Towards sideband-separation for ALMA's highest bands

Hesper, Ronald; Khudchenko, Andrey; Barychev, Andrei; Barkhof, Jan; Bekema, Marielle; Haan-Stijkel, de, Rob

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Towards sideband-separation for ALMA's highest bands

NOVA Sub-mm Instrumentation Group

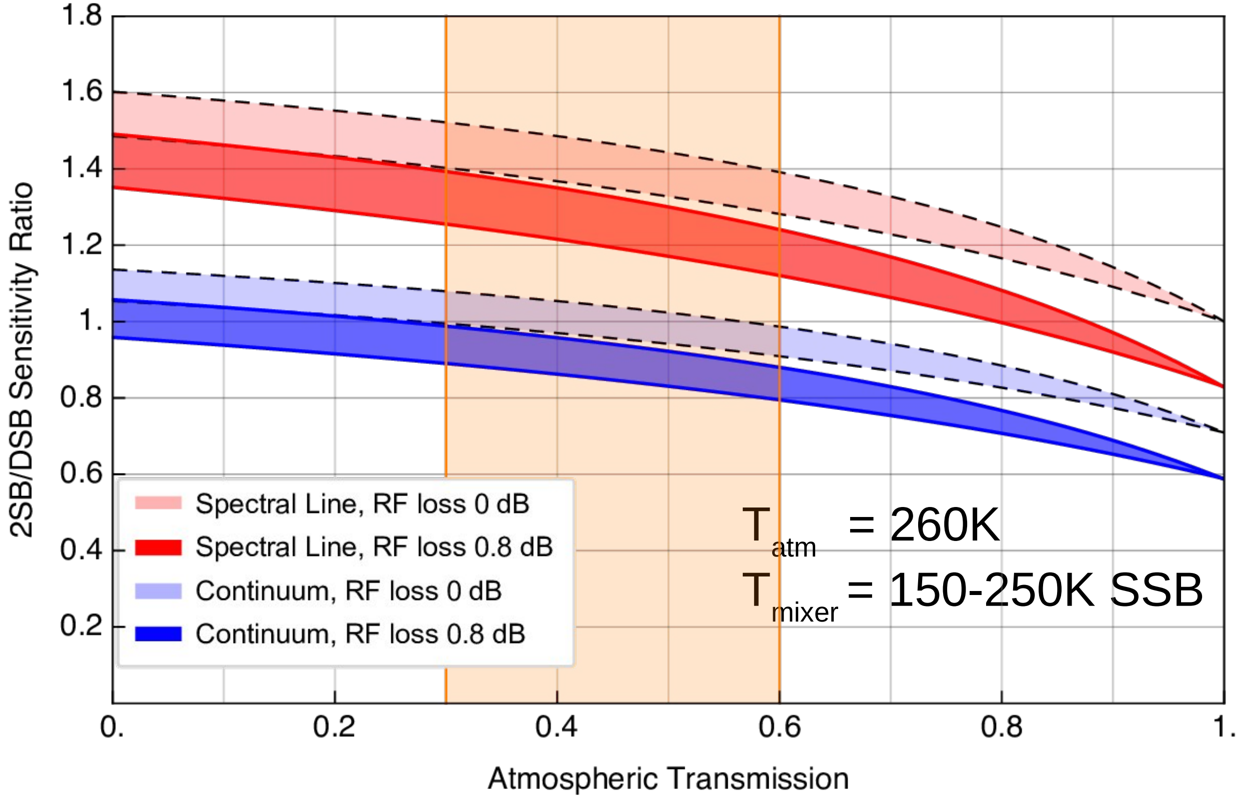
kapteyn astronomical institute

Ronald Hesper
Andrey Khudchenko
Andrey Baryshev
Jan Barkhof
Mariëlle Bekema
Rob de Haan-Stijkel

ALMA Development Workshop, ESO 2019-06-05

Benefits of sideband-separation

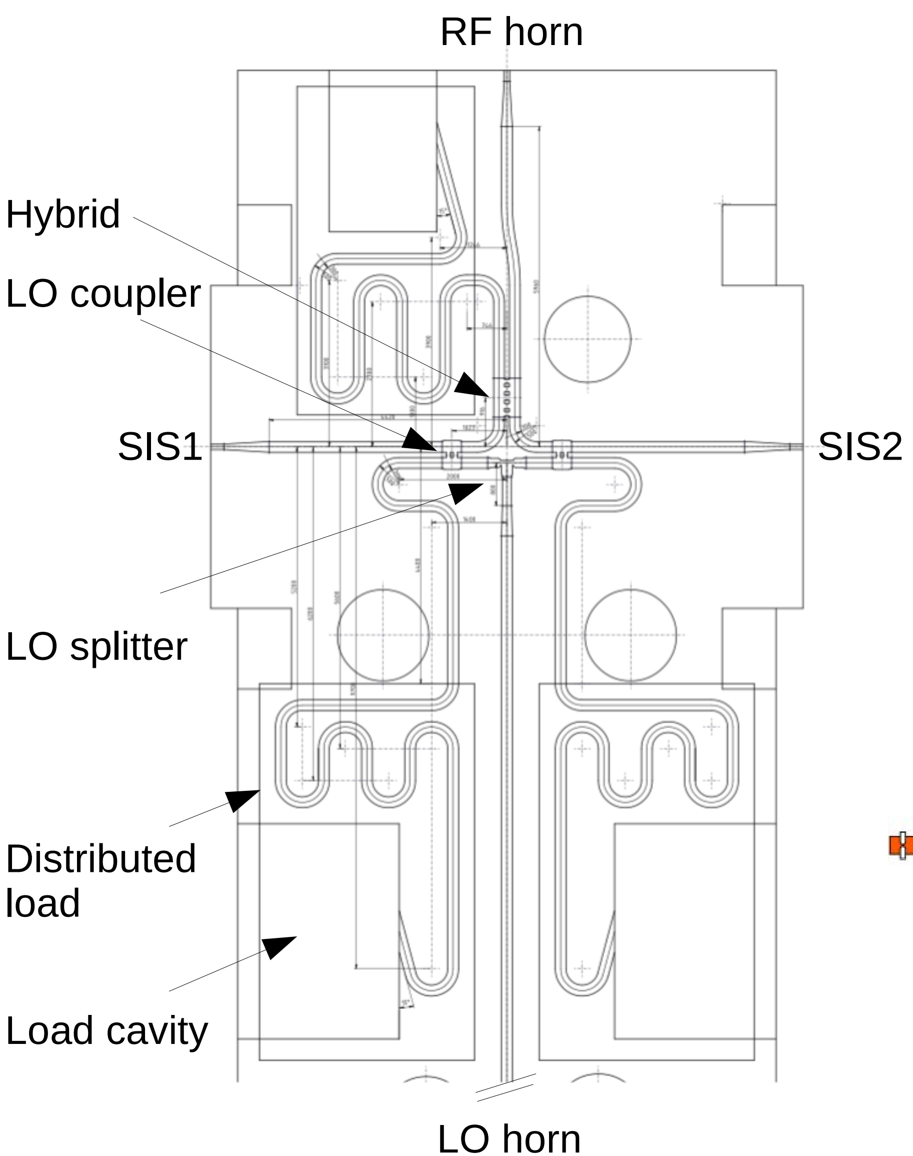
1: Improved spectral line sensitivity for atmosphere-limited bands

