Wire Grids for Calibration

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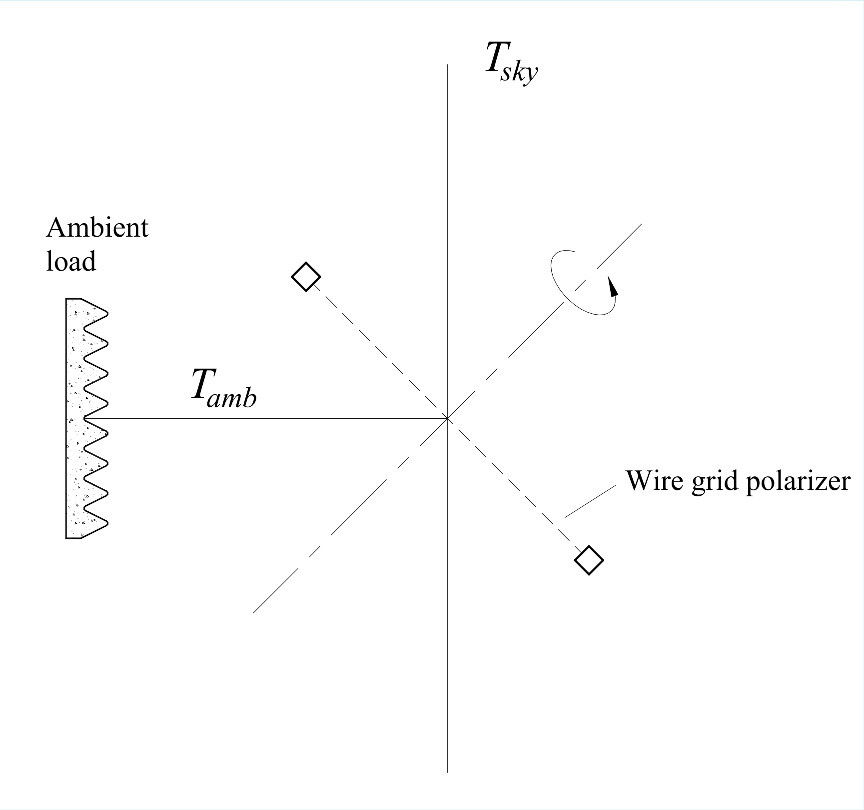
Goals

- Calibration Temperature
  - $T_{sky} < T_{cal} < T_{amb}$
  - Optimum depends on frequency
- Frequency Dependence
  - Negligible over IF bandwidth
  - Slow or no variation with frequency
- Repeatability
  - Should be repeatable to << 1% on short time scales
  - Long-term repeatability good enough to minimize time lost for recalibration
- Simplicity
  - Minimize moving parts
  - Minimize volume requirements

Wire Grid Polarizer



$$T_{cal} = T_{amb}\cos^2(\theta) + T_{sky}\sin^2(\theta)$$

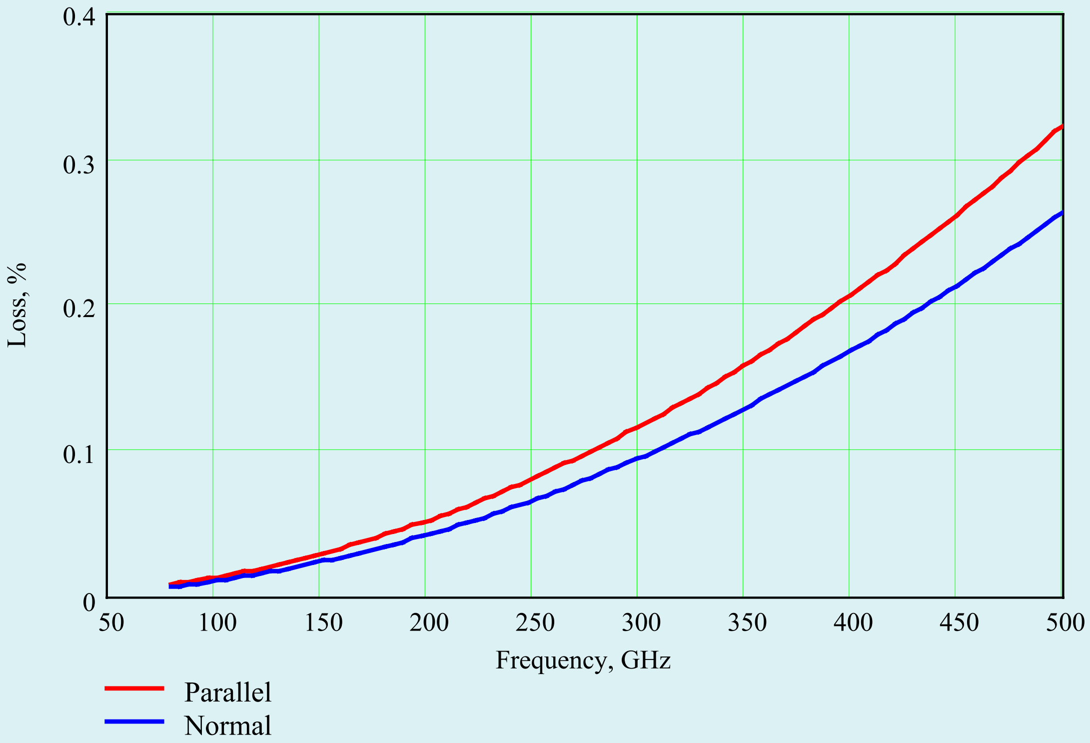
Where θ is the angle of the grid wires to the polarization of the feed as viewed along the optical axis.

