INSET INTERNSHIP PROGRAM
UCSB-SUMMER 2010
"The Early Universe: Cosmic Foreground Explorer"

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Cosmic Foreground Explorer Telescope

- **Elevation:** 100.000 feet ➡ Stratosphere (Vacuum until reaching outer space)
- **Coverage:** 80% of the sky
- **Incoming radiation** ➡ Primary Reflector (Radio Frequency) ⬇ Secondary Reflector ➡ Horns ⬇ Cryogenic Low Noise Amplifiers
- **Mount:** Balloon-borne design for light carbon fiber optical elements

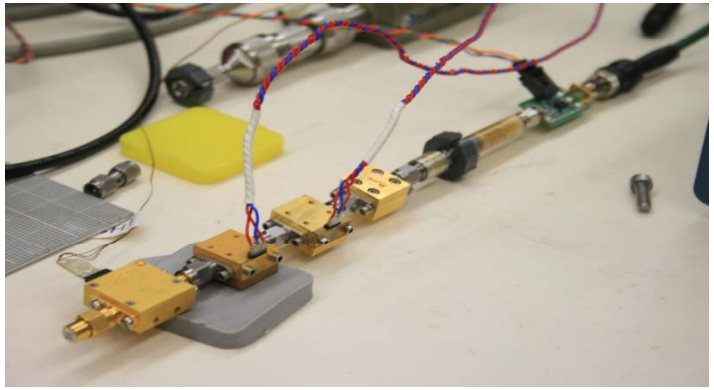
Radio Frequency Signals From the Sky

- **Frequency Response:**
  8GHz to 12GHz and 14GHz to 17GHz

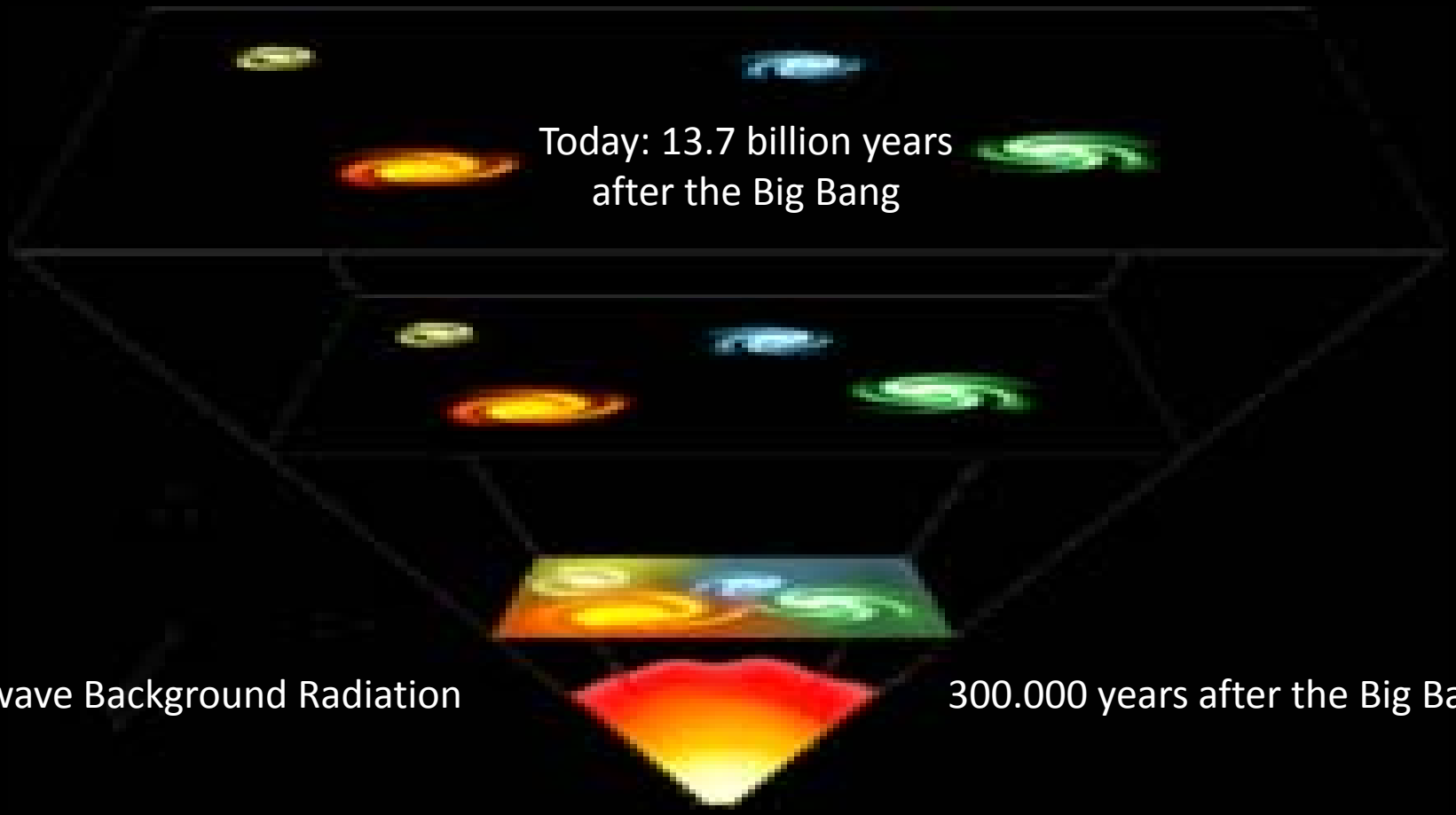
- **Expected Output:**
  Frequency Variations
  Temperature Fluctuations
  System Temperature
  Sky Temperature