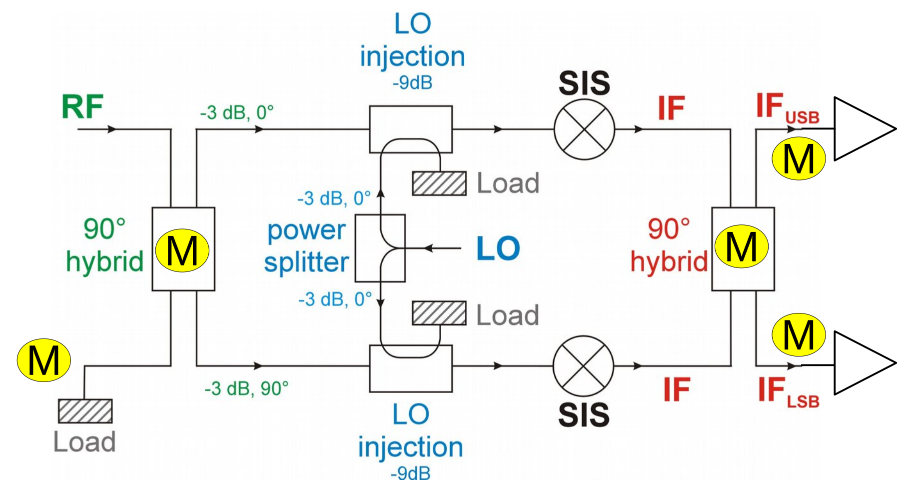


2: Avoiding line-confusion; can partially be solved in the correlator, at the cost of longer integration time

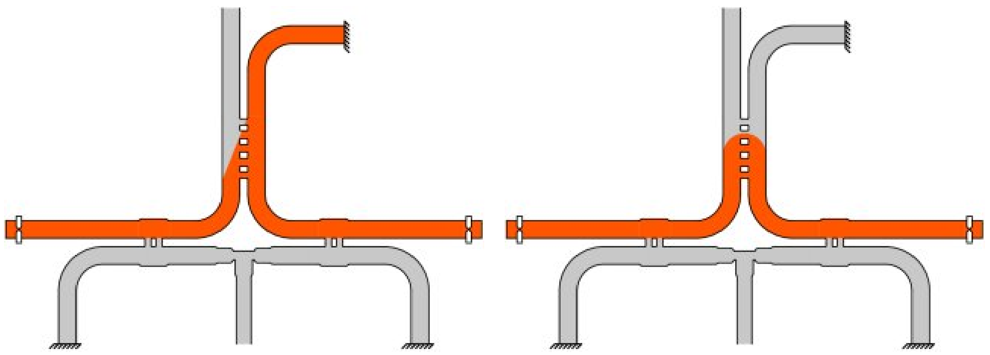
Khudchenko et al., IEEE TST Vol. 7 Nr. 1 PP 2-9

An optimized Band 9 2SB mixer





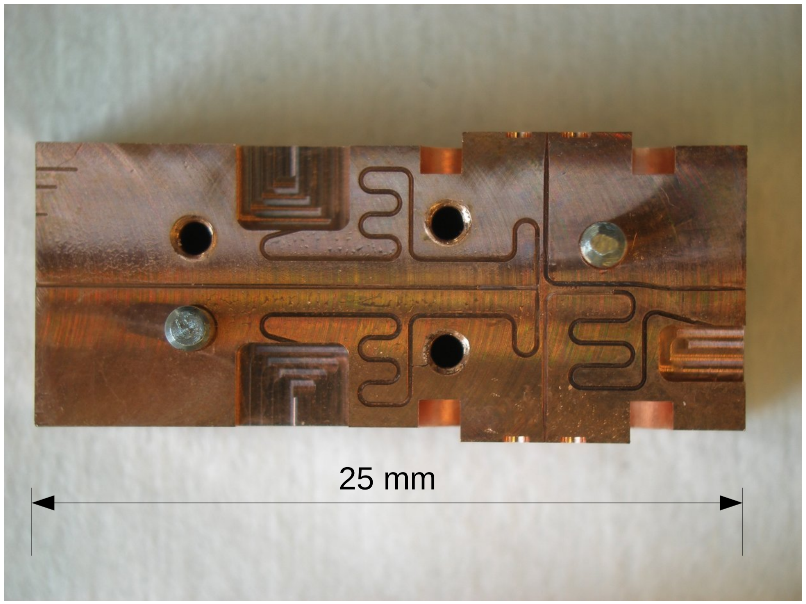
M : Match!