Can set any temperature between T_{sky} and T_{amb}.

Wire Grid Properties

- Very good polarizers
- Cross-polar leakage fraction to a few %
- Wide bandwidth
- Low loss
- Well understood theoretically

Grid Transmission/Reflection Loss *vs.* Frequency



Assumptions

Wire diameter: 25 μm

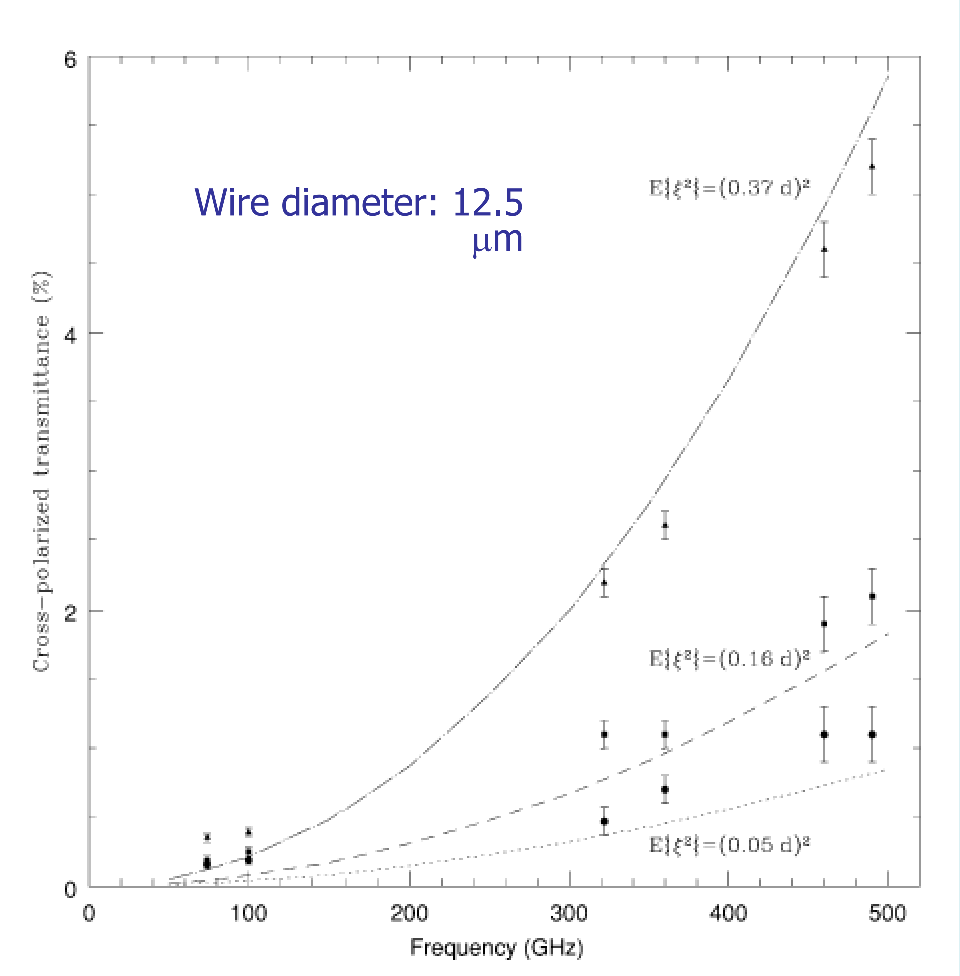
Grid pitch: 100 μm

Angle of incidence: 45°

Ohmic losses: None

[Larsen, 1962]

