



ALMA Band 2+3 Development: Overview

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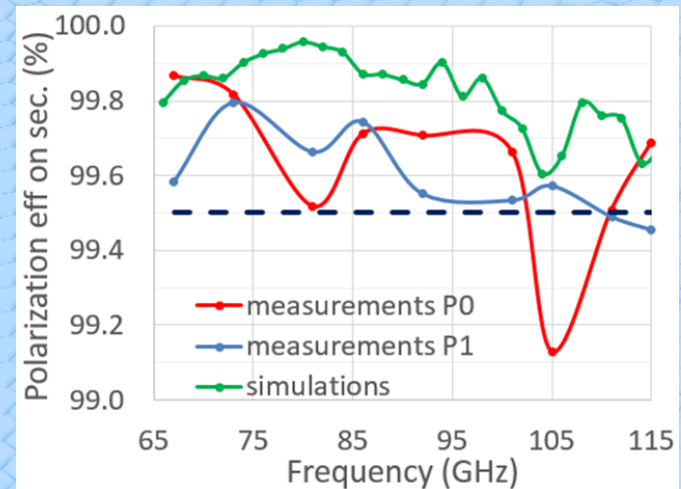
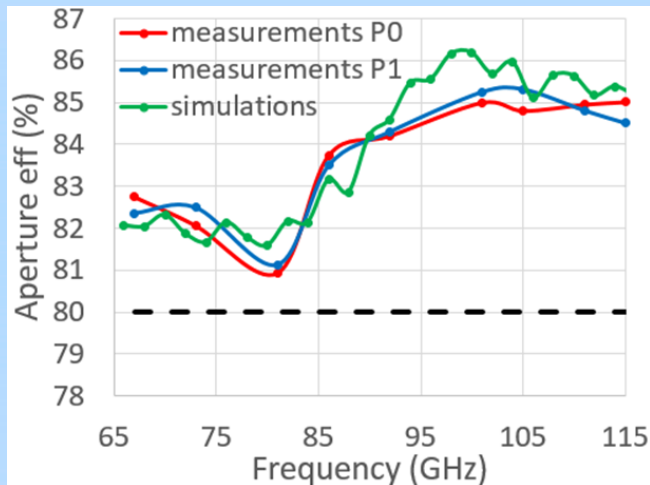


Introduction

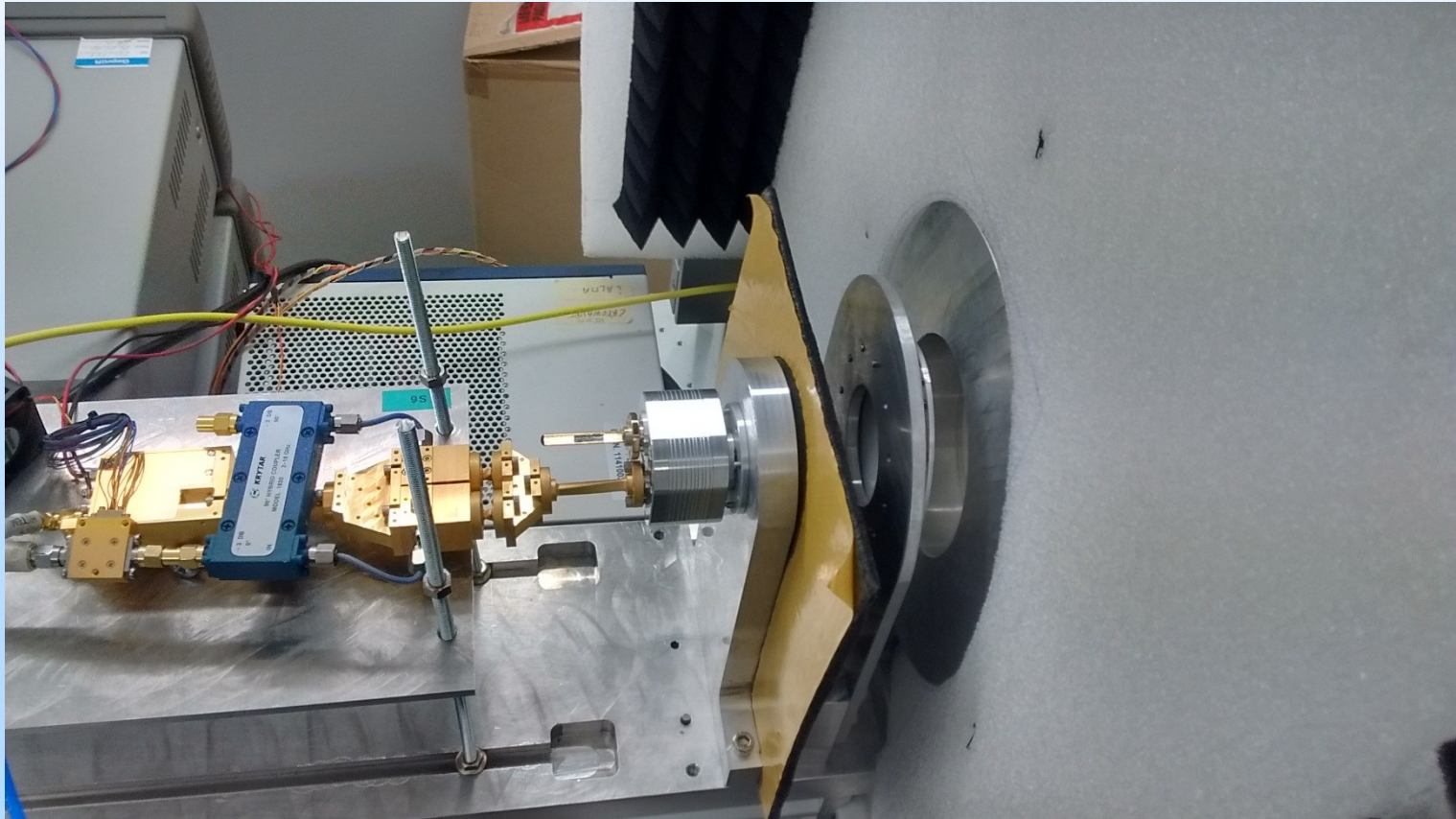
- ◆ 2012-2013: ALMA Band 2 – 3 feasibility study, supported by EU ALMA development studies program
 - ◆ Science case
 - ◆ System design and components: prove of concept
 - ◆ EU participants: U Manchester, INAF, IRAM, RAL
- ◆ 2014: Workshop in Florence. All ALMA regional partners participated:
 - ◆ NRAO decided to develop Band 2 prototype
 - ◆ NAOJ interest to contribute with optics design
 - ◆ U Chile interest to design optical elements and prototype
- ◆ 2015-2017: Band 2+3 development study, supported and coordinated by ESO
 - ◆ Goal is to enable wide-band receiver for 67-116 GHz
 - ◆ Phase A (2015): demonstrate wideband Band 2+3 optics
 - ◆ Phase B (2016-2017): full receiver demonstrator
 - ◆ Participants: INAF, RAL, U Manchester, U Chile, NAOJ (mostly with own national funding)