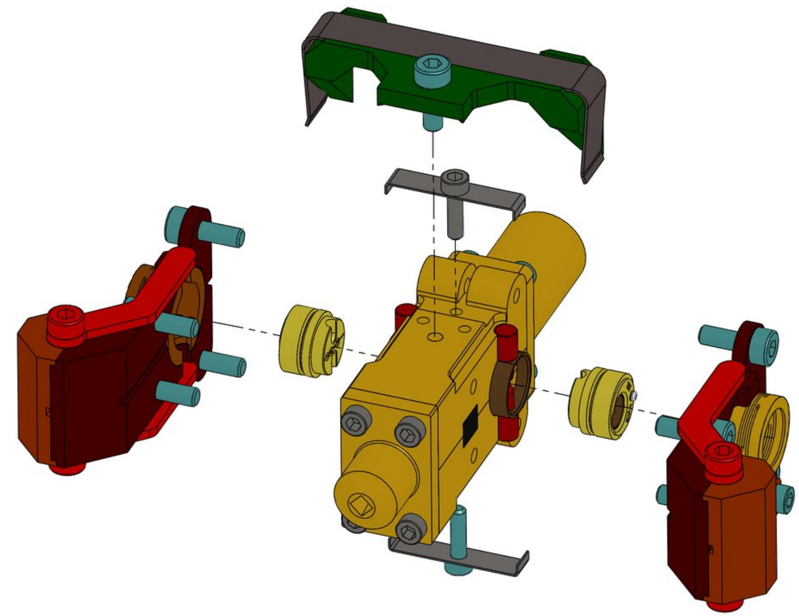


Key: avoid multiple reflection paths

Hesper et al., IEEE TST Vol. 7 Nr. 6 PP 686-693

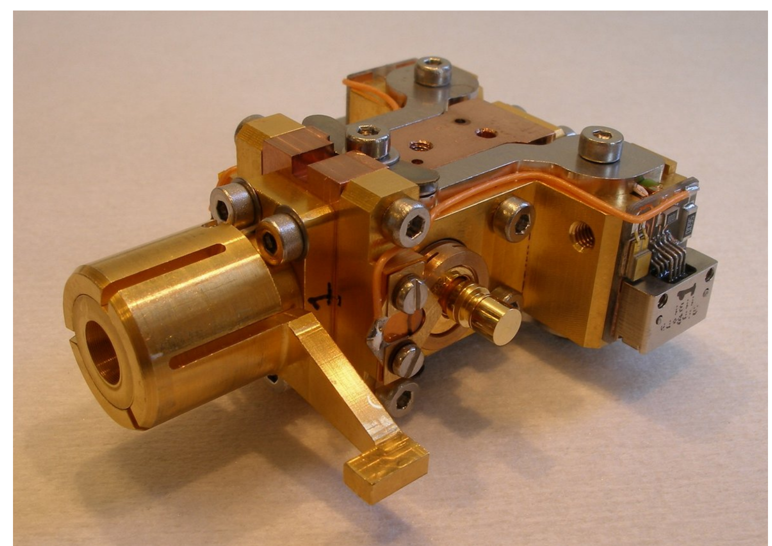
Modularity



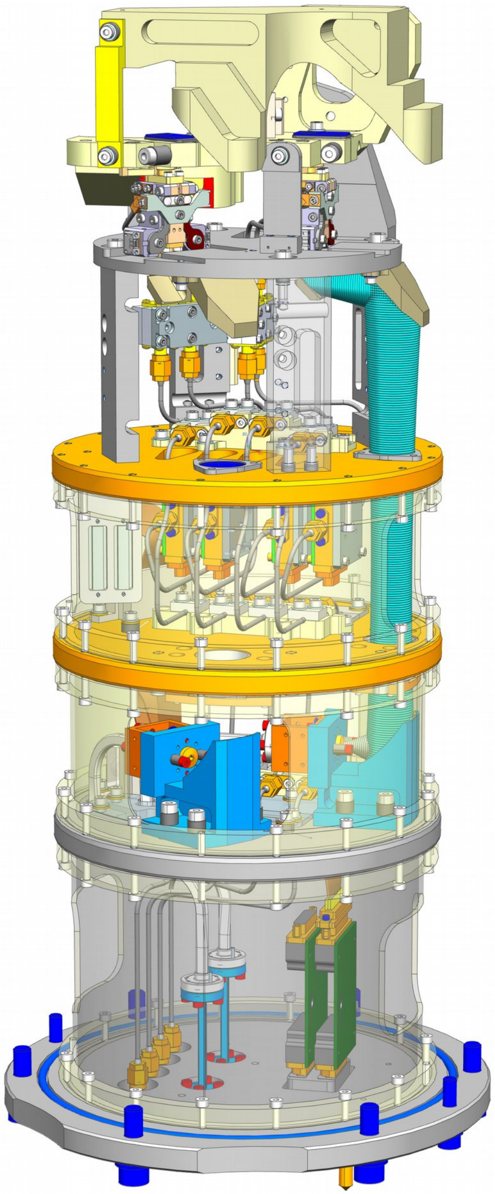


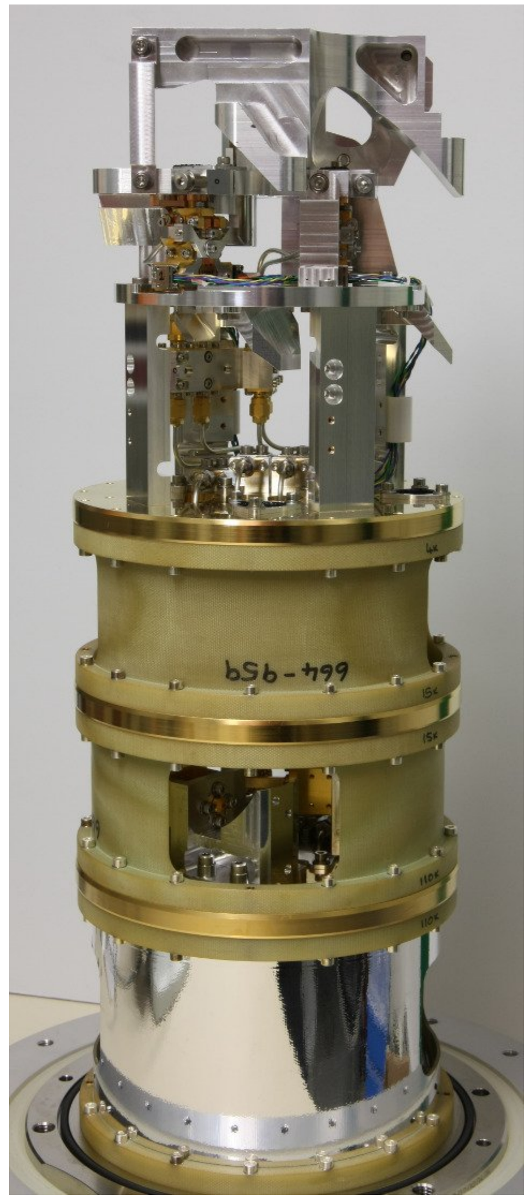
Mixer is modular
- Less critical for manufacturing
- Testable at component-level
- Mix & Match of SIS devices

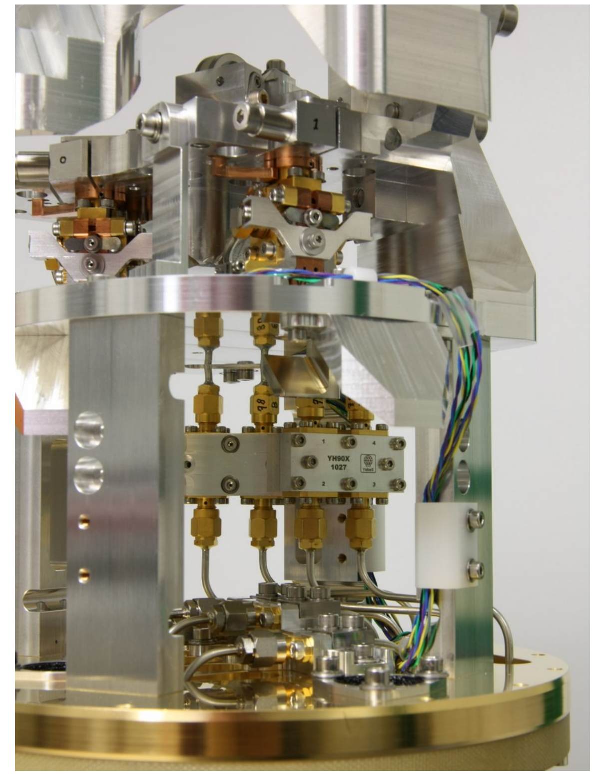
Mixer backpieces are identical to existing Band 9 DSB ones

