

Design low  $Q$  radio frequency (RF) cavity beam position monitor (BPM) for CLIC main linac.

Progress overview

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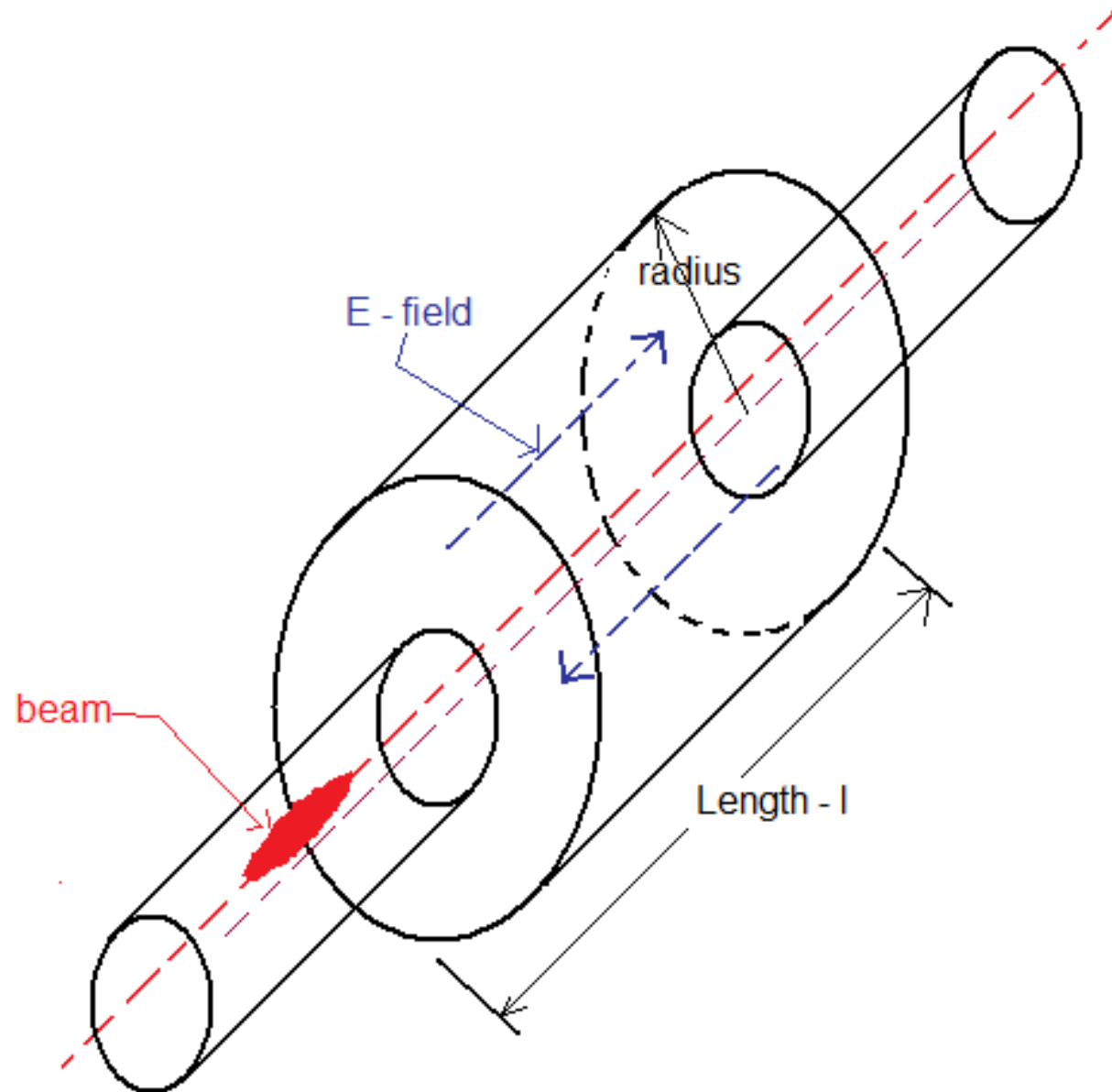
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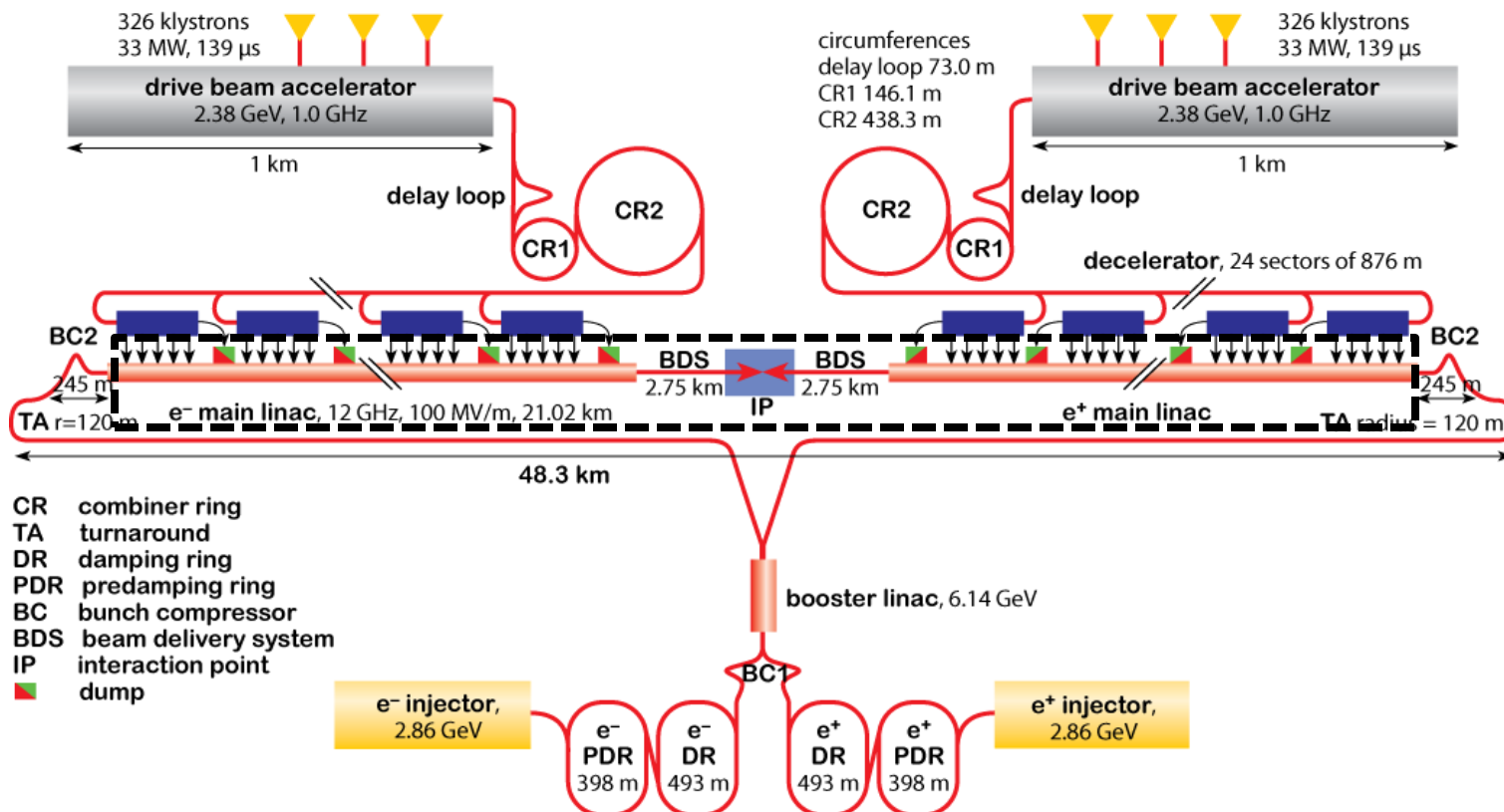
<sup>3</sup> DIAMOND, RAL.



