

ALMA in Cycle 5

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The Atacama Large Millimeter/submillimeter Array (ALMA)



- Aperture synthesis array located in the Atacama desert in Chile on the Chajnantor plateau at an altitude of 5000 m
- Array consisting of 66 antennas
 - Main array: 50 x 12-m
 - ACA (Morita Array): 4 x 12m (Total Power) + 12 x 7m (for extended structures)
- Baselines from 15 m to 16 km
- ALMA will work at frequencies from 30 to 950 GHz (wavelengths from 10 - 0.3 mm)
- Flexible digital correlator giving wide range of spectral resolutions

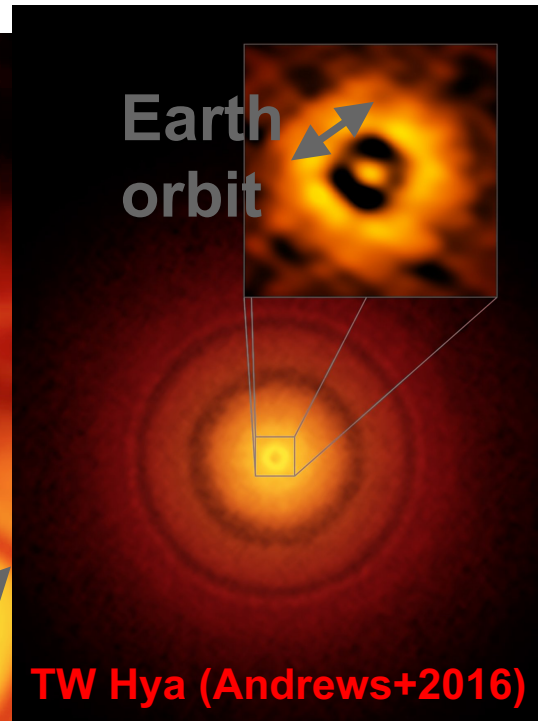
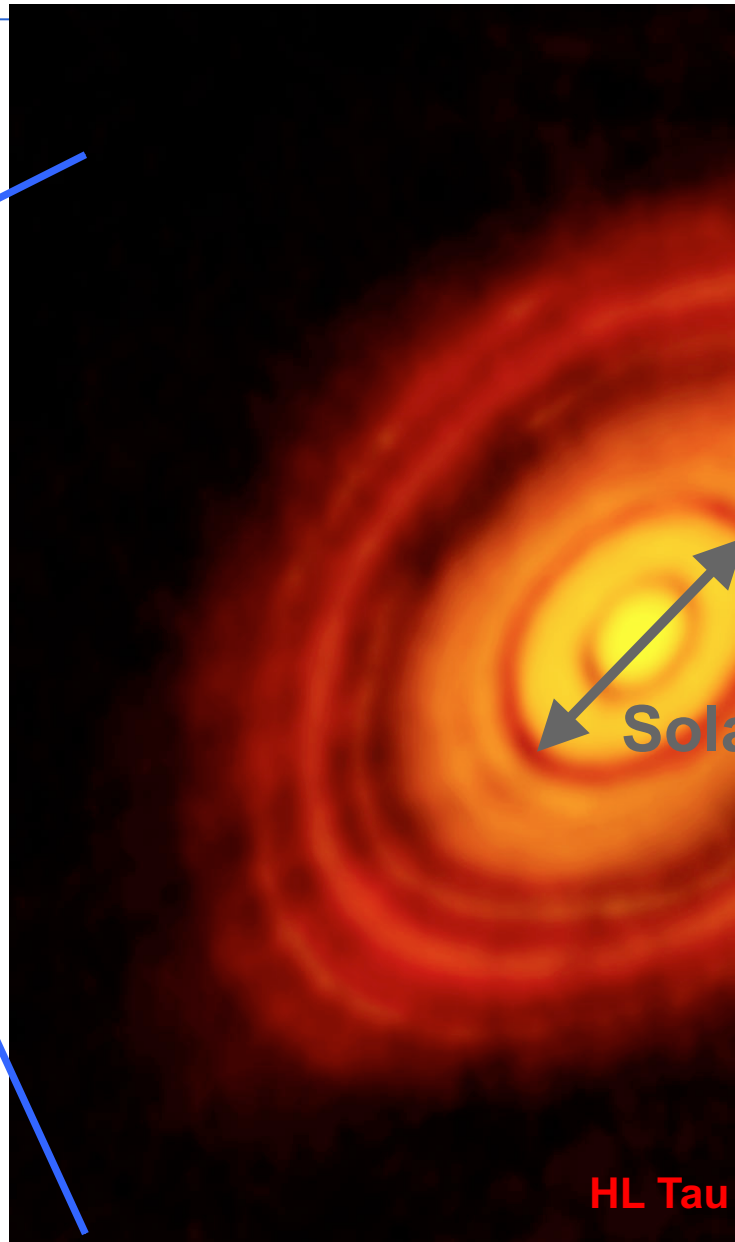
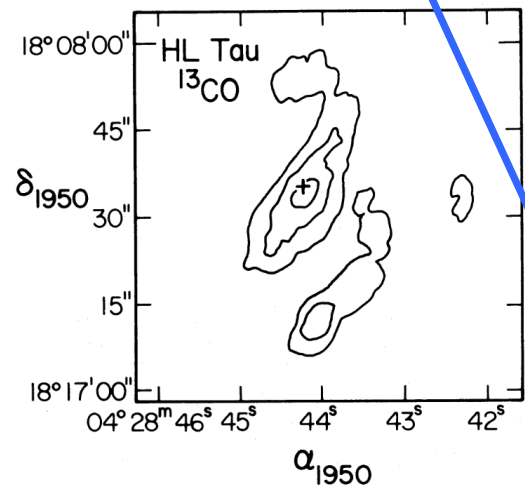
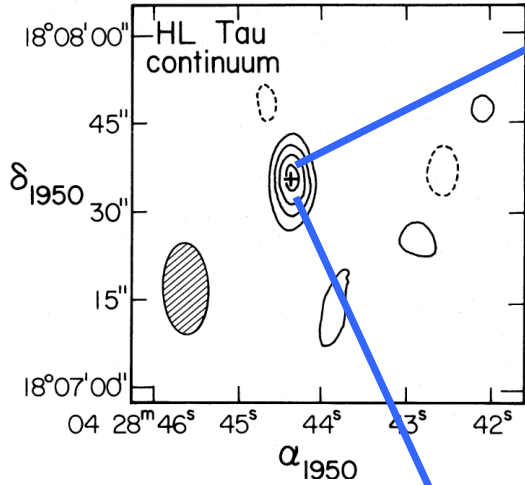
The ALMA Site