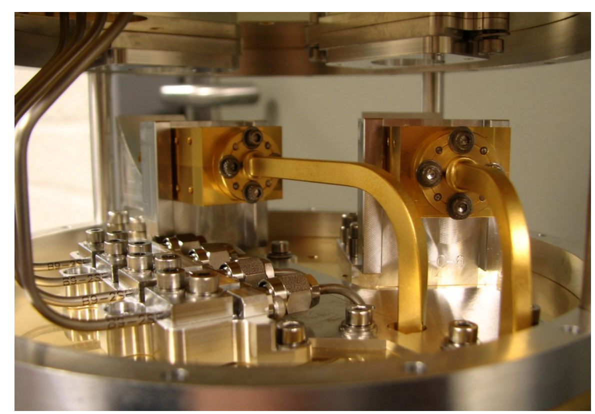


The SEPIA660 cartridge



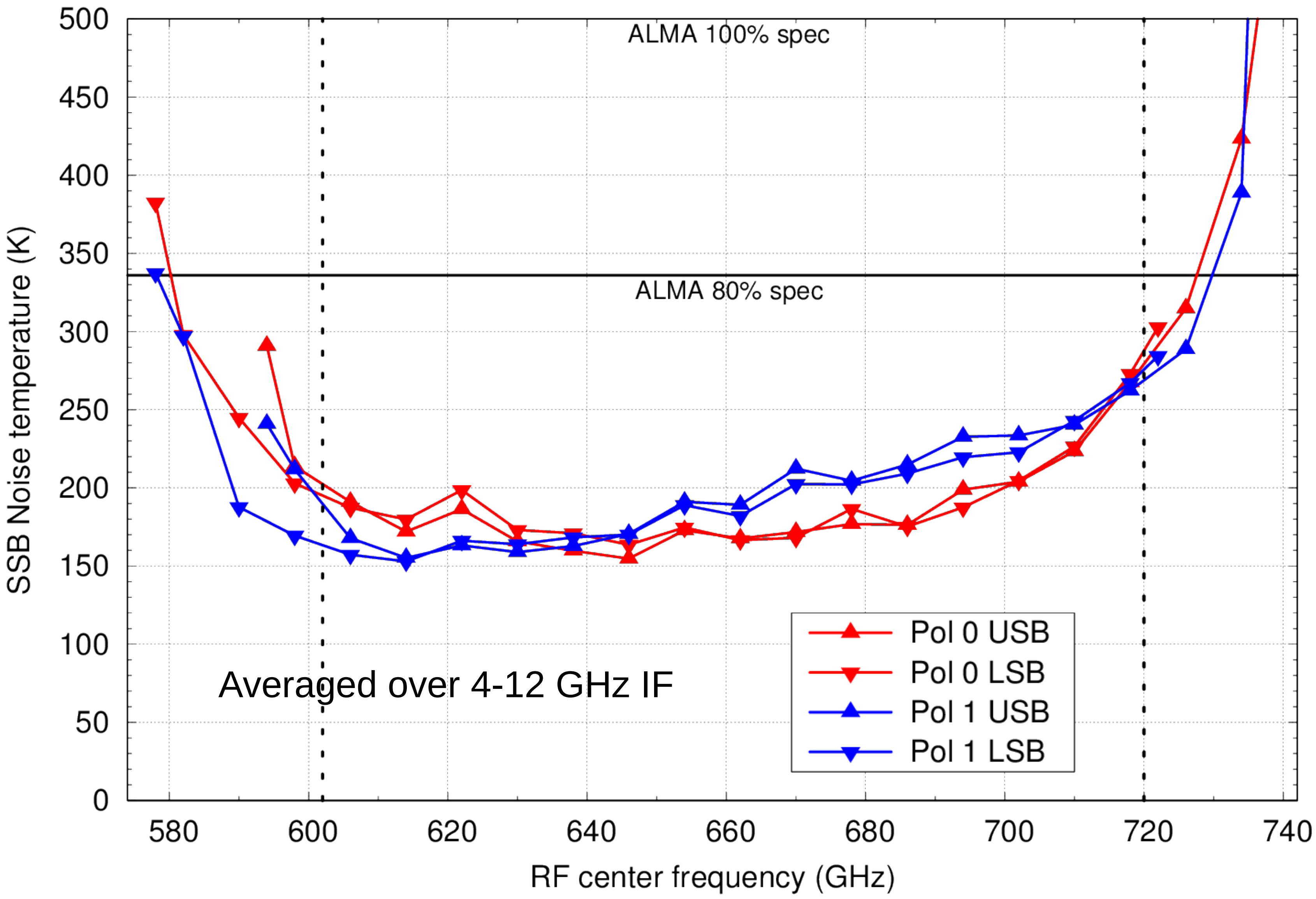




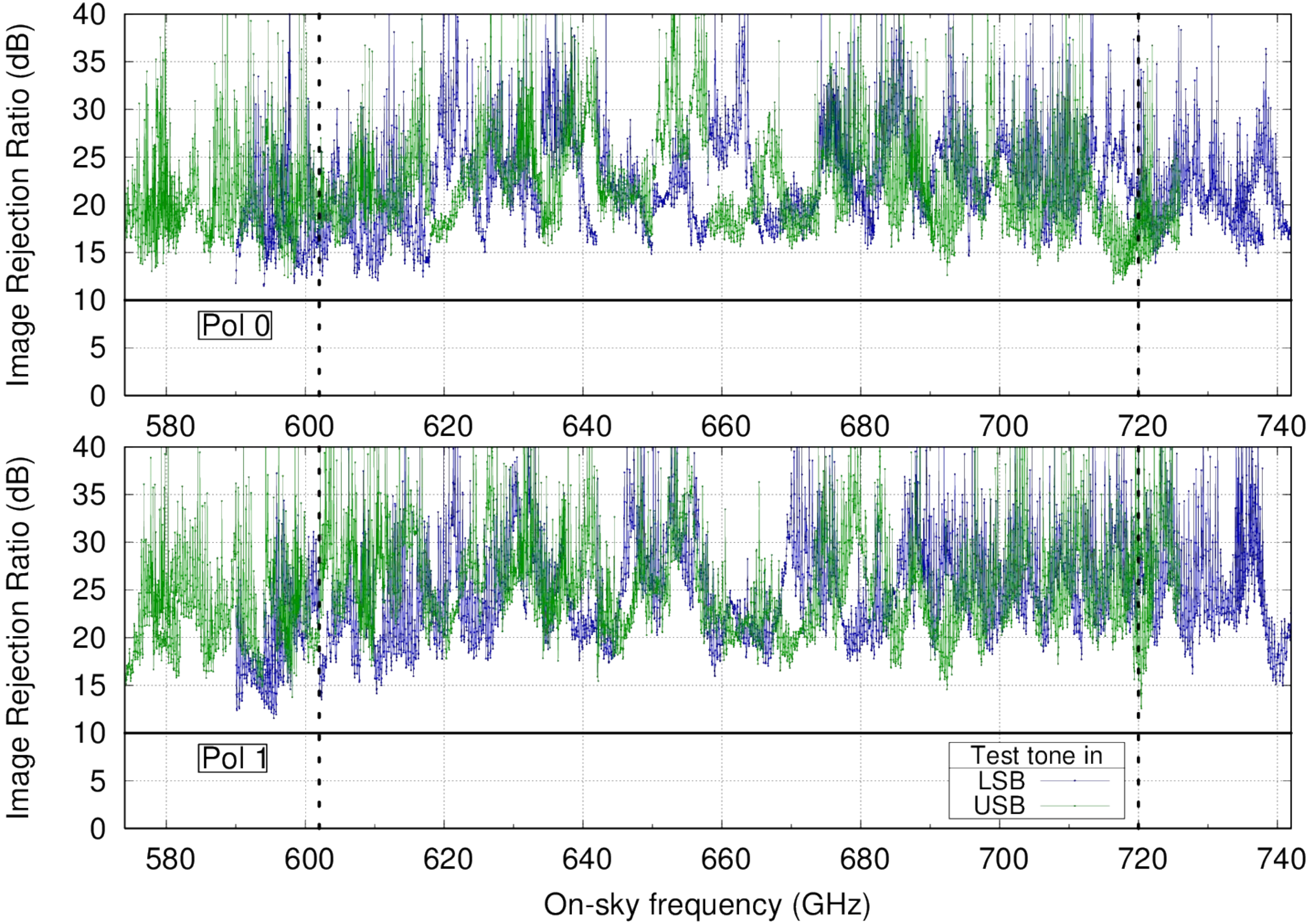


Hesper et al., Proc. 29th ISSTT (2018) PP 98-103