# What is RF cavity BPM ?



# CLIC parameters and BPM requirements



## Linac Parameter

Overall two linac length	48.4 km
Centre of mass energy	3 TeV
Beam power	14 MW
$I_{pulse}$	1.5 A
Number of bunches / pulse	312
Bunch separation	0.5 ns

## BPM requirements

Resolution	50 nm
Accuracy	5 μm
Drift tube diameter	8 mm
Number of BPM required	~ 4776

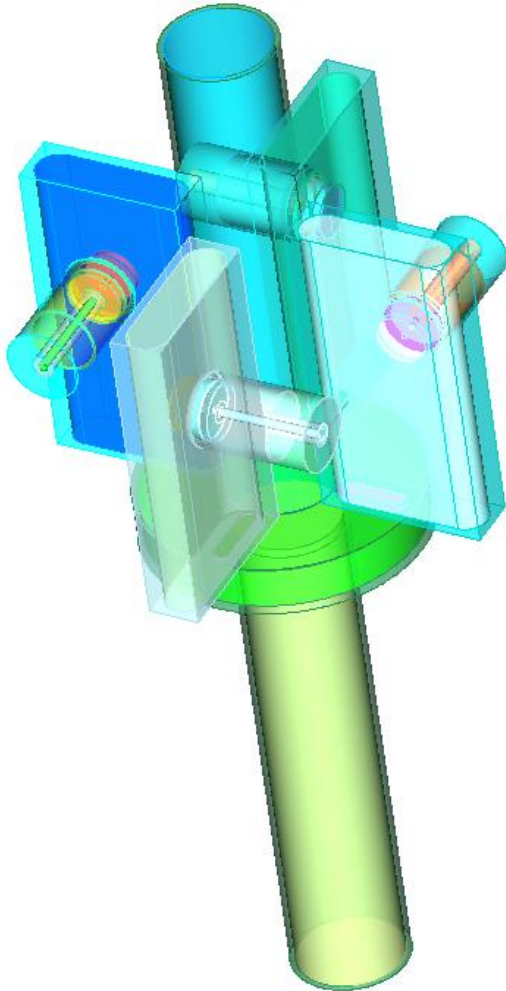
# BPM Project

- ❑ RF design and hardware (DIAMOND cavity BPM project)
  - ❑ RF Cavity and coupler design
    - Monopole suppression.
    - Dipole mode extraction.
  - ❑ RF electronics
    - Signal attenuation/amplification
    - Heterodyne detection
    - Noise reduction
  - ❑ Engineering and Fabrication
    - Vacuum compatibility
    - Heat dissipation
  
- ❑ System testing (DIAMOND)
  - RF parameters and vacuum testing.
  
- ❑ Data analysis and System calibration (Cavity BPM system as ATF)
  - Calibration techniques
  - Noise removal
  - Signal overlapping
  - Digital down conversion
  - Filtering and amplitude measurement
  
- ❑ As CLIC is scheduled to be operational 20 years, hence all fundamental techniques should be studied at machine which are in operation.

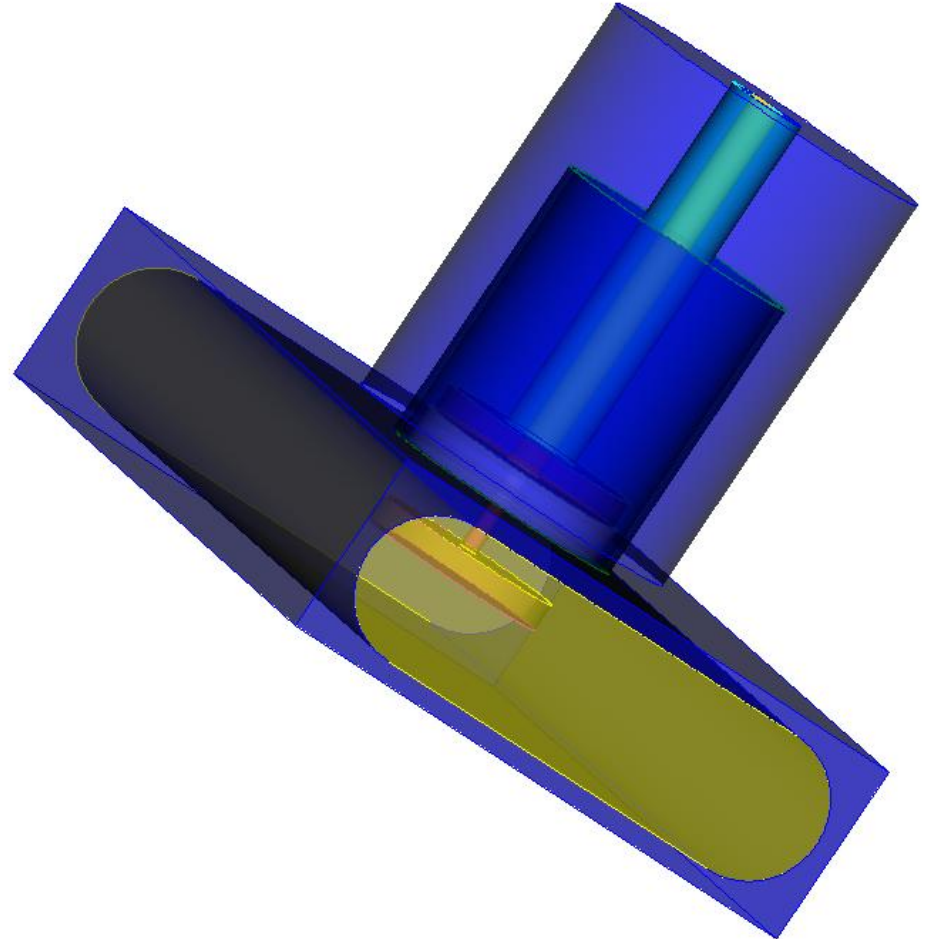
# RF design and hardware

- ❑ BPM development project at DIAMOND.