- Altitude 2900 m
- ALMA control room
- Technical labs
- Dormitories & canteen



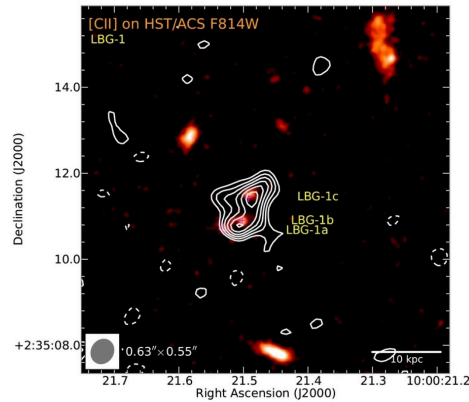
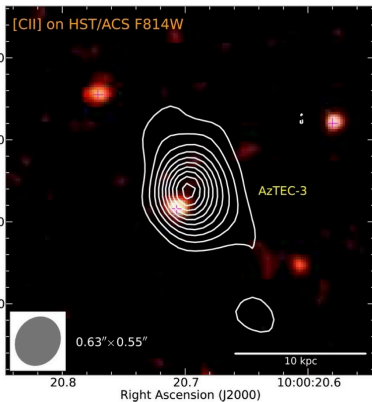
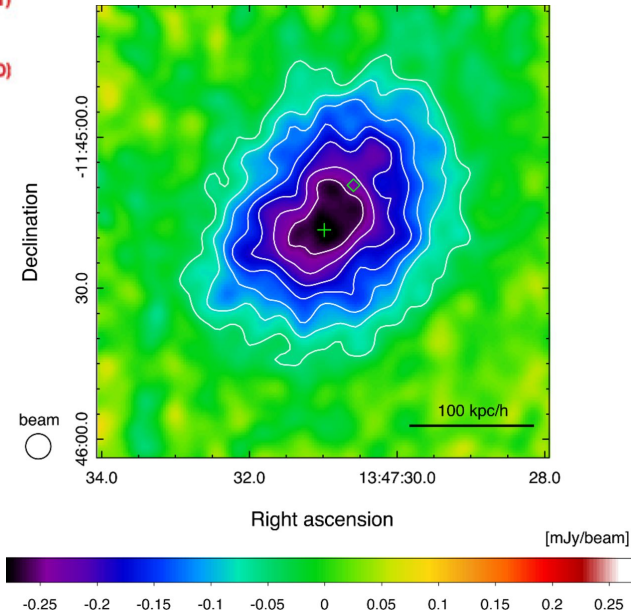
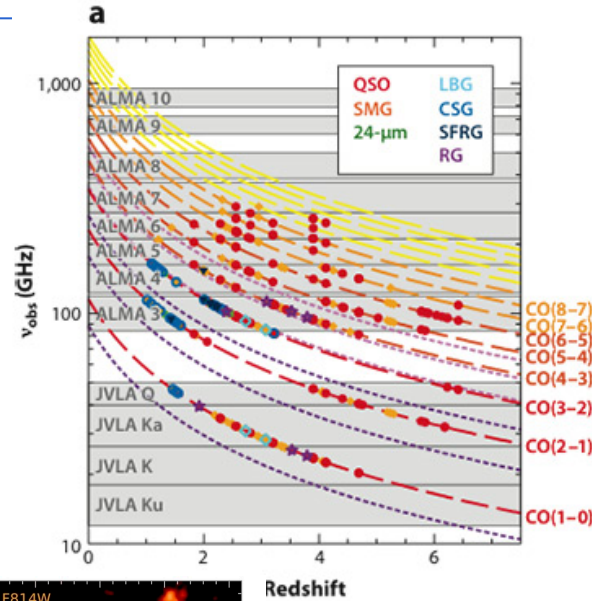
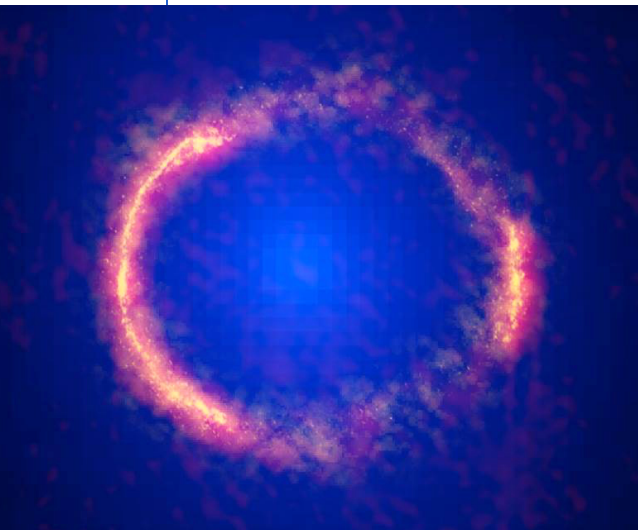
Science with ALMA



Solar System

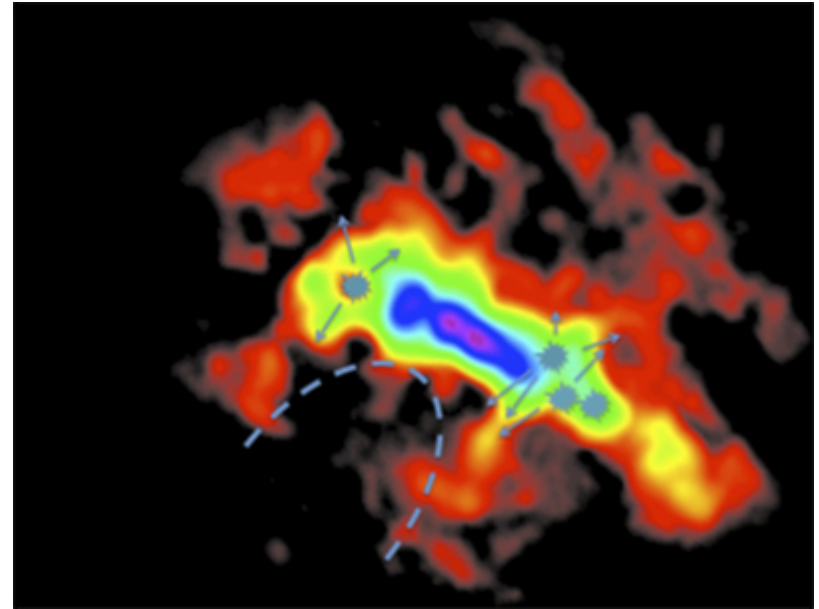
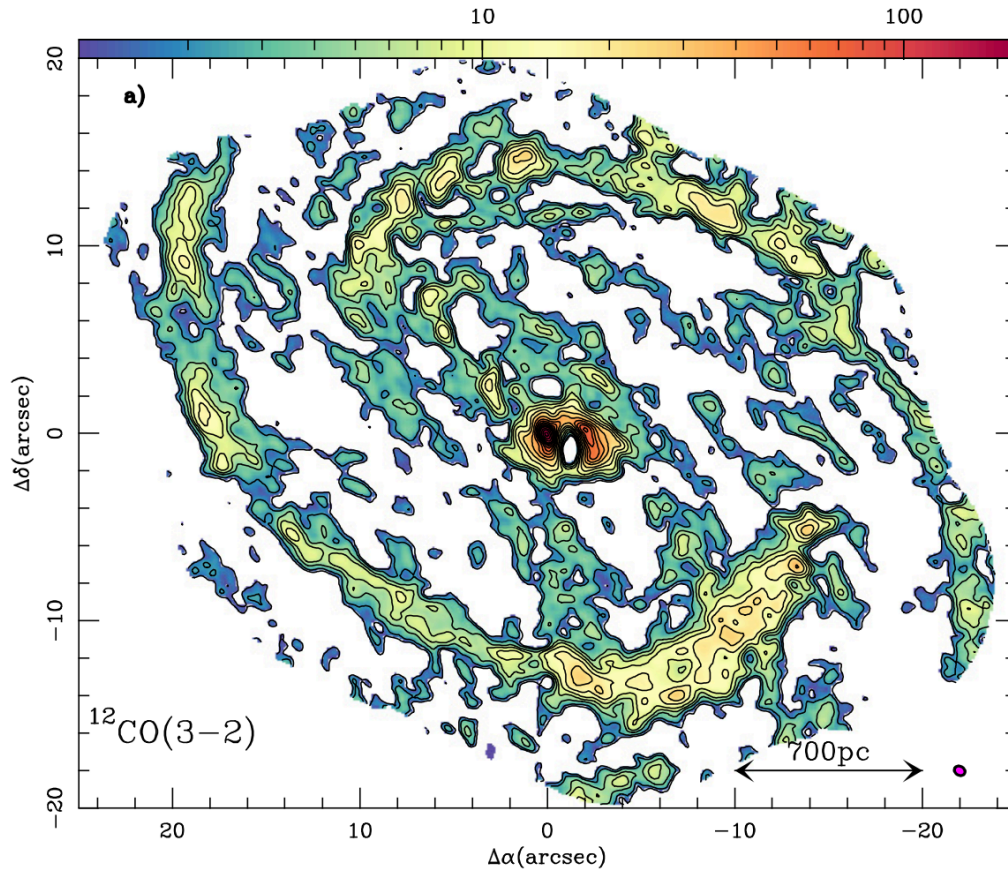
HL Tau (ALMA Partnership 2015)

