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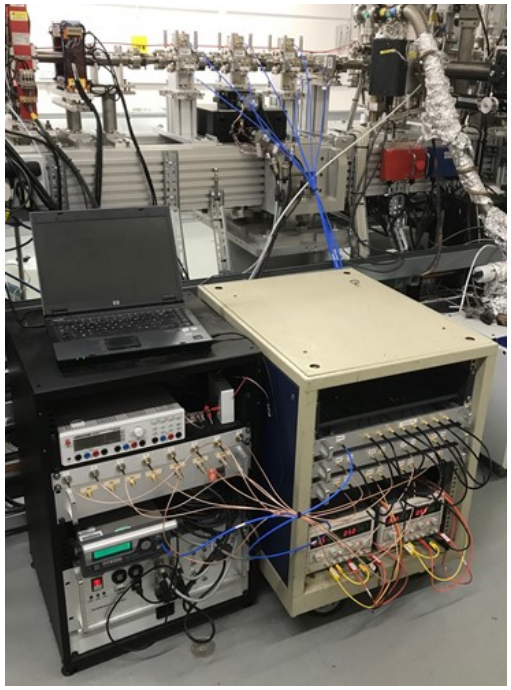
How advanced is this project?

The beam testing of a 3 cavity system is currently ongoing on the VELA Beamline at STFC Daresbury Laboratory in the UK. It will conclude with resolution and range measurements at the end of 2019. However, hardware is already available.

FMB Oxford can provide:

- 6.5GHz cavities with a customized aperture up to 20mm internal diameter
- Front End and Intermediate Frequency Electronics to convert 6.5GHz signals to 30MHz (typical) for use with a customer's preferred DAC option
- EPICS based digital processing algorithms via partners at Royal Holloway, University of London
- Integrated analogue and DAQ electronics with EPICS, Tango and Web interfaces via partners at Instrumentation Technologies
- Suitable Movers and Support Structures



A 3 cavity BPM installation at Daresbury Laboratory, UK

FMB Oxford

New from FMB Oxford Ltd

Cavity Beam Position Monitors—Design led high levels of accuracy enable repeatability of performance to be obtained with a standard build process

Currently in extensive testing and evaluation at STFC Daresbury, UK

This work was undertaken through the provision of a Science and Technologies Facilities (STFC) Industialisation Grant ST/L00013X/1. FMB Oxford Ltd would like to recognize and acknowledge the support provided by Royal Holloway, University of London and STFC Daresbury in the realization of this product.

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Cavity BPM v.1. April 2019

FMB Oxford

Cavity Beam Position Monitors

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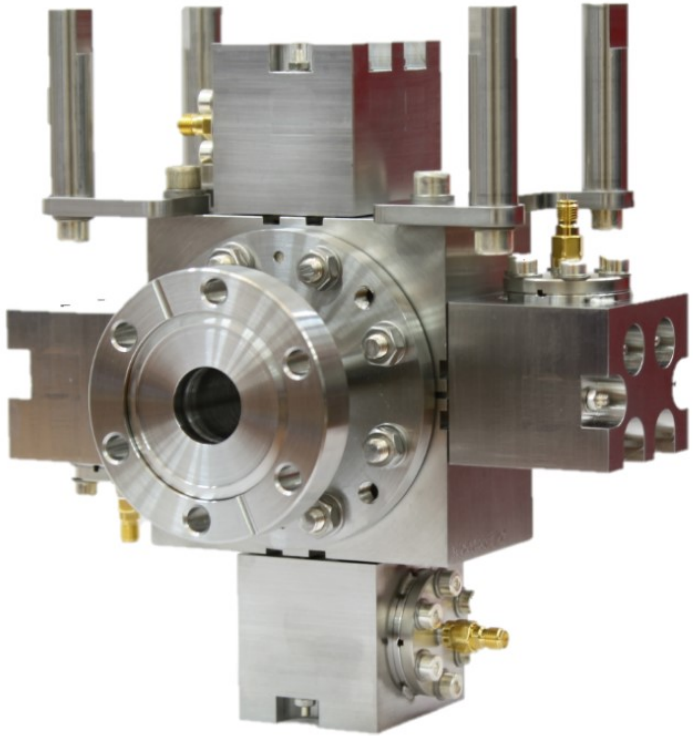