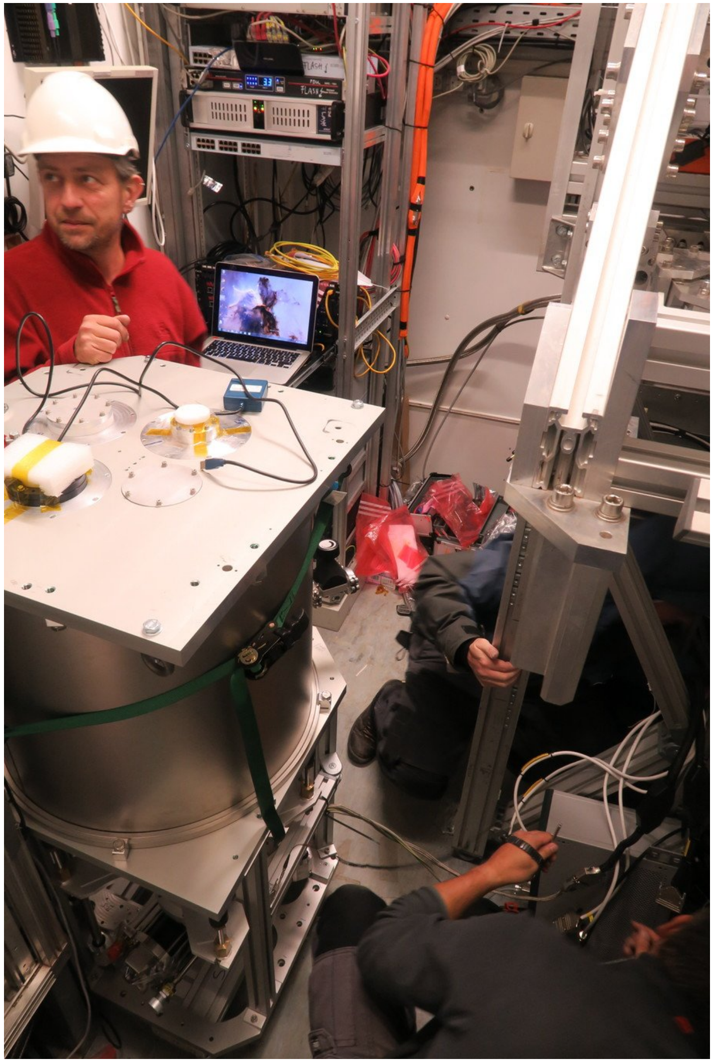
Lab results: noise temperature

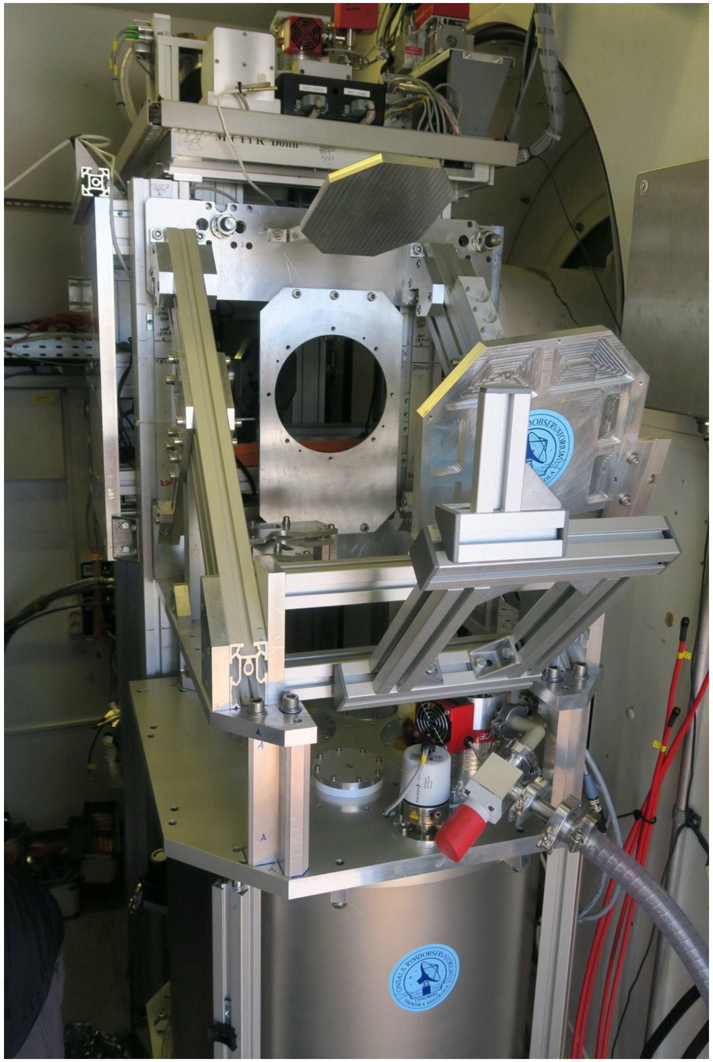


Lab results: image rejection



Into SEPIA...





