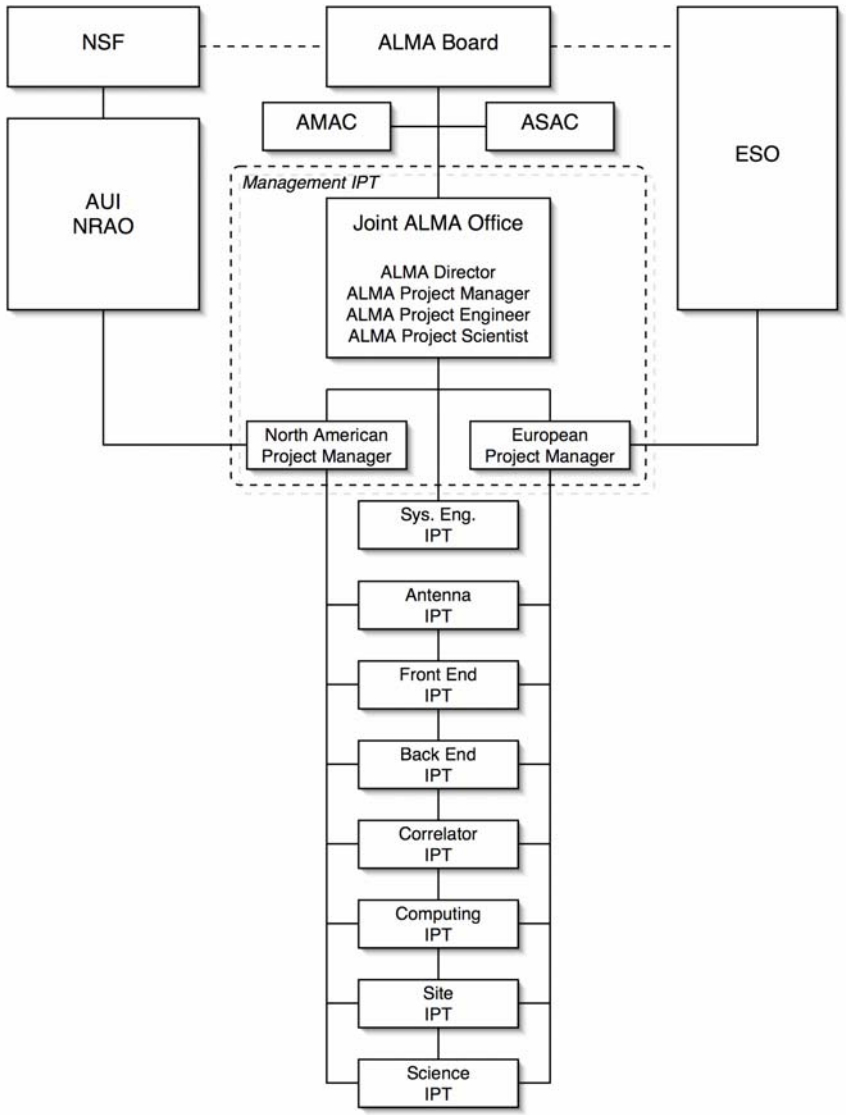
Atacama Large Millimeter Array

Project Status

Atacama Large Millimeter Array
ALMA Project Organization



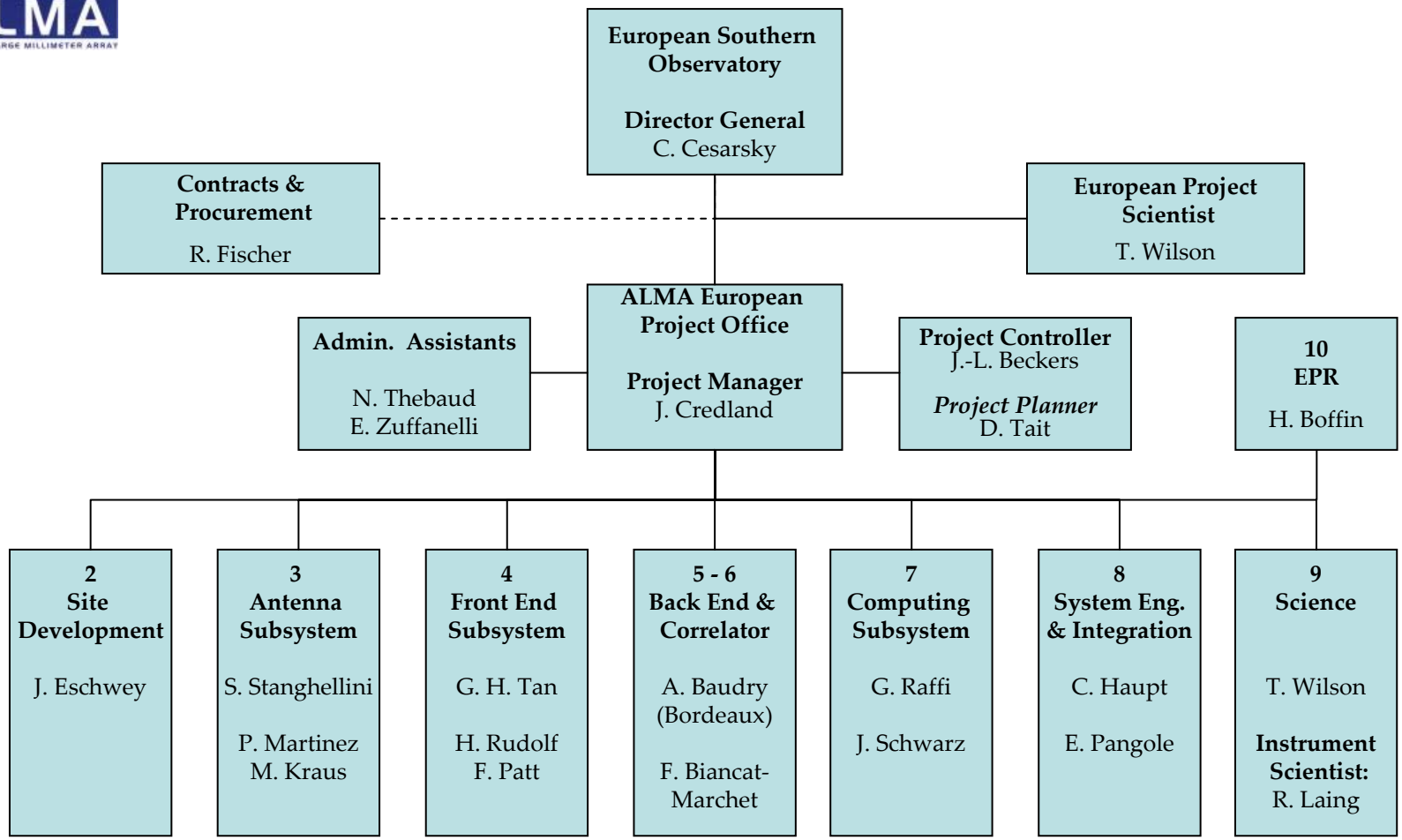
The System Engineering
now reports directly to th

Atacama Large Millimeter Array Management – JAO Staffing

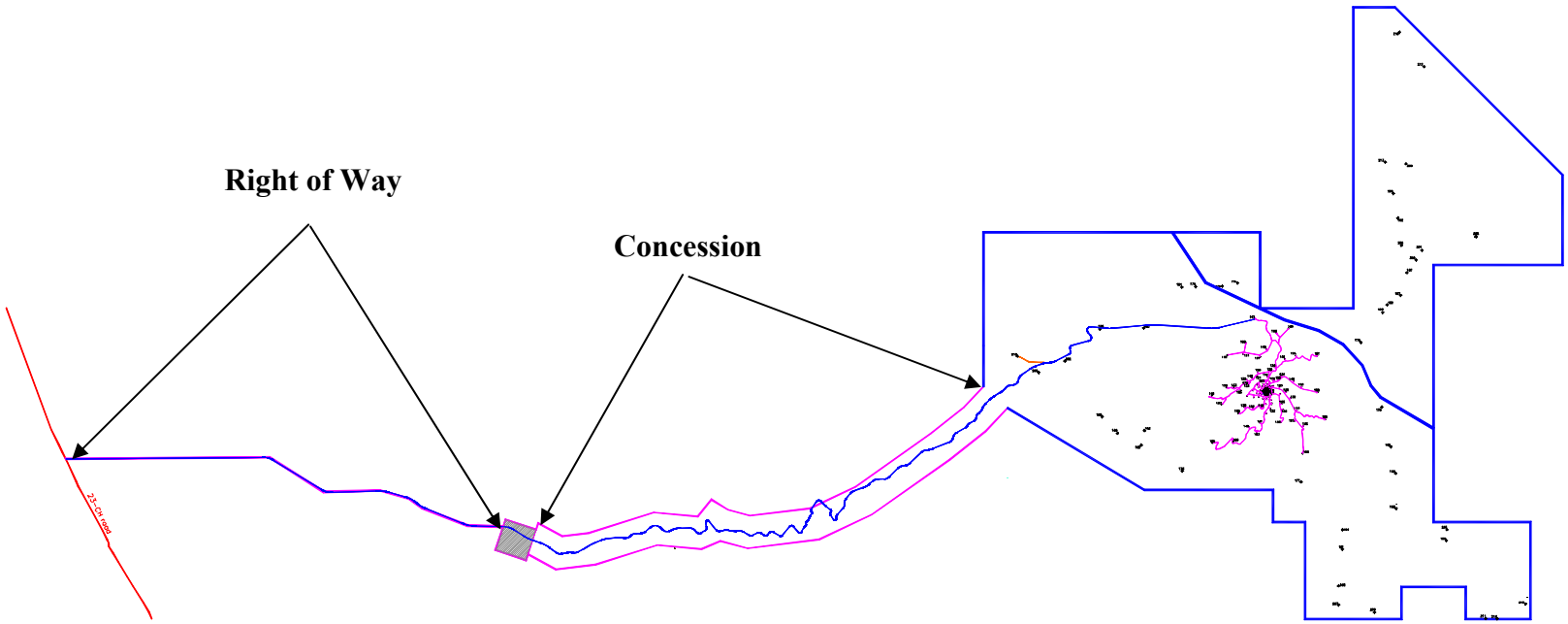
- **The Joint Alma Office (JAO) in Chile has the following staff in post:**

  - **Director:** **Massimo Tarenghi**
  - **Project Manager:** **Tony Beasley**
  - **Project Engineer:** **Rick Murowinski**
  - **Project Scientist:** ***Vacant***
  - **Project Controller:** **Richard Simon**

