Science Items

- CSV planning
- Early configurations
- Current activities
- ALMA’s Scientific Specifications

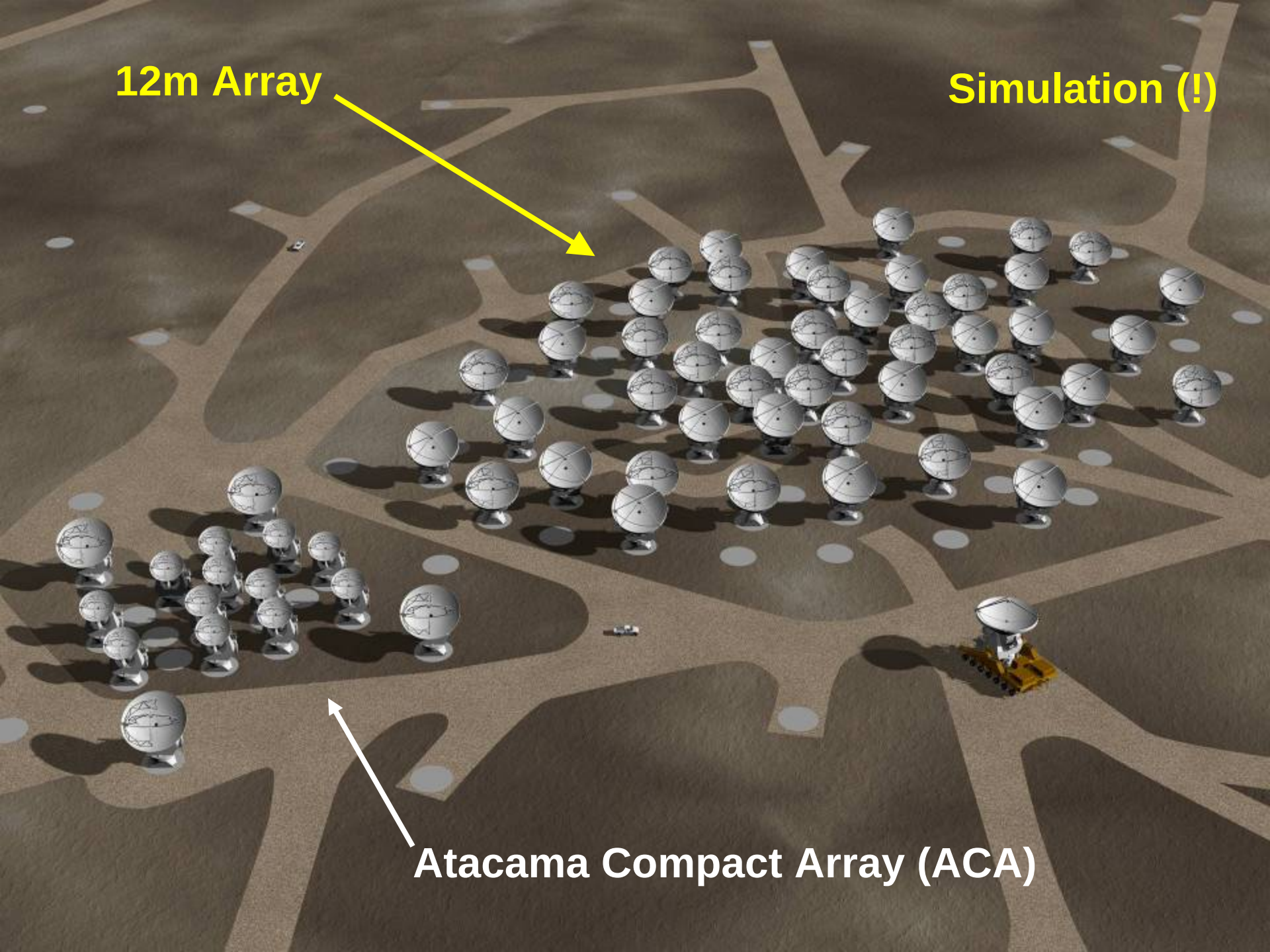
Commissioning and Scientific Verification

- Framework set out in Laing/Vila-Vilaro plan (2007)
- Scientific activities of AIV/CSV/Ops merged (2008)
- These will overlap in the future - presently just AIV
- Detailed planning for CSV implementation in progress
- Writing test procedures and checking them out (if poss)
- First elements of "confrontation with reality" occurring