Radio Frequency Sensitive Horn

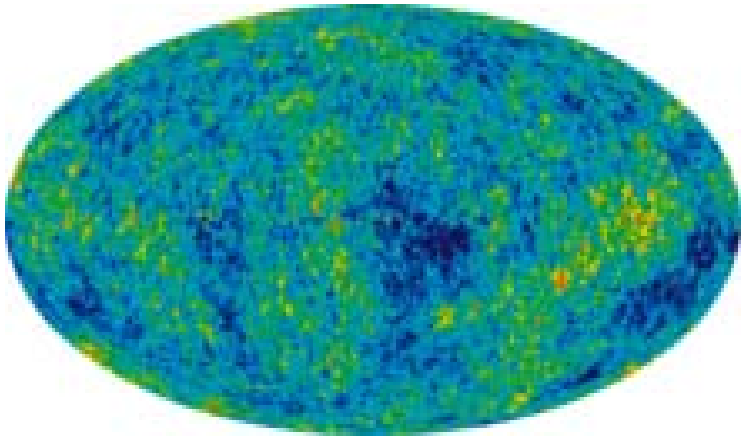
Low Noise Detector



The Big Picture: Cosmic Microwave Background Radiation



Temperature of the Microwave *Backround*



Remnant in Radio Frequency:

2.7Kelvin Temperature (1 Kelvin = -272.15 degrees Celsius)

UNDERSTANDING THE MICROWAVE BACKGROUND

- Development of cosmological scenarios of origin and structure
- Understanding geometry, mass- energy and composition

Why the Cosmic Foreground Explorer?

Limitations of Measuring the Microwave Background

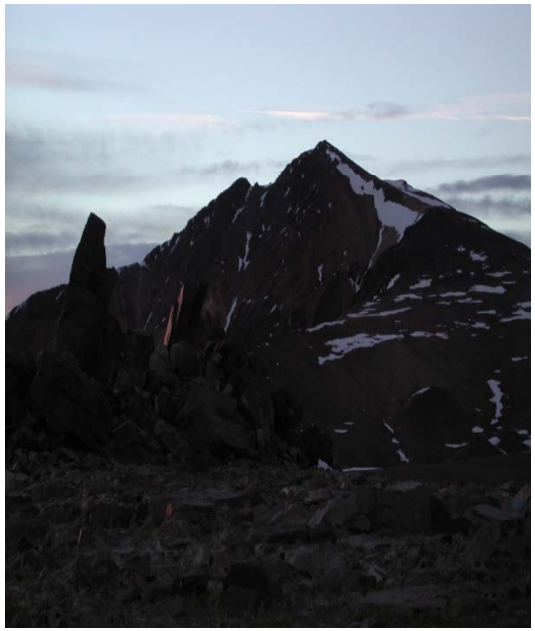
- Contamination by electro-magnetic emissions from our galaxy
- Diffusion of microwave background

Foreground Explorer Expectations

- Gather low frequency fluctuations and measure temperature variations of galactic foreground.