BPM cavity with beam pipe and coupler with feed-through

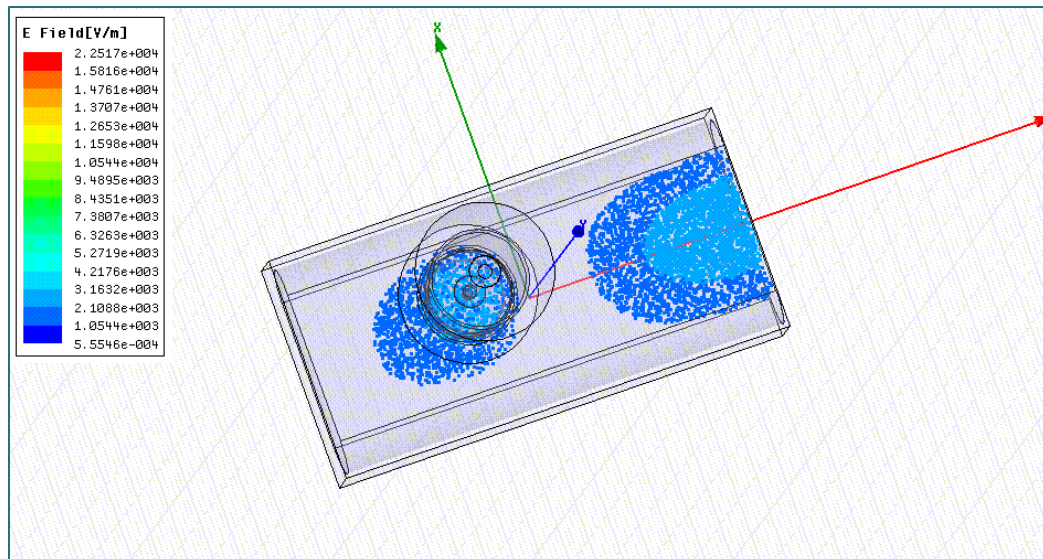
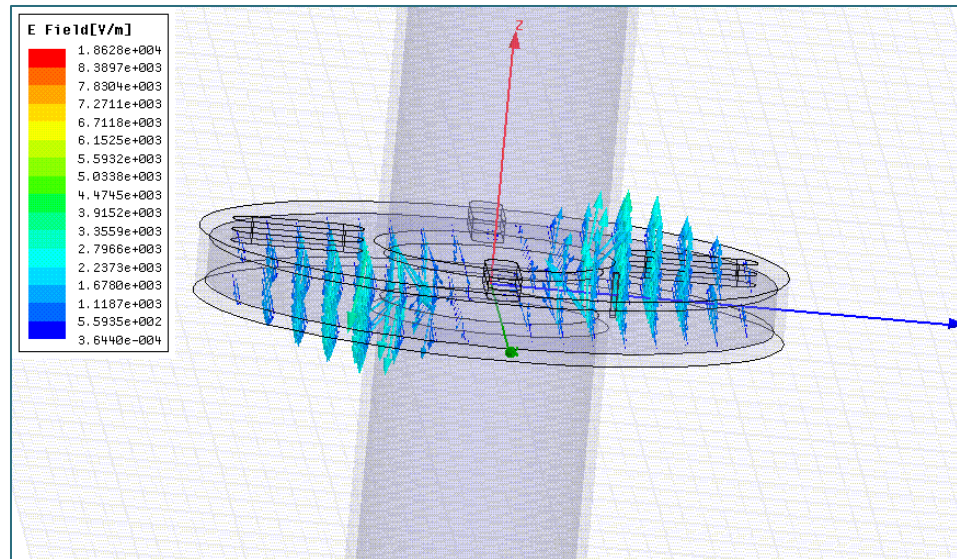