The high-z Universe



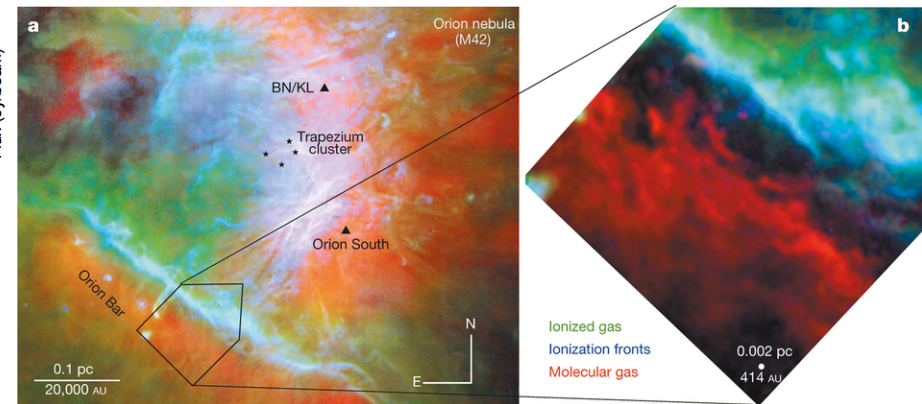
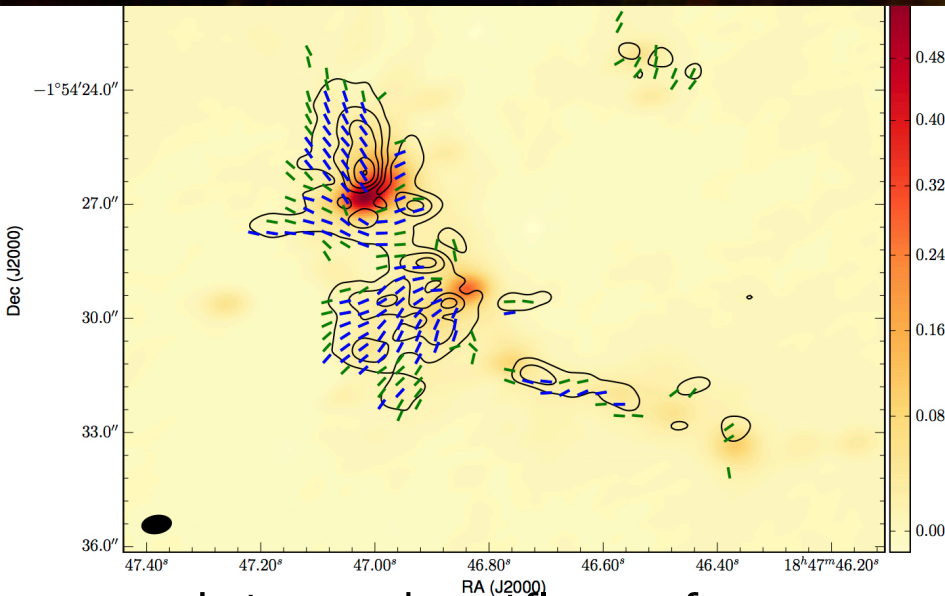
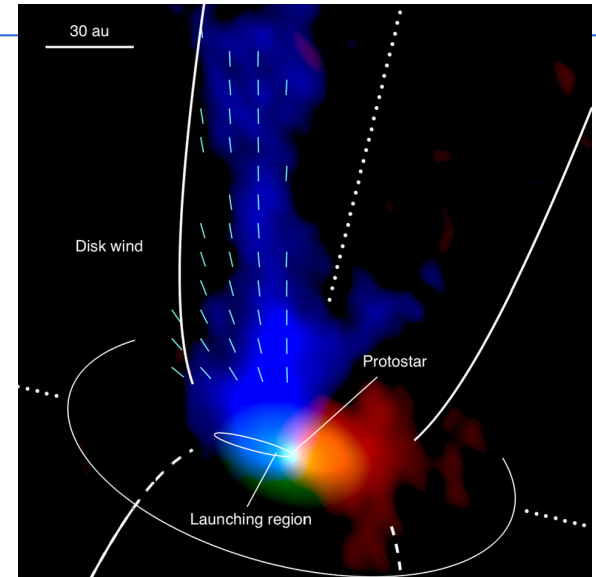
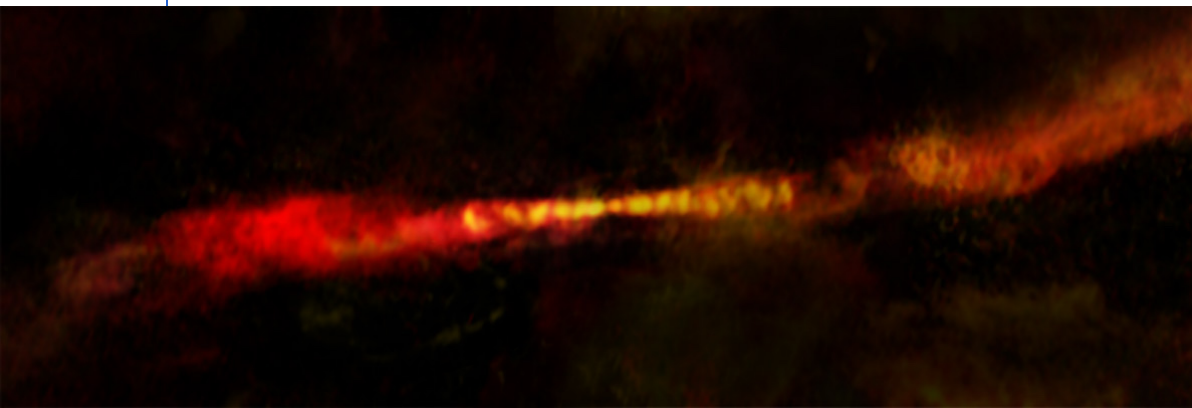
- ◆ Lensed star forming galaxies
- ◆ Atomic and molecular gas at high-z, the SZ effect

Galaxies and their nuclei



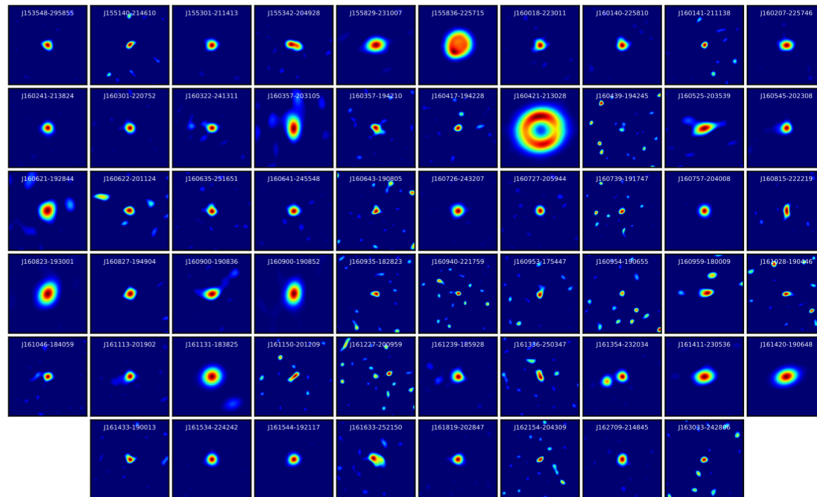
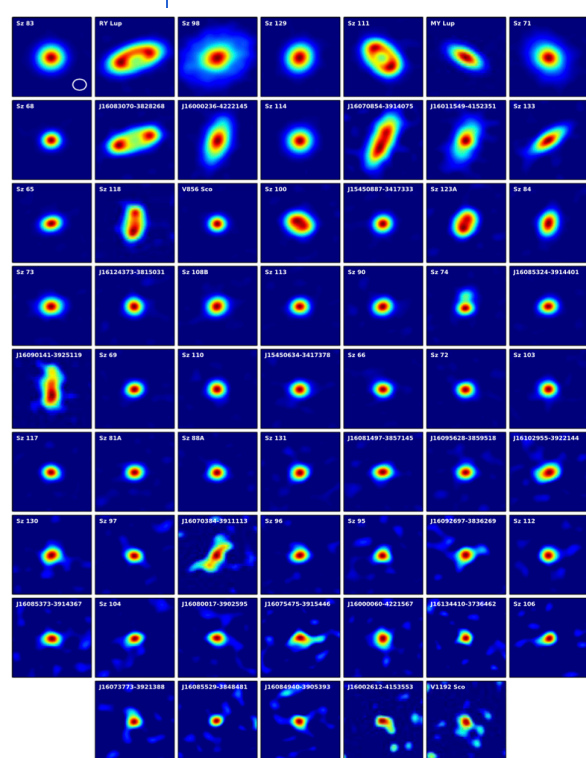
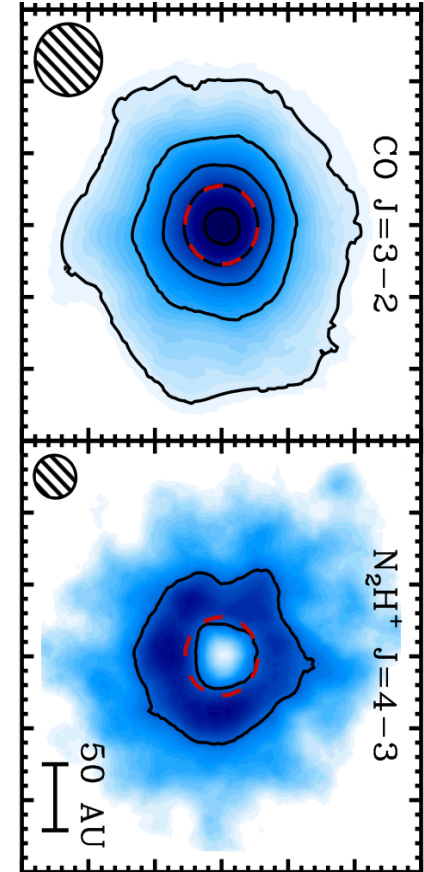
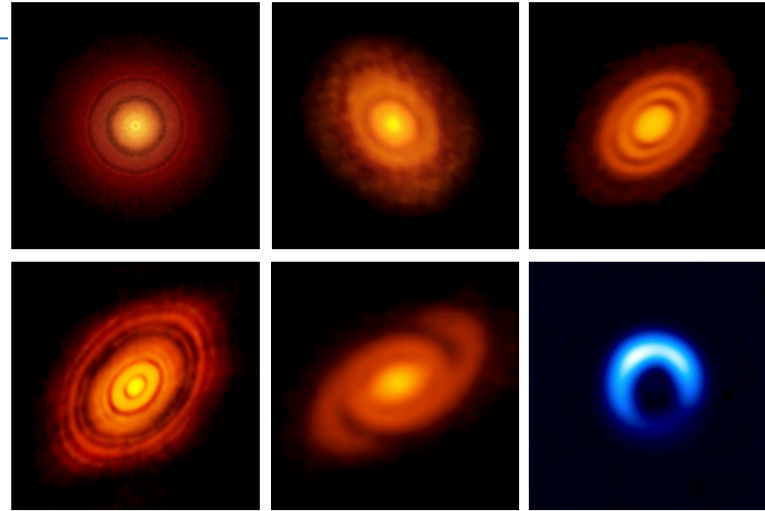
- ◆ Molecular clouds and AGN in NGC1068
- ◆ Star formation and galactic scale feedback in NGC253

