Coherent Receivers: System Considerations

CMB Polarization Technology Workshop
NIST/Boulder

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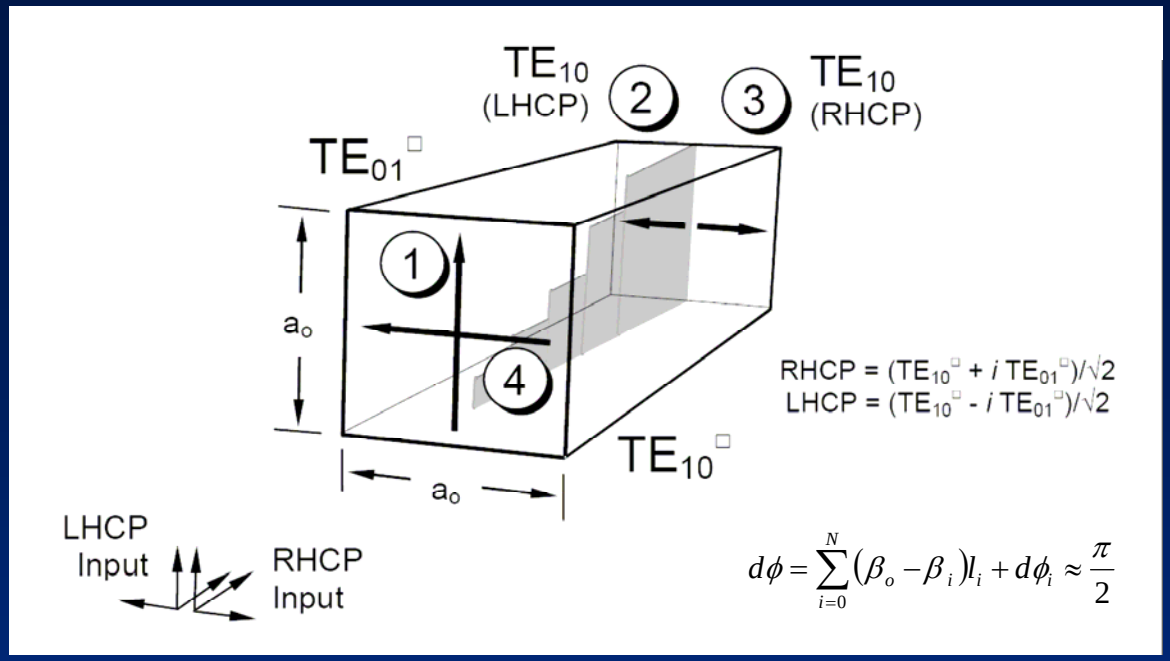
Coherent Receivers

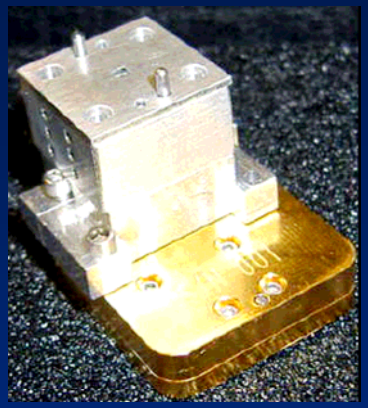
- Ability to make multiple signal copies without additional noise penalty…
  - Allow system architectures with null science data channel
    - Baseline/Offset potentially small and stable…
  - Simultaneous measurement of desired basis set by receiver topology (e.g., Q/U/I, Q/V/I, other…)
  - Rapid phase modulation used to stabilize receiver and measurement basis. Excellent systematic control. Due to high coupling efficiency addition of beam waveguide polarization modulators (e.g., HWP, VPM, other…) un-needed/undesired…
  - Relatively modest cooling and bias stability requirements. System noise properties degrade gracefully with detector ambient temperature…
- Complexity – reduced I&T risk – high reliability
  - Limited number of elements before setting noise
  - Many elements can be testing at room temperature…