- Obtain useful data to map these fluctuations and remove them from Microwave Background

A Test on the Ground: White Mountains 14.000ft Elevation



•Input Radio Frequency Range: 4GigaHertz

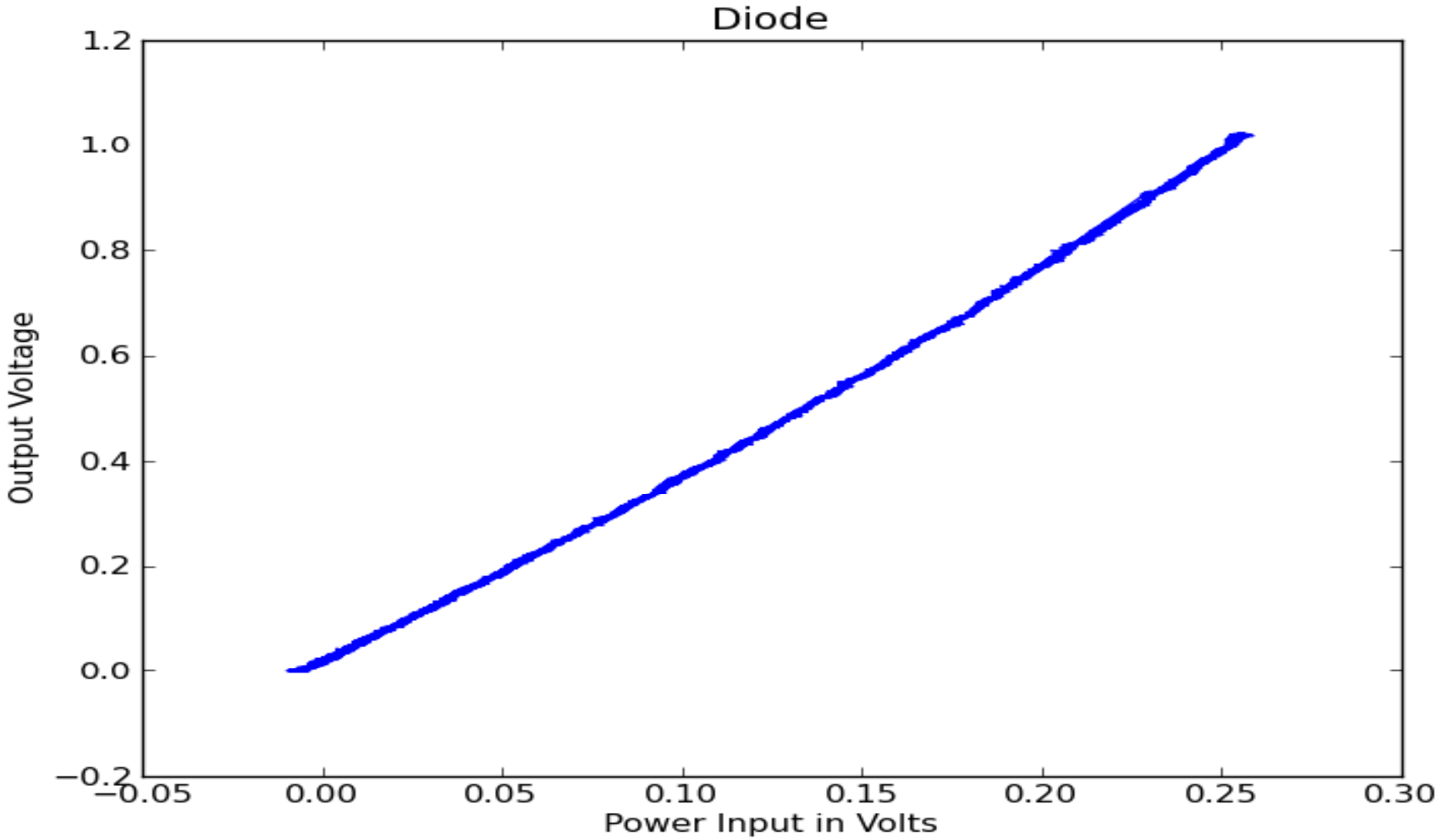
•The Sky at Zenith: Power output 20MicroWatts

•Temperature of the Sky: 20 degrees Kelvin.

