SEPIA 345 GHz Design and Performance


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Outline

- What is SEPIA: Technology and Optics
- 345 GHz Receiver Description
- Receiver performances
- Conclusion
What is SEPIA
(Swedish ESO PI instrument for APEX)

- Collaborative effort by ESO and GARD/OSO: negotiations started in mid 2013, decision taken in January 2014
- Operation supported by the MPIfR by providing FFTS backend recently upgraded to 8x4 GHz
- ALMA technologies adapted to APEX
- Scalable and re-configurable “receiver hotel” (any 3 cartridges of ALMA Band 5...10)
- Installed into the APEX Nasmyth Cabin A, in February 2015 with SEPIA 180
SEPIA Cryostat
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APEX Workshop 2k20

SEPIA Optics

10 extra mirrors compared to ALMA
345 GHz Receiver
ALMA Compatible Receiver Cartridge

Receiver Description:
- Two sidebands (2SB) configuration
- Dual polarization via OMT
- “In-house” Nb-AlOx SIS mixer technology
- RF band: 272-376 GHz
- IF band: 4-12 GHz (x4)
- Trx goal (averaged over IF): ≤ 85K (≈ 4hf/k @ 440 GHz)
- LO (284-364GHz) with WCA are provided by NRAO
345 GHz RX 2SB architecture

Inside the mixer block
345 GHz Receiver Cartridge

Mirror 2
Support bracket
Magnetic coil Pol0
Orthomode transducer
2SB SIS Mixer Pol1
Mirror 1
IF isolator LSB Pol1
IF isolator USB Pol1
DC harness
4 K PLATE
Fiberglass spacer
15 K PLATE
Fiberglass spacer
110 K PLATE
300 K PLATE

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345 GHz Receiver Performances:
Noise temperature example:

Corrected to SBR, averaged over 4-12GHz
Noise temperature of ALMA bands
Side Band Rejection (SBR) example:

- POL0
  - Black – LSB
  - Red - USB

- ≥90% - above 10dB
- 100% above 7dB
345 GHz Receiver Performances: Beam measurements

Gaussivity is over 96%
345 GHz Receiver Performances: Beam measurements

277GHz

371GHz
345 GHz Receiver Performances: OMT Cross-polarization

Measured OMT cross-polarization

S²₁ (dB)

Frequency (GHz)

POL0

POL1

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345 GHz Receiver Performances:
Total power examples:

- Total power Allan Variance in 4-8GHz band
  LO frequency 292GHz, POL0
  - LSB
  - USB

- Total power Allan Variance in 4-8GHz band
  LO frequency 354GHz, POL1
  - LSB
  - USB

measured with a power meter in 4-8GHz IF range
Conclusion:

- New SEPIA 345 cartridge will be installed at the APEX telescope during this operation shutdown (currently CCA and WCA are on the way to APEX);
- IF band 4-12 GHz attainable over RF band 272-376 GHz;
- Receiver performances are close to goal values
- Further improvements require development work on both SIS mixers and IF components

THANK YOU!