LINAC4 Beam Diagnostics Overview

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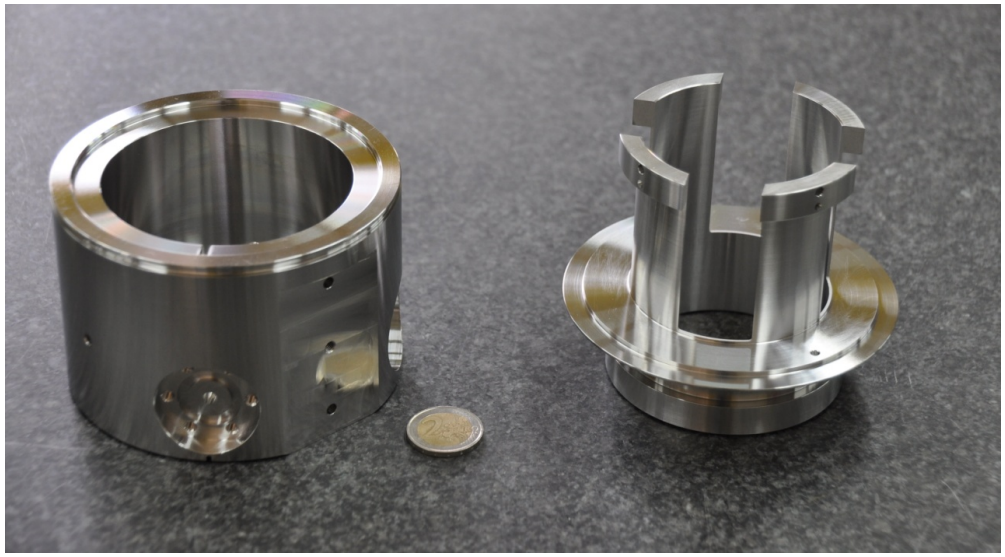
FETS-LINAC4 beam comparison

- LINAC4 (160 MeV):
  - Replacement for LINAC2 (50 MeV)
  - New injector for the proton synchrotron booster
  - Double the brightness of LINAC2

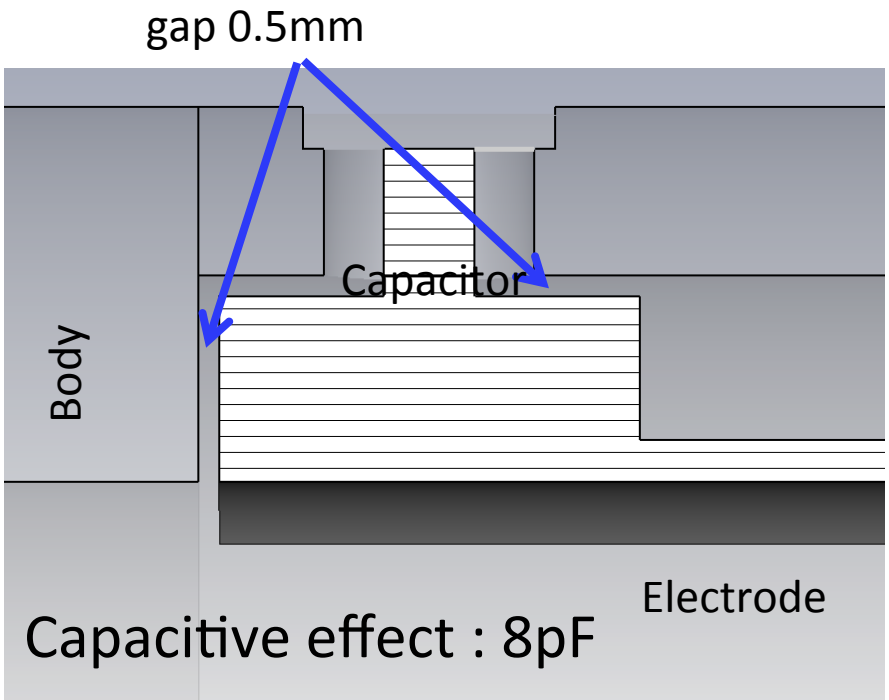
	FETS	LINAC4
Particle type	H-	H-
Bunch frequency	324 MHz	352 MHz
Bunch length	0.25-0.5 ns	0.2-0.6 ns