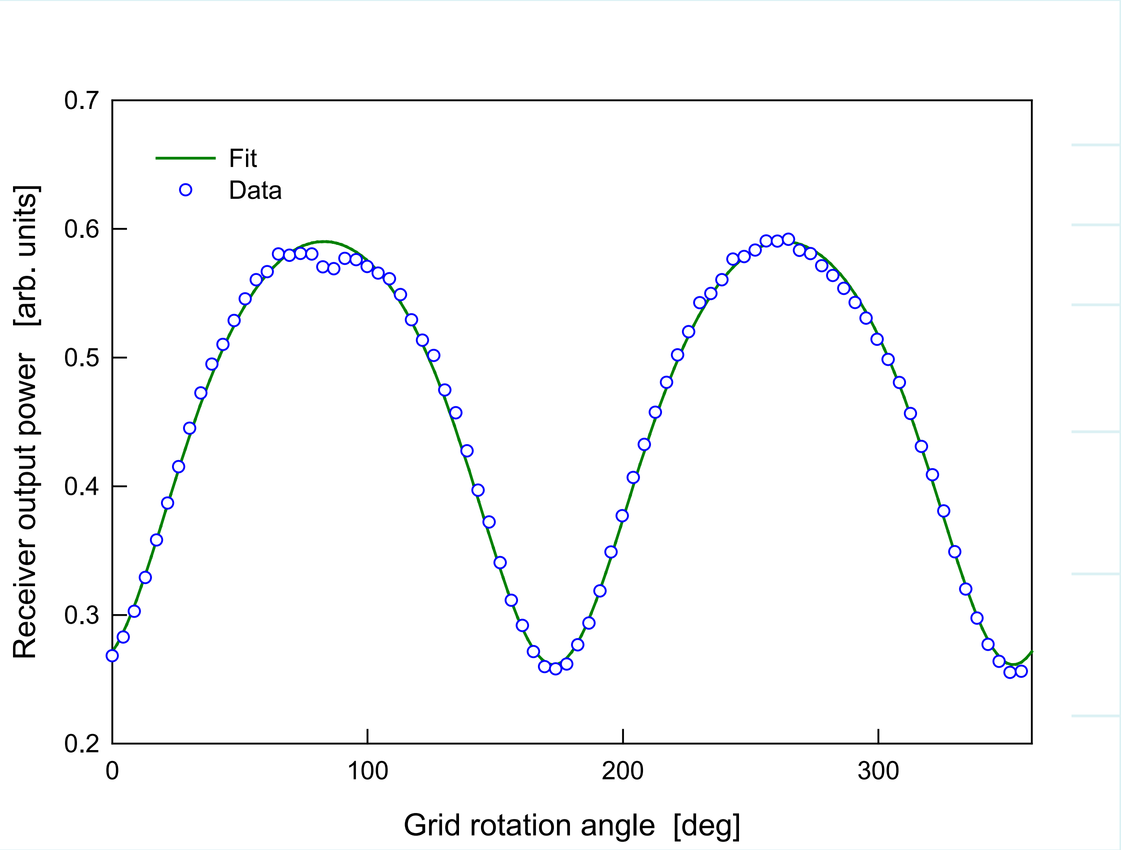
Effect of Grid Non-Uniformity



Theory
[Houde et al., 2001]

Measurements
[Shapiro & Bloemhof, 1990]