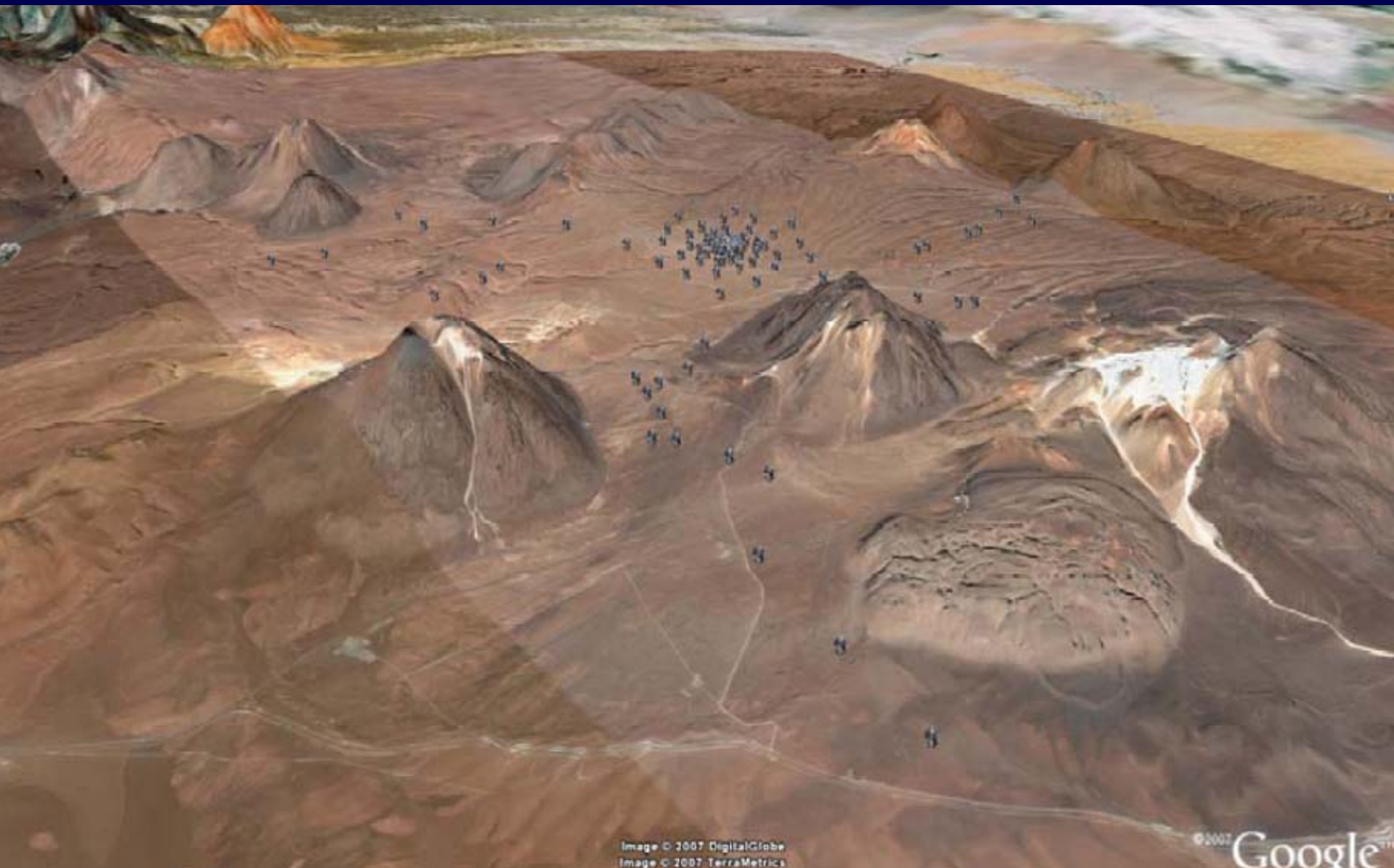
- Review of CSV plan June 18/19 '09.

Staffing

- AIV
  - (McMullin), Knee, Planesas, Cortes
- CSV
  - (Hills), Peck, Lucas, Mauersberger, Hales, Sawada, Corder, Barkats, *Wilson* + up to 6 more
- Ops
  - (Nyman), Dent, Vila Vilaro, Rawlings, Kneissl, Cortes, + Wiklind (Sept 09) + + build up to full level

