

ALMA, Synthesis Imaging and the Astro-Grid

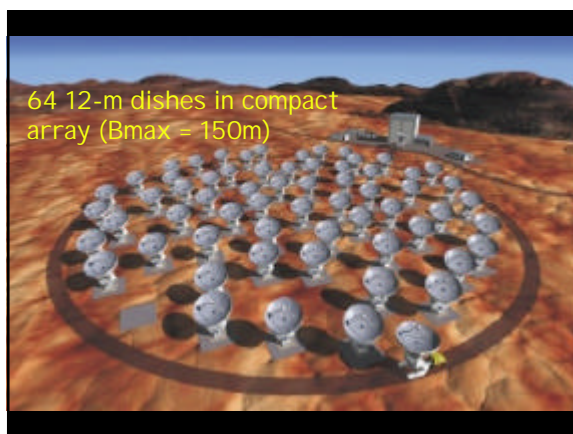
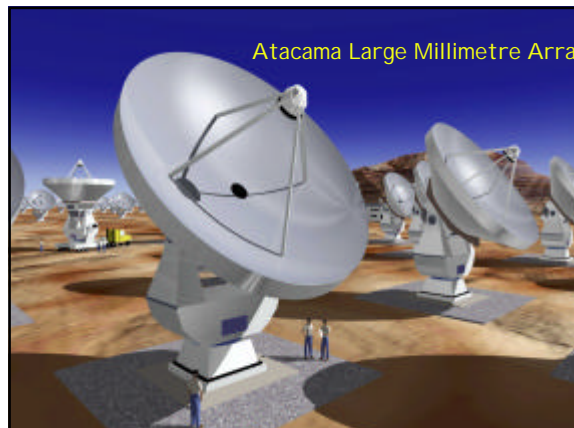
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- ALMA: What, Why, When
- Science Software Requirements
- Data Rates and Data Products
- Unique Aspects of Synthesis Data
- Astro-Grid Relevance

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ALMA in a Nutshell

- 64+ element, reconfigurable interferometric array for 30-900GHz, on a 5000m site in Chile
- Wideband (8GHz), full polarisation, digital correlator with up to 8192 spectral channels
- Routine <0.1 arcsec imaging, sensitivity to detect protoplanetary disks and protogalaxies
- D+D to 2002, build 2002-2010, science 2007?
- UK has 10% share (eventually through ESO?), own D+D programme
- \$552M cost (equal North America/ESO split)
- Japan may increase the scientific scope

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Software Requirements

- Usability - from proposal preparation to data analysis
- Real-time, intelligent data reduction pipeline
 - Produce preliminary data products: visibilities and images
- Automatic flexible scheduling of the array
- Reanalysis of visibility data (e.g. phase correction experiments, mosaicing, adding short spacing data)
- Global access to archive, intensive processing
- Novel image reconstruction tools required
 - Huge number of channels (-> parallelisation)
 - Wide-field surveys, 1000s of pointings
 - Full visibility coverage
- Visualisation of *huge* 4-d data sets
 - 1024 x 1024 x 8192 channels x 4 polarisation = 0.1 TeraBytes

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Data Rates

- Data rate arriving at correlator:
 - 64 x 8 GHz bandwidth x 2 polarisations x 3 bits x 2 sampling = 6 Terabit/s
- Correlation: 8192 channels, 4 pol'n products, 2016 baselines
 - Equivalent to many hundred teraflops
- Archive requirement rate
 - Depends on observing mode
 - On the fly interferometry vs single dish mode
 - Mean rate estimate 6Mbyte/s
 - Pipeline image data AND visibility data must be stored

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Data Volume				
	1 sec	1 hour	1 day	1 year
Average Visibility	4 MB	14 GB	350 GB	126 TB
Average Image	2 MB	7 GB	170 GB	63 TB
Average Total	6 MB	21 GB	520 GB	190 TB

	Visibility Average		Visibility Peak	
	Both	Single	Both	Single
1 sec	250 chans	500 chans	2500 chans	5000 chans
10 sec	2500 chans	5000 chans	25000 chans	50000 chans
30 sec	7500 chans	15000 chans	75000 chans	150000 chans

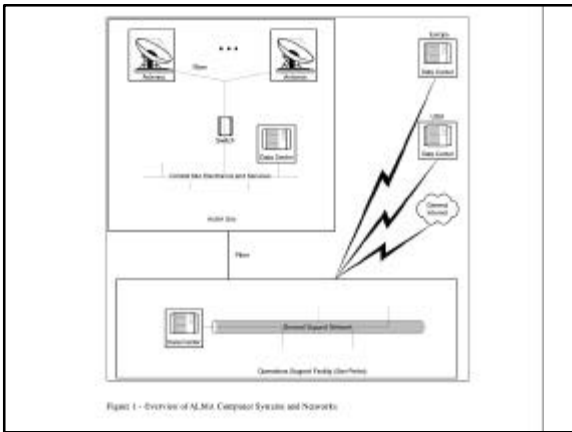
Tradeoffs between integration time, channels, and phase correction for visibilities.
Both and *Single* refer to the atmospheric corrected and/or uncorrected data selection.

	Image Average		Image Peak	
	Both	Single	Both	Single
30 sec	230 chans	60 chans	2300 chans	600 chans
5 min	2300 chans	570 chans	23000 chans	5700 chans
20 min	9200 chans	2300 chans	92000 chans	23000 chans

Tradeoffs between image frequency, image size, and channels.

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- ### Unique aspects of synthesis data
- Incomplete Fourier coverage
 - Must archive uv points (expensive)
 - Requirement to fill uv hole with single dish/other array data
 - Potentially large number of spectral channels
 - Spectral info has special requirements
 - *Non-linear* image reconstruction techniques are a requirement
 - Bayesian schemes most popular
 - Computationally expensive - global data fitting
 - Complex to develop
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- ### ALMA: Astro-Grid Considerations
- Grid technology key to success of ALMA:
 - Remote, *global* access to archive data
 - Multi-wavelength data mining
 - vital synergy with radio, IR, optical, X-ray data
 - Distributed (re)processing of archived data
 - Astro-Grid should encompass interferometry
 - Need to start work now/soon!
 - ALMA software requirements definition underway
 - Detailed *design* will follow soon
 - Synthesis imaging is difficult... long lead times
 - Need to collaborate
 - ESO, NRAO, Japan, Canada, Spain, Chile, ...
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