Atacama Large Millimeter Array Management – European Staffing 1



Atacama Large Millimeter Array
Site – Road Construction 2



Atacama Large Millimeter Array

Site – Road Construction 3

Atacama Large Millimeter Array
Site – Road Construction 4

View West **Road at 18Km** **View East**

Atacama Large Millimeter Array
Site – ALMA Camp 2

ALMA Camp – General View

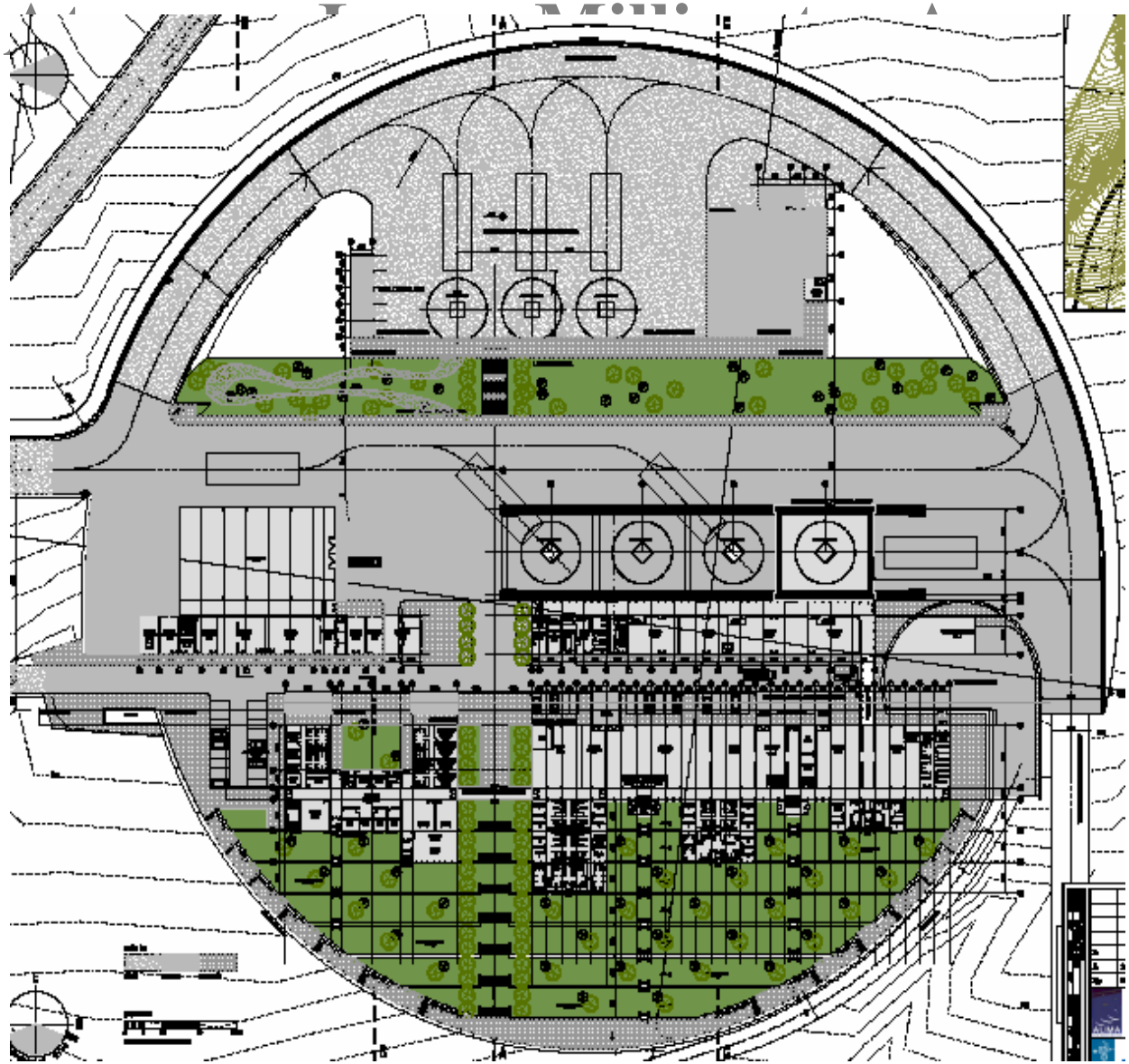
Inner Court

Typical Office

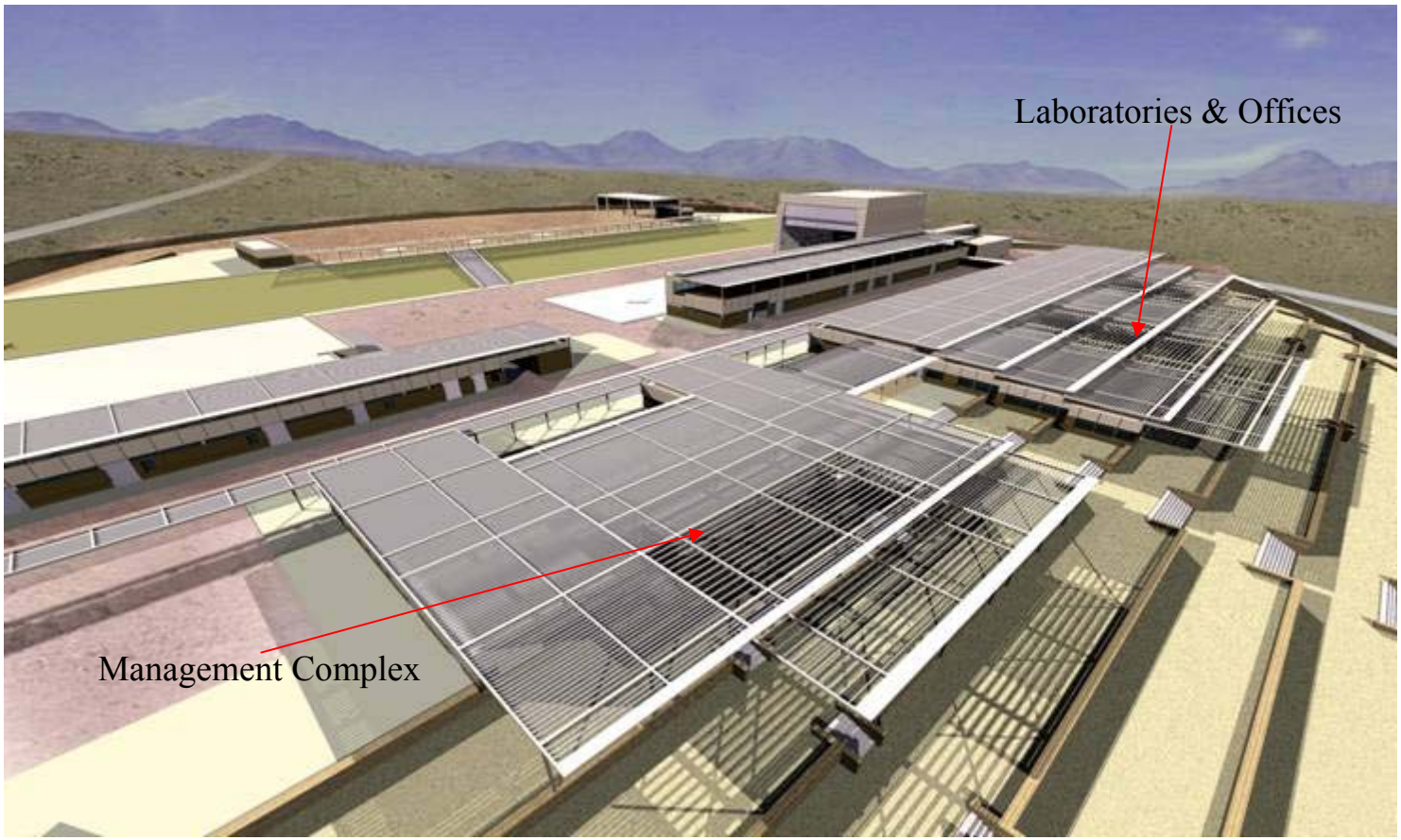
OSF Camps and Technical Facilities

OSF Technical Facilities

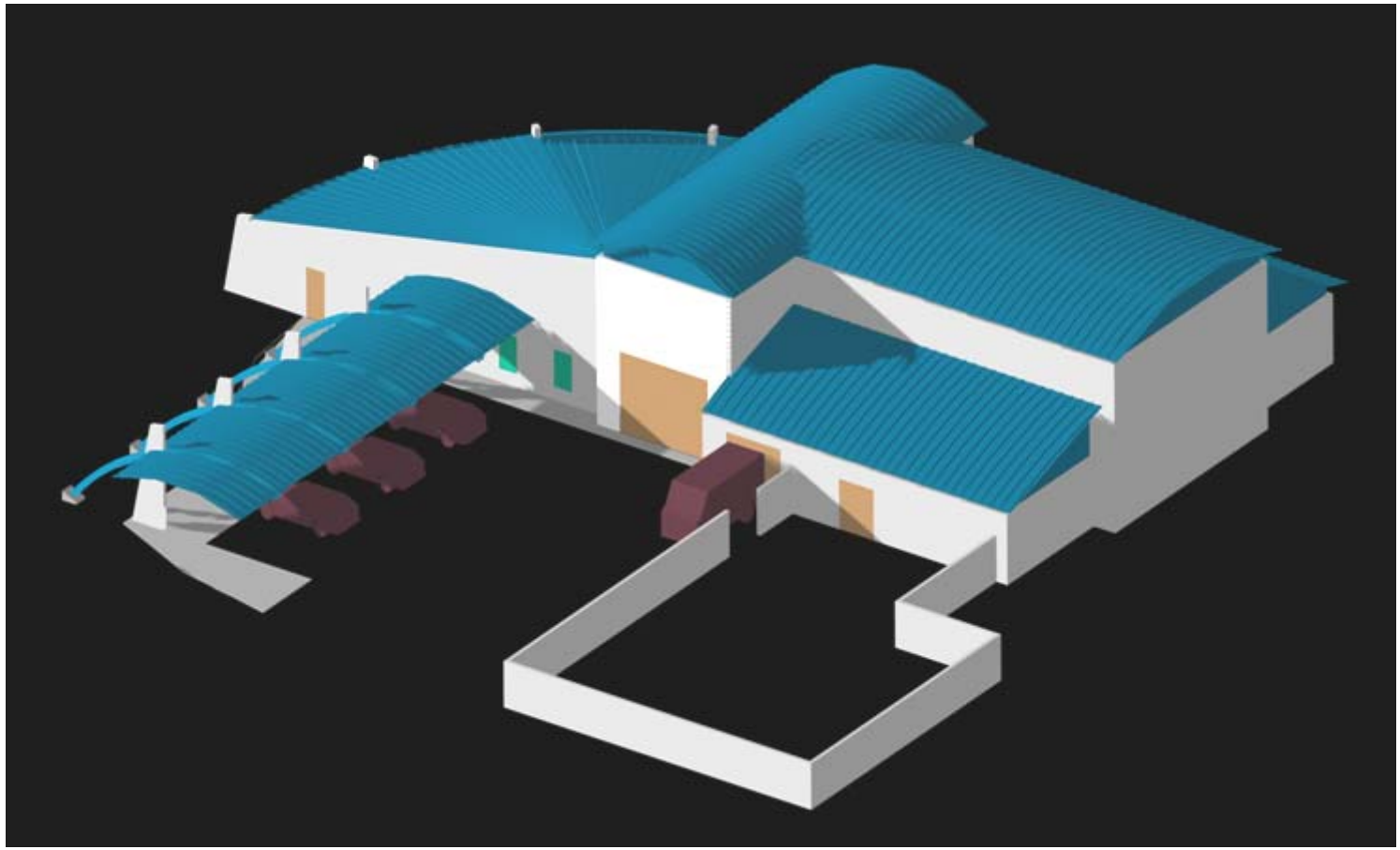
Layout



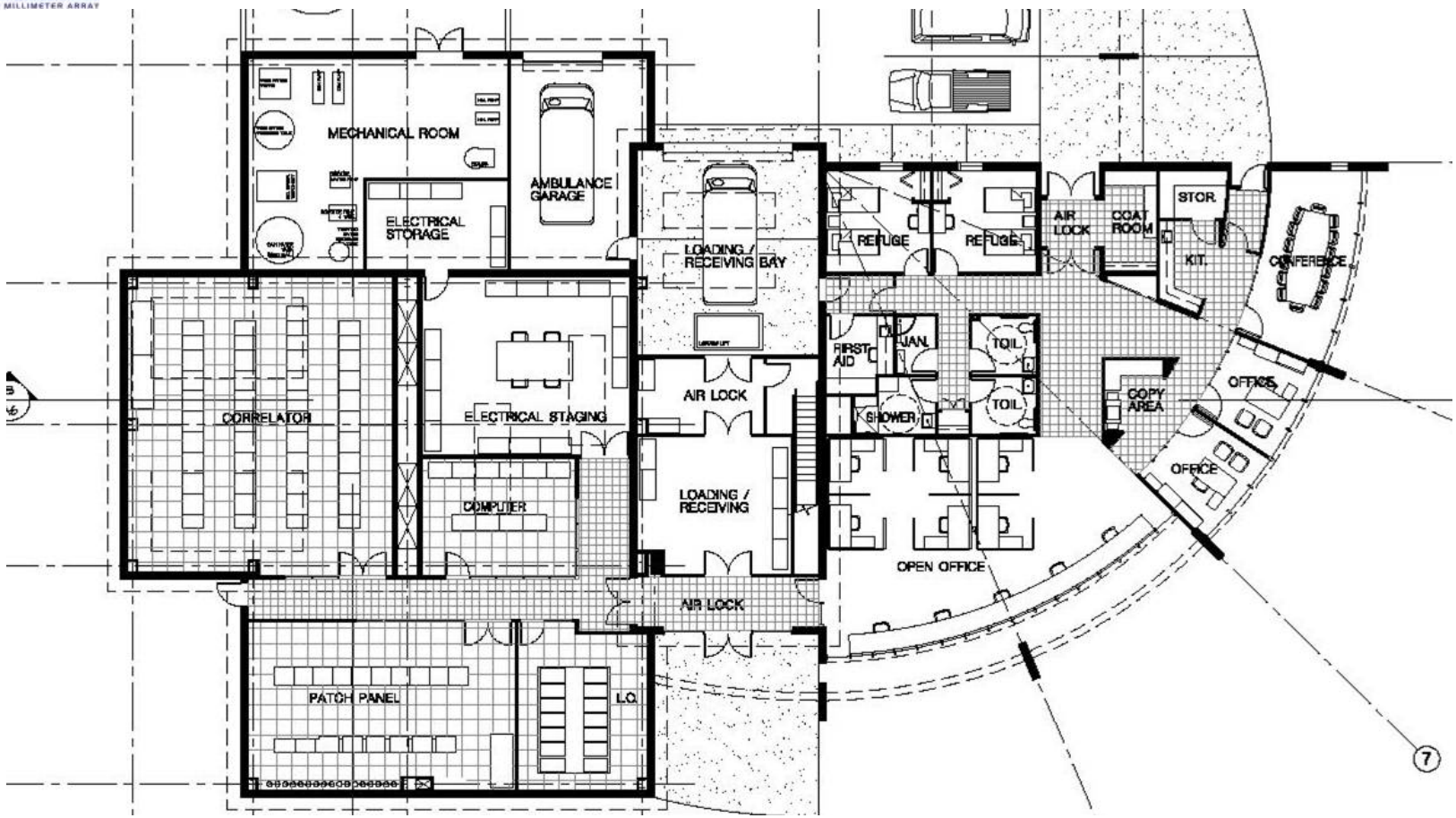
Atacama Large Millimeter Array
Site – OSF Technical Facilities



Atacama Large Millimeter Array
Site – AOS Building 1



Atacama Large Millimeter Array
Site – AOS Building 2



Atacama Large Millimeter Array
Prototype Antennas

Atacama Large Millimeter Array
AEC Prototype Antenna

Atacama Large Millimeter Array
Vertex Prototype Antenna

Atacama Large Millimeter Array Prototypes Design Characteristics

VertexRSI

- 264 Panels, 8 rings, machined Al, open back
- 7 adjusters / panel