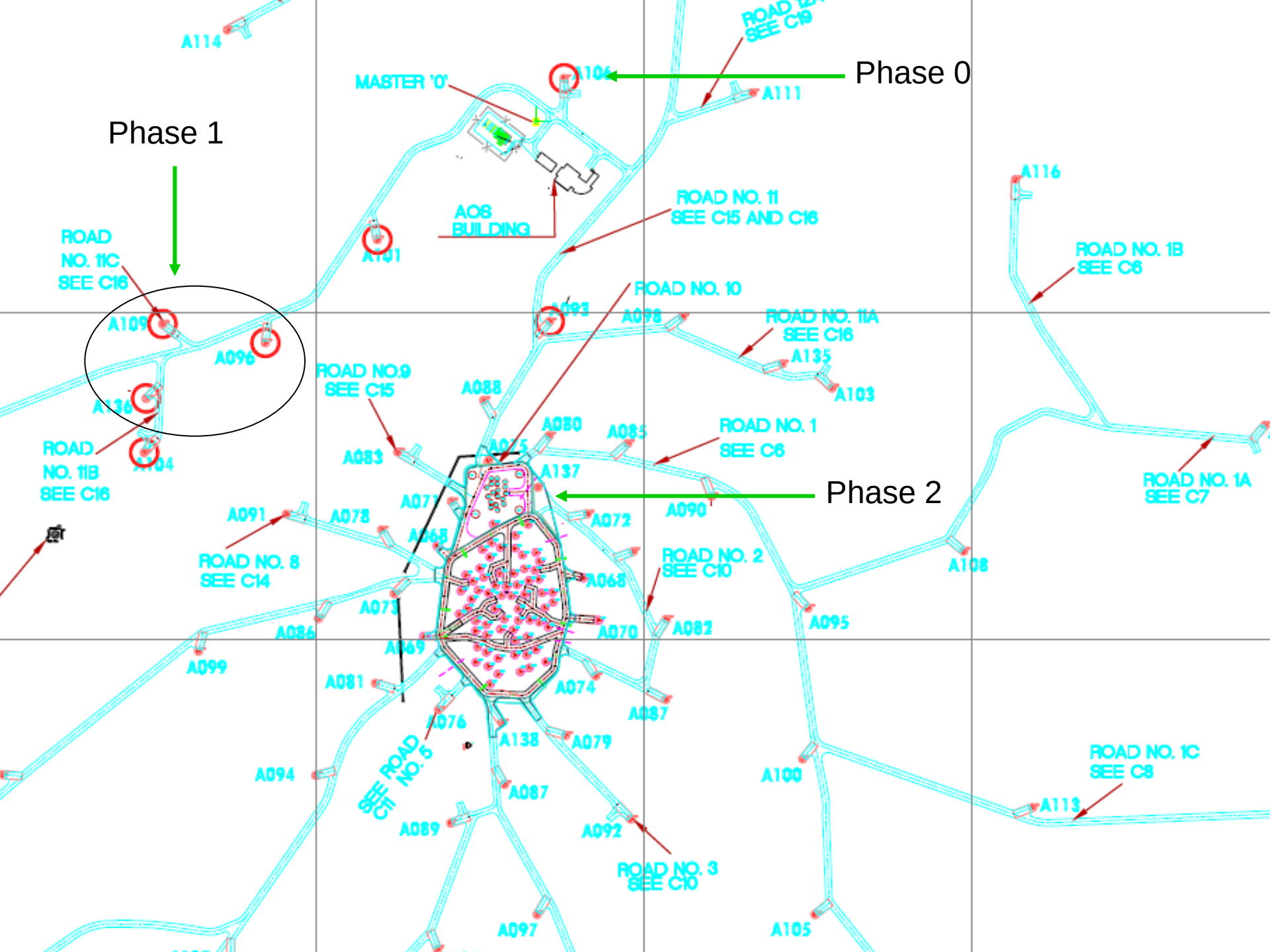

12m Array
Simulation (!)
Atacama Compact Array (ACA)

Google-Earth view of site with antennas in the most extended configuration – baselines to 16km



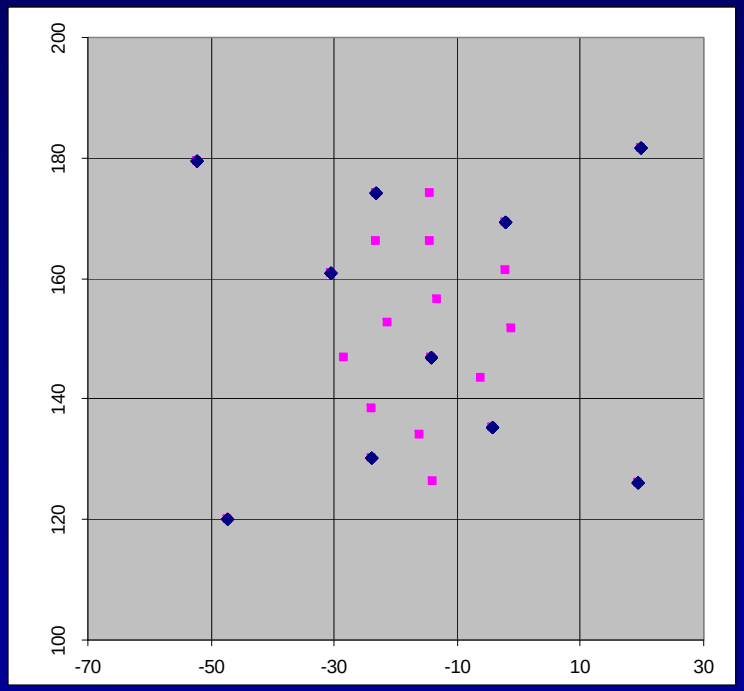
New Plan for Occupation of Antenna Stations