ISM and Star Formation



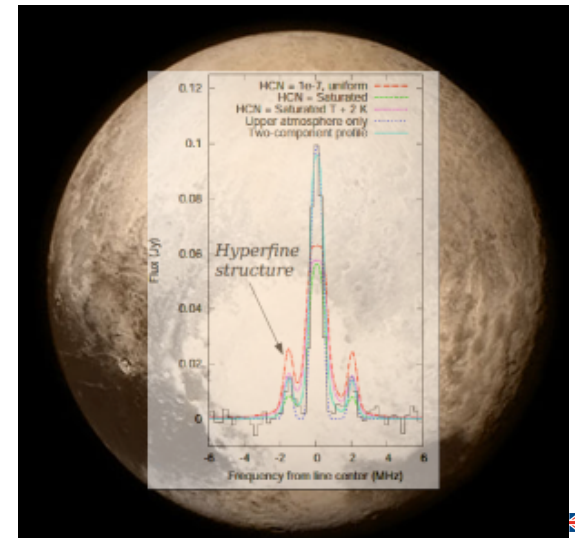
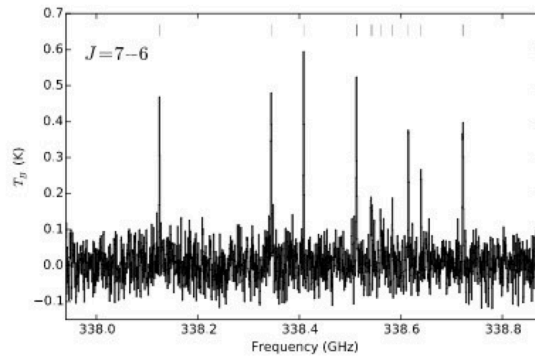
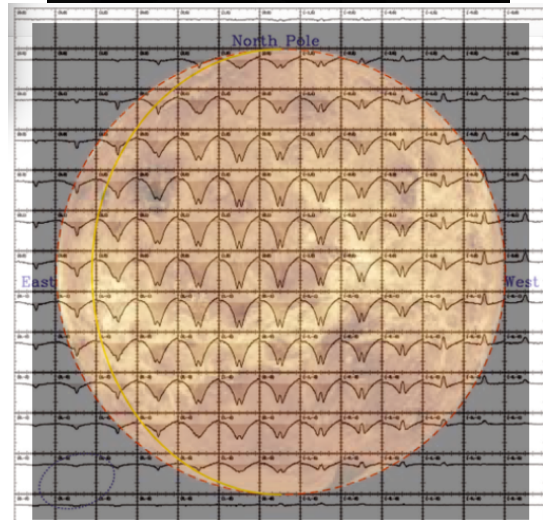
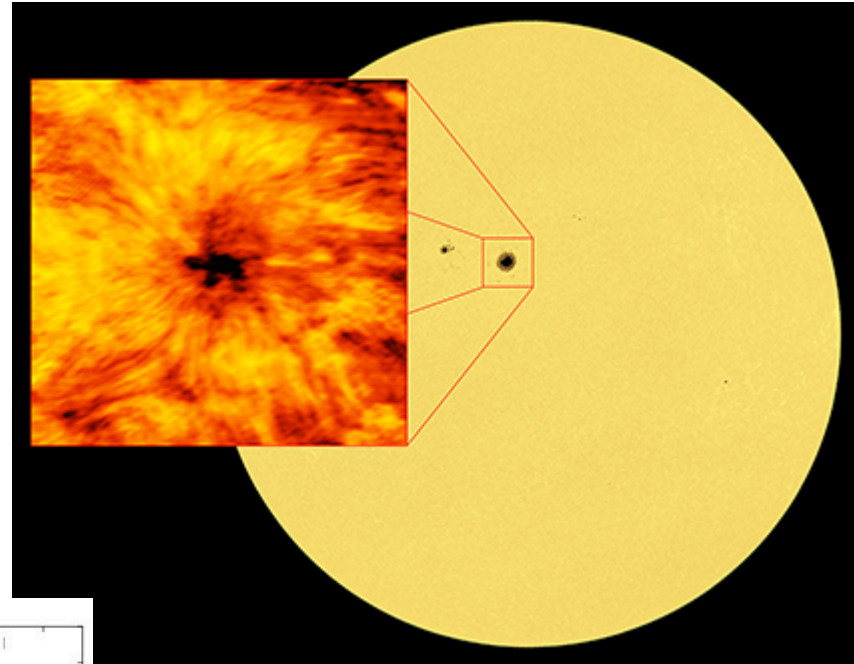
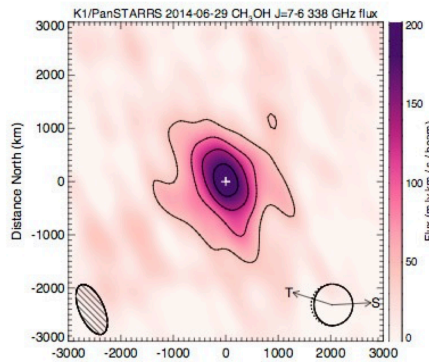
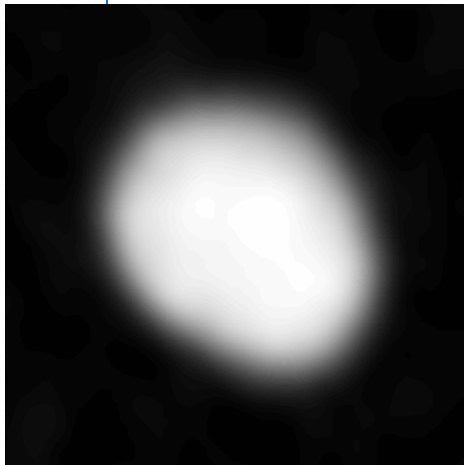
- ◆ Jets and outflows from young stars
- ◆ Magnetic fields and radiation feedback in high mass SFR

Planet forming disks



- ◆ Gaps, holes and asymmetries: the trademarks of planets
- ◆ Disk gas content: mass and chemical composition

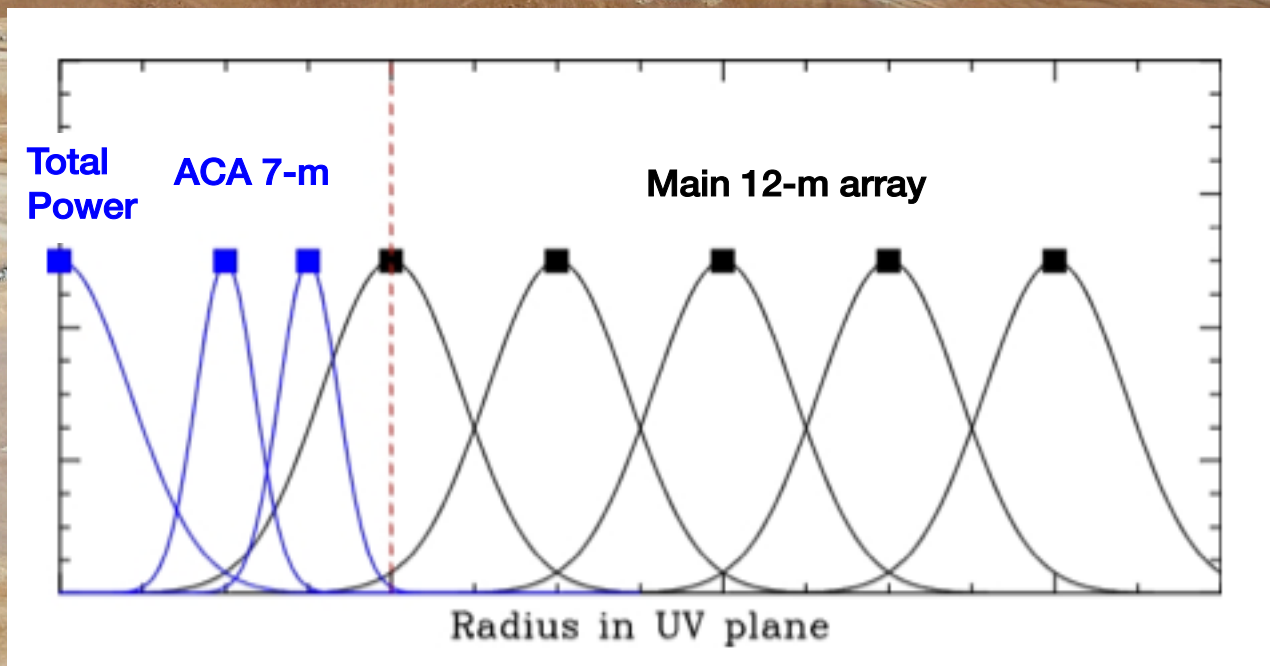
Solar System



- ◆ Asteroids, planetary atmospheres
- ◆ Comets and the Sun

ALMA Capabilities in Cycle 5

- **43** 12-m antennas in the main array
- **10** 7-m antennas for the ACA (Morita Array)
- **3** 12-m antennas for ACA Total Power observations (spectral line observations Band 3-8 only)