Waveguide coupler with feed-through



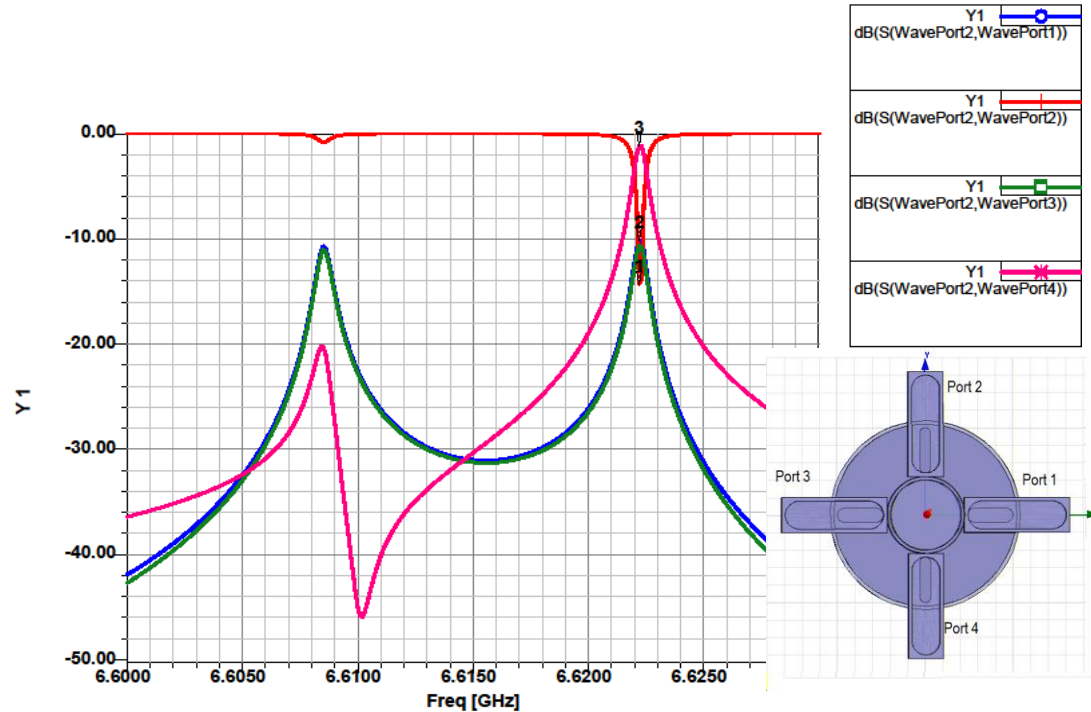
# RF design and hardware

## Electric fields inside BPM cavity and coaxial coupler



# RF design and hardware

## S-parameters of BPM (PEC model without coaxial feed through)

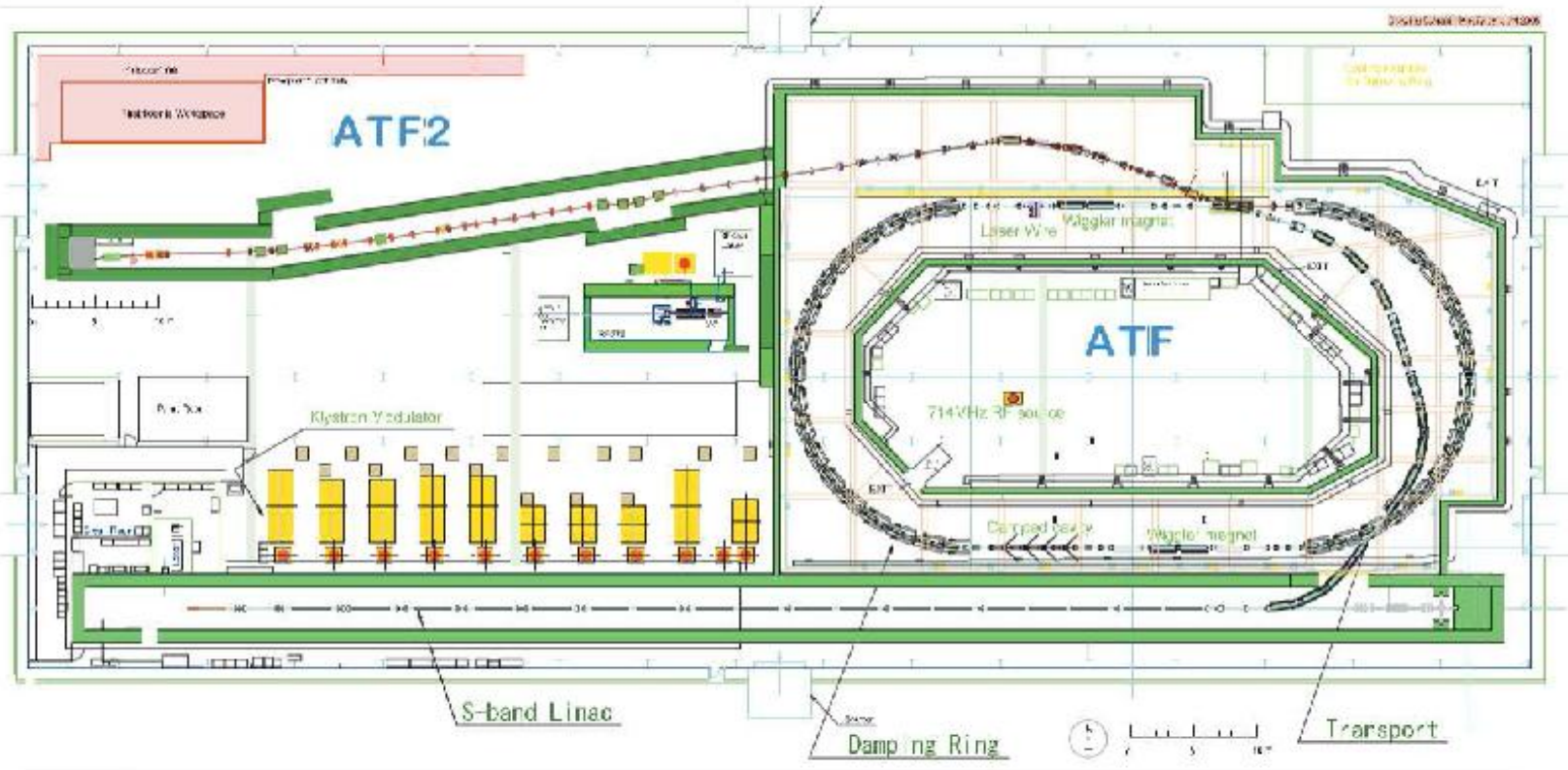


### DIAMOND BPM parameters

Monopole frequency	4.5 GHz
Monopole suppression	-55 dB