- Phase 0 Jun ’09 1 pad for antenna checkout
- Phase 1 Sep ’09 3 pads for first fringes / closure
- Phase 2 Jan ’10 10 ACA pads - initial commissioning
- Phase 3 July ’10 add 6 inner array pads
- Phase 4 Mar ’11 for Early Science - central cluster plus 20 inner array pads
- Phase 5 Oct ’11 high resolution – baselines to ~ 4km
- Phase 6 Apr ‘12 goal for completion of outer array

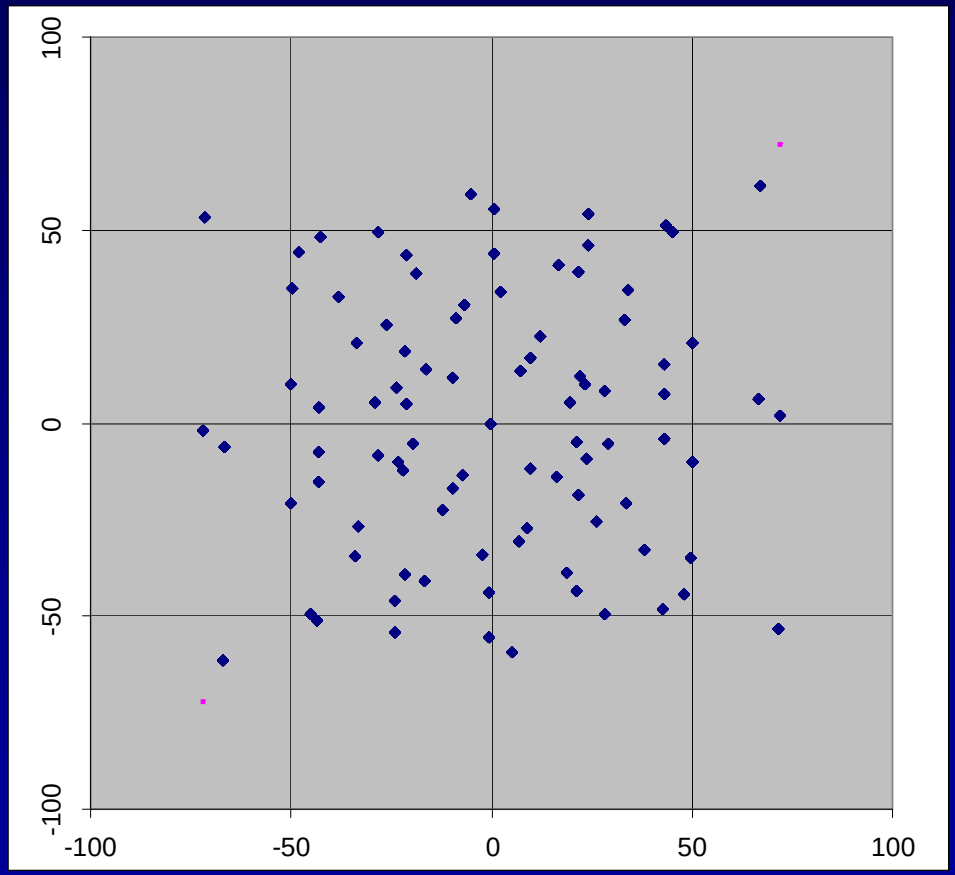

Phase 0
Phase 1
Phase 2
MASTER '0'
A106
A111
A114
ROAD SEE C19
A108
BUILDING
ROAD NO. 11
SEE C15 AND C16
A101
ROAD
NO. 11C
SEE C16
A109
A096
A136
A104
ROAD
NO. 11B
SEE C16
ROAD NO. 10
A093
A078
ROAD NO. 11A
SEE C16
A135
A103
A116
ROAD NO. 1B
SEE C6
ROAD NO.9
SEE C15
A088
A080
A085
A083
A075
A137
ROAD NO. 1
SEE C6
ROAD NO. 1A
SEE C7
A091
A077
A072
A090
A068
ROAD NO. 8
SEE C14
ROAD NO. 2
SEE C10
A073
A086
A070
A082
A095
A099
A081
A074
A087
A076
A138
A079
ROAD NO. 1C
SEE C8
A094
A100
SEE ROAD NO. 5 C17
A087
A113
A089
A092
ROAD NO. 3
SEE C10
A097
A105

