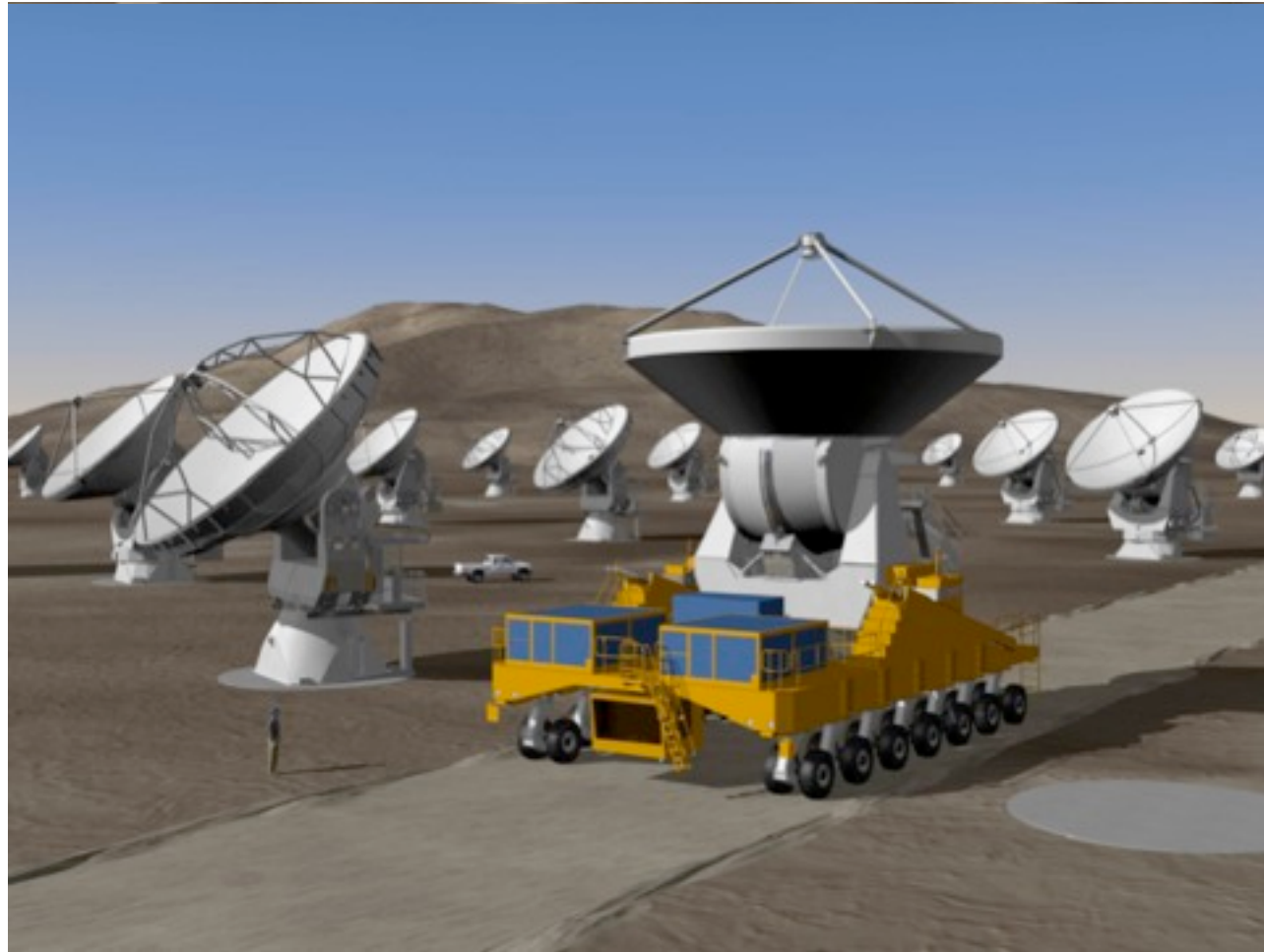


ALMA Development Plan

- ALMA Days 25 Jun 2012
- Leonardo Testi

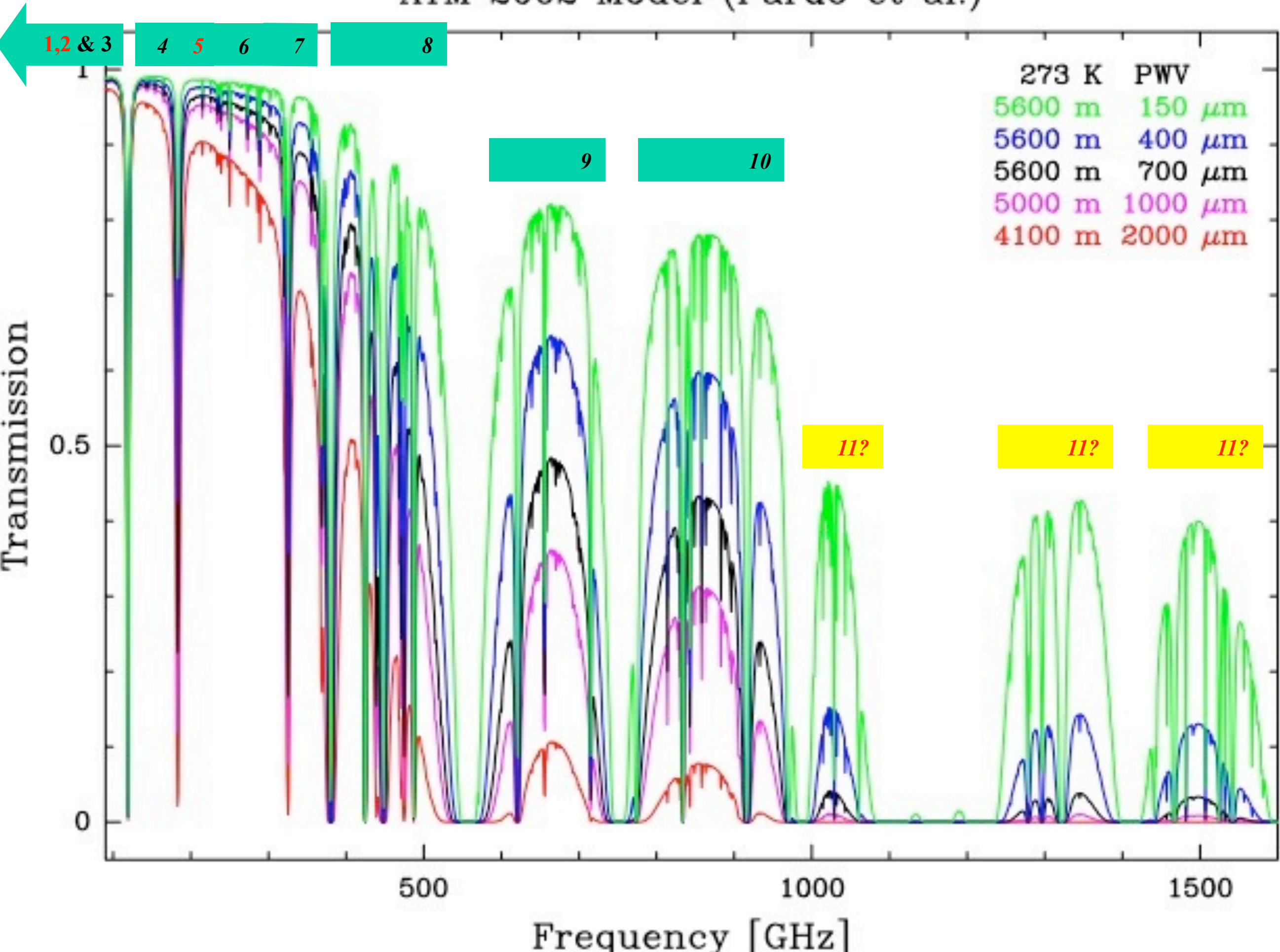
Atacama Large Millimeter Array



- ☑ At least 50x12m Antennas
- ☑ Frequency range 30-1000 GHz (0.3-10mm)
- ☑ 16km max baseline (<10mas)
- ☑ ALMA Compact Array (4x12m and 12x7m)

1. Detect and map CO and [C II] in a Milky Way galaxy at $z=3$ in less than 24 hours of observation
2. Map dust emission and gas kinematics in protoplanetary disks
3. Provide high fidelity imaging in the (sub)millimeter at 0.1 arcsec resolution

ATM 2002 Model (Pardo et al.)



- Upgrade studies are initiated and funded regionally to develop possible ideas into ADP proposals
- ALMA Upgrade Studies in Europe:
 - Preparations for ALMA B5 Full Production
 - Upgrade Options for ALMA B9
 - Phasing up ALMA for mm-VLBI
 - Design and components for ALMA B2(+3)
 - Scientific opportunities for supra-THz interferometry with ALMA
 - Options for upgrading the instantaneous bandpass
- Science Case, Technical Readiness, Cost, Timeline
 - Getting ready to implement the upgrades from 2013-2015
- Our ability to setup and follow studies is limited