Dipole frequency	6.5 GHz
Frequency separation between X and Y position data	8 MHz
Signal attenuation at feed through output	7.5 dB
X and Y plane isolation	8 dB

# Data analysis and System calibration

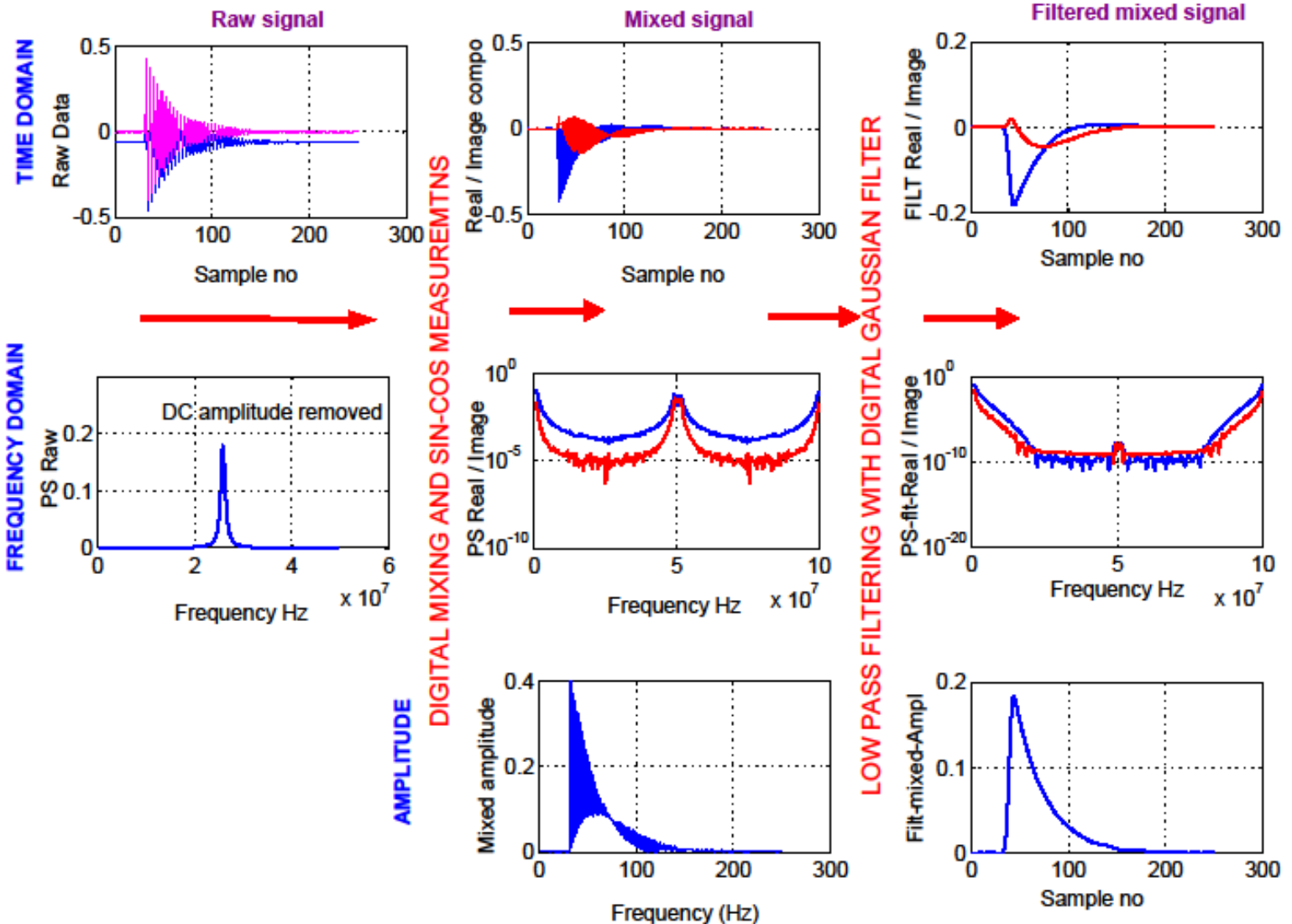
- ATF machine layout
  - 35 BPM at various places on ATF2 linac.
  - Bunch separation  $\sim 1\mu\text{s}$ .