Phase 2

Pads

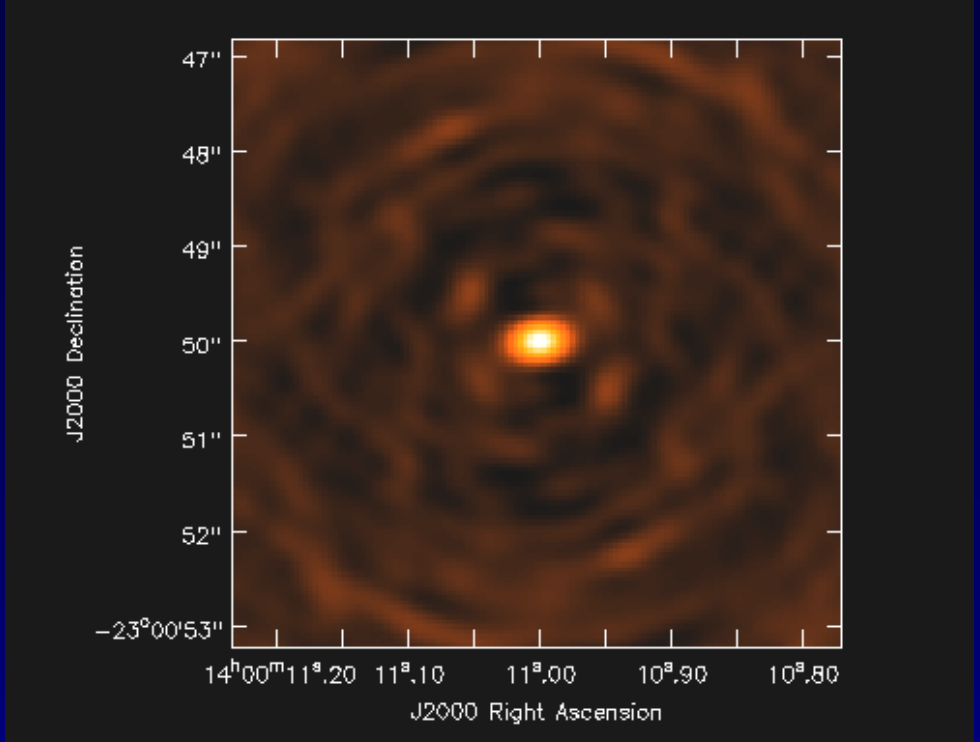


Baselines

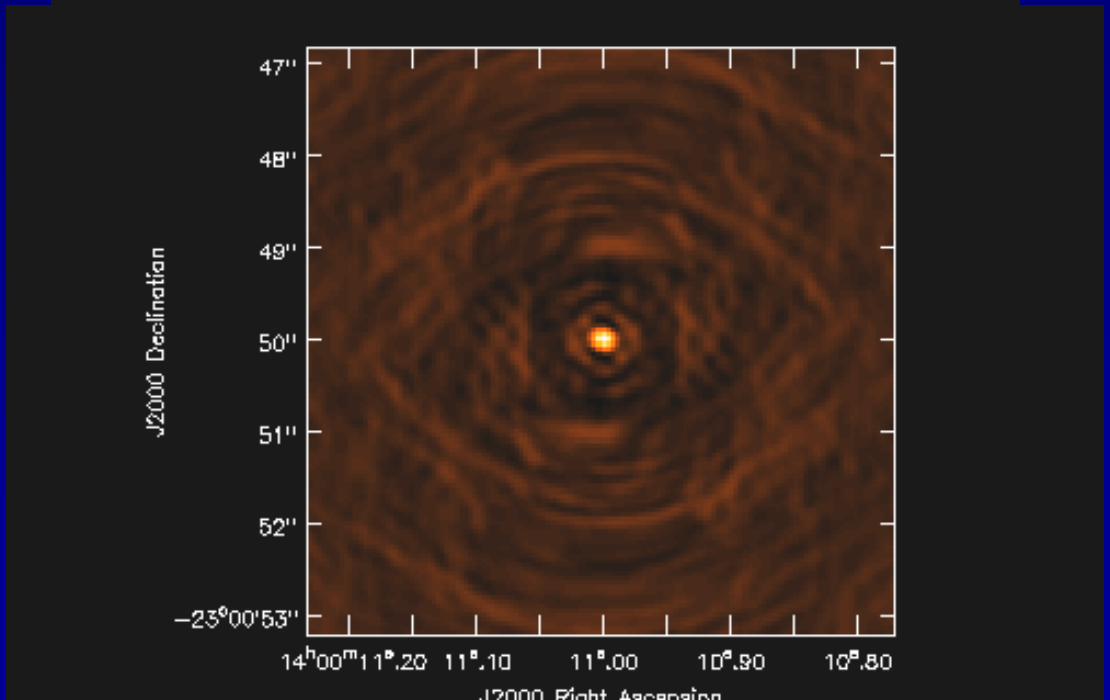


Phase 4
Early Science Beams

