



# European ALMA Development Projects and Studies

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ALMA in the Coming Decade: a  
Development Plan Workshop  
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# Outline

- EU Call for Studies 2010: progress report
- ALMA Band 5
- Forthcoming Call for Studies



# 2010 Call for Studies

- Following overall scientific priorities (ASAC and ad hoc working group)
- Study process
  - Open call
  - Evaluation (ESO + community involvement from ESAC and STC)
  - Deliver science case + technical information (conceptual design, supporting R&D, detailed design or implementation plan, as appropriate)
  - Duration 1-2 years
  - In practice, external funding used to supplement ESO resources



# Call Details

## ■ Timeline

- Recommendation Apr 2010, call/deadline July/Sept 2010
- Evaluation Oct 2010
- Kick-off 2011-2012 (phased)

## ■ Selected studies

- Preparation for Band 5 full production (NOVA, GARD, STFC)
- Sideband separation upgrade for Band 9 (NOVA)
- ALMA Phasing Project (zero cost; MPIfR)
- Design and components for ALMA Band 2+3 (Manchester, STFC, IRAM, INAF)
- Supra-THz interferometry (Oxford, Cambridge, STFC)
- Costing of options for upgrading bandwidth (ESO internal)



# Band 5

## ■ Study

- Optimization of Band 5 design for full production
- 45k€ ESO + EC-FP6
- Completed Feb 2012
- Led to full production proposal

## ■ Science

- 163-211 GHz
- Originally lower priority because of atmospheric water line
- Water in the nearby Universe (183 GHz line)
- [CII] from distant galaxies
- Science Workshop (Rome, May 2010)



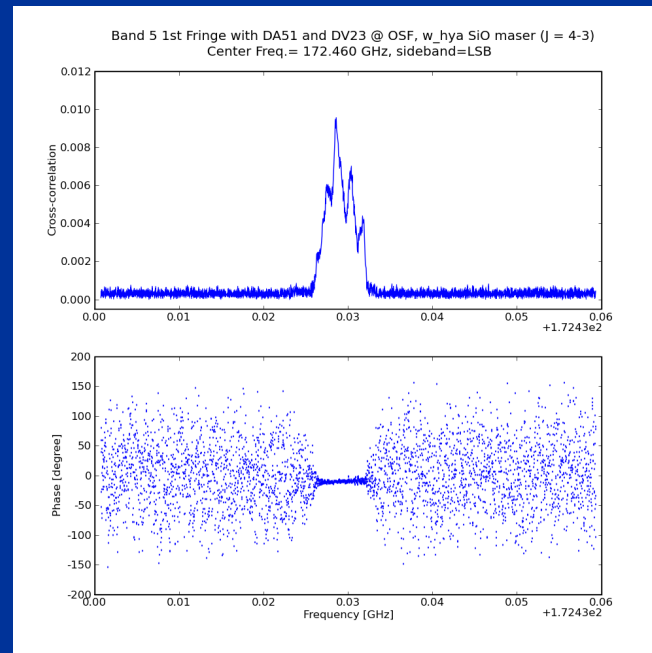
# Band 5 Project

- Receiver development and pre-production
  - OSO/GARD, STFC/RAL, U Chile, ESO
  - ALMA Enhancement EU FP6 (6.5M€)
  - 2006-2012
  - 5 cartridges now in Chile (6<sup>th</sup> retained for pre-production tests)
- Preparation for full production
- Production
  - ESO contract with NOVA and OSO/GARD for cold cartridge (12.5M€). Commits EU Development Budget until ~2017
  - NRAO manufactures local oscillator (3.3M\$)

# Band 5 Performance

## ■ Specification

- Noise temperature 55K over 80% of band (was 65K); 75K over full band (was 108K)
- More stringent image rejection criterion
- LO range extended to keep atmospheric water line out of sideband





# Band 5 Key Dates

- Jan 2006 EU FP6 project start
- Dec 2009 Band 5 CDR
- Feb 2012 Review of pre-production study
- April 2012 First light at OSF
- April 2012 ALMA Board approves full production
- October 2012 First fringes
- Feb 2013 Start of full production
- February 2014 Acceptance of first cartridge
- March 2017 Completion of production





# Band 9 Upgrade

- Goal: upgrade Band 9 to use sideband separation
- Details
  - 35k€ ESO + NOVA internal
  - Completed April 2012
  - Successful prototype testing
  - Science
    - Factor of 2 decrease in integration time for the same line sensitivity
    - Improved rejection of unwanted sideband, so line confusion reduced
  - Option to increase bandwidth (8 GHz for each of USB and LSB)
  - Implementation straightforward



# Band 2+3

## ■ Band 2 or combined Band2+3 design

- 150k€ ESO + in-kind
- Start June 2012
- Science
  - Deuterated molecules
  - Low-J CO at high redshift
  - Single receiver to cover Bands 2 and 3
  - Wide bandwidth option
- Deliverables
  - Science case (Workshop, Bologna, May 2013)
  - Study of key technologies (active components, optics, windows, OMT)
  - Collaboration with Caltech on LNAs; also commercial HEMTs
  - Promising results so far



# Supra-THz interferometry

- Feasibility of THz astronomy with ALMA
  - 30k€ ESO + matching STFC to look at technical developments
  - Start Nov 2012
  - Science case and synergies (Workshop Oxford March 2013)
  - Which atmospheric window(s)?
  - Transmission, phase correction, antenna performance
  - Likely instrumental capabilities (especially noise temperatures)



# Options for increasing bandwidth

- Cost and feasibility of increasing the digital bandwidth to 16 GHz (or more) per polarization
  - ESO internal study
  - Draft report complete
  - Approximate costs for back-end and correlator using existing technology as a baseline (not recommended)
  - Assessment of evolving technology (high-speed digitizers) suggests that eliminating the second down-conversion will be possible and cost-effective by ~2016



# 2013 Call

## ■ Timeline

- Recommendation ESAC/STC next week
- Call May/June; deadline Aug/Sept
- Review October (ESAC/STC meetings)
- Start 2014-2015 (3-year cycle)
- Max ESO funding available 200 k€/year

## ■ Perspectives

- Coordinate call with other executives (this workshop)
- How to approve/merge/fund multi-region studies?



# 2013 Call: Example topics

## ■ Components

- Preparation for production
- Upgrade of existing receiver band
- Upgrade of digital processing system (including correlator)
- New software

## ■ Techniques

- Advanced calibration
- New observing modes
- Data processing/analysis tools

## ■ Research and Development

- Receivers and focal plane concepts
- Software
- Digital processing