First light – R-Dor

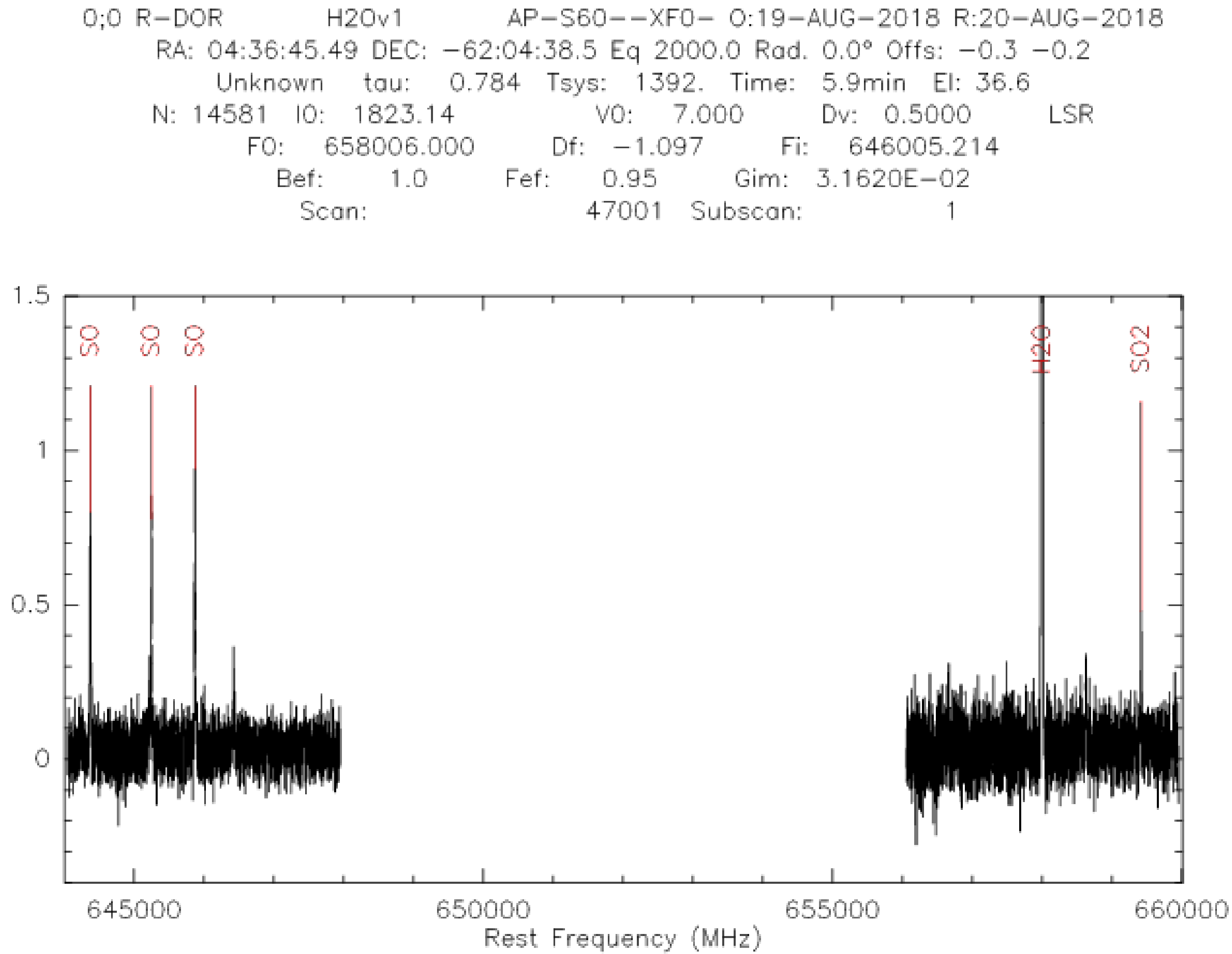
