Detector characterisation for investigations of micro-bunch instabilities at Diamond Light Source.

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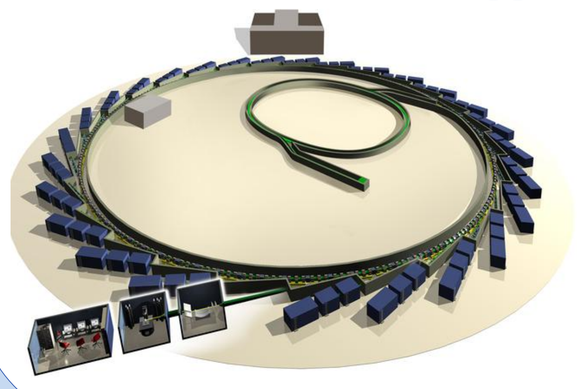
1. Abstract

Micro-bunch instabilities (MBI) result in additional bursts of coherent synchrotron radiation (CSR) in the millimetre range [1]. They are observed when the bunch current exceeds a threshold. The driving force behind MBI are unknown. In order to investigate this instability, a single shot spectrometer is to be developed. Three detector varieties have been chosen as potential candidates for the spectrometer. The detectors will be quantified against one detector, the 'gold standard', to aid in the decision process and for general evaluation.

2. Diamond Light Source (DLS)

DLS is based at Harwell Campus in Oxfordshire. It is a third generation light source, producing light at wavelengths of x-ray to far infrared. There are currently 26 operational beamlines. These beamlines are created via undulators, wigglers, or dipoles. The port specific to the investigation of mm emissions was installed after bending magnet B06 and it will house the spectrometer.



Energy	3 GeV
Circumference	561.6 m
Emittance (h)	2.47 nm rad
Beam Current	300 mA

4. RF Source

- Ka band emitter
- 26.05 – 40 GHz
- Voltage controlled oscillator (Gunn diode)
- Frequency & attenuation controlled via BNC contacts or dials.

4. Set Up

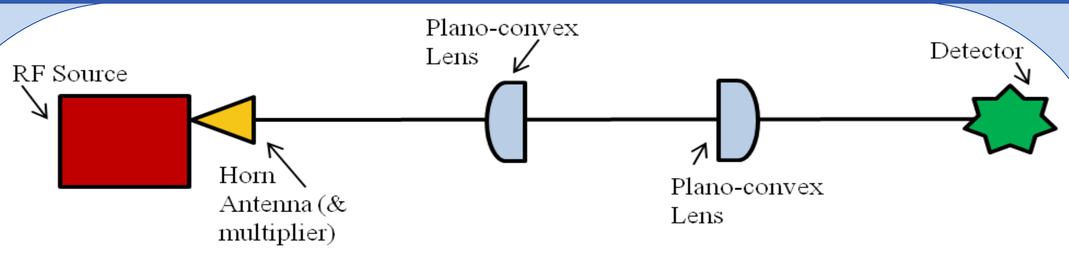


Fig 1 (above): Schematic of the Set Up.

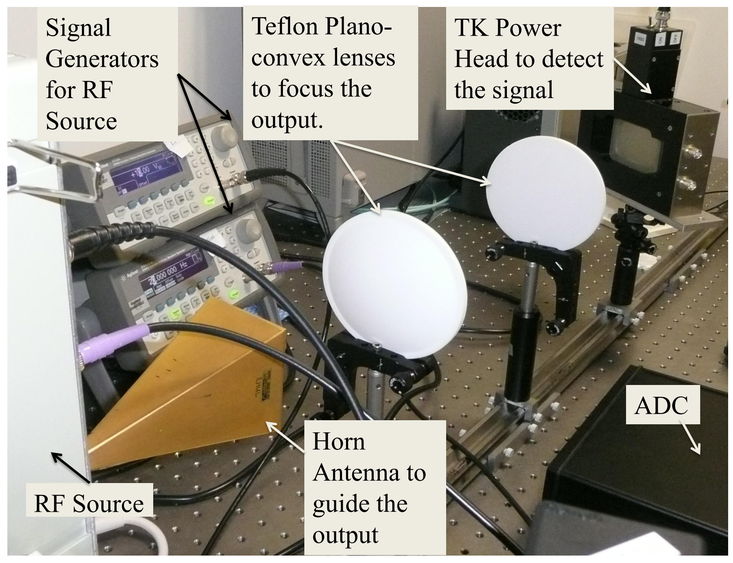


Fig 2 (right): Photo of the Set Up.