12-m array and ACA

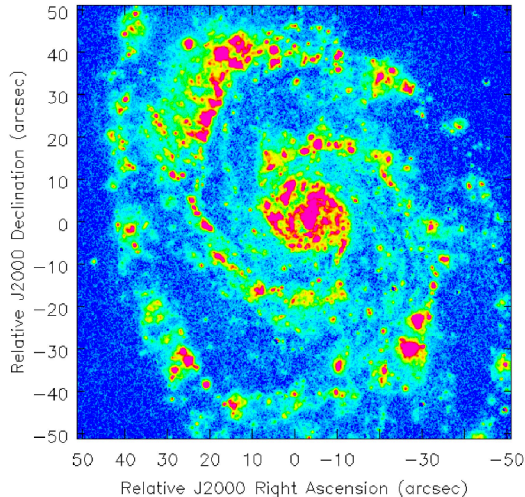
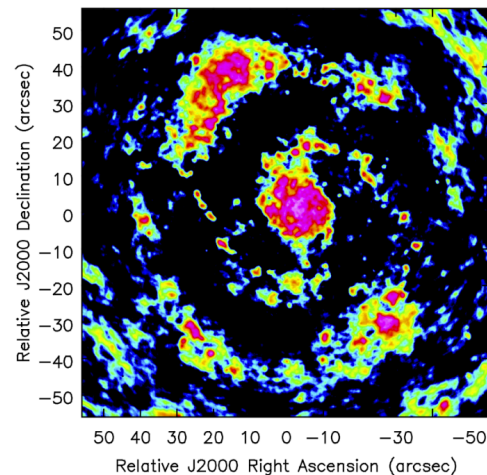
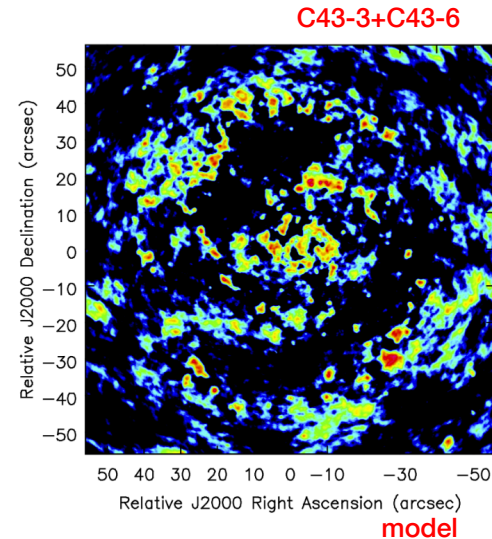
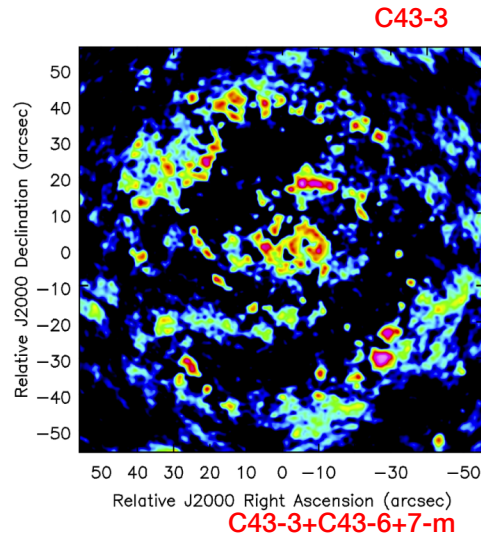
ACA is really very compact!



12-m antenna for Total Power

Configurations

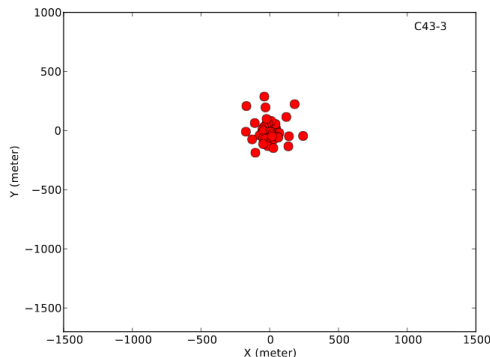
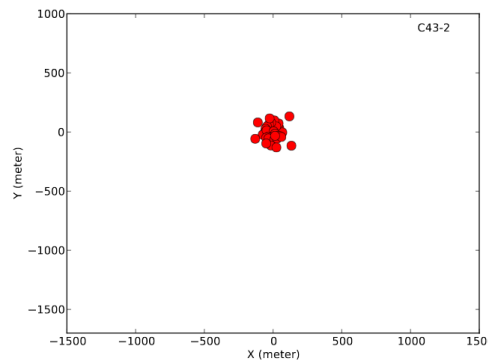
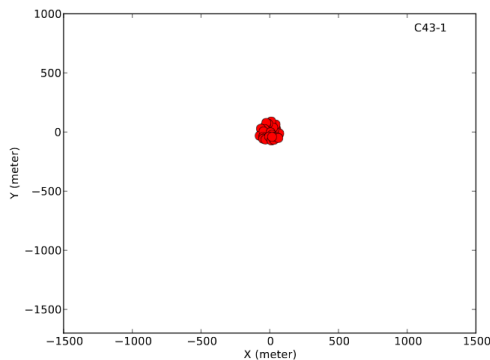
- **10** 12-m array configurations, C43-1 to C43-10
- **1** ACA configuration



Combine different configurations to image different angular scales!

Configurations

- **10** 12-m array configurations, C43-1 to C43-10
- **1** ACA configuration



Baselines from
15 – 500 m

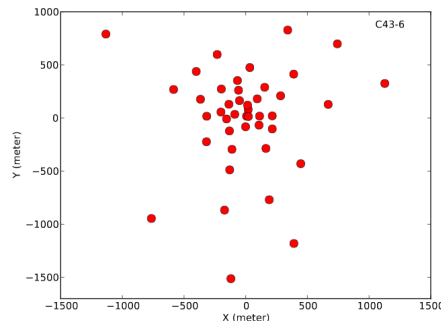
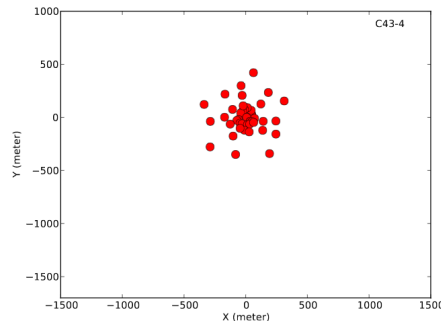
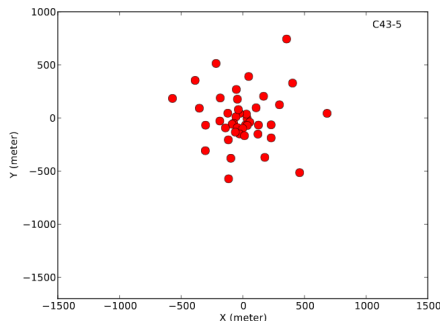
Compact Configurations: C43-1 – C43-3

- can be paired directly with ACA
- Angular resolution $\sim 0.4-1''$ (B7)
- All bands offered
- Solar & VLBI

Configurations

- **10** 12-m array configurations, C43-1 to C43-10
- **1** ACA configuration

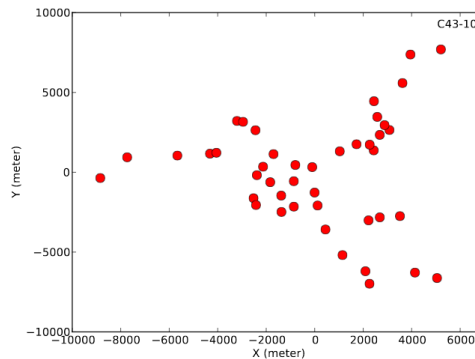
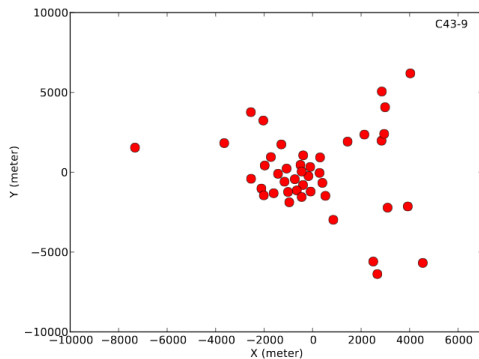
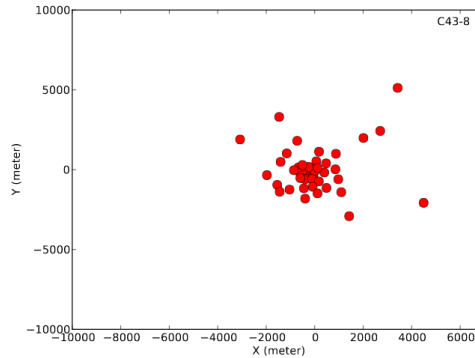
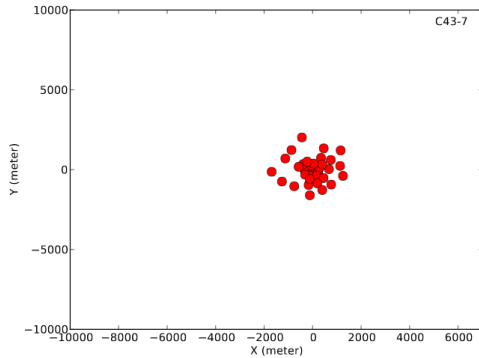
Baselines from
15 m – 2.5 km