Band 5 Study

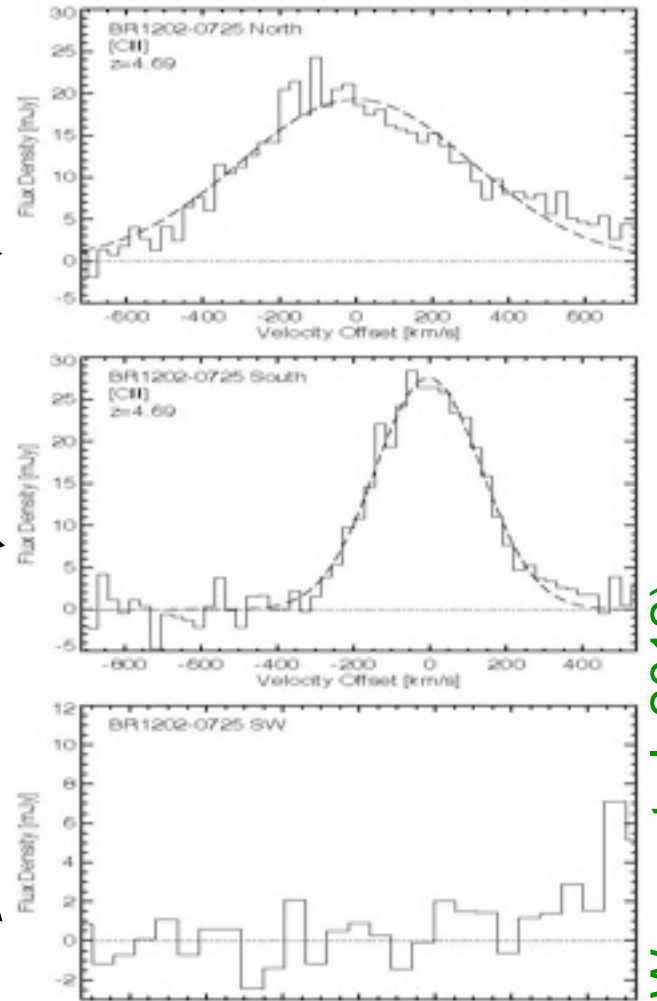
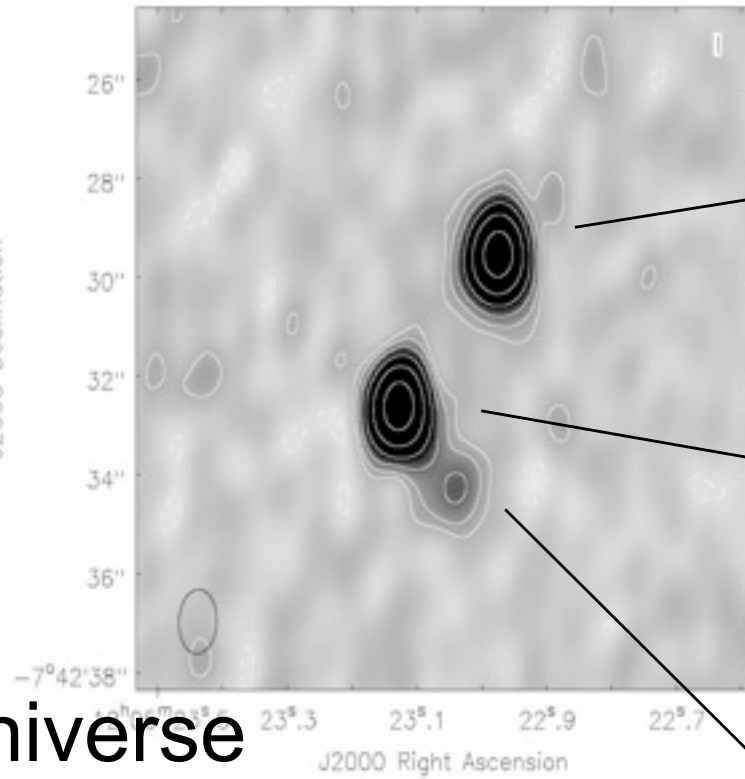
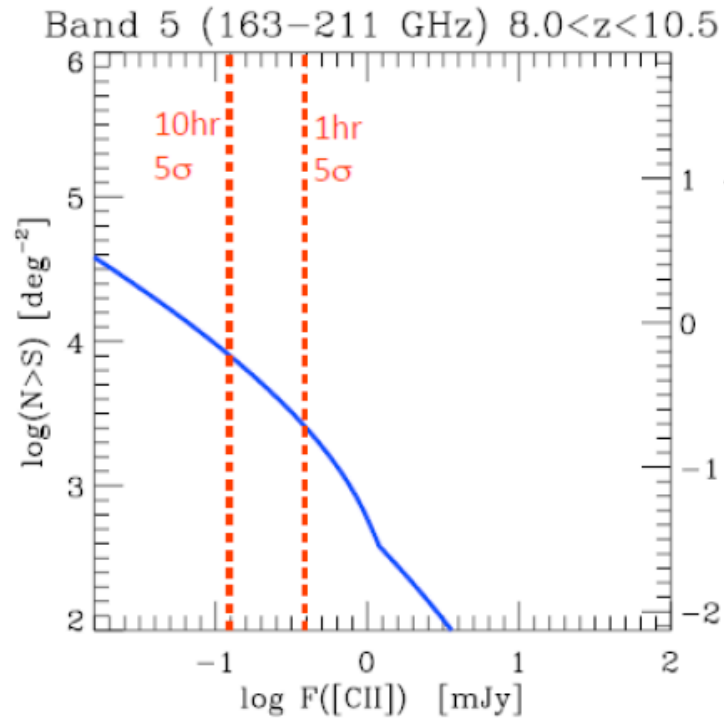
- Completed March 2012
- Six cartridges from EC-FP6 led by GARD
- Science Case for full production from EC-FP6
- Optimization of design for production from EC-FP6/NOVA + Cost, risk, production plan
- Science case mostly builds on:
 - [CII] and high-ex CO at high redshift
 - Water in the local Universe
- Approved by ALMA Board in Apr 2012, positive recommendation from ESAC/STC and FC
- CCA by NOVA/GARD, WCA by NRAO
- Completed by 2017