•System Temperature Noise = 100Kelvin

•Cold System Temperature = 10 Kelvin

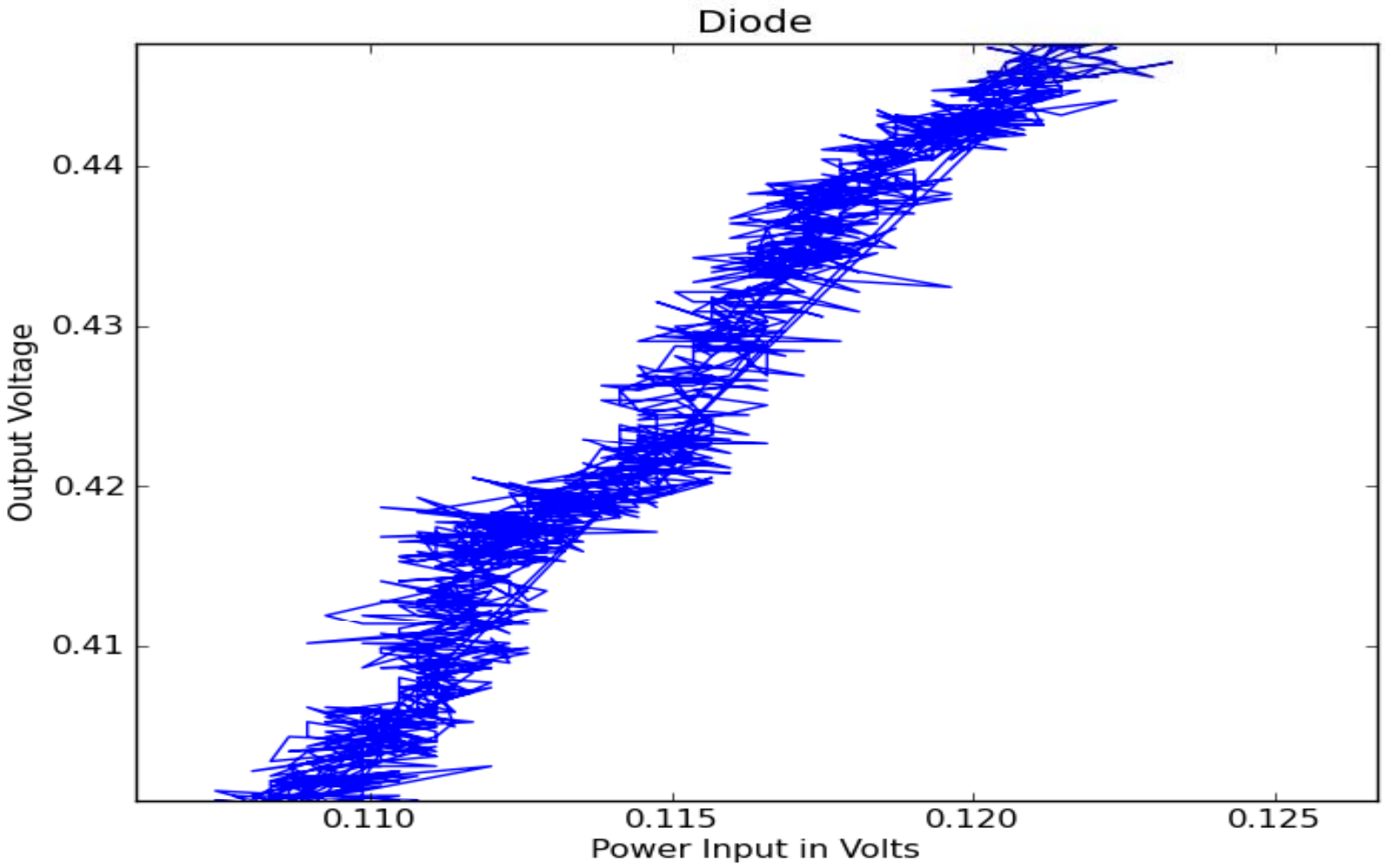
Rectified Current Output



Power Input: 0 to 30MicroWatts

Range: 0 to 300 MilliVolts

Range: 15 MilliVolts



Observations and Conclusions

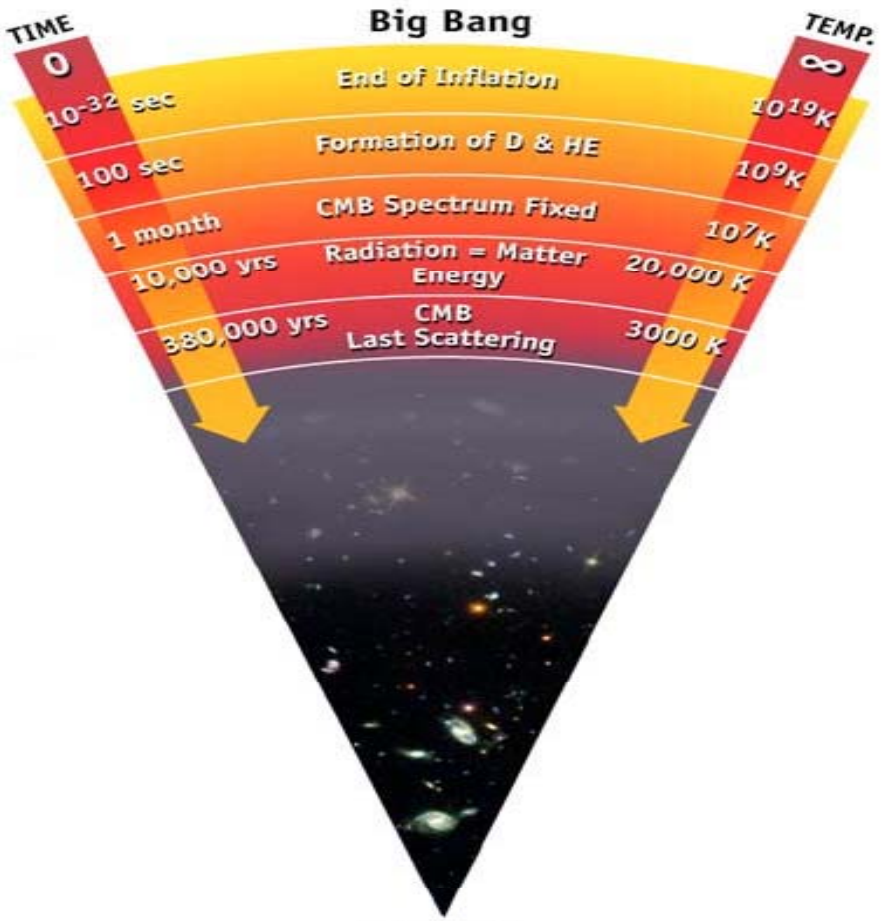