Intermediate Configurations: C43-4 – C43-6

- can be paired with one of the compact 12-m configurations
- Can then also use ACA
- Angular resolution ~0.09-0.3" (B7)
- All bands offered, **EXCEPT B5 in C43-6**

Configurations



Extended Configurations

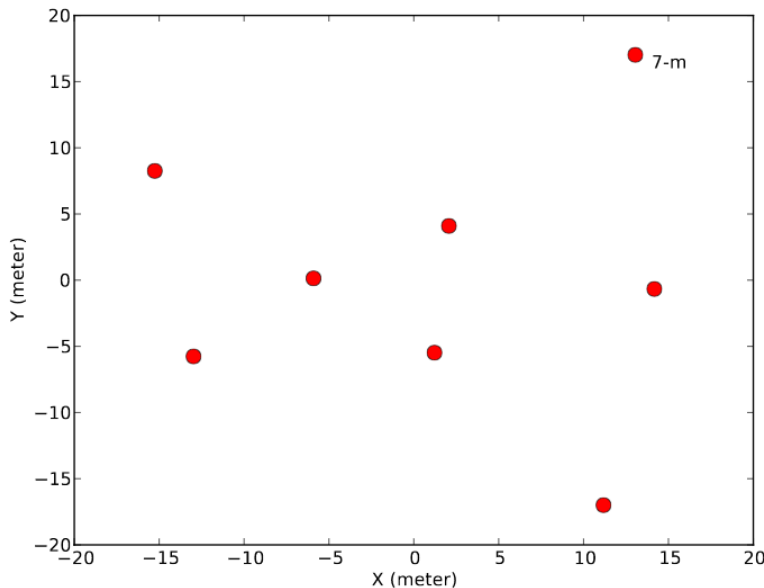
- C43-7 – C43-9 can be paired with one of the intermediate 12-m configurations
- C43-10 cannot be paired at all
- No ACA
- Angular resolution ~0.02-0.09'' (B6)
- C43-7: all bands
- C43-8: B3-7
- C43-9/10: B3-6

Baselines from 64 m – 16.2 km

Band 5 not offered in any of the extended configurations due to the configuration schedule!!!

Configurations

- **10** 12-m array configurations, C43-1 to C43-10
- **1** ACA configuration



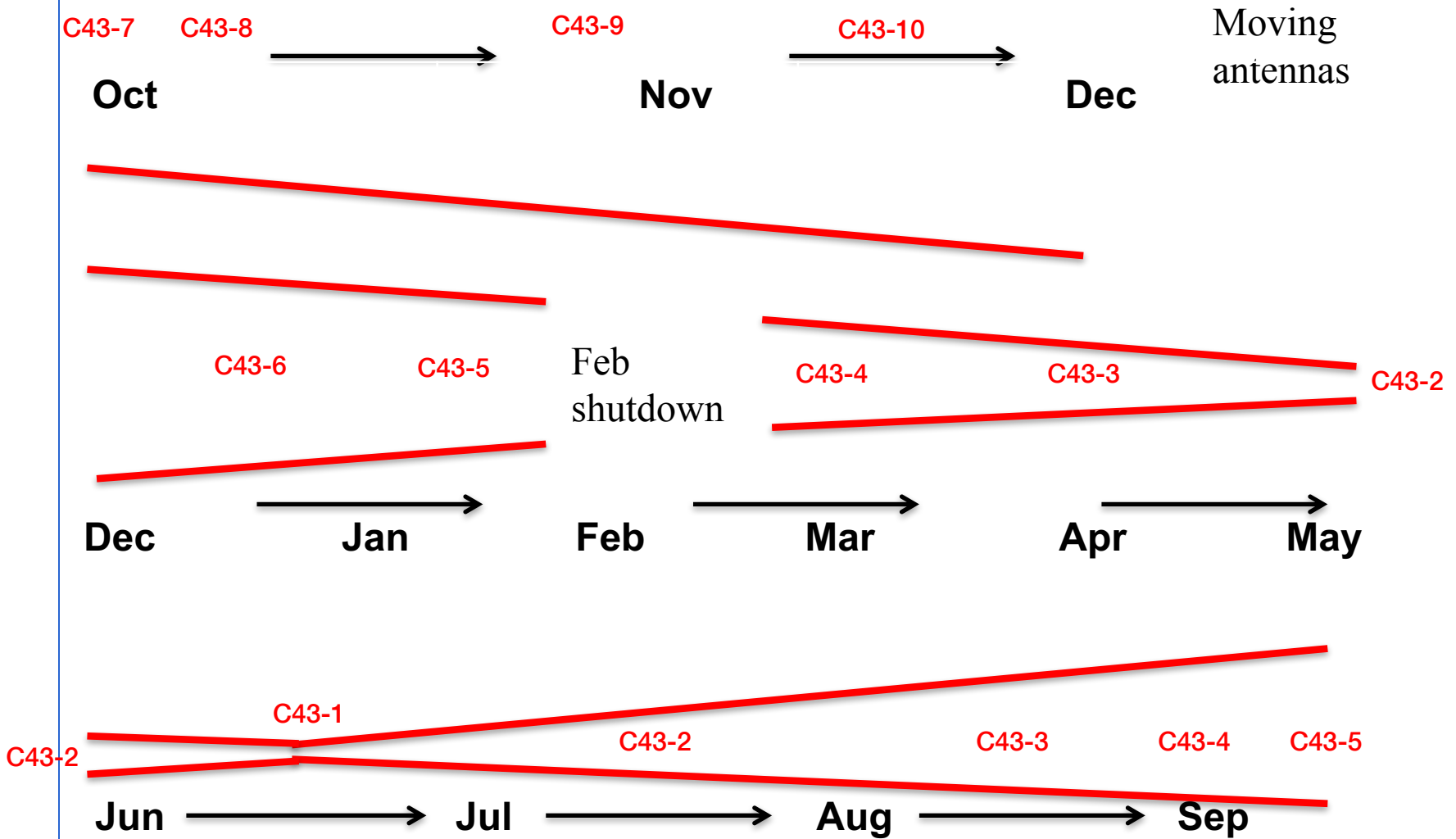
7-m array: Baselines from 9 – 45 m

ACA

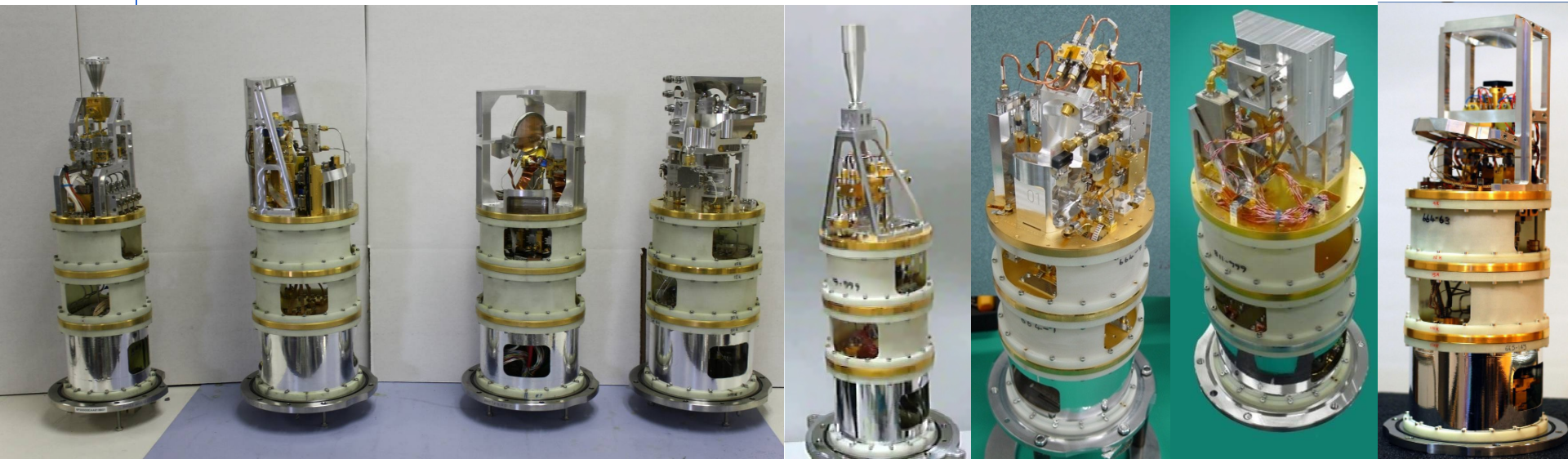
- Consists of 7-m array and TP if necessary for requested LAS
- Can be paired with 12-m array or used in **stand-alone mode**
- TP is available **ONLY** together with 7-m array and **ONLY** for spectral line observations B3-8
- Angular resolution **~3.6'' (B7)**