Engineering Science for a Brighter Tomorrow

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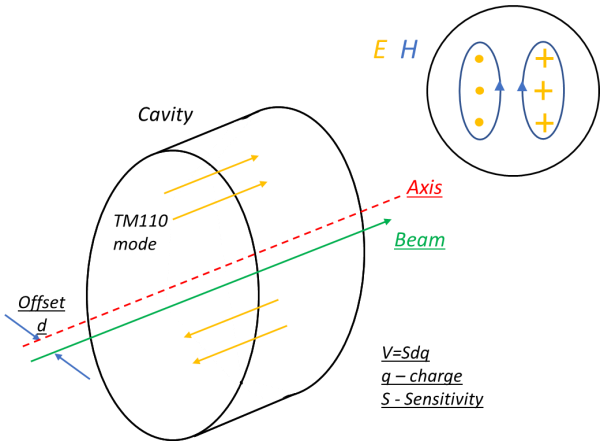


What are Cavity BPMs?

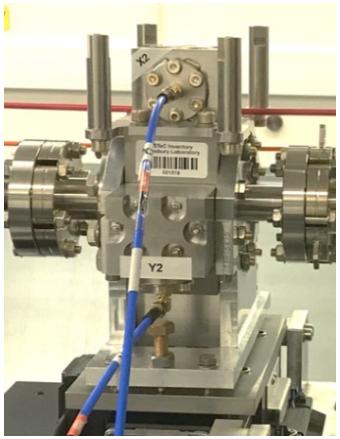
Microwave cavities may not only be used for accelerating charged particle beams but also for sensing their arrival time, charge and position. Cavity BPMs use position dependent dipole modes to achieve nanometer level position resolution.

Signals produced by Cavity BPMs are high frequency oscillations decaying exponentially. The offset dependency is predominantly linear over most of the aperture. However, as the frequency is often too high for direct digitisation frequency downconversion is used as a common processing technique. In addition to the Position Cavities a Reference Cavity is used to detect the charge and arrival times for normalization.

Cavity BPMs have become a useful tool in FELs due to their high sensitivity which allows high resolution measurements to be realised even at low bunch charge which is often a side effect of trying to achieve extremely short bunches.

Nominal Specifications

Bunch charge	**10..100pC**
Operating frequency	**6474MHz**
Cavity decay time	**30ns**
Positional sensitivity	**1mv/mm/pC**
Longitudinal dimension	**typ 100mm**



A position cavity installed at STFC Daresbury

We would be very interested in hearing about your potential applications. Please drop by for a chat or contact us!

Customization

There is no 'good for all' Cavity BPM and as such customization is required. Our main design operates at 6.5GHz with an aperture of 20mm. The aperture can be reduced to fit smaller beamlines such as undulator sections. Additionally, higher (X band) and lower (S-band) frequency versions are in planning so please ask!

Mechanical Design

Our sensors are made of stainless steel in order to minimize degradation over time. UHV compatible vacuum sealing technology and ceramic microwave feedthroughs are also employed which allow our sensors to be repaired if they are damaged.

A prototype reference cavity during assembly

Electronics and Digital Processing

Analog electronics have been designed to optimally process Cavity BPM signals. The front end (high frequency) should be located close to the sensor cavities but the intermediate frequency (IF) electronics can be located further away (for instance in a rack room). The IF electronics can compensate for cable losses in addition to conditioning the signals for digitization.

The Demonstrator system was developed using consumer grade DAQ boards, as such almost any Digitizer that meets the minimum specification—14bit, 125MS/s, 50MHz analog bandwidth—will be suitable. Hence allowing Users a wide range of freedom of selection.

Digital processing algorithms provided by Royal Holloway, University of London have been successfully employed in various systems including the Cavity BPM system at ATF2 (KEK, Japan) where up to 40BPMs have been routinely processed since 2010. The package developed for EPICS includes example scripts for calibration and visualization.

Integrated solutions combining analog and digital electronics are also available from commercial companies such as Instrumentation Technologies.