Band 5 Science - Laing doc

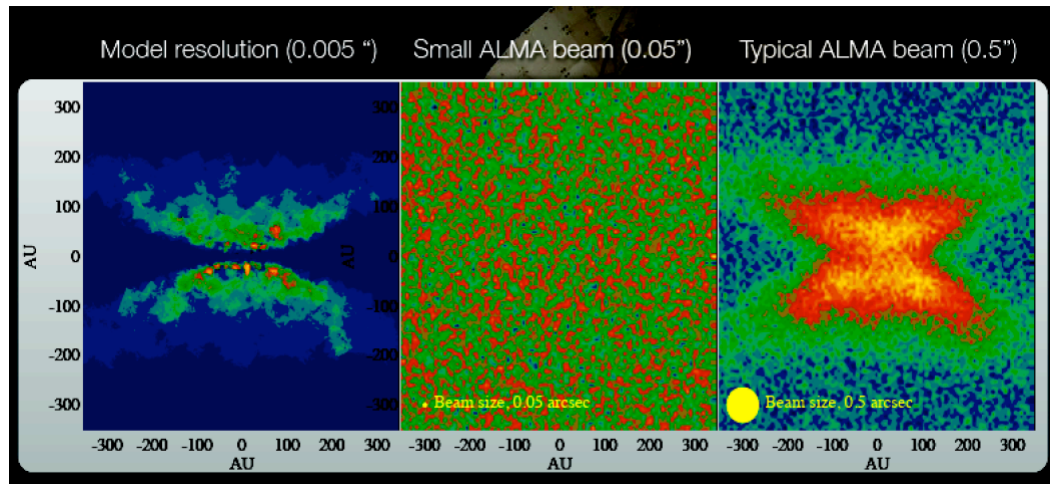
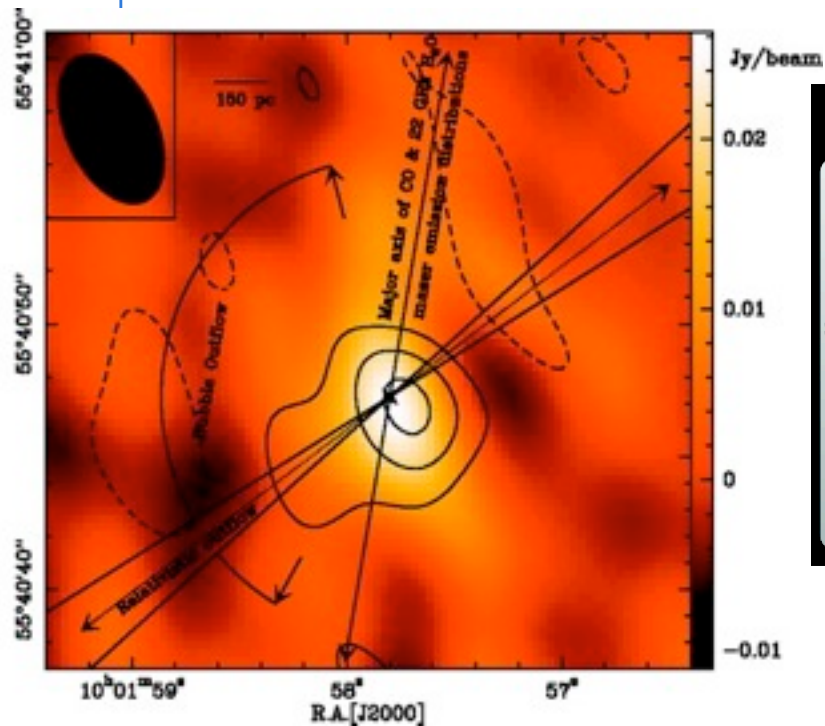


[W] [CII] in $z \sim (8-10)$ and high-ex CO at high-z



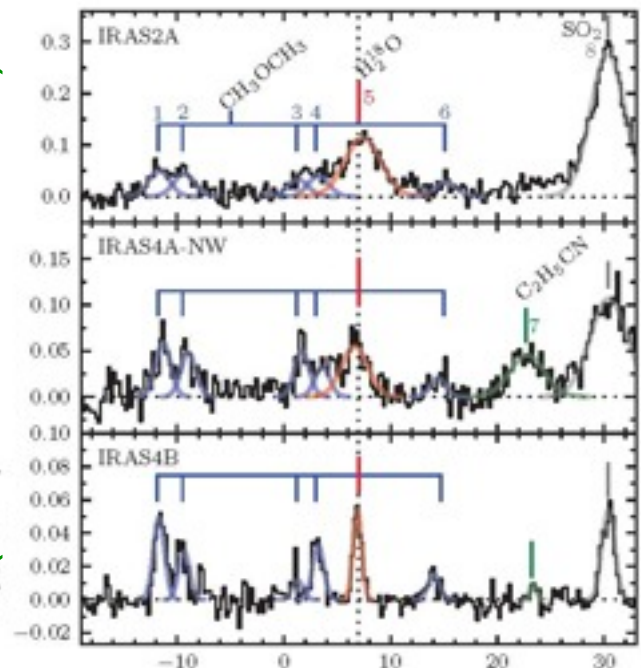
[W] water in the local Universe

(Humphreys et al. 2005)



(Brinch 2010)

(Perrsson et al. 2012)



(Wagg et al. 2012)