Configuration Schedule



- **Bands 3, 4, 6** (84-275 GHz) offered for all configurations
- **Band 5 (NEW!)** (163-211 GHz) for configs C43-1 to C43-5
- **Band 7** (275-373 GHz) for configurations C43-1 to C43-8
- **Bands 8, 9, 10** (385-950 GHz) offered for C43-1 to C43-7



Band 3	Band 6	Band 7	Band 9	Band 4	Band 8	Band 10	Band 5
HIA	NRAO	IRAM	NOVA	NAOJ	NAOJ	NAOJ	GARD+

ALMA Bands

Band	Frequency range ¹ (GHz)	Wavelength range (mm)	IF range (GHz)	Type
3	84 – 116	3.6 – 2.6	4 – 8	2SB
4	125 – 163	2.4 – 1.8	4 – 8	2SB
5	163 – 211	1.8 – 1.4	4 – 8	2SB
6	211 – 275	1.4 – 1.1	5 – 10	2SB
7	275 – 373	1.1 – 0.8	4 – 8	2SB
8	385 – 500	0.78 – 0.60	4 – 8	2SB
9			4 – 12	DSB
10			4 – 12	DSB

NEW: Walsh switching enabled for B 9 and 10! This means the data from the “image” or “mirror” spectral windows can now be recovered!

Spectral capabilities

- **6** FDM correlator modes (3840 channels, spectral line)
- Spectral resolution up to 0.03 MHz (Dual Polarisation)
- **1** TDM correlator mode (128 channels; continuum)
- 8-16 GHz total continuum bandwidth (**16 GHz with Walsh switching enabled for B9 and 10**)

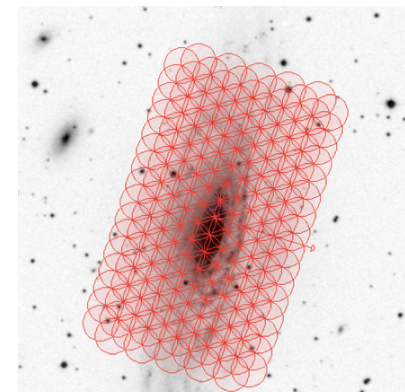


Spectral capabilities

- **4** basebands with up to **4** spectral windows each
- Different correlator modes possible in different basebands
- **Single polarisation** for best spectral resolution (0.015 MHz)
- **Full polarisation** measurements offered for TDM and FDM modes
 - Offered for Bands 3, 4, 5, 6, 7
 - On-axis sources only
 - Single pointings only
 - Minimum 3 hours
- Spectral dynamic range offered:
 - **1000** for Bands 3, 4, 6
 - **500** for B 5, **400** for B 7, **250** for B 8, **170** for B 9, **150** for B 10

Spatial field setup capabilities

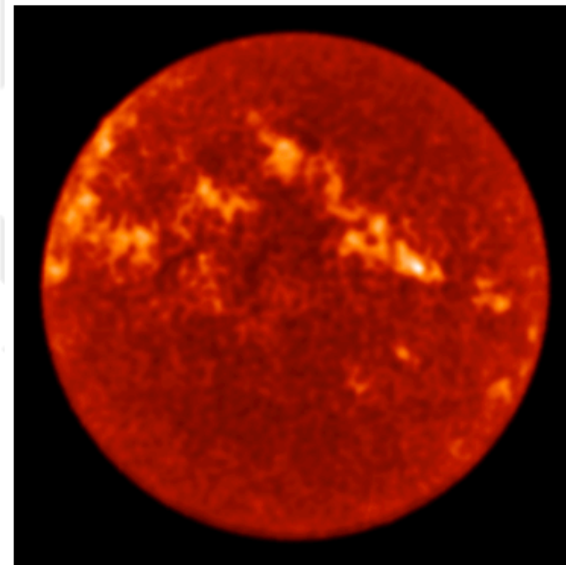
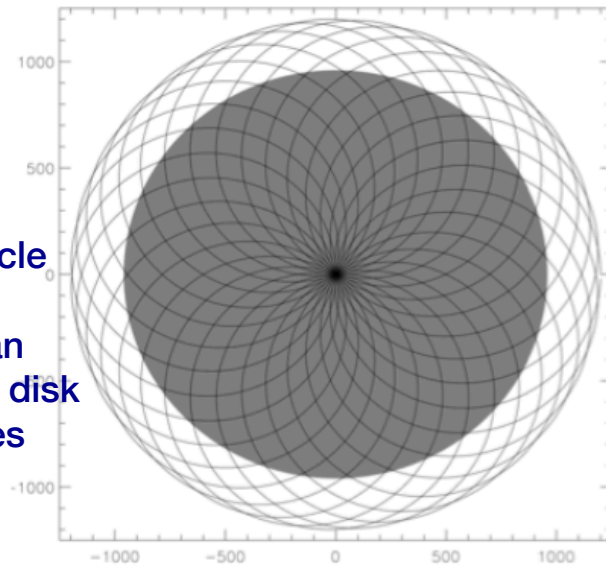
- Sources up to declination of $+47^\circ$ possible, but **declinations less than $+37^\circ$ preferable**
- Mosaics and overlapping offset pointing patterns allowed
- **New:** non-overlapping pointings not allowed within one source definition
- **No mosaics for Band 10**
- Maximum number of 12-m pointings to be observed and imaged together (in one source cluster) is **150**
- Imaging dynamic range up to **~ 100** in Bands 3-7
- closer to **50** in Bands 8-10 and for baselines > 2 km
- Astrometric accuracy typically **\sim angular resolution/20 with a minimum of $0.003''$**



Solar observations

- Conducted in **campaign mode** during one of the 3 most compact 12-m array configurations
- Only **Band 3 and 6 pre-defined continuum setups**
- No full polarisation
- **Special interferometric array** comprising 12-m array and 7-m antennas
- **Contemporaneous TP observations** always included

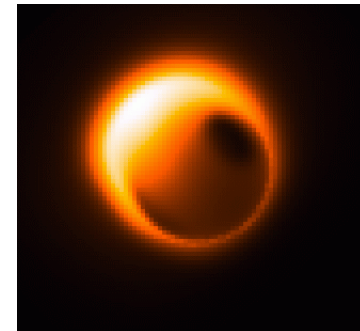
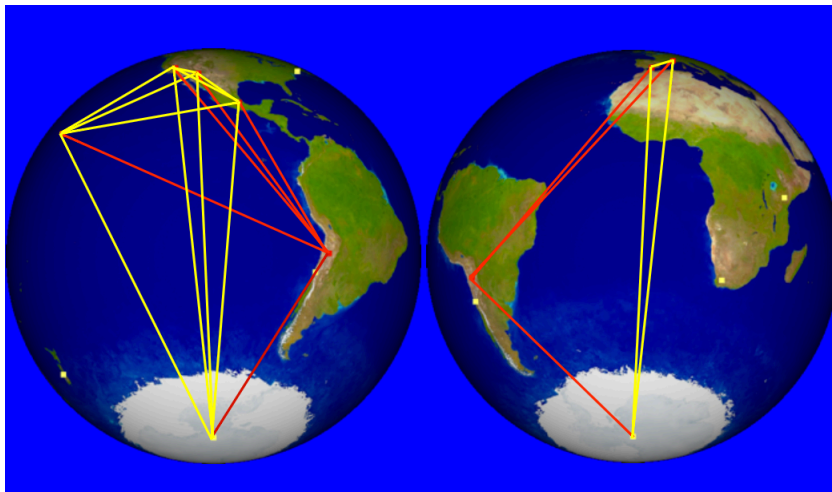
Double-circle scanning pattern, can scan Solar disk in 7 minutes



Real TP map of the Sun!