Sensitivity of the Instruments

- Power Input at antenna = 166 FemtoWatts or 3 Kelvin
- Power Range of Detector: 10MicroWatt
- Decibels of Gain needed: 70

Better Understanding of the Instruments

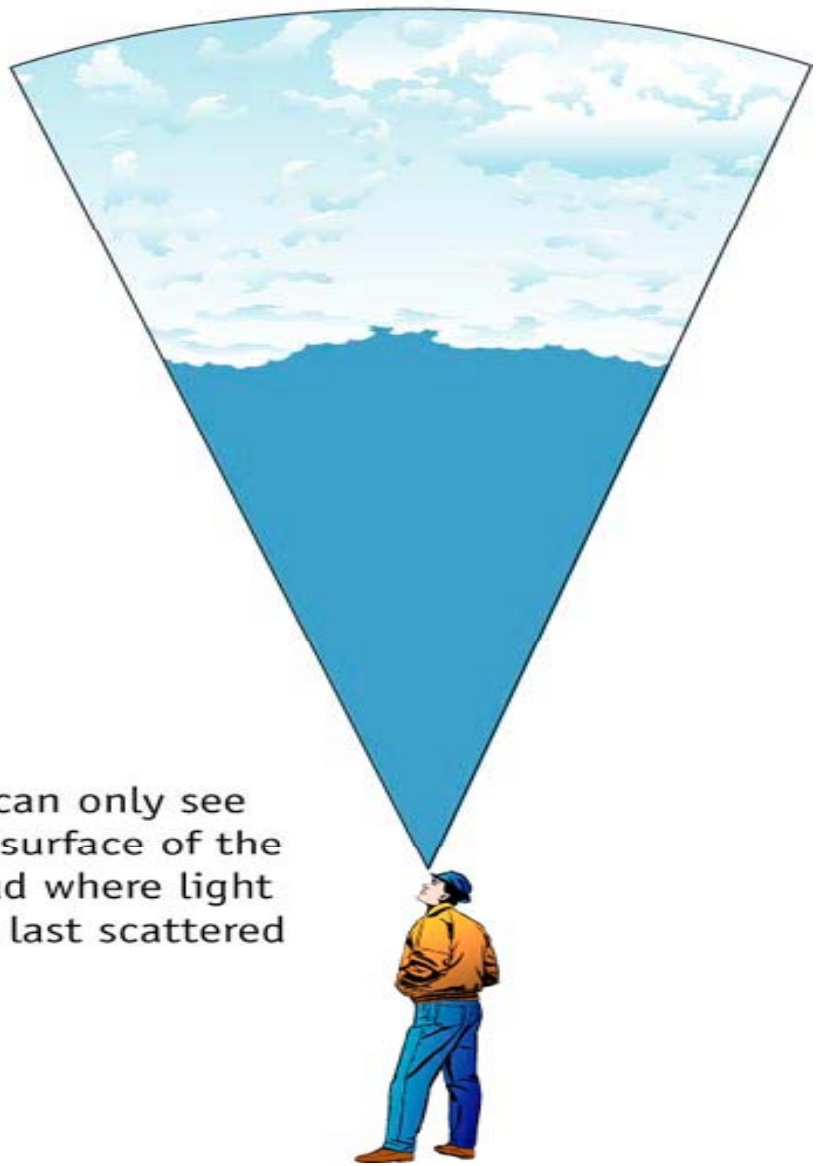
- Precise measurements of cosmic background radiation and it's irregularities