Medium



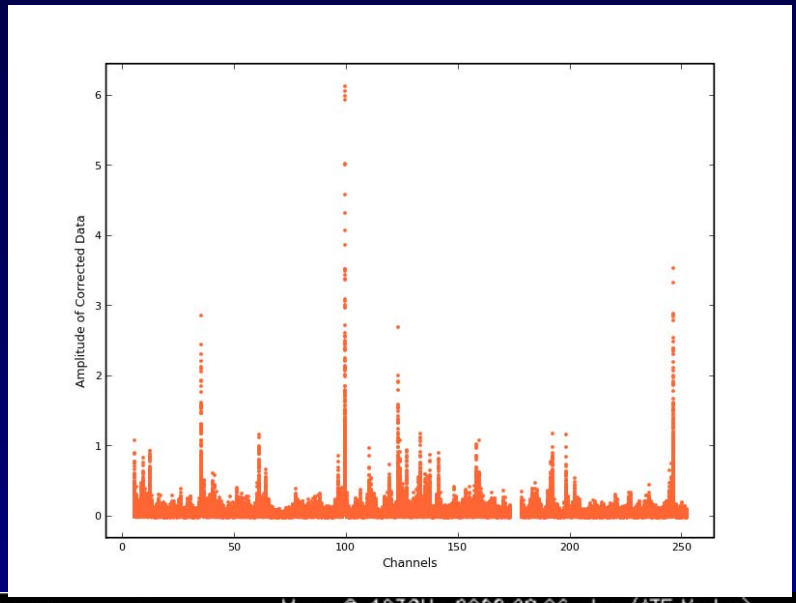
Large



Milestones Achieved at ATF

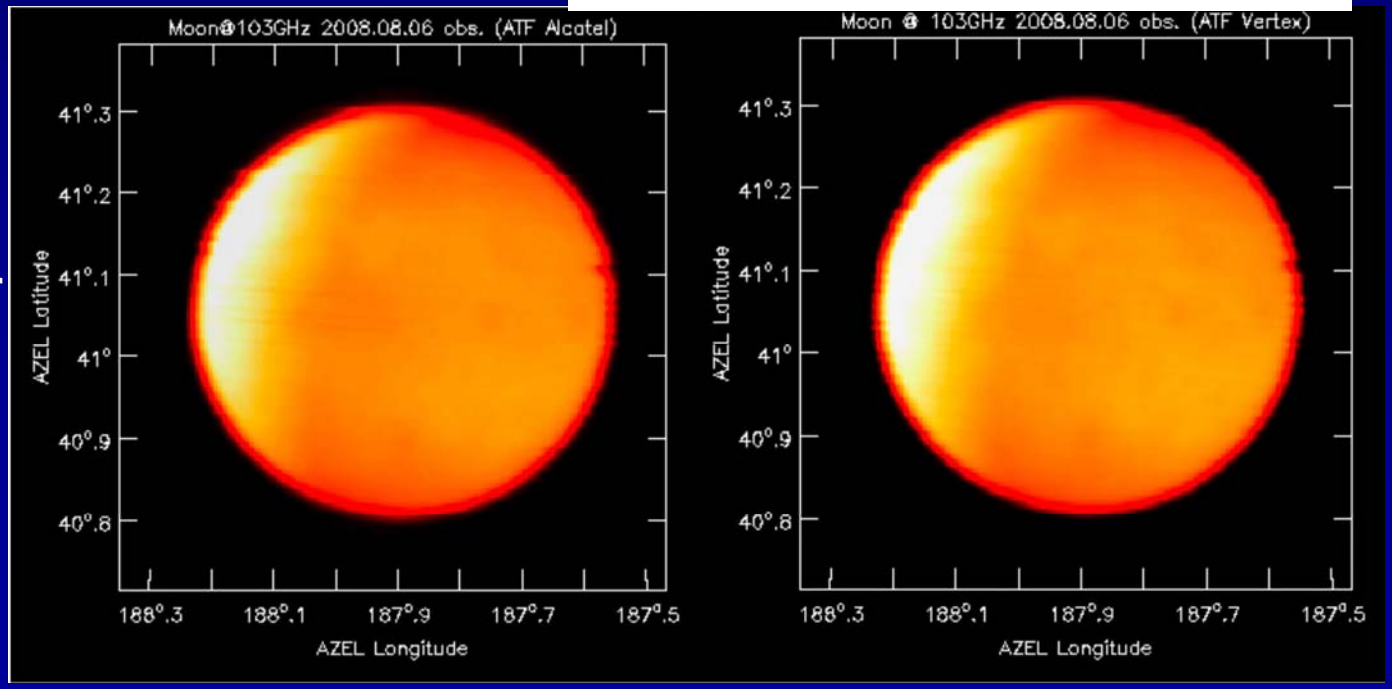
Software testing:

Sgr B2 Spectrum
97.9 GHz

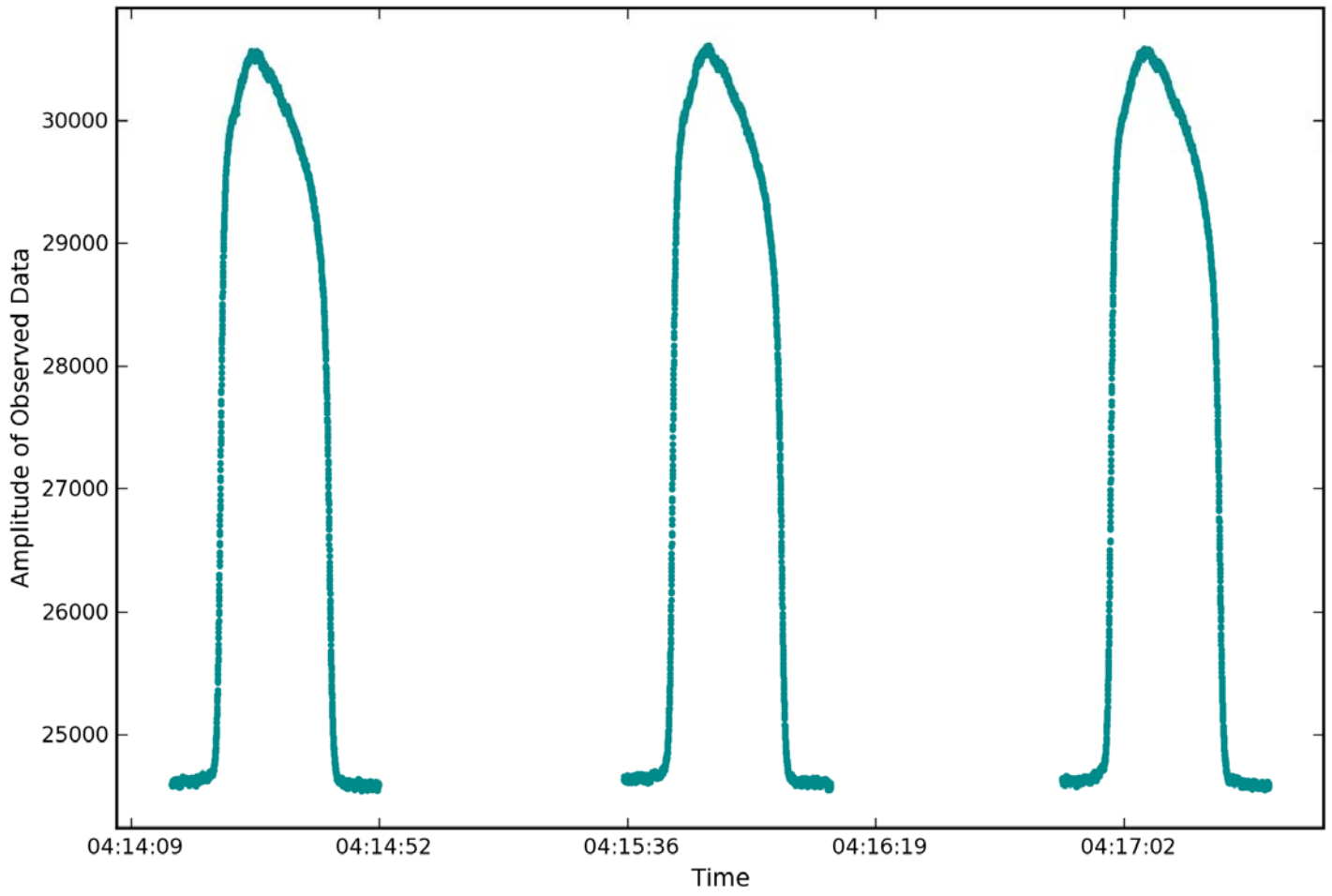


Raster on Moon with Total Power detectors simultaneously on 2 antennas

Taken at ATF, not using production receivers, but verifying software for control, tuning, correlator and data reduction



Scans of Moon 11th March 09 at OSF



Level 1 Science Requirements - at present

1. The ability to detect spectral line emission from CO or C II in a normal galaxy like the Milky Way at a redshift of z=3, in less than 24 hours of observation.