- 24 CFRP BUS sectors, open back
- Feed legs & Apex in CFRP
- Hexapod secondary positioner
- Invar support cone I/F Bus-cabin
- Cylindrical Invar/steel Rx. Cabin
- Pinion drive
- Absolute Encoders
- 3 Point support base

ALCATEL/EIE

- 120 Panels, 5 rings, Replicated Nickel, Rhodium coated, closed back
  5 adjusters / panel
- BUS in CFRP, 16 sectors, close back
- Feed legs and Apex in CFRP
- Three axes Apex mechanism
- Direct connection Cabin BUS
- Cabin in CFRP
- Direct drives on both axes
- Incremental encoders
- 6 Point support base

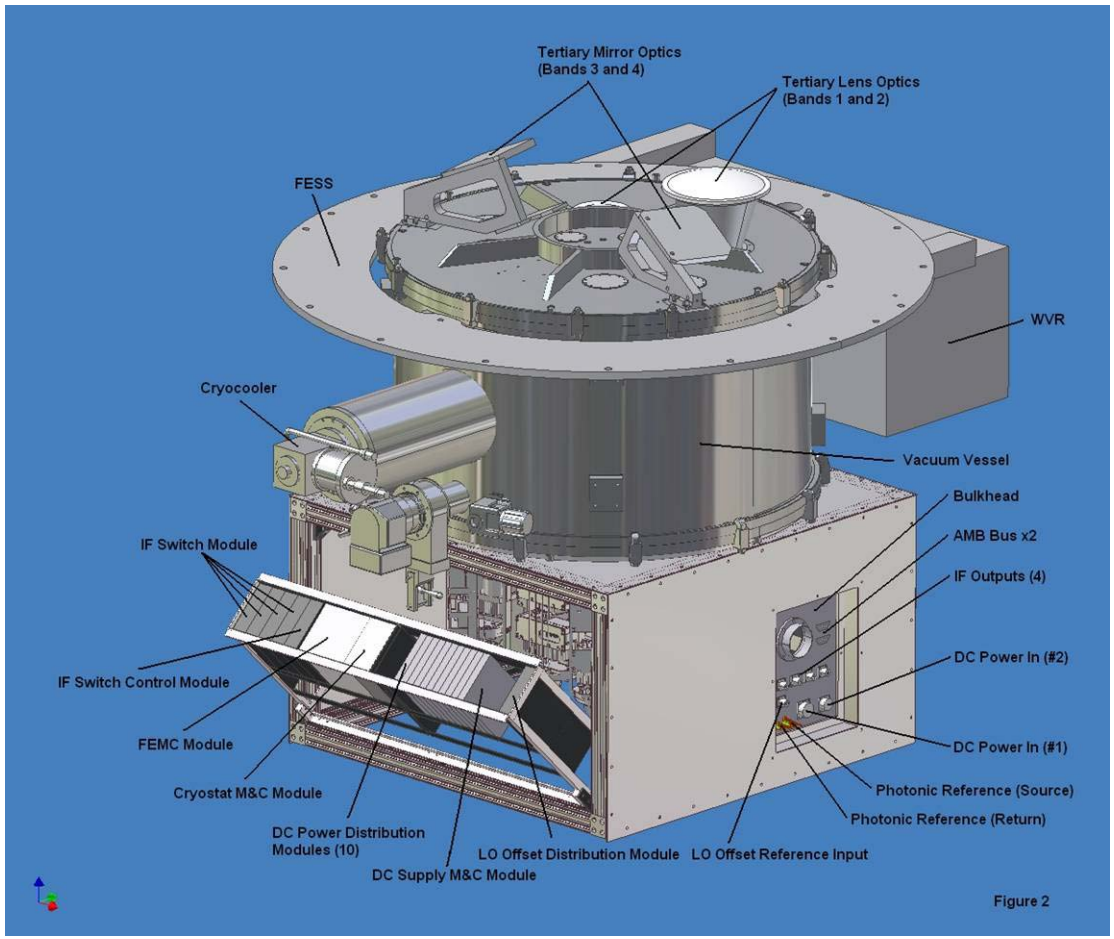
Atacama Large Millimeter Array
ALMA FE key specifications

ALMA Band	Frequency Range	Receiver noise temperature		Mixing scheme	Receiver technology
		T_{Rx} over 80% of the RF band	T_{Rx} at any RF frequency		
1	31.3 – 45 GHz	17 K	28 K	USB	HEMT
2	67 – 90 GHz	30 K	50 K	LSB	HEMT
3	84 – 116 GHz	37 K	62 K	2SB	SIS
4	125 – 169 GHz	51 K	85 K	2SB	SIS
5	163 - 211 GHz	65 K	108 K	2SB	SIS
6	211 – 275 GHz	83 K	138 K	2SB	SIS
7	275 – 373 GHz*	147 K	221 K	2SB	SIS
8	385 – 500 GHz	98 K	147 K	DSB	SIS
9	602 – 720 GHz	175 K	263 K	DSB	SIS
10	787 – 950 GHz	230 K	345 K	DSB	SIS