Thank you



PRESENT
13.7 Billion Years after the Big Bang

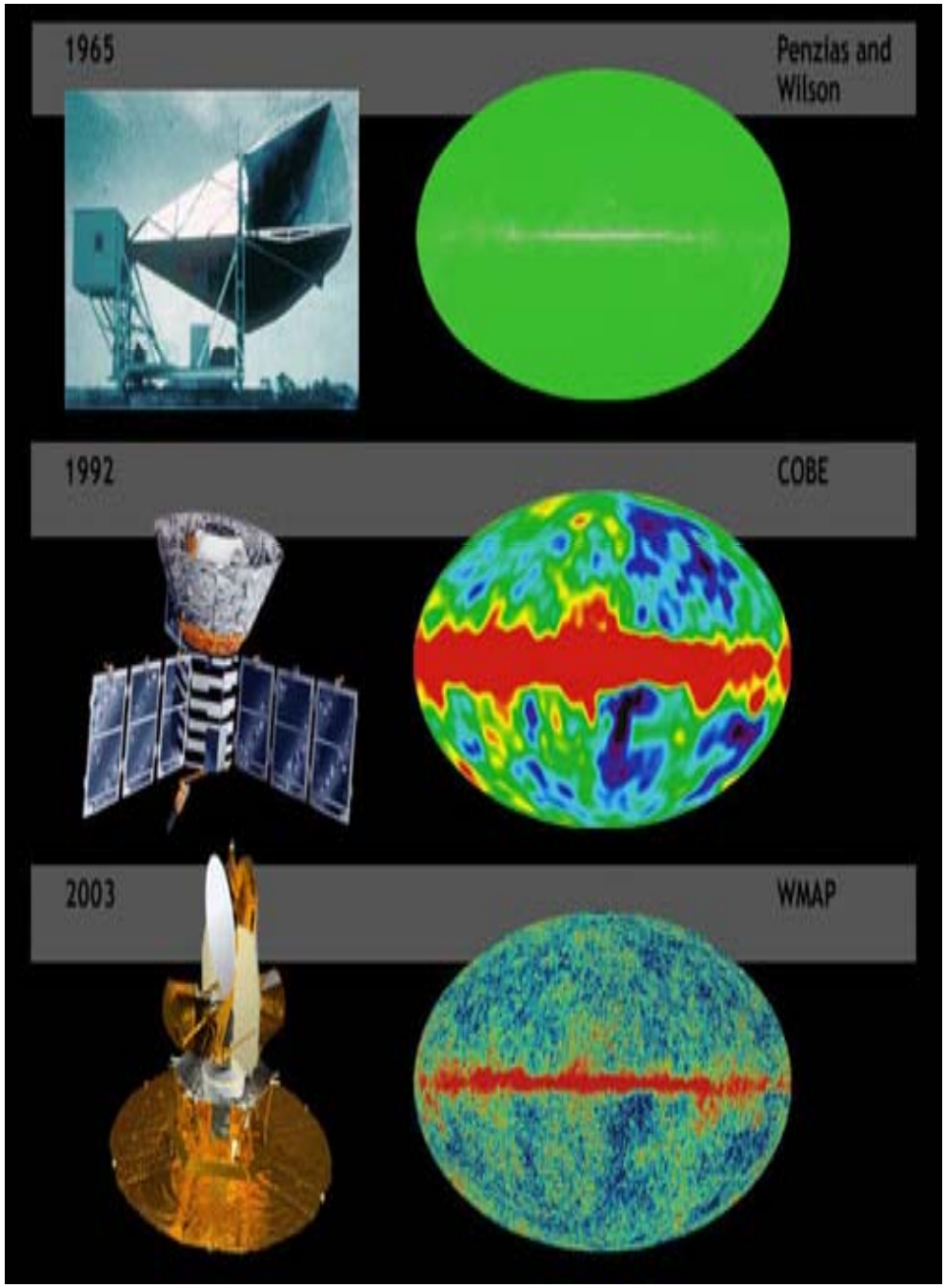
The cosmic microwave background Radiation's "surface of last scatter" is analogous to the light coming through the clouds to our eye on a cloudy day.