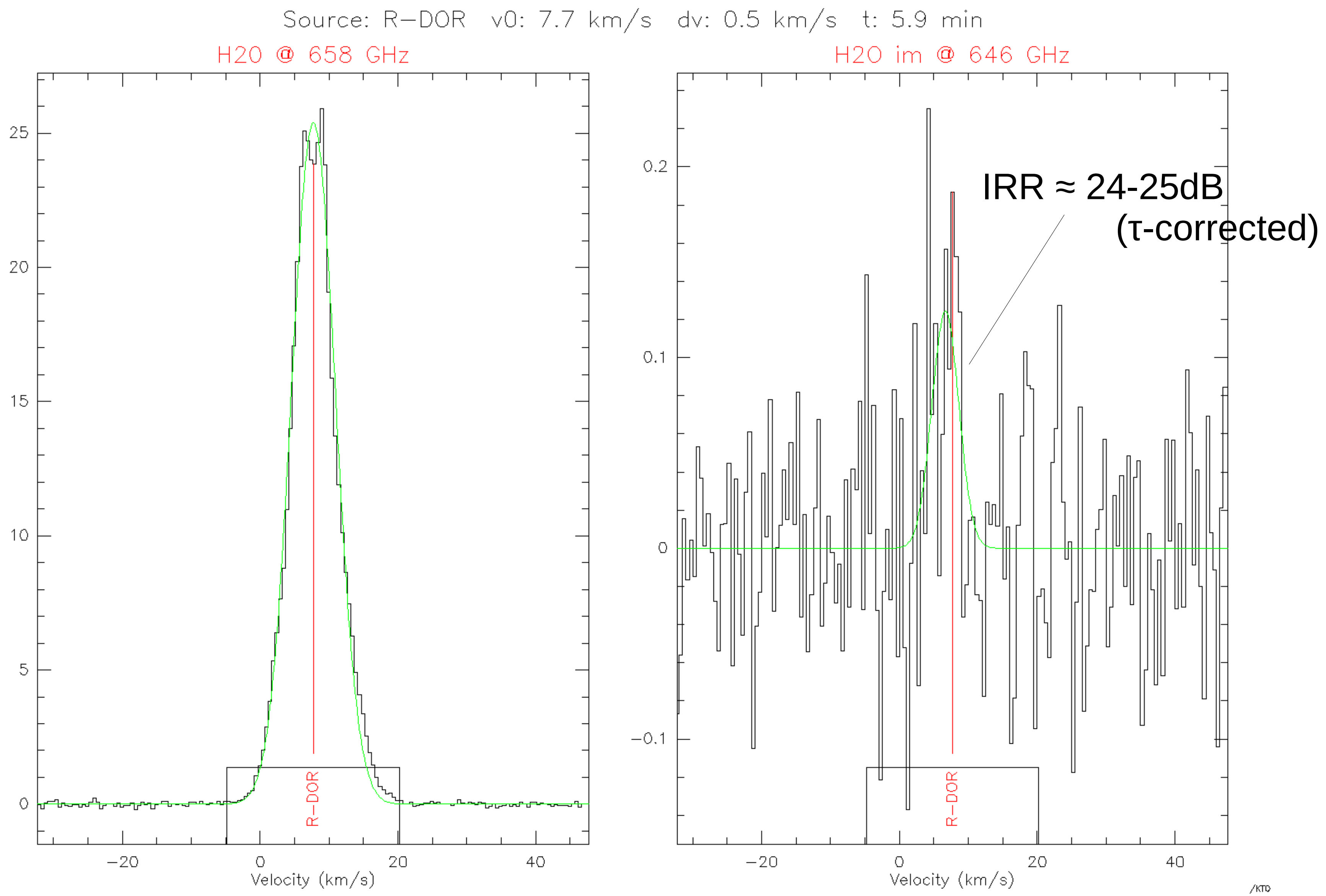
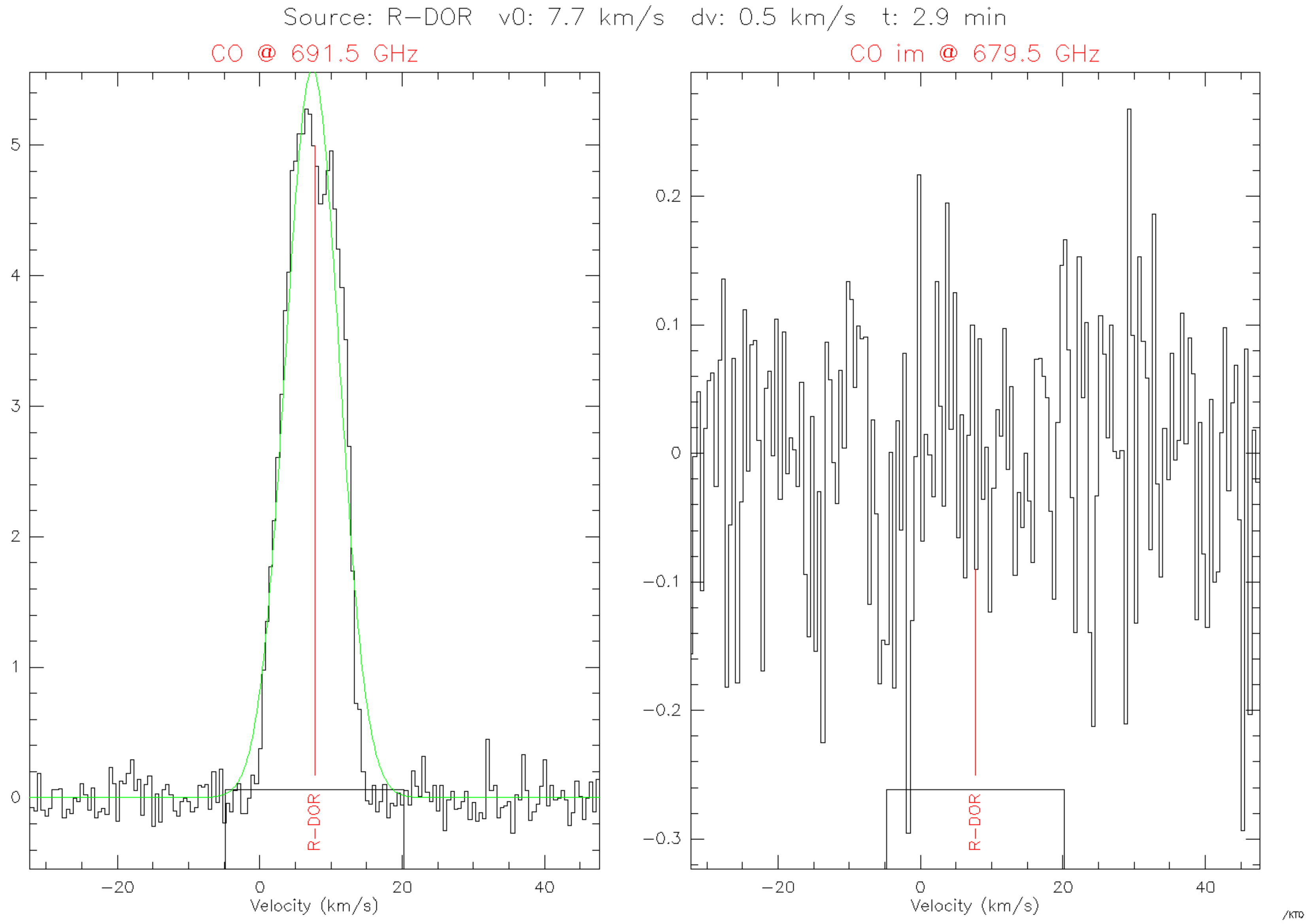