Measurement of Linearity

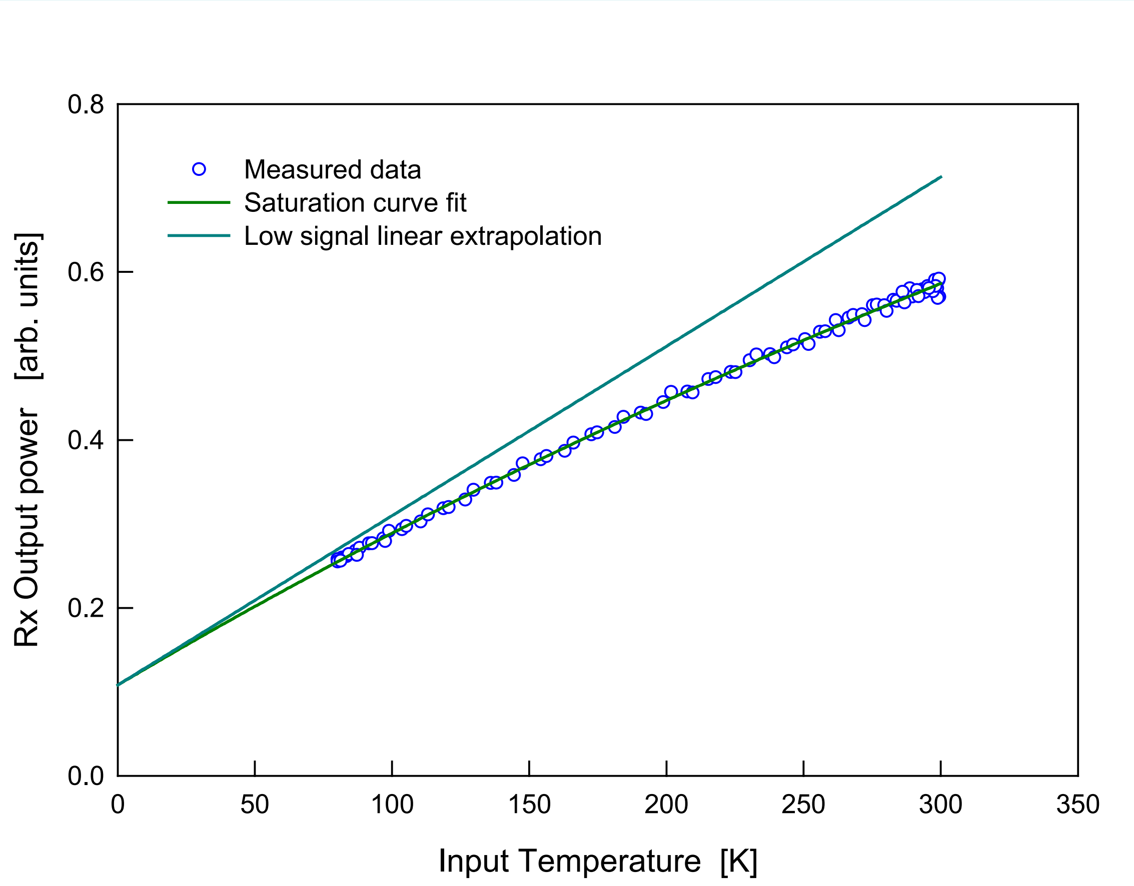


Frequency: 100 GHz

T_{hot}: 300 K

T_{hot}: 80 K

Determination of Non-Linearity



Saturation Equation

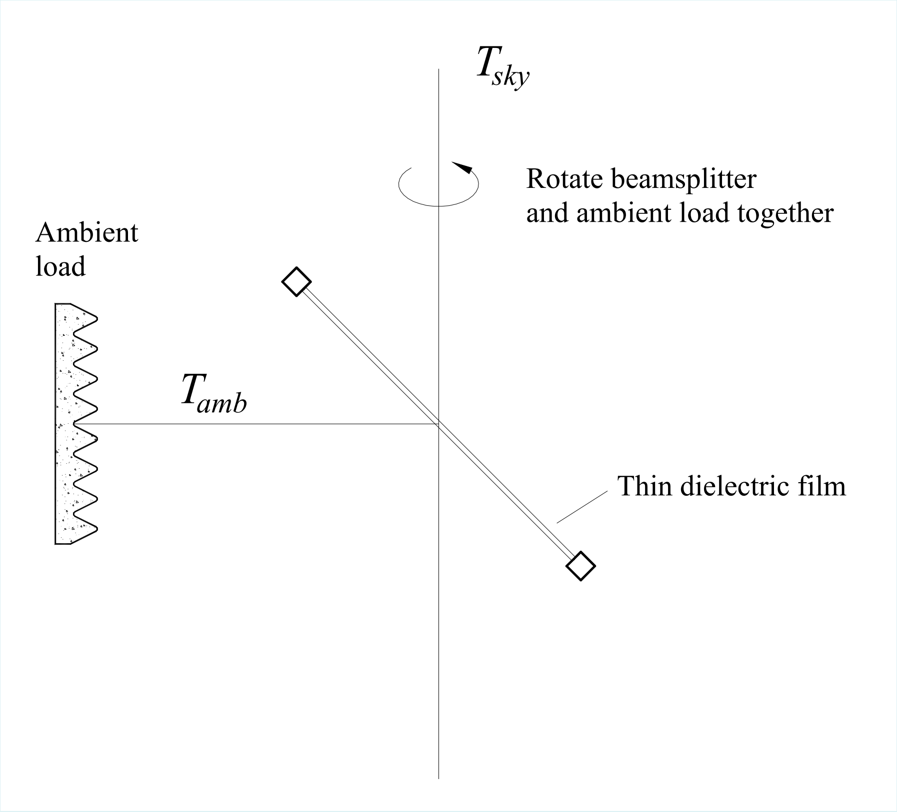
[Feldman, Pan and Kerr, 1987]

$$P_{out} = \frac{K_0 (T_{in} + T_{Rx})}{1 + T_{in}/T_{sat}}$$

T_{Rx}: 54 K

T_{sat}: 1400 K

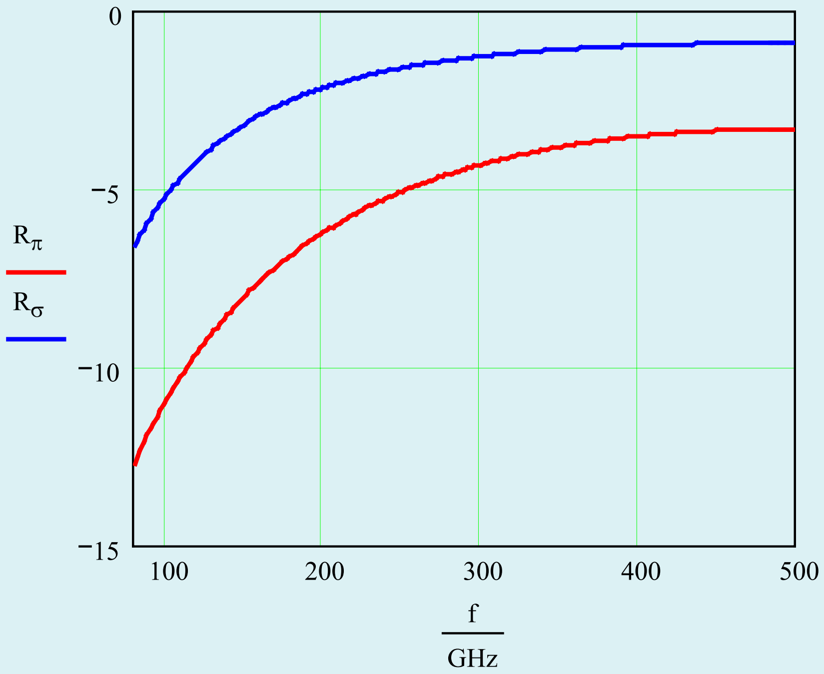
Dielectric Beamsplitter



$$T_{cal} = T_{amb} R + T_{sky} (1 - R)$$

R is the power reflection coefficient. It depends on the polarization of the feed.

Reflection By Dielectric Film



Assumptions

Dielectric const: 3.35

Loss: 0

Thickness: 50 μm

Angle of incidence: 45°

Comparison of Methods

	S/T Vane	Wire Grid	Dielectric Beamsplitter
Cost	Low ✓	High	Moderate
Frequency dependence	Significant	Slight ✓	Moderate
Range of Cal. Temperature	Small	0 – 300 K ✓	3 – 250 K
Ruggedness	Good ✓	Poor	Moderate
Simplicity	Good ✓	Poor	Low – Moderate
Predictability	Poor	Good ✓	Moderate
Accuracy	?	?	?