We can only see the surface of the cloud where light was last scattered

Isotropy of the Cosmic Microwave Background

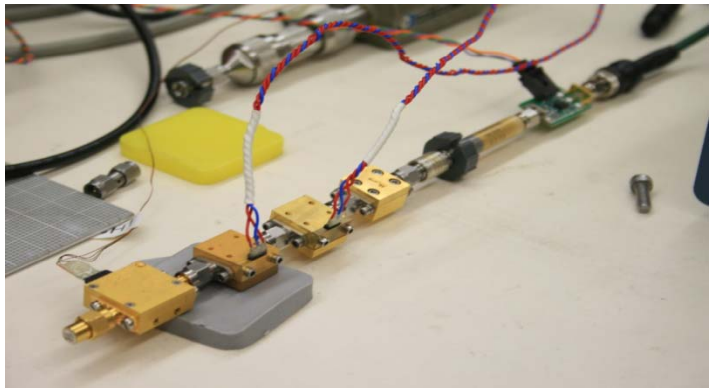
Anisotropy of the Cosmic Microwave Background: Frequency Fluctuations, Temperature Fluctuations



Measurement of low frequency foregrounds and noise

Signal Detector Components
(RF Signal Process)

Signal Input

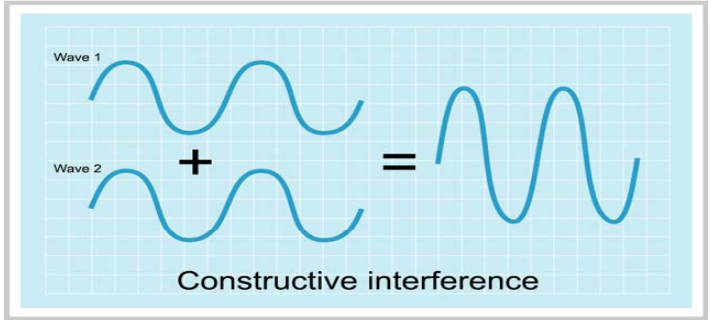


Signal Output

Capacity and Calibration of Devices

- **10 GHz Amplifiers test**

  Frequency range (6-12 GHz)
  Back end: 20dB Attenuator
  Power Output: 0.6 to 33µW



- **Diode Test**

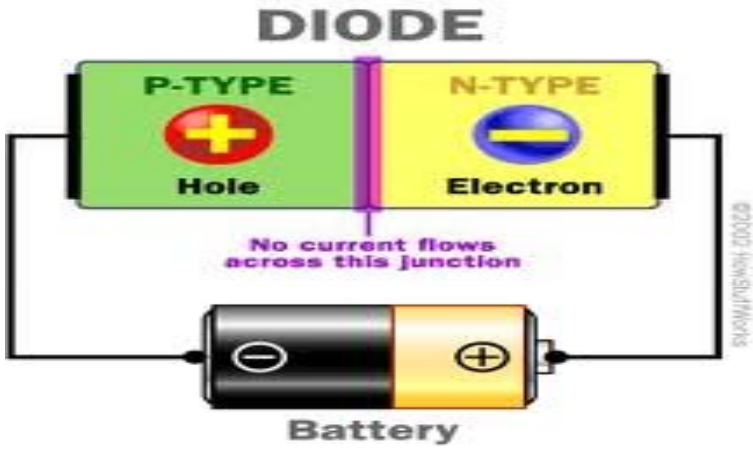
  Frequency range (6-12 GHz)
  Back end: 10dB Attenuator
  Voltage Output: 1 to 10mV