Image rejection - H_2O maser



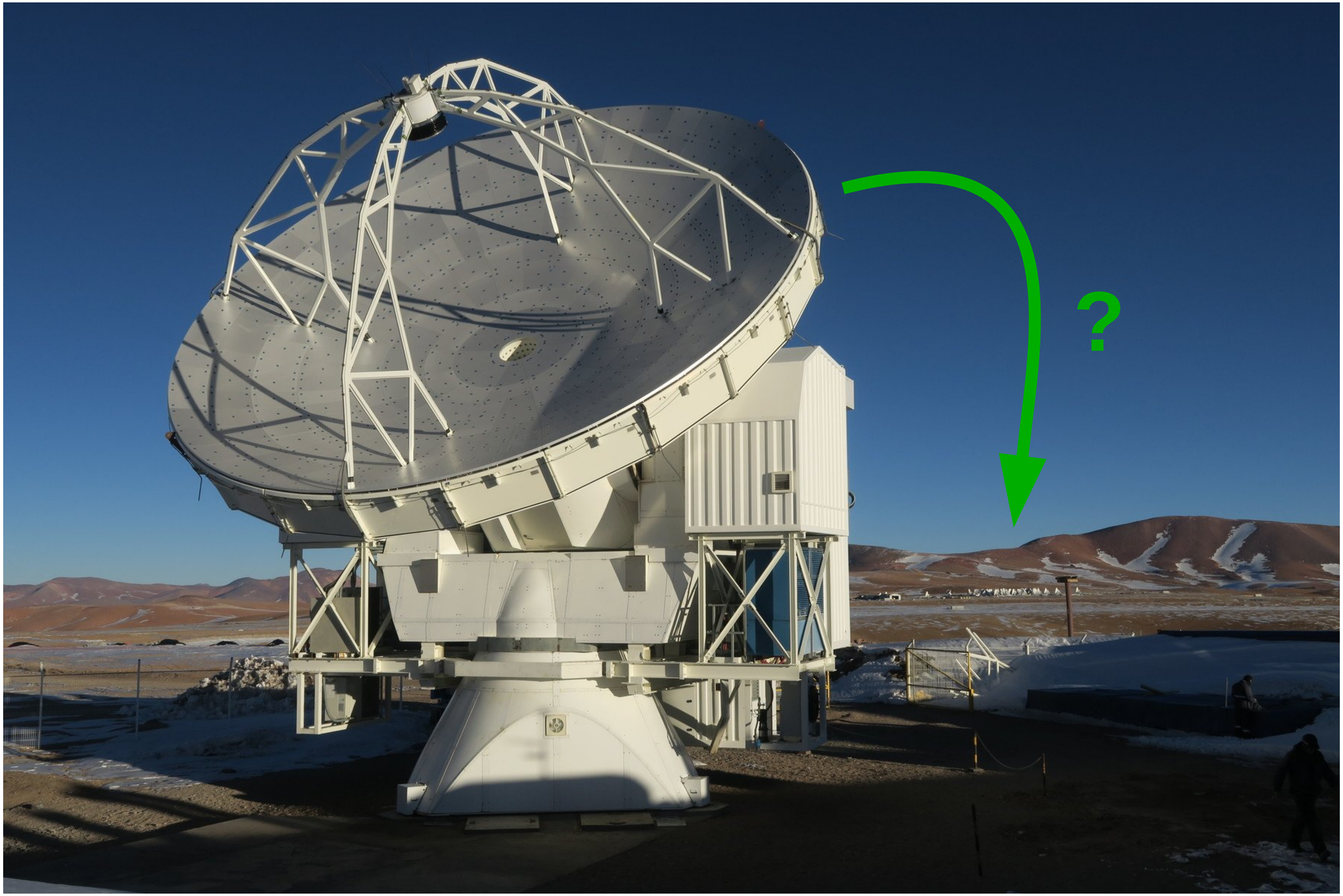
P. Bergman et al., SEPIA660 Commissioning Report (2019)

Image rejection - CO 6-5



For CO *J* = 6-5: no image detectable - IRR better than 24dB

From APEX to ALMA



Goals of the study

1. **Further extension of the IF bandwidth to 4x12 GHz or even more (SEPIA660 has 4x8 GHz)**

2. Extension of RF bandwidth beyond 600-720 GHz

3. The availability of a sufficient number of SIS mixer devices to enable a full upgrade

4. Optionally, the improvement of the optical cross-polarization performance

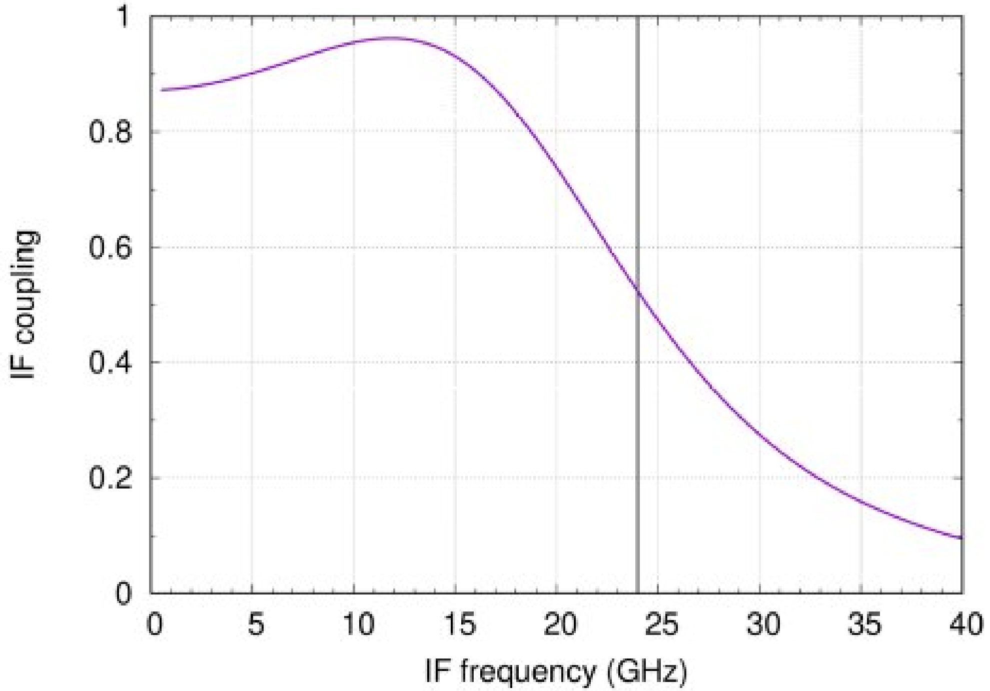
5. The expected cost for all existing ALMA Band 9 receivers to be upgraded

6. The expected cost for a limited number of pre-production receiver modules

7. The upgrade strategy, especially the possibility to allow continued Band 9 operations during upgrade

Increasing the IF bandwidth

New simulations show that current Band 9 SIS devices may have an IF bandwidth up to 24 GHz



K. Rudakov

Provided that the IF infrastructure can accomodate this, it would mean a total IF coverage of 80 GHz!

Challenges:
- cryogenic IF LNAs
- cryogenic IF hybrids

Conclusions

A dual-pol sideband-separating Band 9 ALMA-class receiver has been demontrated and commissioned on-sky, with a total IF bandwidth of 32 GHz and image rejection in excess of 20dB on average (better than 15dB everywhere)

RF BW extension to 580-732 GHz was demonstrated.

The technology to implement this in ALMA is ready; expensive components like SIS devices (probably) and LOs (certainly) can be re-used.

Extension of the total IF BW to 48 GHz looks quite feasible,
64 GHz possibly so.

And...

For the Flash receiver (MPIfR) on APEX, we have a 2SB 790-950 GHz mixer with similar performance
→ poster Andrey Khudchenko