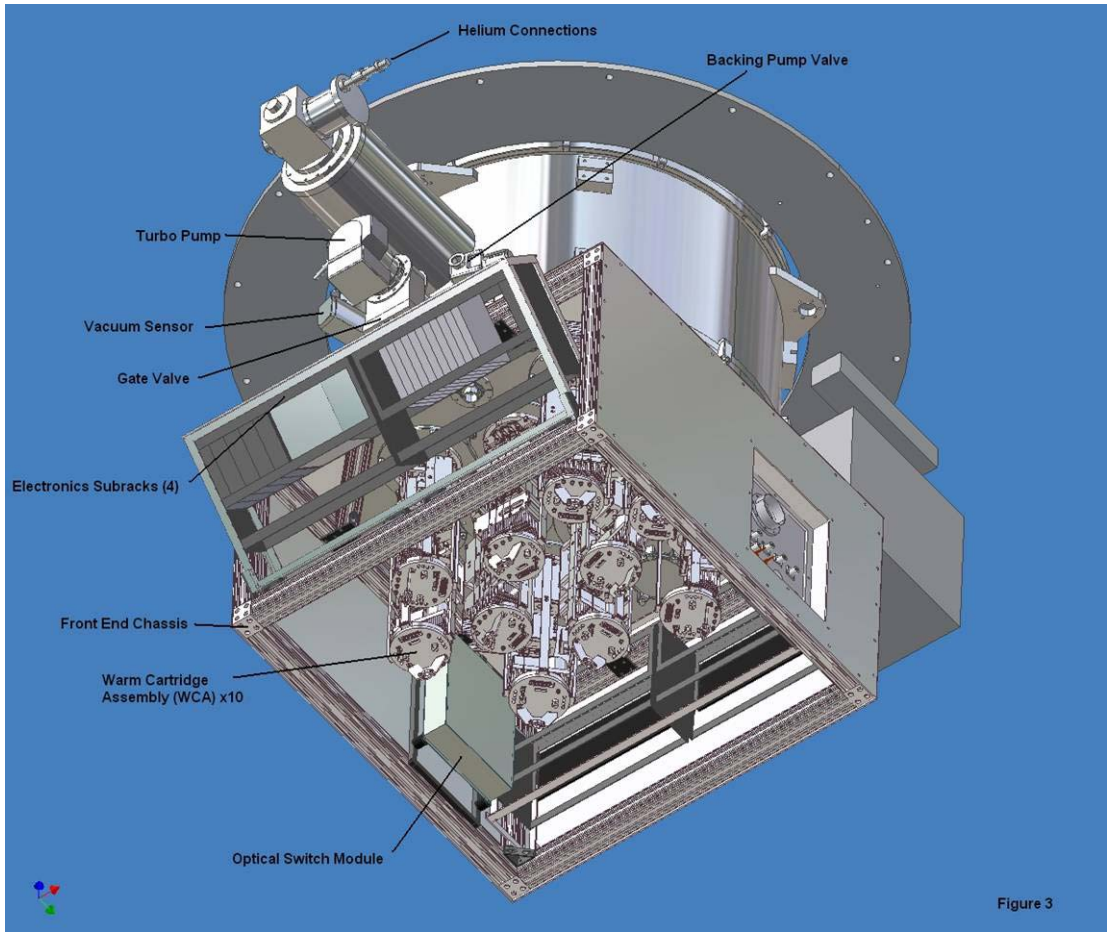
* - between 370 – 373 GHz T_{rx} is less then 300 K

- Dual, linear polarization channels:
  - Increased sensitivity
  - Measurement of 4 Stokes parameters
- 183 GHz water vapour radiometer:
  - Used for atmospheric path length correction

Atacama Large Millimeter Array
Front End assembly

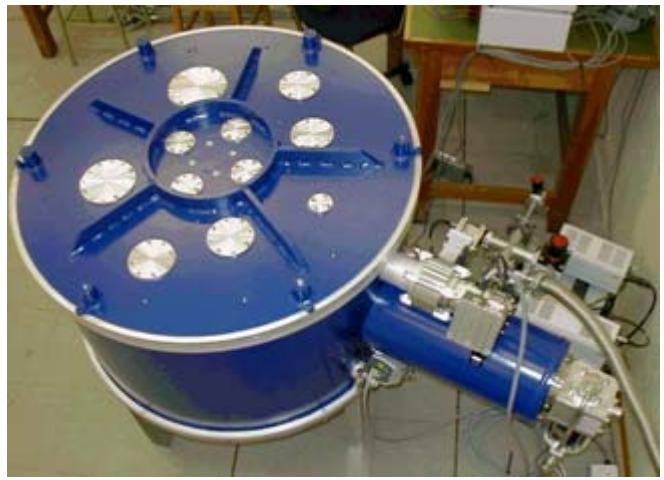


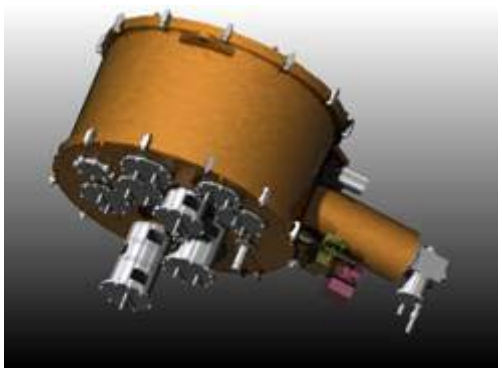
Atacama Large Millimeter Array
Front End assembly

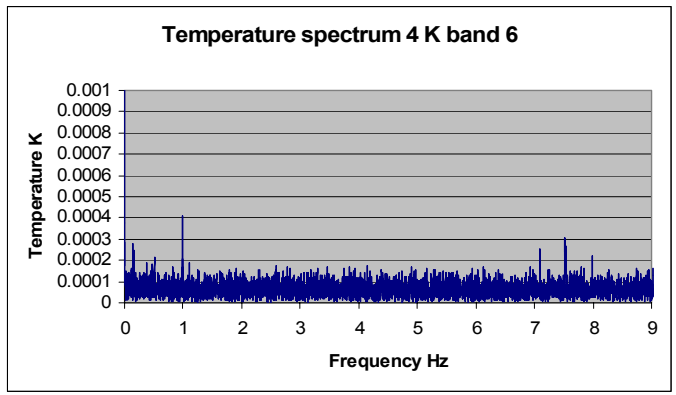


Atacama Large Millimeter Array
Cryostat - 1

- Testing of prototype
  - Thermal performance evaluated under different load conditions
  - Design has been fully qualified
- Manufacturing Readiness Review
  - Held Dec. '03
  - Release pre-production cryostat #1-8
  - At the MRR a concern was raised about the long term use of the nylon rings under vacuum. This is being investigated as it is a major issue for the survival of the cryostat. Thermal cycling tests on Nylon and Delrin rings have been done. No evidence of failure has been detected after > 130 cycles.







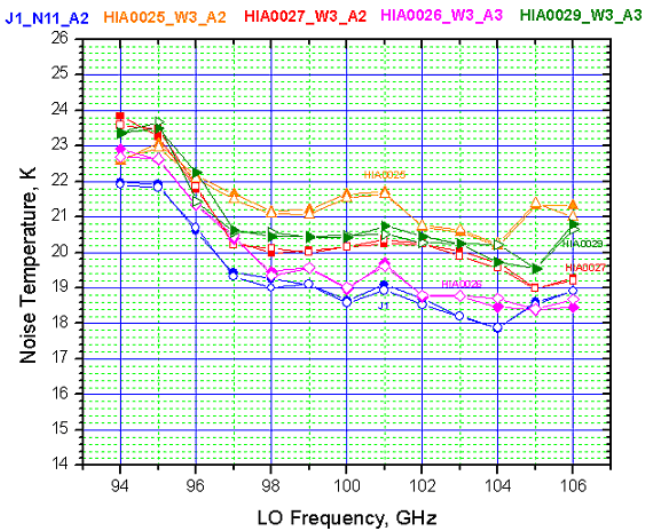
Cartrudge	4K stage	12K stage	90K stage
1	-	12.31	108
2	-	12.37	108
3	3.75	12.24	105
4	3.62	12.18	106
5	3.64	11.96	102
6	3.67	12.25	106
7	3.64	11.95	102
8	3.58	12.19	106
9	3.52	11.95	102
10	3.59	12.31	108

Atacama Large Millimeter Array
Cryostat - 2

- First pre-production cryostat
  - Delivery Aug / Sep ’04, has shifted after accident in the production outer vacuum vessel. Accident resulted in total loss in vessel.
- Cartridge bodies being fabricated
  - After approval of band specific cartridge body designs by the cartridge groups production has started for Bands 3, 6 and 7
  - Delivery of first set completed.
- Cryocooler procurement
  - RfT for 7 cryocoolers for pre-production cryostats #2-#8 has been published in the Official Journal of the European Union (OJEU) number 2003/S 245-217953, tender number WD1476.
  - 4 enquiries, but at the close of the tender period there was only one tender submitted
  - This tender was compliant with all technical and programmatic requirements. Order has been placed
- Pre-production cryostat acceptance and delivery
  - Detailed Acceptance procedure for (pre-)production units has been defined.
  - Acceptance procedure will be a model for other production deliveries.

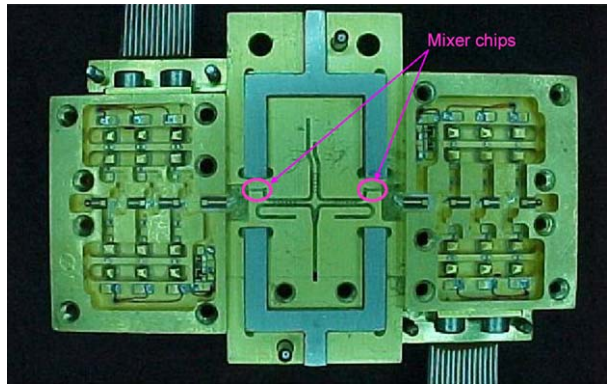
Atacama Large Millimeter Array
Band 3 Cartridge

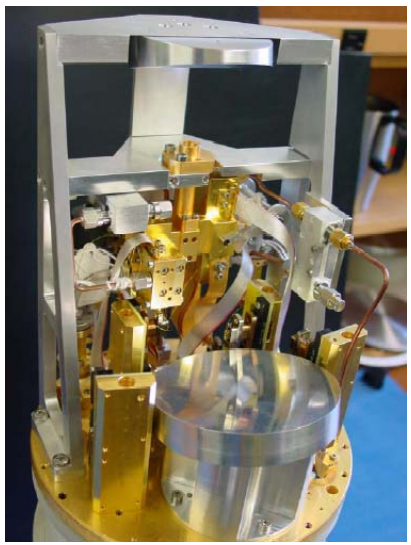
- Mixer development
  - Focus on a 2SB, 4 – 8 GHz IF bandwidth, mixer solution
- Cartridge PDR held March ‘04
- Current status:
  - Complete the construction of the cartridge test set in semi-automatic mode
  - Finalize integration of cartridge #1 with two fully characterized 2SB mixer units and four LNAs.