# Data analysis and System calibration

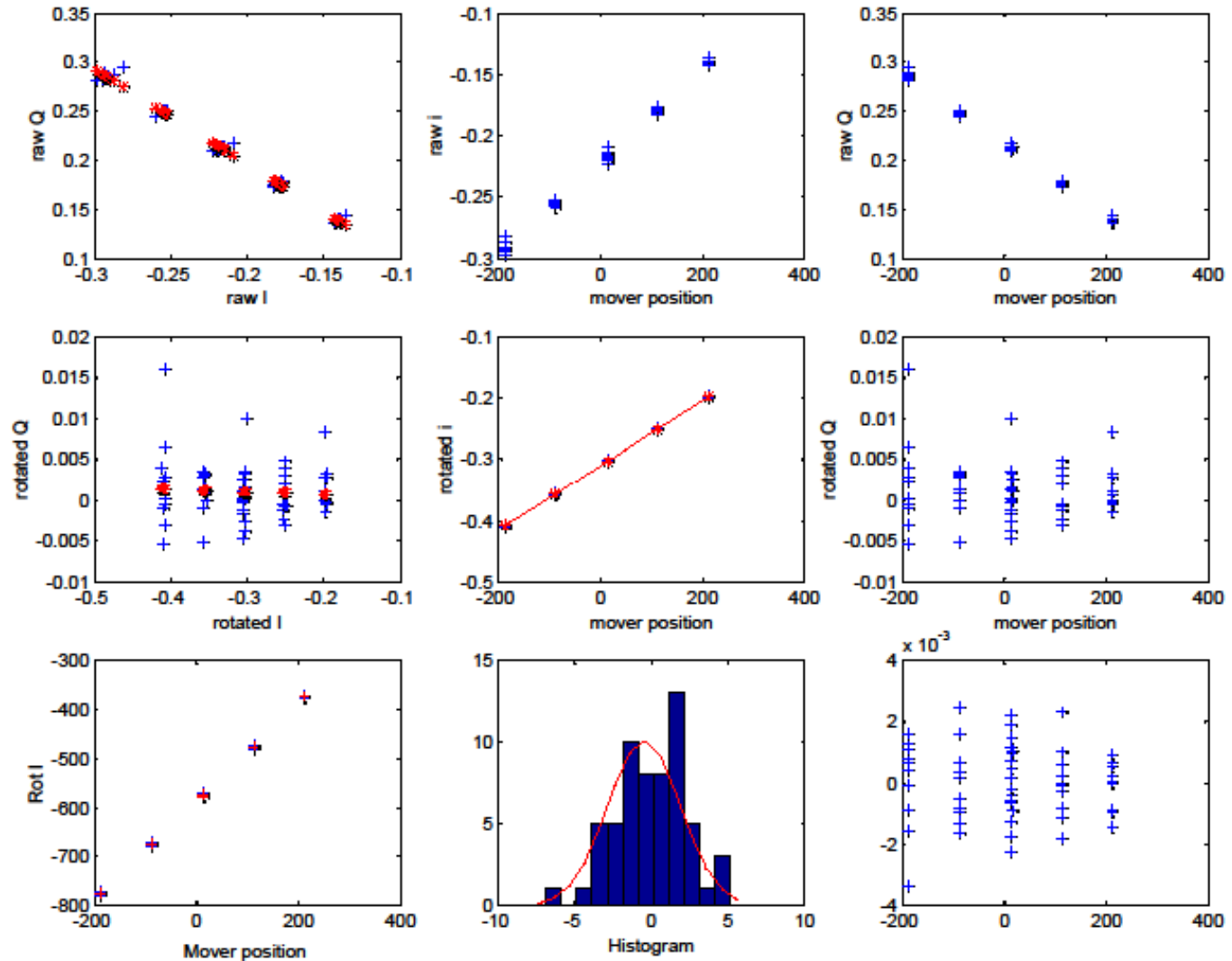
Signal analysis and amplitude determination.