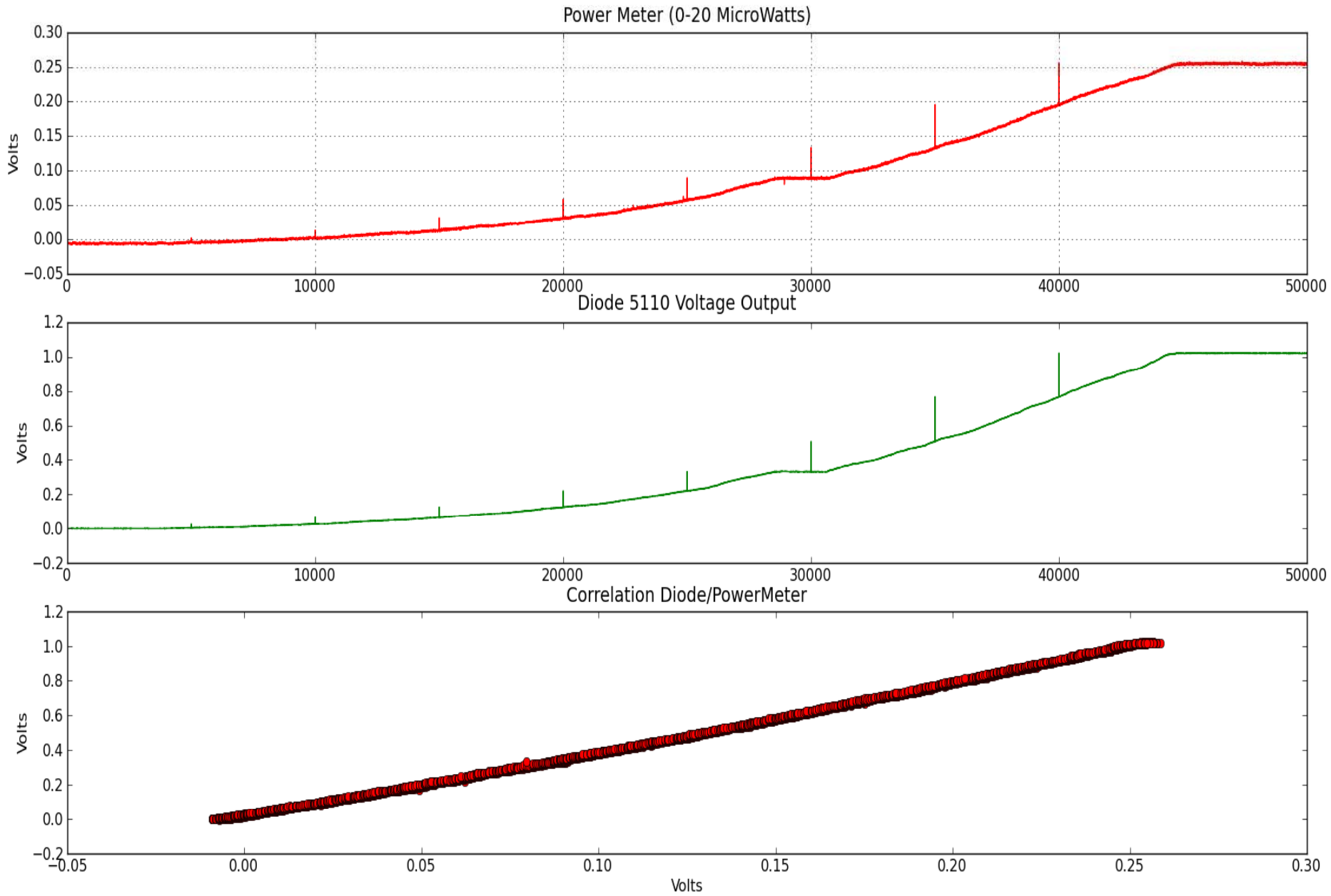
Ideal Diode Test

* Power Input: 40 µW

*Voltage Output in circuit: 15mV

* Gain: 93x average, No gain on DC output




Power Meter (0-20 MicroWatts)
Volts
0.30
0.25
0.20
0.15
0.10
0.05
0.00
−0.05
0
10000
20000
30000
40000
50000
Diode 5110 Voltage Output
Volts
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
0
10000
20000
30000
40000
50000
Correlation Diode/PowerMeter
Volts
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.05
0.00
0.05
0.10
0.15
0.20
0.25
0.30
Volts