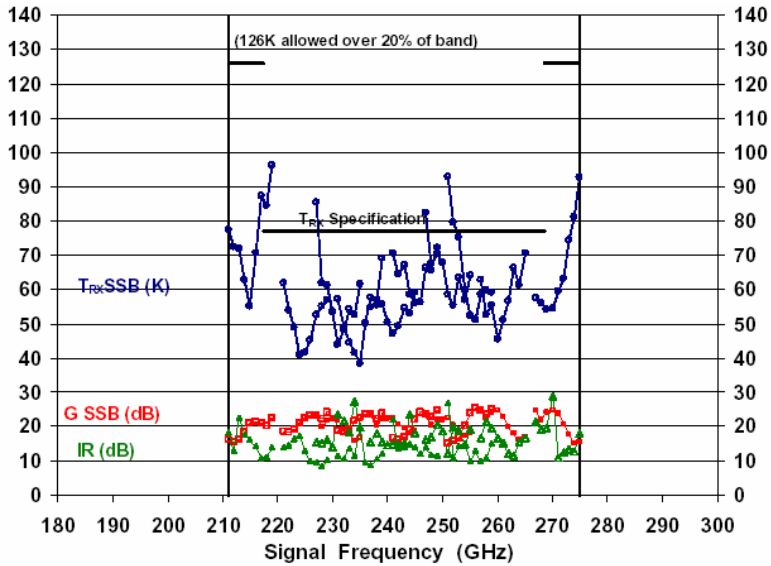


Atacama Large Millimeter Array
Band 6 Cartridge

- Mixer development
  - Focus on a 2SB, 4 – 12 GHz IF bandwidth, mixer solution without isolator
- Cartridge PDR held April '04
- Current status:
  - Finalize integration of cartridge #1
  - Prepare automated test set up for production

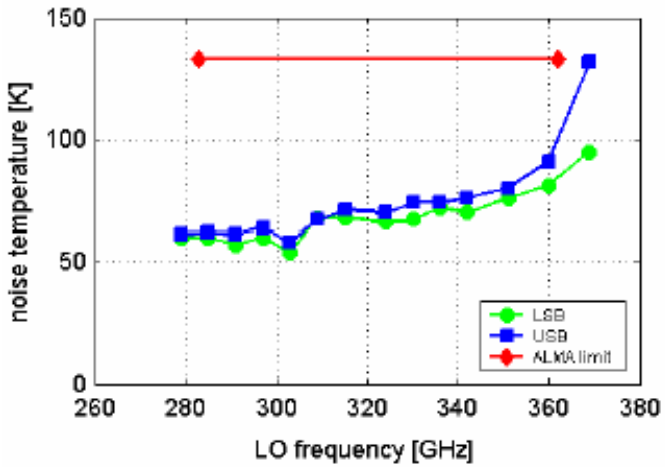


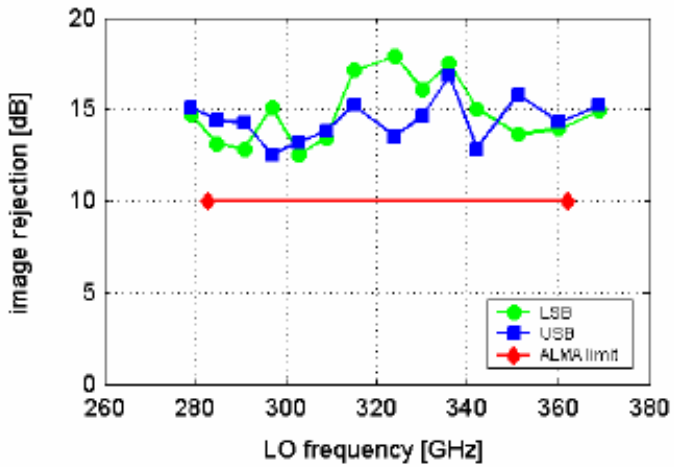




Atacama Large Millimeter Array
Band 7 Cartridge

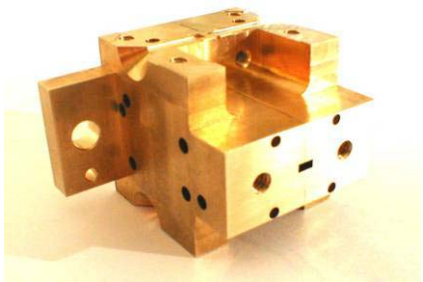
- Mixer development
  - Focus on a 2SB, 4 – 8 GHz IF bandwidth, mixer solution
- Cartridge PDR held June ‘04
- Current status:
  - Finalize integration of cartridge #1 with two fully characterized 2SB mixer units and four LNAs

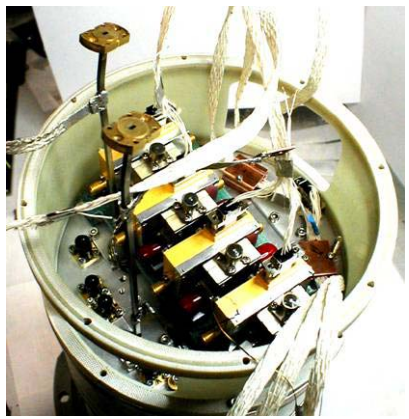


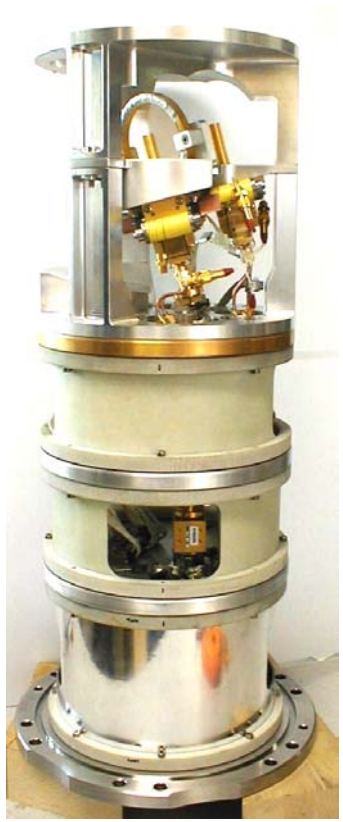


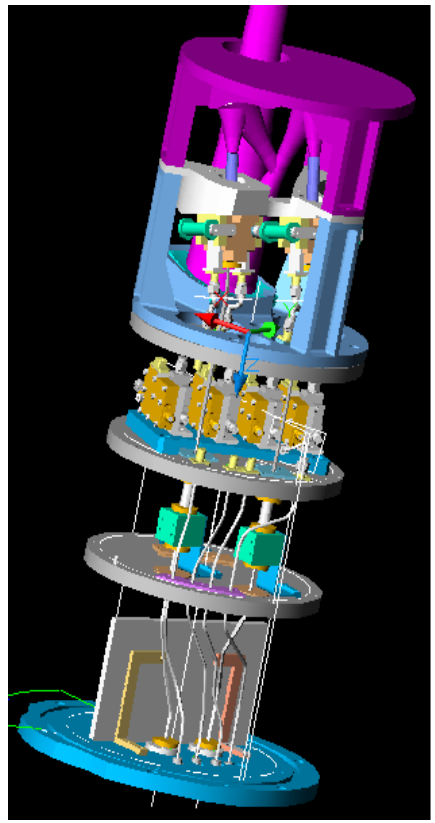
Atacama Large Millimeter Array
Band 7 Cartridge

- Mechanical design
  - 4K Optics made up and measured
  - New Coupler for 2SB Mixer made up at IRAM
  - New circular shape Grid delivered
  - Cartridge plates machined (WG/Semi-Rigid feed through & fixing holes)
  - Parts for assembling made up (Including SS WG and Semi-Rigid)







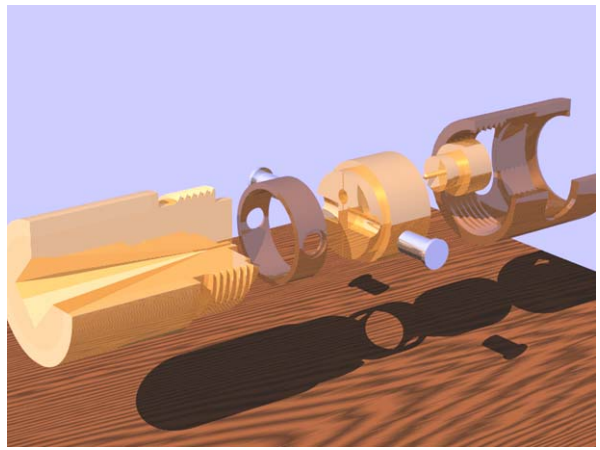


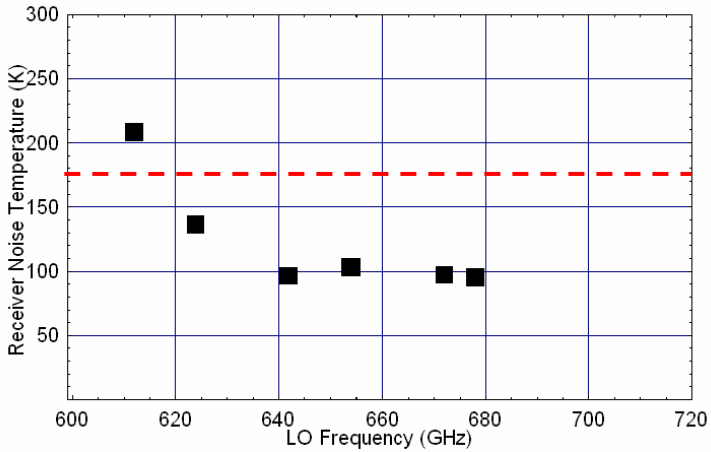
Atacama Large Millimeter Array
Band 9 Cartridge

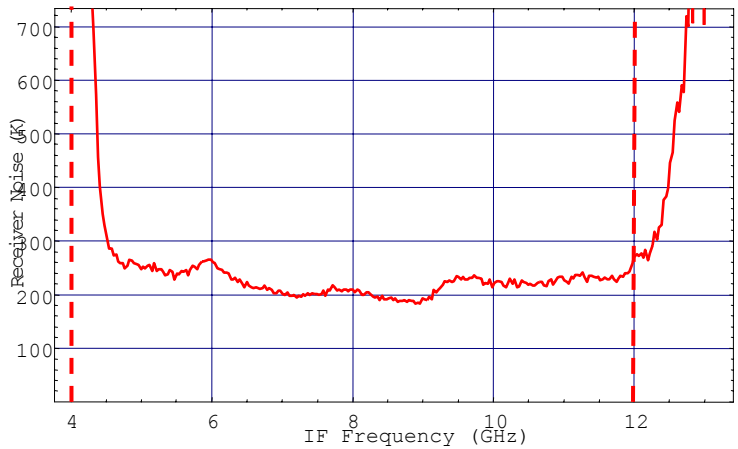
- Mixer development
  - Focus on a DSB, 4 – 12 GHz IF bandwidth, mixer solution
- Cartridge PDR held March ’04
- Final design is in progress that should fulfill ALMA requirements:

  < 175 K (80 % of full RF band)

  < 263 K (20 % of full RF band)