Band 2 Study

- Study of Band 2 or combined Band 2+3 design
- Kick-off in June 2012, duration ~1.5yrs – STFC / IRAM / INAF
- Deliverables: Science Case, Study of key technologies to develop a Band 2 or a Band 2+3 cartridge design
- Scientific advantages
 - Heavy/Deuterated molecules in Band 2
 - High-z Low Excitation CO
 - Possibility of using a single receiver to cover the whole Band 2+3 Frequency range
 - Wide bandwidth option

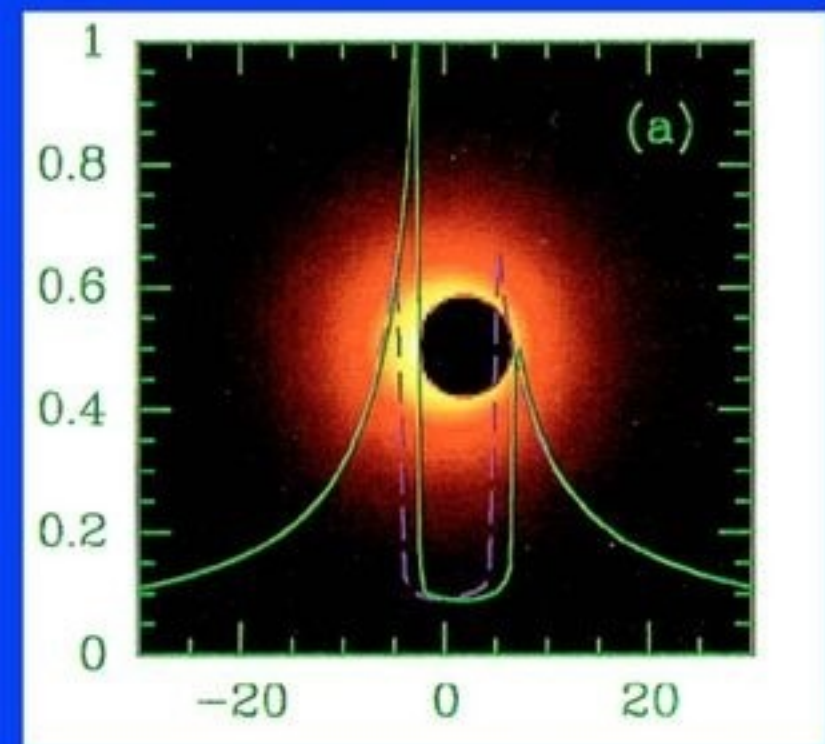
- Feasibility study of THz astronomy with ALMA
- Advanced negotiation – STFC
- Deliverables:
 - Science Case
 - Definition of the most scientifically interesting frequency range
 - Study of the weather/instrument/operational conditions
- Scientific advantages
 - New frequency band for ALMA, unique for the site (challenging)
- Kick-off expected in Sep 2012, duration ~1.5yrs

Phasing ALMA for VLBI

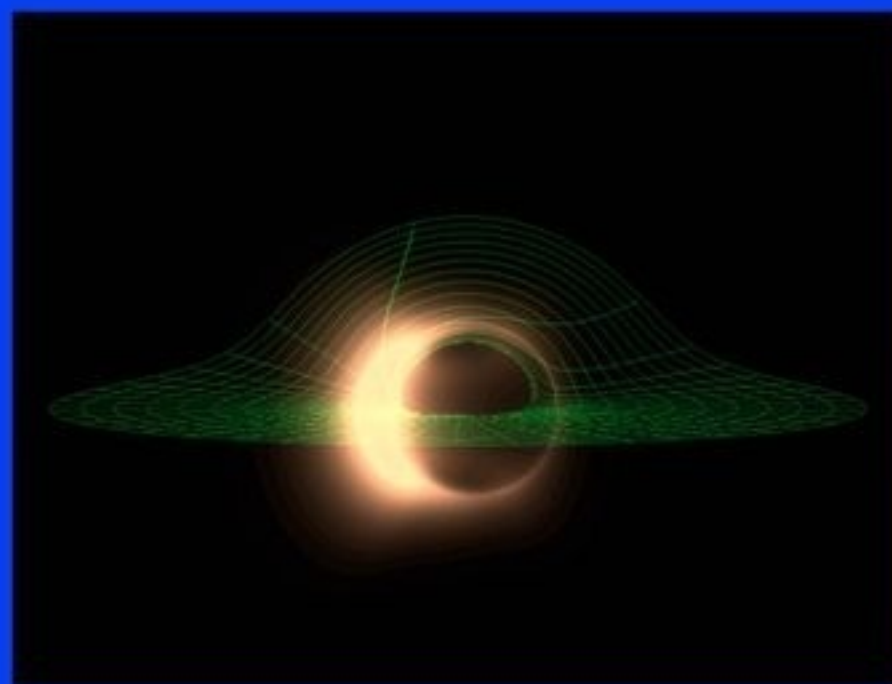
- Strongly driven by the EHT project (PI Shep Doeleman, MIT)
- Very strong science goal (Sgr A* and M87), but experiment type
- Within Europe there are some groups involved in EHT, but most VLBI users would want a facility
- Working with Radionet to:
 - Understand Eu contribution to technical implementation
 - Work with Eu community to set up a broad science case
 - Provide a forum to discuss mm-VLBI allocation models (this will also involve JAO, the ALMA partners, and other observatories)