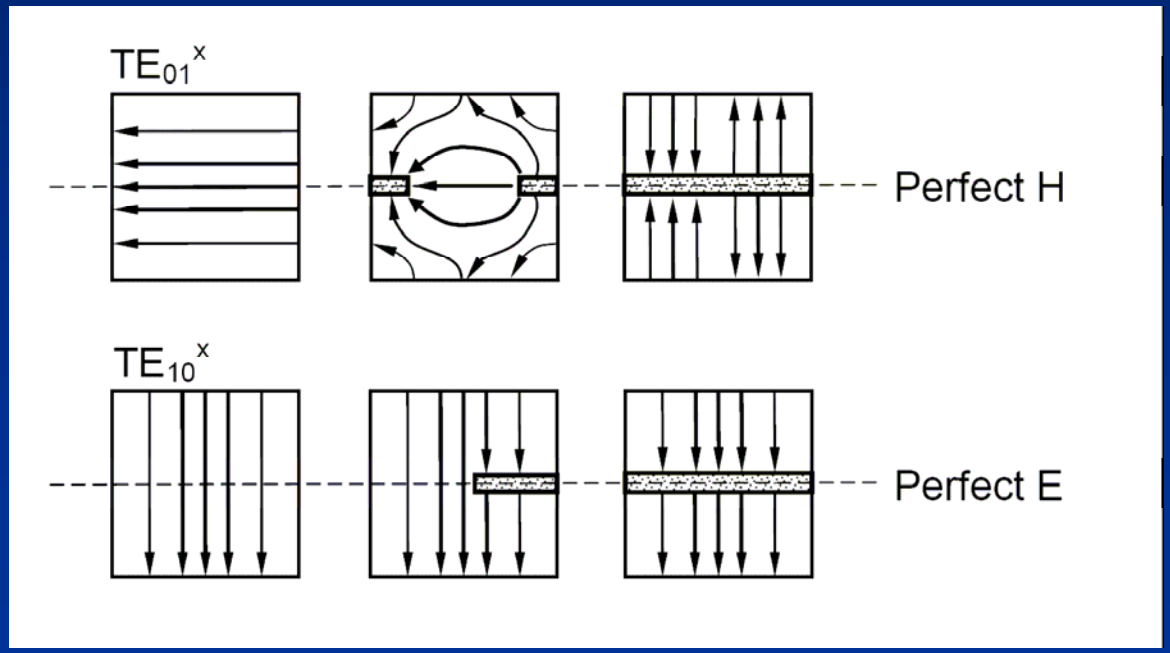
Future Technology Needs

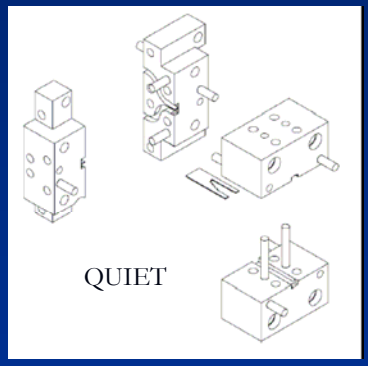
- Approaching QL Device Noise
  - 1/f-noise more pronounced as device noise approaches QL – charting the unknown, however, might anticipate higher phase switching rates to stabilize radiometer…
- Optimal Element Design
  - Phase switch, transitions, other…
  - Q/U polarimeter desire circular polarization from antenna – need high performance antenna polarization diplexers with greater bandwidth... – presently elements ~20% fractional bandwidth need to be pushed to full waveguide band…

Waveguide Hybrid Septum Polarizer







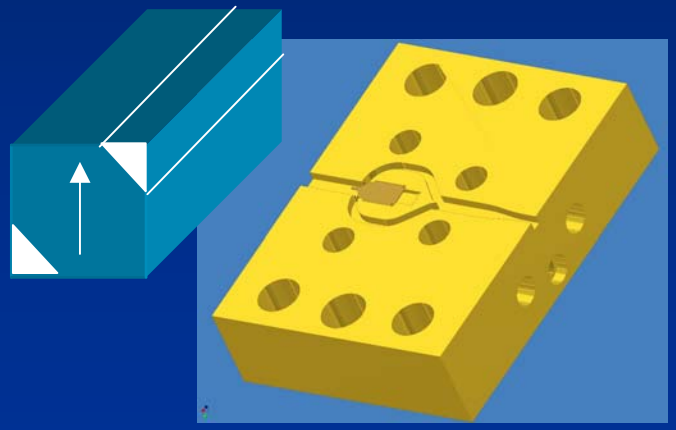


[1] P. Bannister, G. Nixon, S. Staggs, "Final Preproduction Memo for QUIET W-Band OMTs", April 24, 2006.

[2] J. Bornemann, V.A. Labay, "Ridge Waveguide Polarizer with Finite and Stepped-Thickness Septum," 1995, IEEE Transactions on Microwave Theory and Techniques, Vol. 43, No. 8., pp. 1782—1787.

Broadband Solution: OMT + QWP + HWP

- Feed Horn
- Broadband 90 degree waveguide polarizer
  - Mount at Fast Axis 45degrees WRT OMT H/V
- Symmetric Split-Block OMT Design
- Phase Match Main/Side-Arm OMT



Centimeter wave solutions have from radioastronomy have been demonstrated…