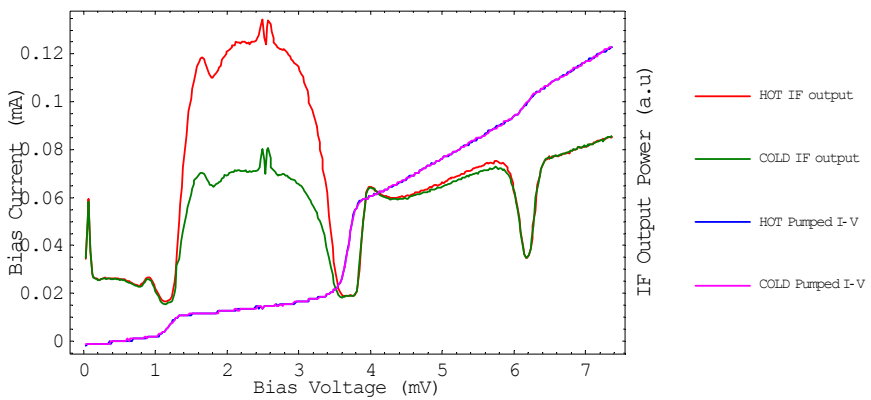


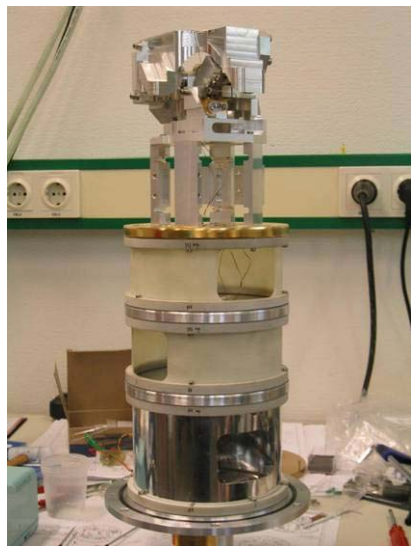


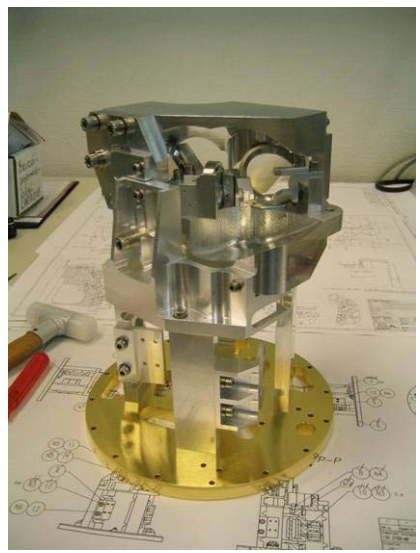


Atacama Large Millimeter Array
Band 9 Cartridge

- Status of detailed design
  - Investigating NbTiN SIS devices
  - Continued mixer testing
    - 4 – 12 Ghz cooled isolator prototype has become available
  - Cartridge design completed
    - 4 K stage components finalized
    - 20 k / 90 k stage components in progress
    - Optics prototype tested at IRAM

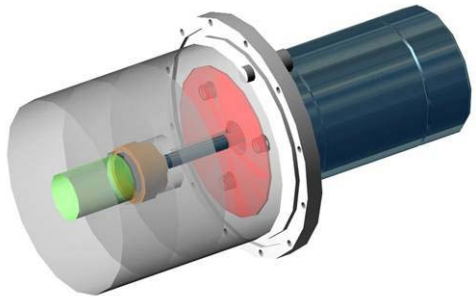


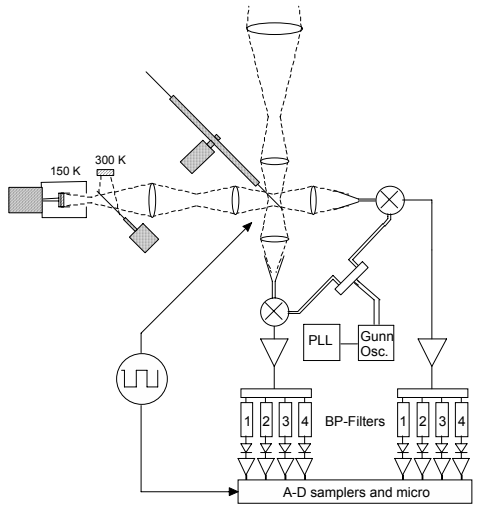


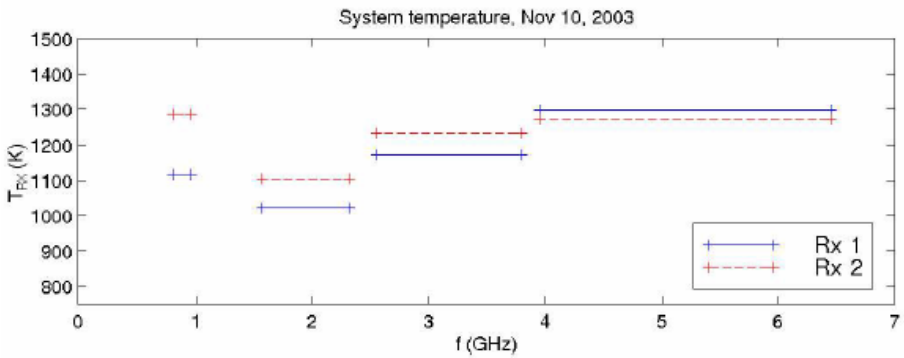


Atacama Large Millimeter Array
Water Vapour Radiometer

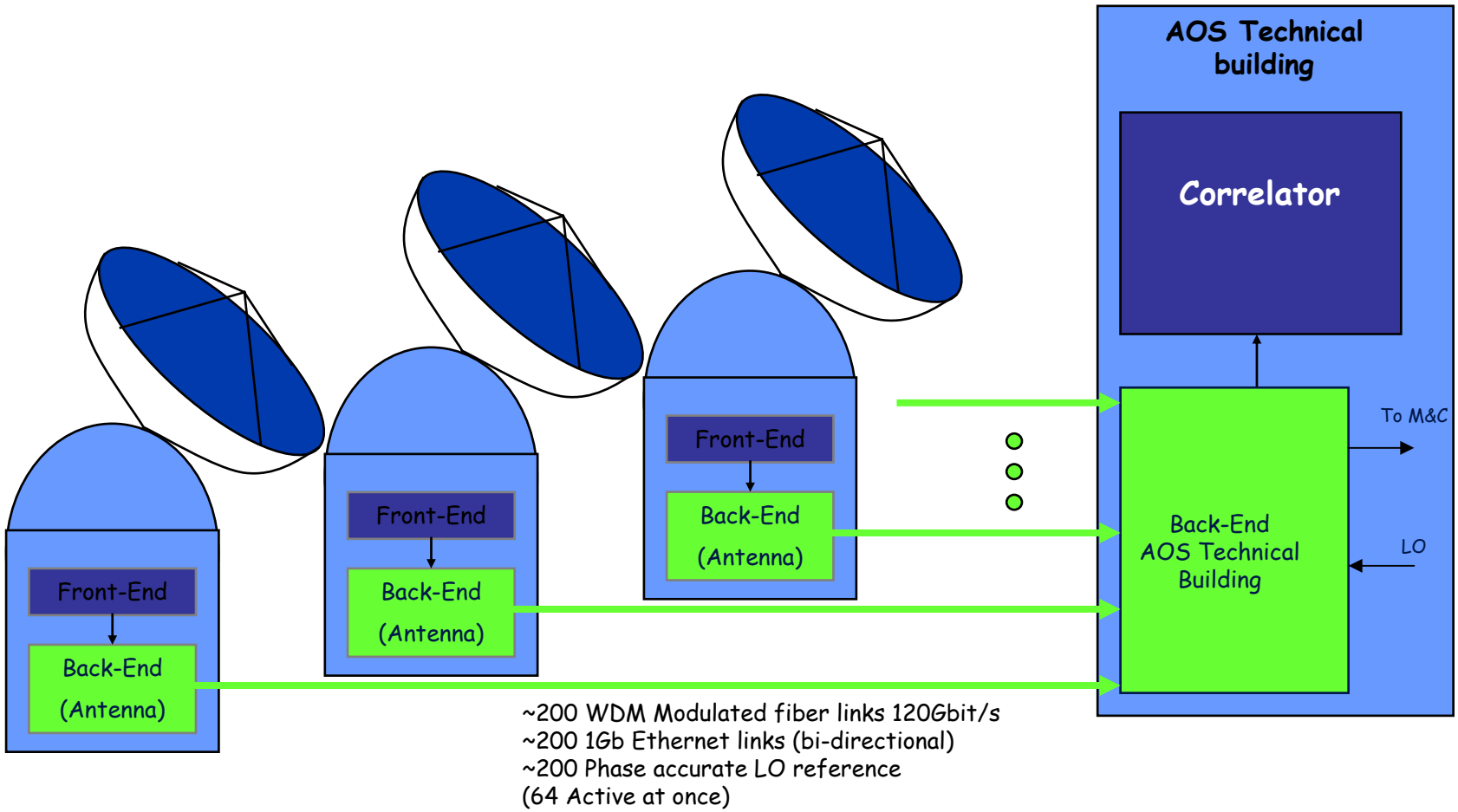
- Development status
  - Completion of final integration of prototypes at Cambridge, correlation type, and Onsala, Dicke switched
  - Performance verification of prototypes
  - Preparation of integration and test plans of prototype WVRs at ATF in Socorro