Phasing ALMA for VLBI

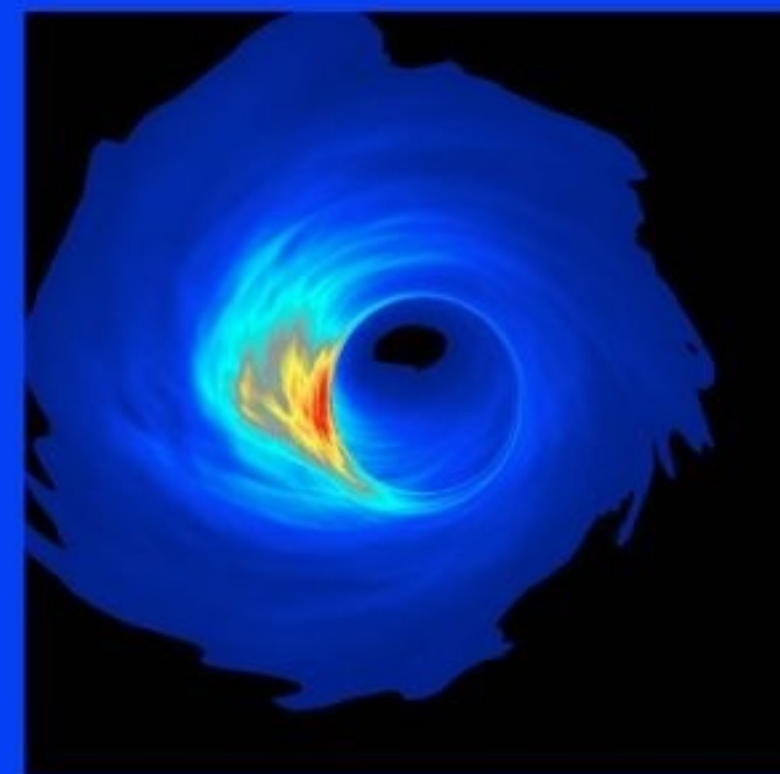
- The Even Horizon Telescope and Sgr A*