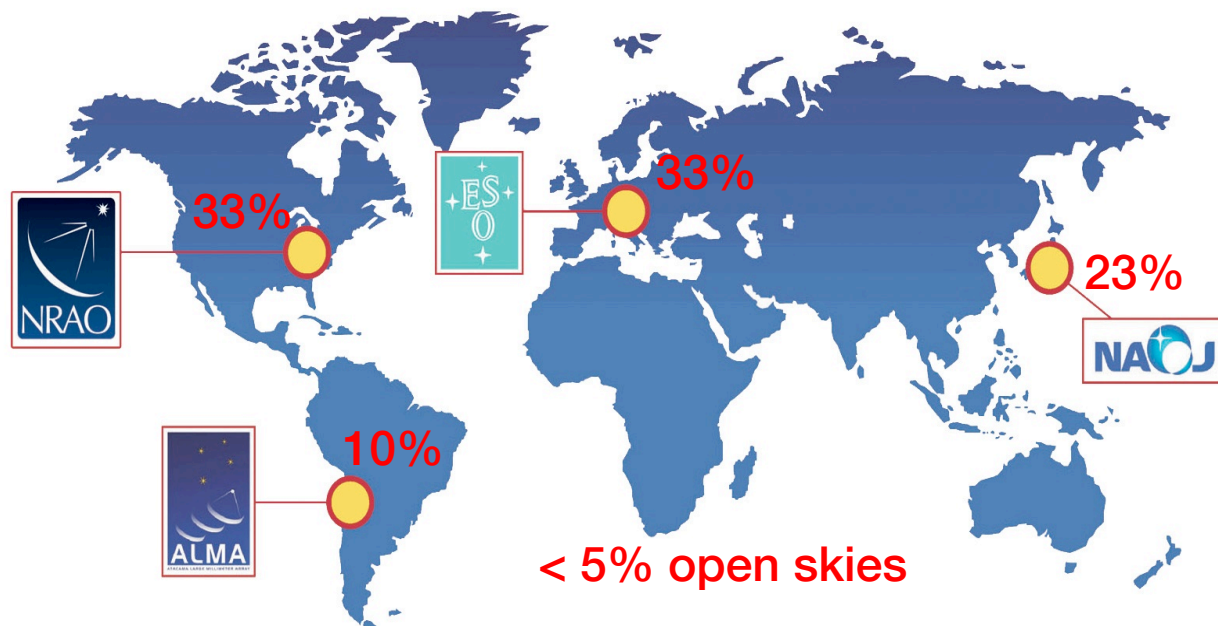
VLBI

- Conducted in **campaign mode** during one of the most compact 12-m array configurations
- Phased-up ALMA array will be used as a single dish in the VLBI network
- Only targets with flux > 0.5 Jy on baselines out to 1 km allowed
- Only **Band 3 and 6 pre-defined continuum setups**
- **For Band 3** proposals must have also been submitted to GMVA (deadline was on Feb 1)
- **For Band 6** ALMA will forward the proposals to the EHTC network – PIs need to submit a proposal only to ALMA!



Large Programmes

- More than 50 h of 12-m array or more than 150 h of ACA standalone time
- Standard modes only, no time-critical or ToO programs
- Allows time-intensive observing programmes to be split across executives of the PI and (multiple) co-PI s
- Data products to be delivered to ALMA within 1 year of data delivery

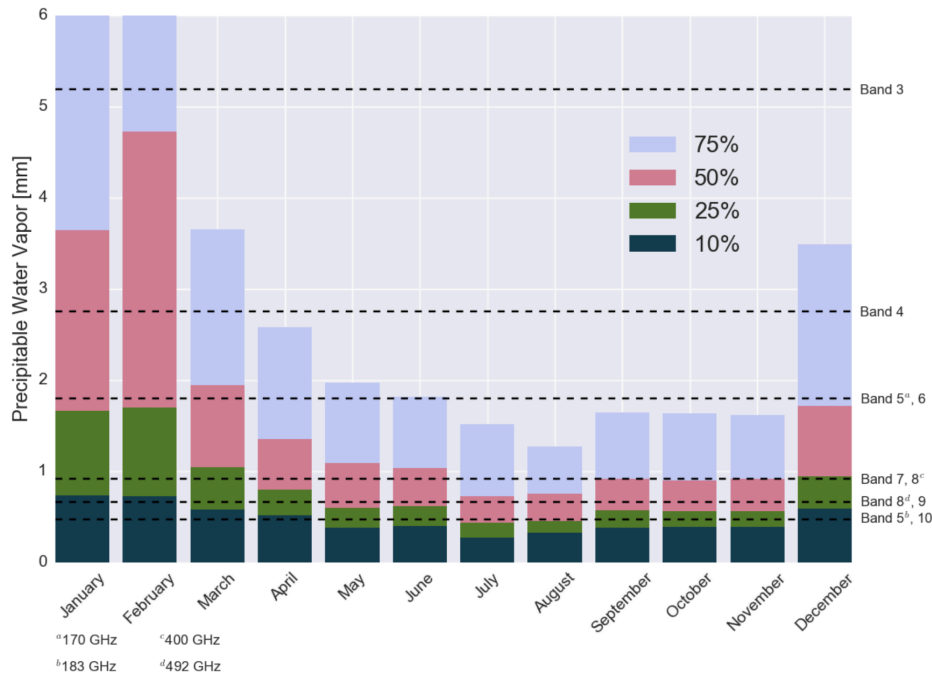


Observing Time available

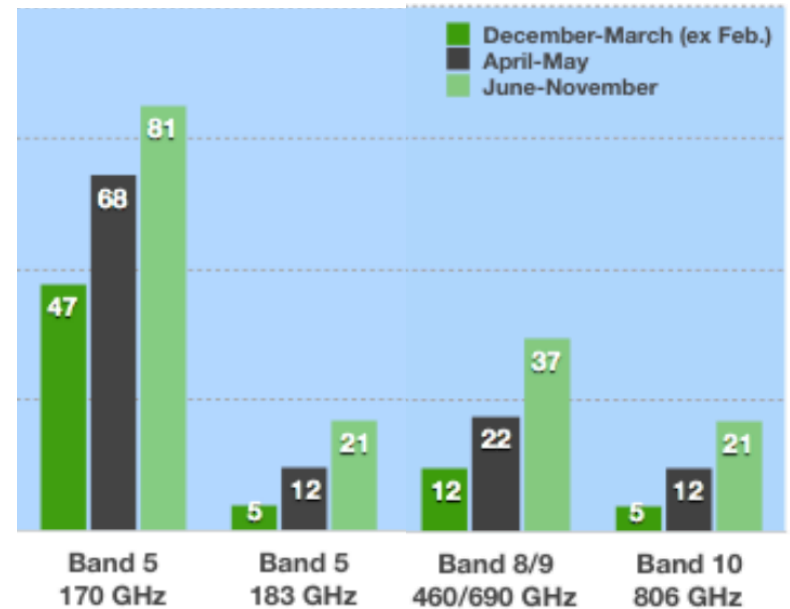
- up to **4000** hours offered on the 12-m Array and up to **3000** hours of the ACA
- maximum of 20% for non-standard observing modes:
 - High frequency (Bands 8, 9, 10)
 - Band 7 observations with maximum baselines > 5 km
 - Full polarisation
 - Spectral scans
 - Bandwidth switching projects (< 1 GHz aggregate bandwidth)
 - Non-standard calibrations (user-defined calibrations selected in OT)
 - Solar & VLBI
 - Astrometric observations (require user-defined calibrations)
- Large Programs limited to 15%, VLBI and DDT observations to 5% (each) of the total available time

Scheduling science observations

- Scheduling priority (in decreasing order): weather, requested AR/LAS, target elevation, project's priority rank, project completion
- Priority: Cycle 4 A-rank (carry-over), Cycle 5 A, Cycle 5 B, Cycle 5 C
- Solar & VLBI observations have priority during the campaigns



Fraction of time that the PWV falls below a given value over a year



B5 water line, B8/9 and B10 observations possible only ~10-20% of the time, mostly in June-November

Duplications & Resubmissions

- **Duplications are not permitted** unless scientifically justified
- **PIs need to check** proposed observations against the archive and the list of Cycle 4 accepted programs
- **NEW:** special box in the OT for justifying duplications
- **NEW:** Re-submissions are now determined by the observatory on a per-SG basis
- To be classed as a re-submission, the Cycle 5 SG is
 - a duplication of an active (Cycle 4) SG**AND**
 - the PI of the corresponding Cycle 4 project is PI or co-I on the Cycle 5 project OR the Cycle 5 PI is a co-I on the Cycle 4 project

Phase 2 preparation by PIs

- **PIs will need to review and submit their Phase 2 material by the Phase 2 submission deadline**
- After the notification of grades, PIs with A, B, C ranked projects will be able to download their proposal in Phase 2 mode
- Minor changes can be made directly by the PI
- **Major changes require a change request** (via Helpdesk); the necessary changes can only be made by an ALMA staff member, who will submit the project on behalf of the PI
- **NEW:** in Cycle 5, PIs will not need to create SBs, this will be done by ALMA after the Phase 2 deadline

Cycle 5 Timeline

- Call for Proposals: March 21, 2017
- Proposal Deadline: **15:00 UT on April 20, 2017**
- Announcement of the PRP outcome: late July 2017
- Submission of Phase 2 by PIs: September 2017
- Start of observations: October 2017
- nominal duration of Cycle 5 is 12 months

More information available on the Science Portal:

www.almascience.eso.org