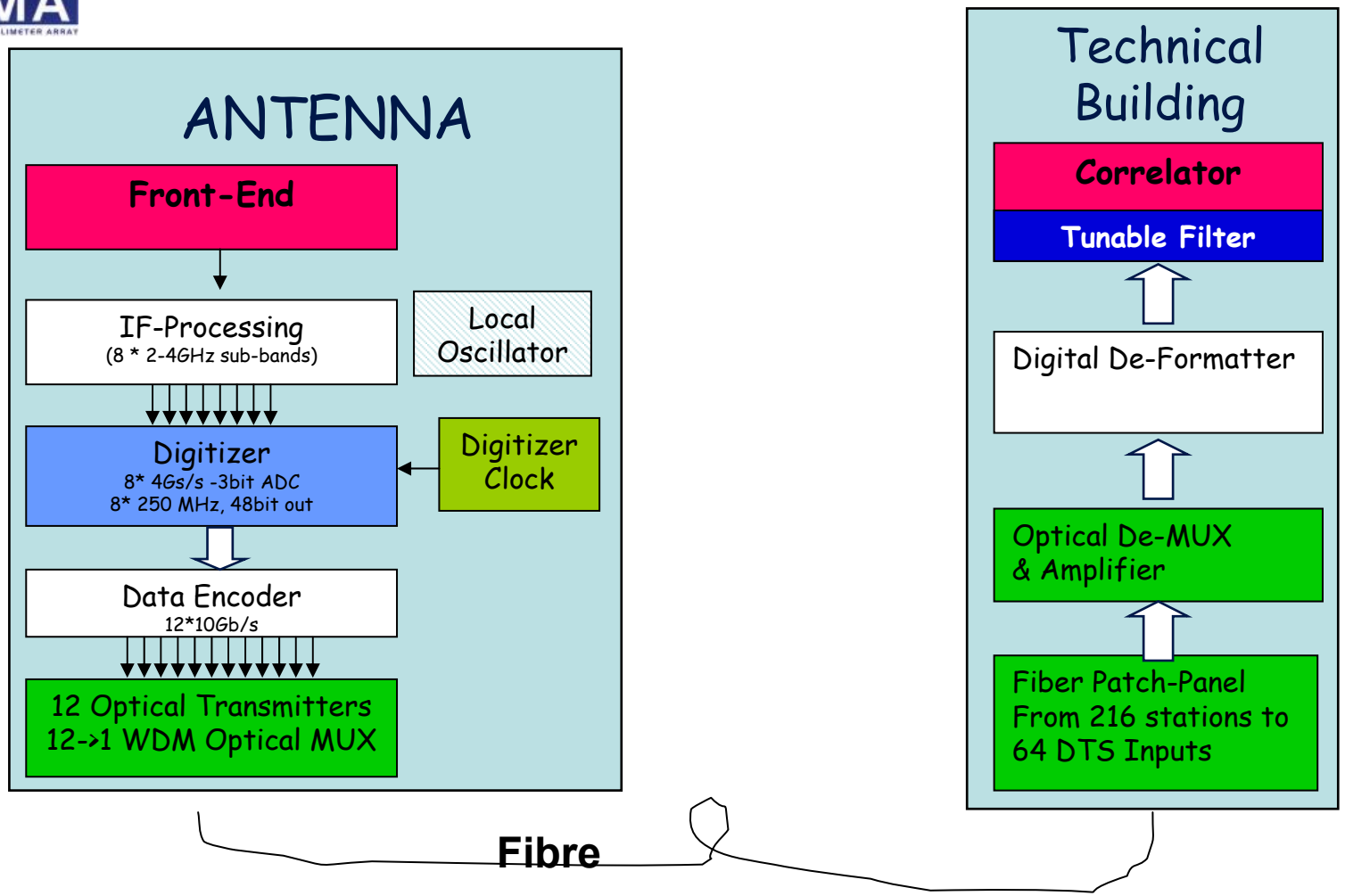




Atacama Large Millimeter Array
Back End & Correlator

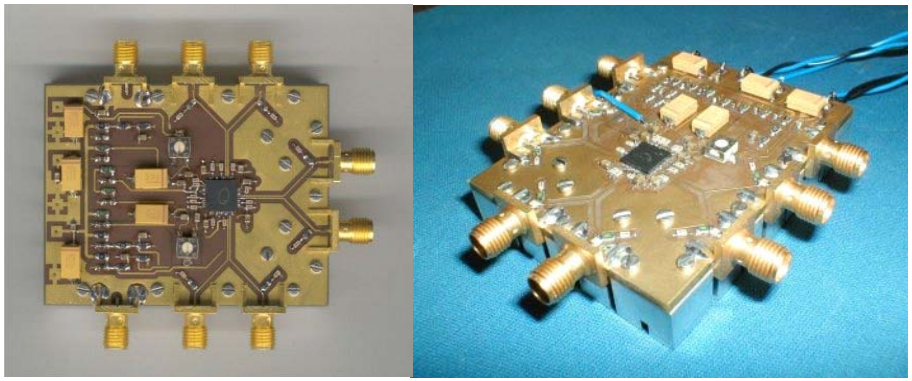


Atacama Large Millimeter Array
Back End & Correlator



Atacama Large Millimeter Array
Digitizer & Clock

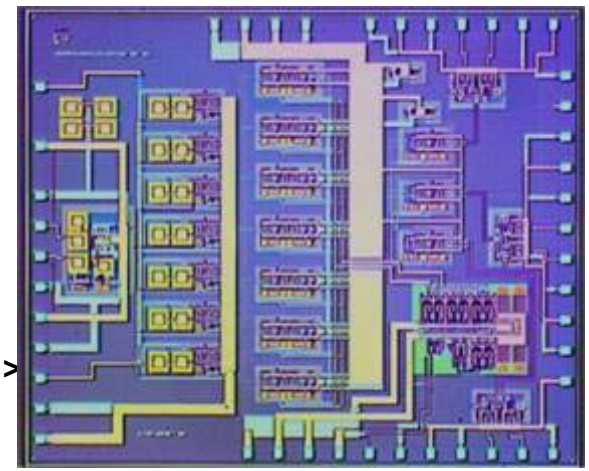
Prototype Digitiser > Sub-assembly



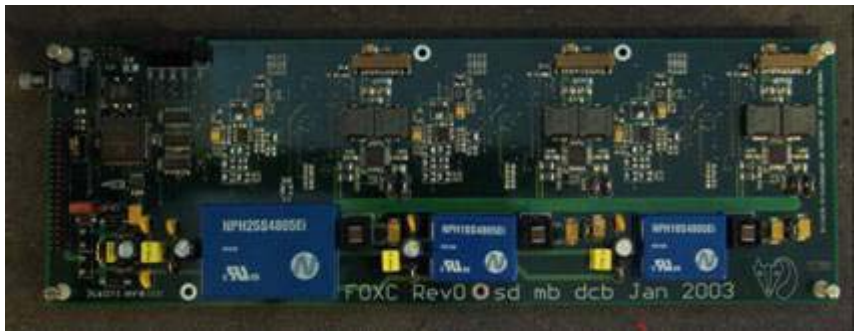
< Digitiser Clock

DGS Chip microphoto >

Die size 3 x 3 mm

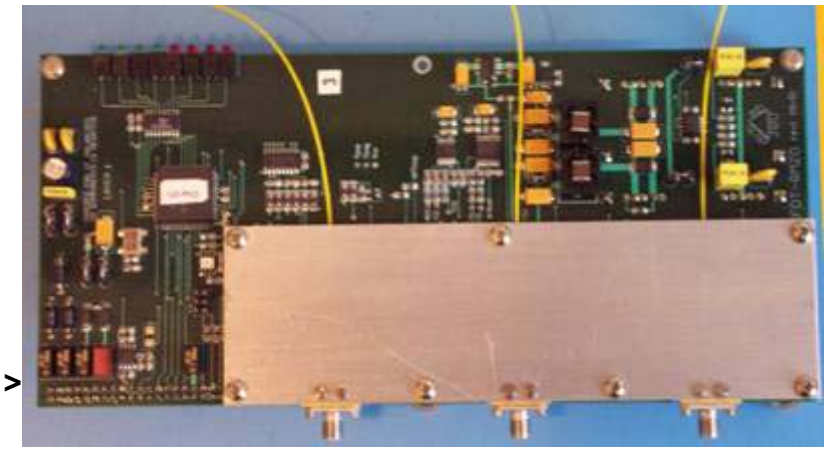


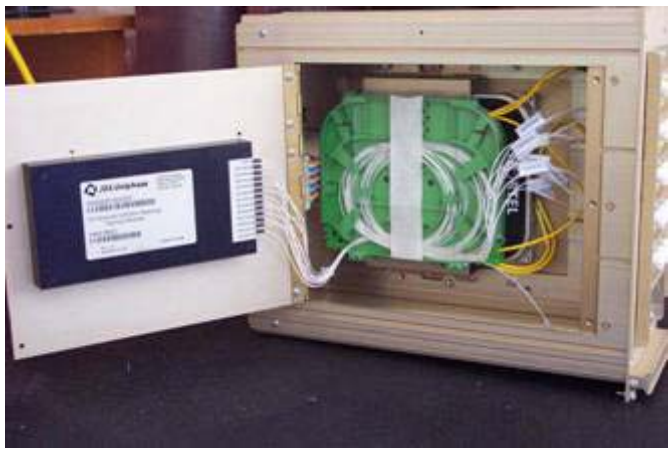
Atacama Large Millimeter Array
Back End – Optical DTS