Falcke et al 2000



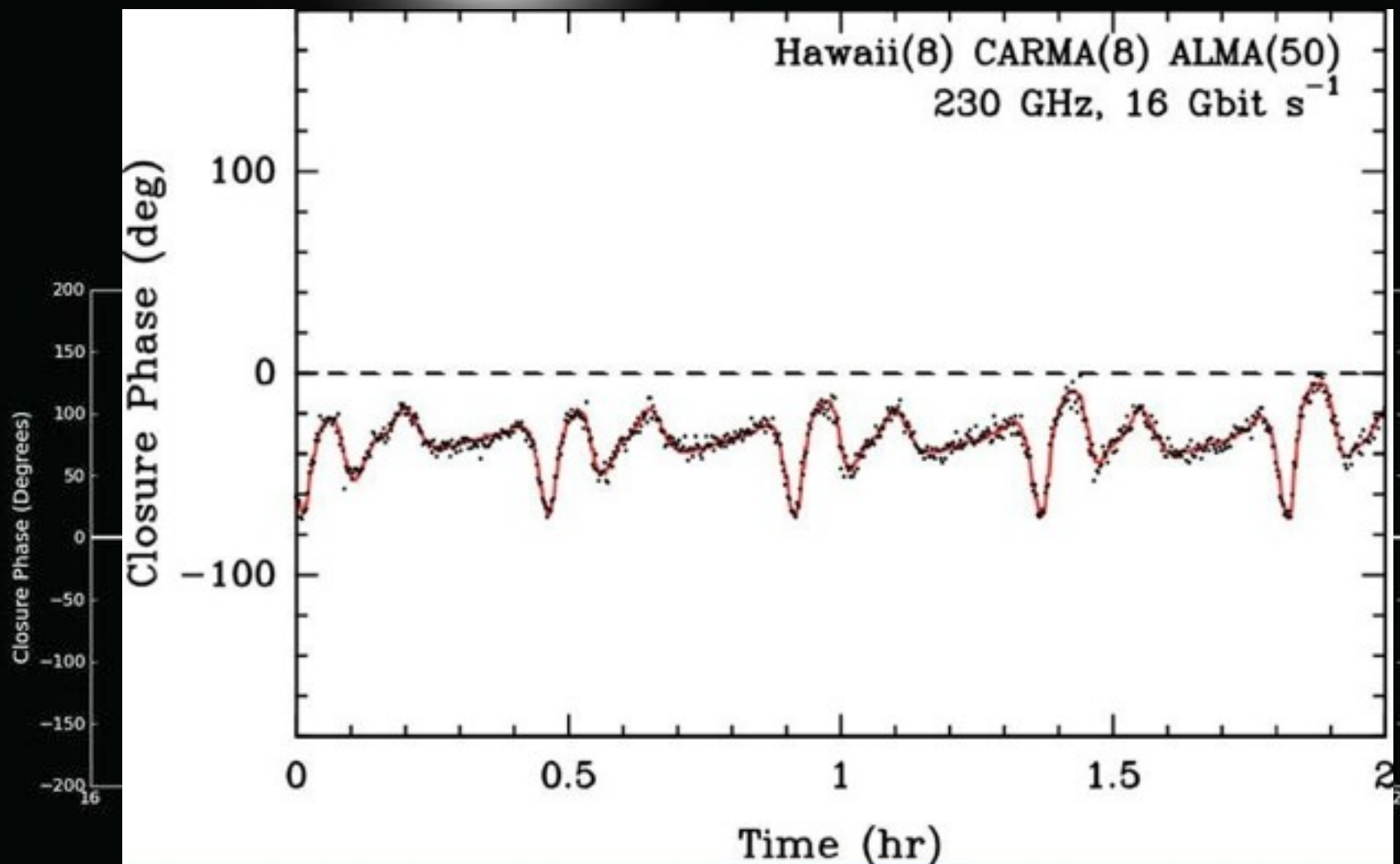
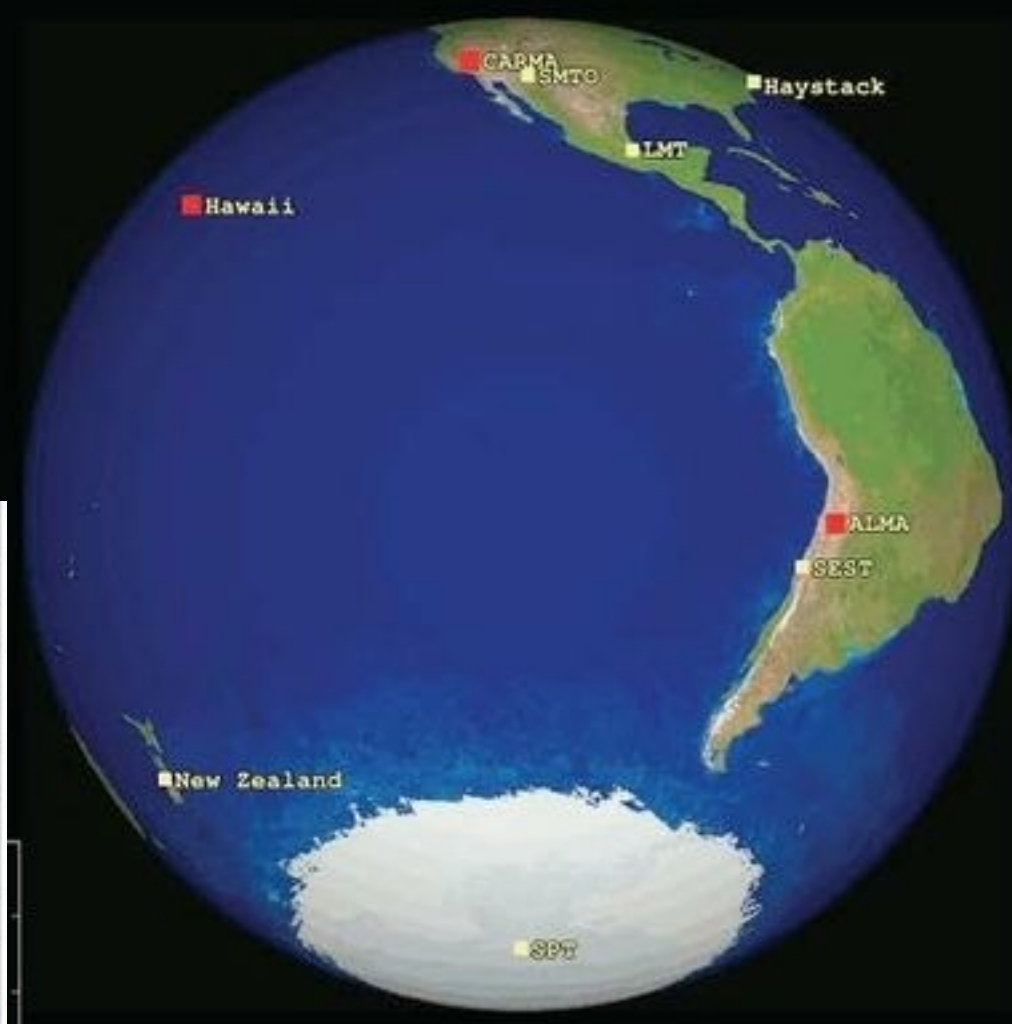
Broderick & Loeb 2009