2. The ability to image the gas kinematics in protostars and protoplanetary disks around young Sun-like stars at a distance of 150 pc (roughly the distance of the star forming clouds in Ophiuchus or Corona Australis), enabling one to study their physical, chemical and magnetic field structures and to detect the tidal gaps created by planets undergoing formation in the disks.

3. The ability to provide precise images at an angular resolution of 0.”1. Here the term precise image means representing within the noise level the sky brightness at all points where the brightness is greater than 0.1% of the peak image brightness. This requirement applies to all sources visible to ALMA that transit at an elevation greater than 20 degrees.

Detailed Requirements (first 5)

Compliance

Requirement Category	Specification	Number [SCI-90.00.00.00-nnn-00]
1. Frequency	ALMA should be able to observe in all atmospheric windows between 31.3 and 950 GHz.	Yes
1.1 Bands	In order to achieve this technically, the receiving system shall be separated into 10 bands, of which four shall be built during ALMA construction: band 1 = 31.3-45 GHz; band 2 = 67-90 GHz; band 3 = 84-116 GHz; band 4 = 125-163 GHz; band 5 = 163-211 GHz; band 6 = 211-275 GHz; band 7 = 275-373 GHz; band 8 = 385-500 GHz; band 9 = 602-720 GHz; band 10 = 787950 GHz. Ref [RD2] Table 1.1, CRE81.	10 Yes (Bands 1 and 2 left out. Only 6 band 5 receivers)
1.2 Tunability	It shall be possible to tune ALMA completely across the observable windows, i.e., reach a spectral line transition at any arbitrary observable frequency.	20 Yes (by design)
1.3 Spectral resolution	It shall be possible to configure the correlator to achieve sufficient resolution (0.01 km/s) at 100 GHz to *resolve* thermal line widths.	30 Yes
1.4 Intraband tuning	It shall be possible to retune ALMA to a second frequency within a band from a first in the same band in a time not greater than 1.5 seconds. Switching frequencies (e.g. to cancel primary-secondary standing waves of this frequency) shall take no more than 10 ms. Note that this applies to Total Power Modes when switching within (rather than between) bands.	40 Yes (by design) Software ?
1.5 Interband tuning, second band ready	It shall be possible to retune ALMA to a new frequency in a different band that is currently on standby (``warm'') in a time not greater than 1.5 seconds; there shall be two standby bands in addition to the band currently employed for array observations.	50 Yes 2 standby bands?

Detailed Requirements (next 6)

		Compliance
1.6 Interband tuning, second band unready	It shall be possible to retune ALMA to a new frequency in a different band in a time not greater than 15 minutes.	60 Yes
1.7 Spectral dynamic range	The required spectral dynamic range is 10000:1 for measurement of weak spectral lines in the presence of stronger ones, and 1000:1 for weak lines in the presence of strong continuum emission.	70 some problems
1.8 Image dynamic range	The required image dynamic range, for small sources in a single larger field, is 50000:1, peak to rms with self-calibration in interferometric mode.	75 inconsistent with level 1 as it is.
2. Sensitivity	ALMA shall maximize sensitivity over its frequency bands	
2.1 Flux sensitivity	ALMA shall routinely obtain sub-millijansky point source sensitivity at all observing frequencies, within ten minutes of integration time, under median atmospheric conditions (τ=0.082, [RD33]) in Interferometric Mode. (in 600s, expected zenith sensitivities are B3: 0.01mJy; B6: 0.02 mJy; B9: 1.0 mJy)	80 Yes (very loose spec)
2.2 Site	ALMA shall be sited at the Llano de Chajnantor, to take advantage of the extremely dry and phase-stable conditions there, which derive from the transparent and stable atmosphere over the site.	90 Yes !
2.3 Antenna complement	ALMA shall be comprised of 64 12-m antennas (see Appendices).	100 No !!

Specifications Update

- Clarify imaging requirements and derive the ACA specifications from them.
- Clarify how the polarization requirements arise.
- Integrate the top-level calibration requirements.
- Include requirements on observing efficiency and relate these to software overheads
- Transfer many of the more detailed technical items to the Systems Requirements document
- Draft of revised spec to ASAC by April ’09
- Work in parallel on Systems Requirements / flow-down
- Final Sys Reqs Review in September
- Seek ASAC and Board approval at next f2F meetings