Band 2+3 Project status

- ◆ Kick-off – Feb. 2015
- ◆ Phase A (Feb. 2015 – Feb. 2016) completed:
 - ◆ Refractive optics chosen to prototype and test
 - ◆ 110K filter design provided by IRAM
 - ◆ Two optical designs of horn and OMT, by U Chile and INAF
 - ◆ Optics and lenses designed by NAOJ
 - ◆ Both U Chile and INAF designs fabricated and tested
 - ◆ Optical performances tested at ESO. Mostly compliant to ALMA specifications, further optimization possible and planned for Phase B



Band 2+3 prototype for optical performances verification



Represents ALMA configuration and interfaces: optical window, infrared filter
Commercial 2SB receiver, covers full RF bandwidth and 16 GHz per polarization but
with reduced performance requirements

Band 2+3 Project status, cont.

- ◆ Phase B (Feb. 2016 – mid/end 2017):
 - ◆ Band 2+3 receiver, 67-116 GHz RF bandwidth and 16 GHz IF bandwidth per polarization
 - ◆ Horn and OMT optimization, both U Chile and INAF. To be tested at RT
 - ◆ Reflective optics option, to be investigated
 - ◆ 110K filter design evaluation and optimization
 - ◆ Design and built LNA compatible with ALMA specs for 67-116 GHz
 - ◆ Develop engineering model LO and downconverter mixer for a 2SB receiver
 - ◆ System design
 - ◆ Design and built ALMA compatible cold receiver (CCA), to be tested at cryogenic temperatures
 - ◆ Cryogenic test systems: LNAs, receiver noise, optical performances
 - ◆ Demonstrate Band 2/3 receiver with noise performance limited by the LNA (may not meet ALMA specs yet)
 - ◆ Develop and assess compatibility with ALMA specifications
 - ◆ Further develop science case

Band 2+3 LNAs development within Consortium, and related studies in EU

- ◆ U Manchester (LNA):
 - ◆ Excellent MMIC simulated design over full 67-116 GHz range
 - ◆ Package designed and fabricated
 - ◆ Northrop-Grumman MMIC fabrication run in the end of 2015
 - ◆ LNAs are expected to be packaged and tested by June 2016

- ◆ U Chile interest to support LNAs development and test commercial MMICs (e.g. OMMIC)

- ◆ Related EU studies: AETHER / AETHRA (Horizon 2020)
 - ◆ European foundry: IAF (Fraunhofer)
 - ◆ Limited internal funding
 - ◆ MMICs not (yet) optimized for cryogenic operation
 - ◆ Modelling to be improved

Far field @92GHz

$\eta_{app} = 83.46 \%$; $\eta_{polar} = 99.71 \%$; $\eta_{spill} = 91.72 \%$; $\eta_{taper} = 91.67 \%$