# Data analysis and System calibration

## System calibration

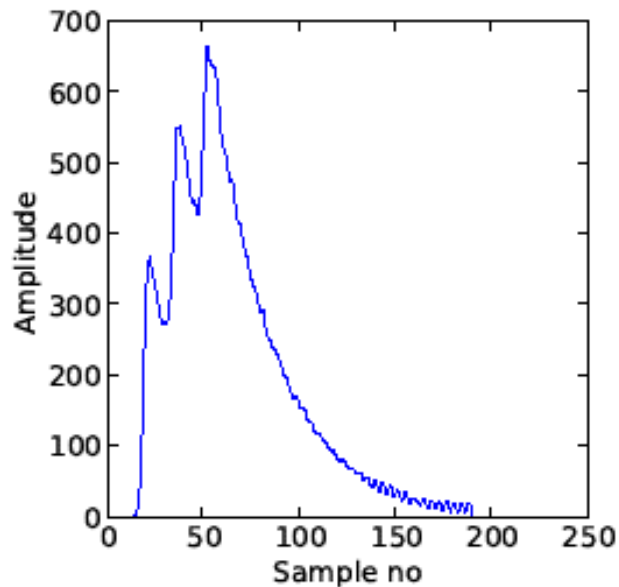
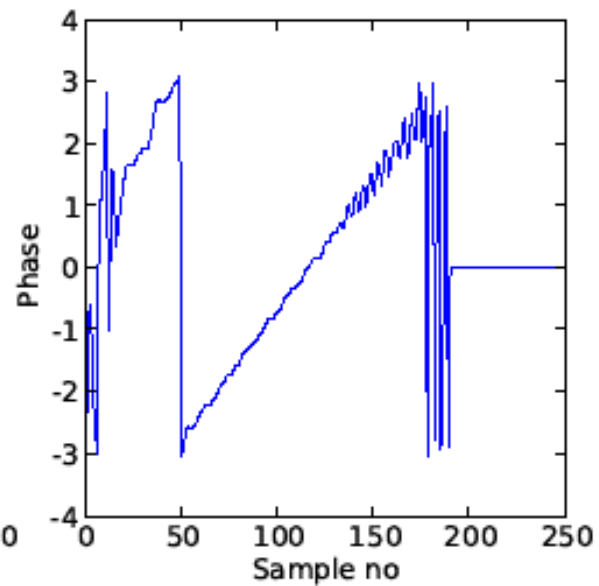
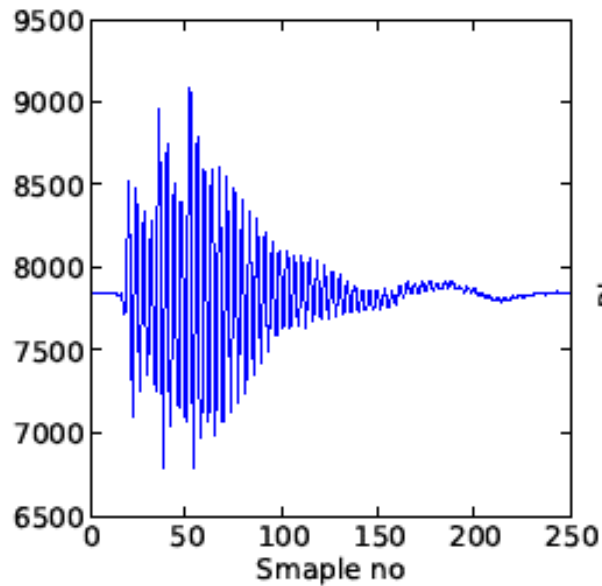
□ BPM system resolution  $\sim 5 \mu\text{m}$ .



# Data analysis and System calibration



## Multi-bunch data at ATF.



# Conclusions

- ❑ RF design and hardware (DIAMOND cavity BPM project)
  - ✓ RF cavity design is been completed and is in engineering realisation & fabrication stage. Participating in this project gave me extensive on hand experience on RF cavity BPM system fundamentals
  - ✓ Electronics development is also undergoing as well.
  
- ❑ System testing (DIAMOND)
  - ✓ Will be performed for DIAMOND RF cavities in upcoming few months.
  
- ❑ Data analysis and System calibration (Cavity BPM system as ATF)
  - ✓ A code is developed to get RF cavity data from ATF BPM system.
  - ✓ Similar code to perform system calibration.
  - ✓ Multi-bunch data with signal overlapping is under examination and expected to complete in one month.
  
- ❑ Future plan
  - ❑ CLIC main linac Q cavity design fabrication, possibly testing at CTF3.

With these experience in various areas of BPM project, recently we have started working for our project as the signed MOU.