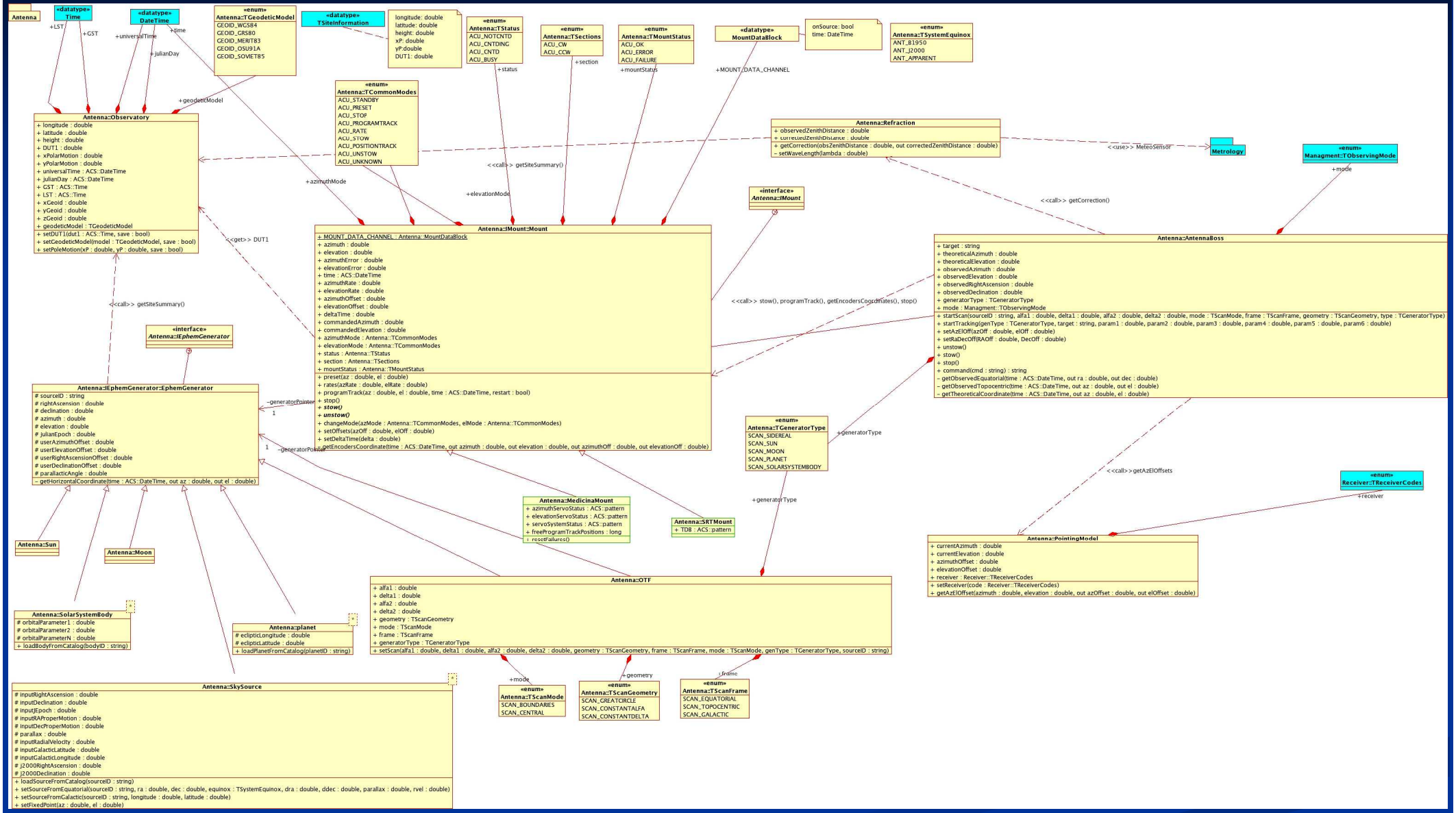
- The ALMA Common Software (ACS) provides a software infrastructure common to all partners and consists of a documented collection of common patterns in and of components, which implement those patterns. The heart of ACS is an object model based on Distributed Objects (DOs), implemented as CORBA objects. The teams responsible for the control system development use DOs as the basis for components and devices such as an antenna mount control.
- ACS provides common CORBA-based services such as logging, error and alarm management, configuration database and lifecycle management. A code generator creates a Java Bean for each DO and programmers can write Java client applications by connecting those Beans with data-manipulation and visualization Beans.
- **ACS is based on the experience accumulated with similar projects in the astronomical and particle accelerator contexts**, and reuses and extends proven concepts and components. **Although designed for ALMA, ACS can be and is being used in other control systems and distributed software projects, since it implements proven design patterns using state of the art, reliable technology**. It also allows, through the use of well-known standard constructs and components, that other team members whom are not authors of ACS easily understand the architecture of software modules, making maintenance affordable even on a very large project .

  ACS is publicly available under the GNU LGPL licence.

ACS overall scheme



ESCS overall scheme



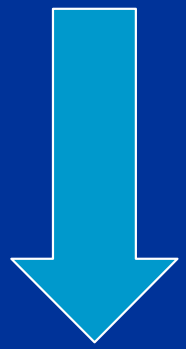
ESCS System Requirements: IRA technical report n. 409/07

Science with the multi-beam and ESCS

Wide **blind survey** at 18-20 GHz to serve different research projects.

My personal task: study of **extragalactic compact sources as foreground "noise"** signal of CMB observations.

Study of the Astrophysics of extragalactic sources (by statistical properties) – other people involved in.



Complementary to the AT20G southern survey, ongoing at the ATCA (Australia Telescope Compact Array): completed - but data not released, yet

Our goal…

Thanks to the new multi-beam receiver and the updated control software, we plan to improve and increase the single-dish activity for the 32-m antenna in Medicina, making it available in an international context.