Noble & Gammie 2007

Phasing ALMA for VLBI

- The Even Horizon Telescope and Sgr A*



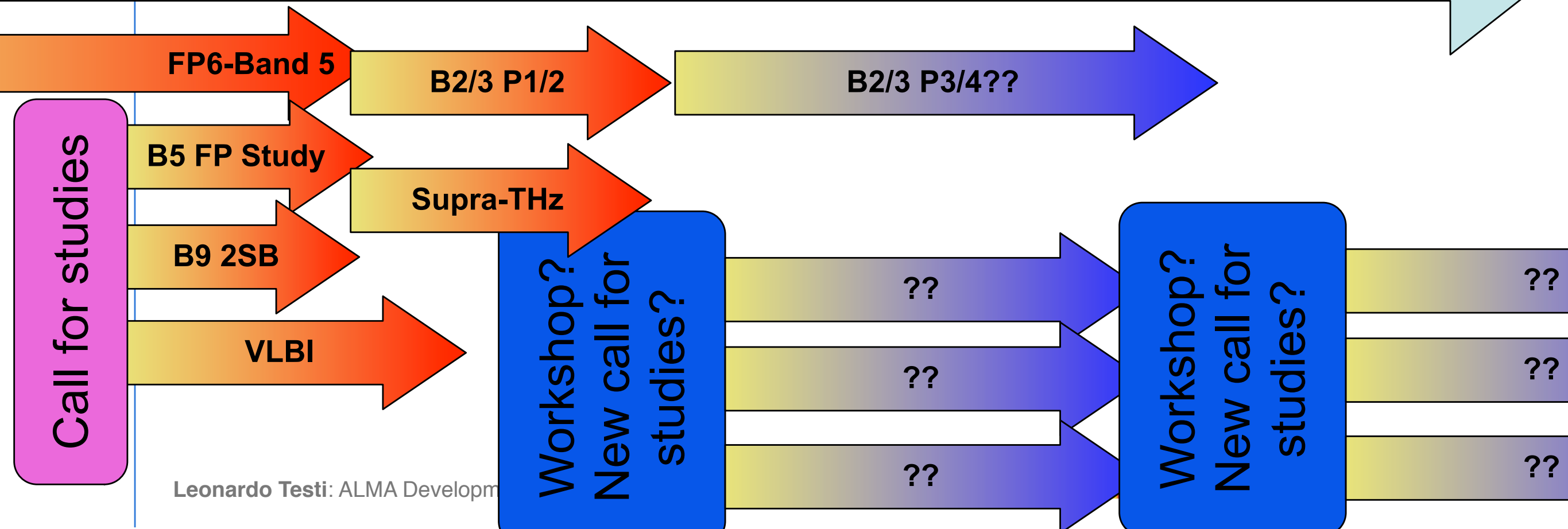
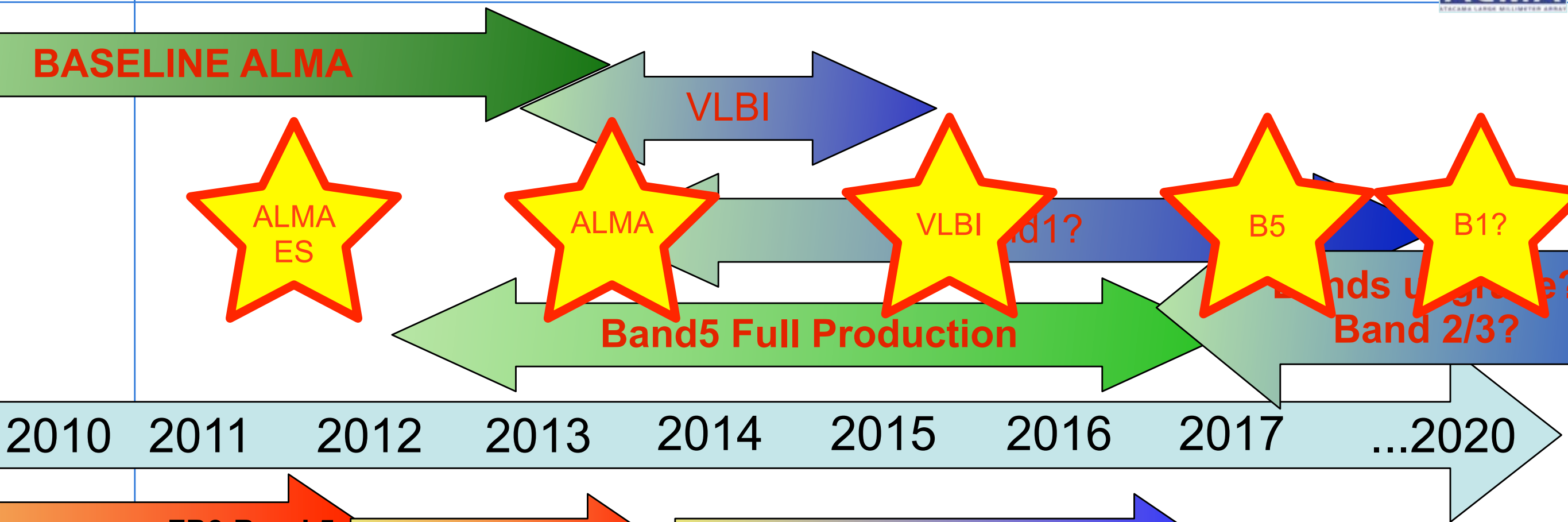
Phasing ALMA for VLBI

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- Science Workshop Jun 27-28

Initial projects

- The ADSC recommended to proceed with
 - ALMA Band 5 – outfit the entire array
 - Fibre connection from OSF to SCO
 - In planning: VLBI capability
 - In planning: ALMA Band 1
- ADSC issued recommendations to ALMA Director who brought these forward to the Board

Timeline summary



Summary

- Develop science priorities for upgrades
- Solicit input from community
 - Ensure ESO priorities are developed to the appropriate level for discussion with ALMA/partners in ADSC
- Plan the Studies/R&D to time ADP proposals to match reasonable pace/budget
- First cycle of studies approaching completion
 - Workshop in 2013, being planned
 - Coordinate future calls with other regions