Fig 3 (below): Front panel of the RF source.

5. Chosen Detectors

Pyroelectric detectors are thermal detectors. They operate at room temperature and over a wide spectral range.

Golay cells are opto-acoustic thermal detectors. They are slower yet higher responsivity than pyroelectric detectors.

Schottky diodes have metal-semiconductor junctions. They are ultra-fast switching with low noise and high responsivity [2].

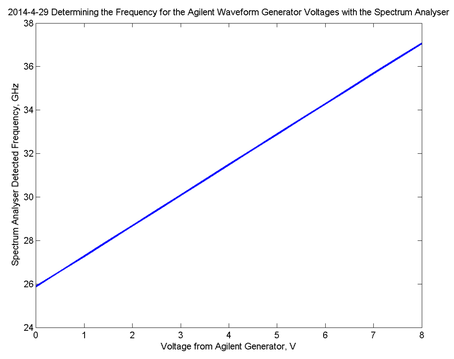
6. Method for Quantification

RF Source
- Evaluating frequency output
- Determining effect of attenuation
- Stability of frequency output
- Orientation & Brewster's angle
- Power output of fundamental & with multipliers

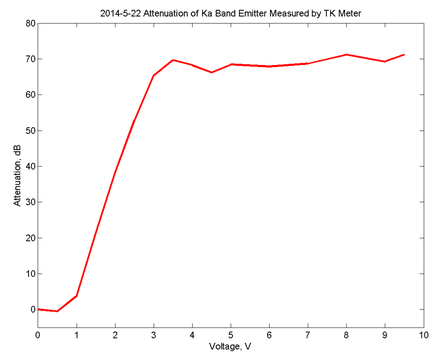
Detectors
- Calibration of power meter - the 'gold standard'
- Sensitivity of each detector
- Comparison between all the detectors in regards to sensitivity, response times and frequency ranges.

7. Results

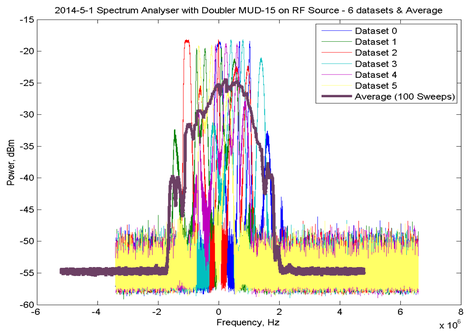
Frequency Determination



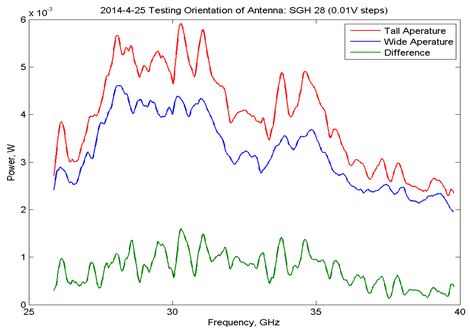
Attenuation Determination



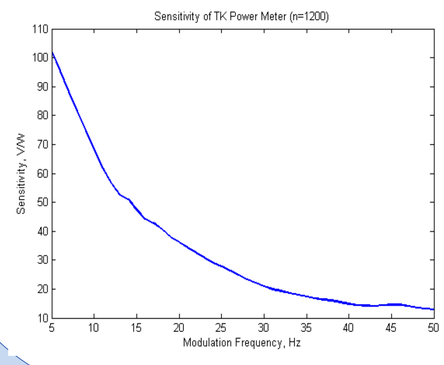
Stability of Frequency



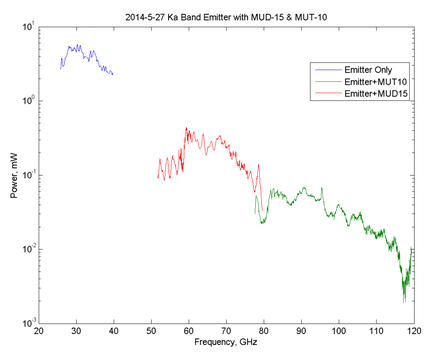
Orientation & Brewster



Sensitivity or NEP



Power Output with Multipliers



8. Summary & Further Work

- The source has been investigated.
- Amplifiers are to be introduced.
- Compilation of one complete MATLAB code.
- The detectors can now begin quantification.

References:
[1] Shields, W., Bartolini, R., et al., 2012, J. Phys. Conf Ser. 357 012037.
[2] Smith, R., Dorf, R., 1992, Circuits, Devices & Systems, Wiley Inc.