Optical Transmitter

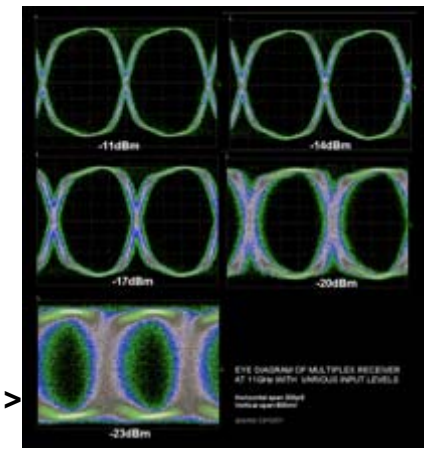
Optical Receiver >



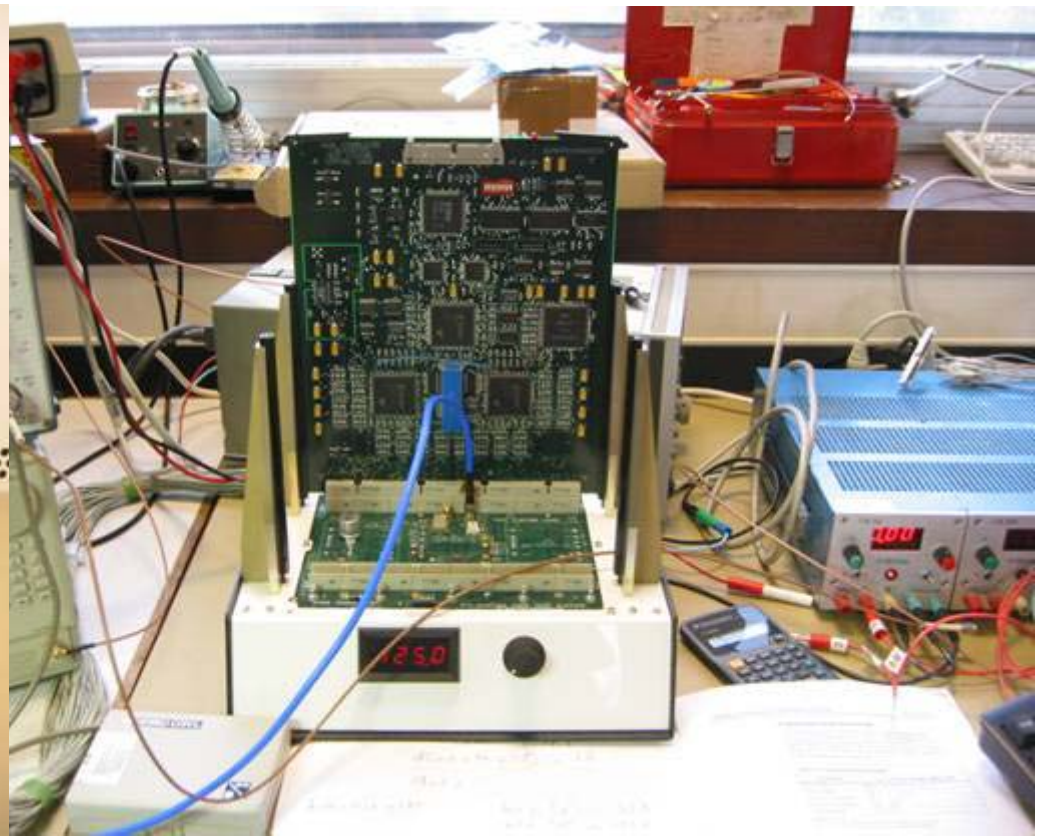


< Optical Amplifier Demux

Eye Diagram >



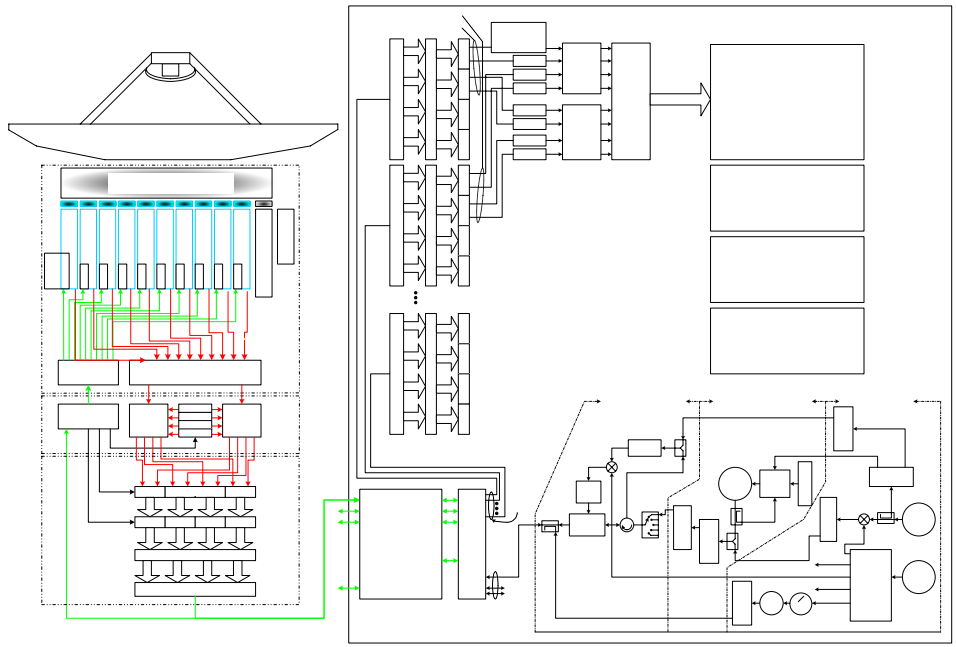
Atacama Large Millimeter Array Correlator – Tunable Filter Bank



Atacama Large Millimeter Array
System Engineering

- **Design and analysis**
  - **Overall ALMA system design**
  - **Maintaining ALMA system technical budgets**
  - **Supporting IPTs on all technical aspects**
  - **Participation in reviews**

- **Interface Control and Requirements**
  - **Preparation and implementation of ALMA engineering requirements**
  - **Maintaining ICDs**
  - **Preparation and maintaining of system performance requirements**
  - **Definition of ALMA standards**

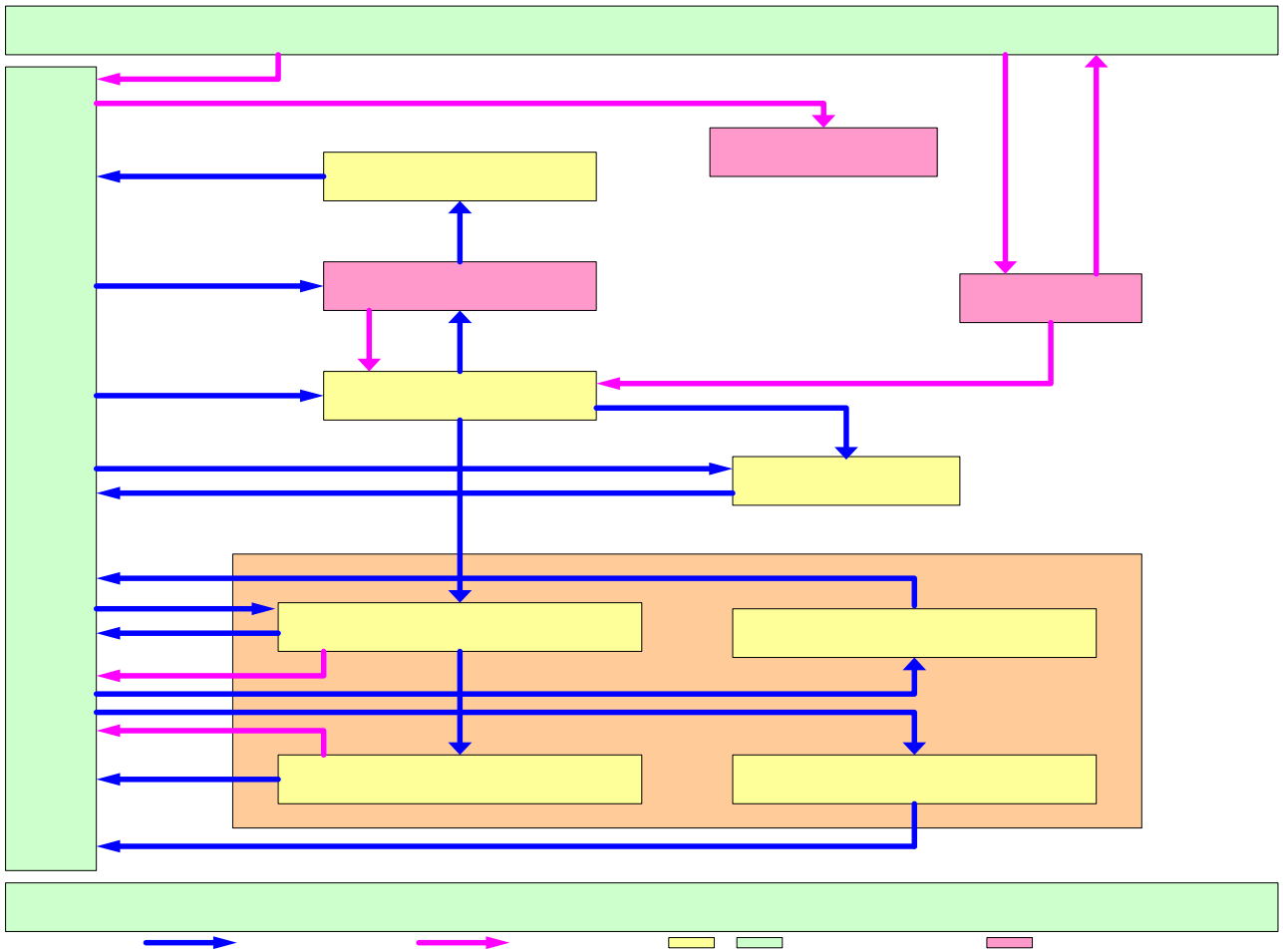


Atacama Large Millimeter Array
Prototype Integration

- **Lab Integration and testing in Tucson and Socorro**
  - **Signal Path from IF through correlation (Socorro)**
  - **RF simulator, LO reference distribution and 1st LO (Tucson)**
- **Combined lab integration and testing in Socorro**
  - **Equipment from Tucson will be moved to Socorro November 2004**
  - **Tests: end-to-end signal integrity, gain vs. frequency, error rates, crosstalk, gain stability, phase stability, phase switching and LO offsetting**
- **ALMA Test Facility (ATF) integration and testing**
  - **Equipment will be moved, installed and checked at ATF Jan-Feb 2005**
  - **First fringes are expected in spring 2005**
  - **Astronomical testing, software testing, switch over to real prototypes, WVR testing, Front End installation**

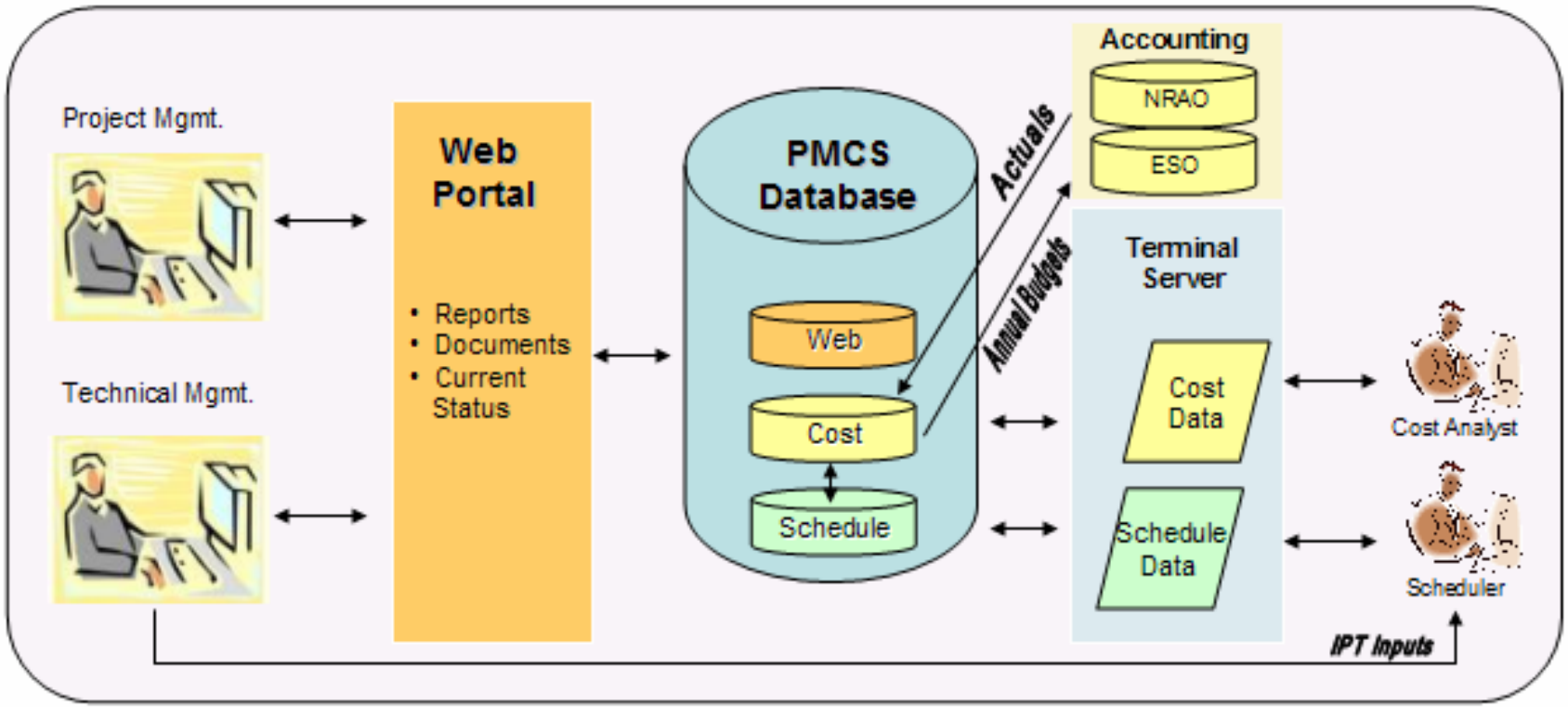
Atacama Large Millimeter Array
Prototype Integration

Atacama Large Millimeter Array
Computing - Architecture



h. Store adı

Atacama Large Millimeter Array
ALMA PMCS Concept



Atacama