THE 1ST MULTICHROIC POLARIMETER ARRAY ON THE ATACAMA COSMOLOGY TELESCOPE

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LTD’16 Meeting
ATACAMA COSMOLOGY TELESCOPE POLARIMETER

- Upgrade to the Atacama Cosmology Telescope (ACT)
- Site located at a height of 5190m at Atacama desert in Chile;
  high and dry >> low Precipitable Water Vapor
- Off-axis Gregorian configuration. Consists of a 6 m primary mirror and a 2 m secondary mirror
- Upgrade to the Atacama Cosmology Telescope Polarimeter
- Site located at high and dry location in Chile
- Off-axis Gregorian configuration. Consists of a 6 m primary mirror and a 2 m secondary mirror
ACTPOL INSTRUMENT

Dilution refrigerator for continuous sub-100 mK operation

Receiver contains two GHz focal planes and one GHz focal plane
ACTPOL INSTRUMENT

Dilution refrigerator for continuous sub-100 mK operation

Receiver contains two 146 GHz focal planes and one 170 GHz focal plane
ACTPOL INSTRUMENT

Dilution refrigerator for continuous sub-100 mK operation

Receiver contains two 146 GHz focal planes and one 90/146 GHz focal plane
ACTPOL INSTRUMENT

Dilution refrigerator for continuous sub-100 mK operation

First Multichroic Array!!!

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Artacama!
MULTICHROIC FEEDHORN COUPLED DETECTORS

- Broad Band OMT
- Diplexer: two stub filters to split the two bands
- Hybrid tees to reject unwanted modes and combine TE11 signals
- TES bolometers to readout each polarization and each band (4 total)

McMahon et al. JLTP (2011)
PASSBAND OF DETECTORS

See Poster:
G4.12: Design and Deployment of a Multichroic Polarimeter Array on the Atacama Cosmology Telescope
-Rahul Datta
DETECTOR ARRAY READOUT

- Time division multiplexing with three stages of SQUID amplification, developed at NIST

- Flexible circuitry (FLEX)

SSPS I T3.4: Advanced ACTPol detector-readout interface: High-density superconducting cable fabrication process and array assembly techniques
- Christine Pappas

Readout chips

Silicon detector wafer (Semihexagonal wafer)
ARRAY PACKAGES

Single broadband corrugated feedhorn

- Design:
  - 255 pixels
  - 1020 TES detectors
    - 510 each at 90 and 150 GHz

Fully Assembled PA3 package array

Courtesy: E. Grace, Princeton
ARRAY PACKAGES

Yield of PA3 : ~ 85 %
Sensitivity : ~ 9uK-√s
(Preliminary!)

- Design:
  - 255 pixels
  - 1020 TES detectors
    510 each at 90 and 150 GHz

Fully Assembled PA3 package array

Courtesy: E. Grace, Princeton
PA3 CHARACTERIZATION

on-site measurement of full array

**Tc**: Target = 165 mK

**G**: Target = 260/300 pW/K

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<table>
<thead>
<tr>
<th></th>
<th>90 GHz</th>
<th>150 GHz</th>
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<tr>
<td>n=3.3</td>
<td></td>
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<td>Hex</td>
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<td>SemiHex</td>
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<td>Tc (mK)</td>
<td>153.3</td>
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<td>Kappa</td>
<td>5264</td>
<td>4723</td>
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<tr>
<td>G (pW/K)</td>
<td>227.15</td>
<td>218.13</td>
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</tbody>
</table>

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ACTPOL
ATMOSPHERE RESPONSE

\[ P_{\text{sat}} = C_{\text{wet}} \frac{\text{PWV}}{\sin(\theta)} + C_{\text{dry}} \frac{\sin(\theta)}{\sin(\theta)} + P_{\text{dark}} + P_{0} \]

- Average atmosphere response for 150 GHz detectors is 0.55 pW/mm
- 90 GHz detectors is 0.15 pW/mm

\( C_{\text{wet}} \) can be used for (relative) optical efficiency, later calibrated by the planet peak height
DEPLOYMENT/ OBSERVATIONS

- January 2015: PA3 deployed
- ACTPol fully deployed at the site
- First Light of PA3 in February 2015
- Continuously observing
- Data processing in progress
CENTURUS A

- Preliminary results using Multichroic array
- Maps contain ~ 10 hours, covering 6x6 degree patch of the sky
CENTURUS A

- Preliminary results using Multichroic array
- Maps contain ~ 10 hours, covering 6x6 degree patch of the sky

ACTPol 150

ACTPol 90
CENTURUS A

Planck146

Planck100
CENTURUS A & CMB

ACTPol 150

ACTPol 90

There is CMB feature!
THANK YOU!