Shorted Stripline design (3MeV Test Bench)



Beam aperture: 67 mm
Electrode length: 60 mm
Stainless steel body
45° angle

- Fully simulated in CST
- Three currently constructed with a prototype already tested.
- Hor./Vert. resolution ~ 3µm

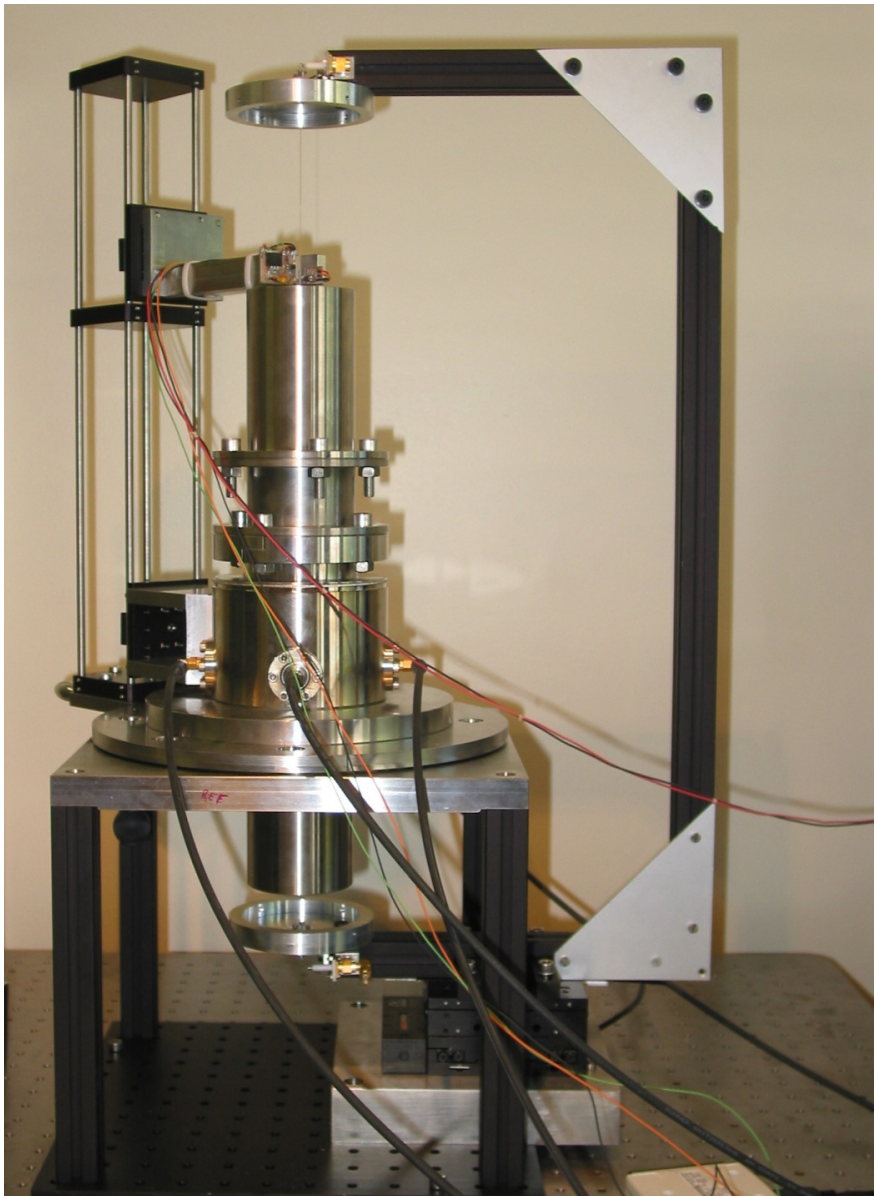


Capacitive effect : 8pF

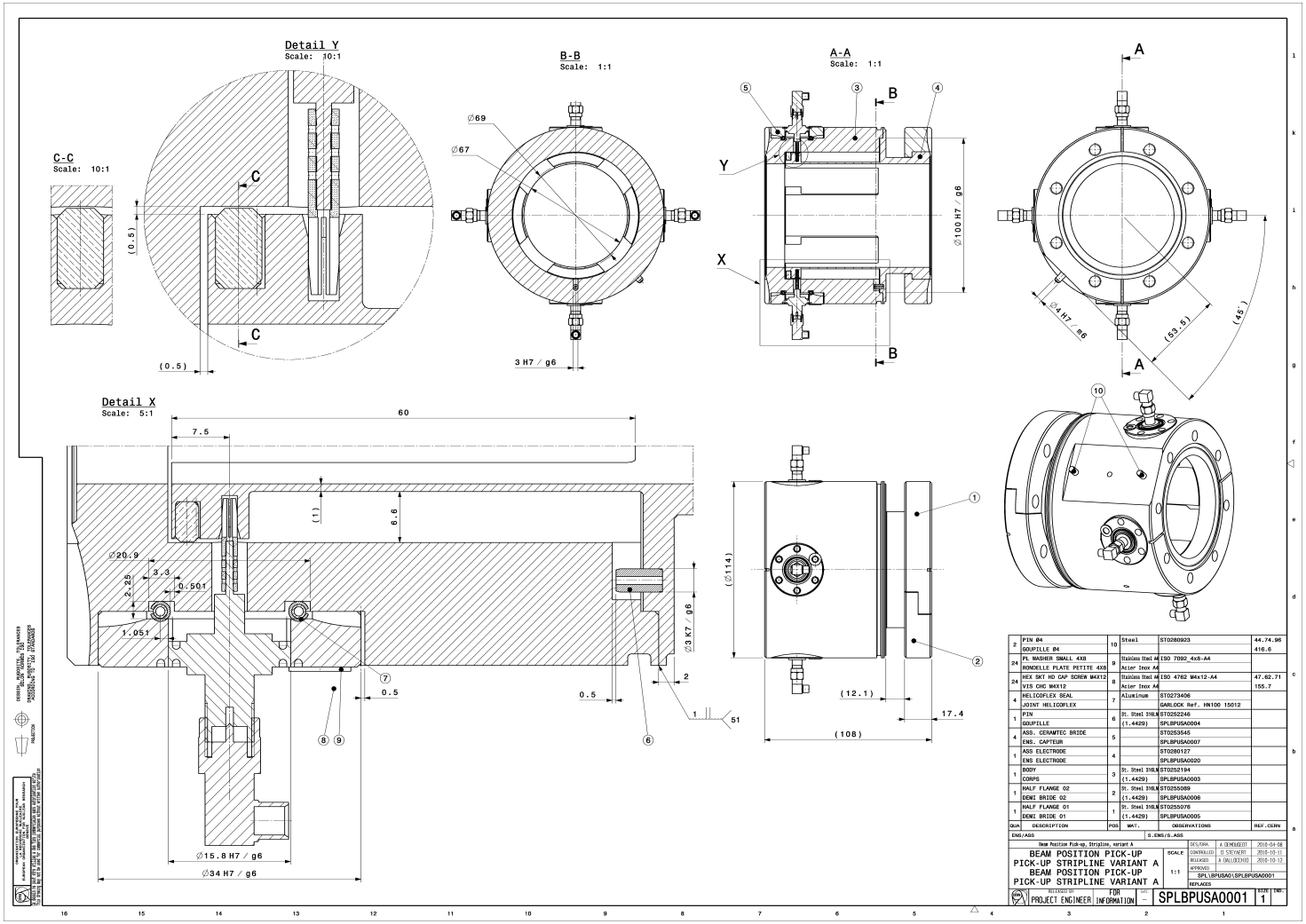
BPM test bench

- Wire technique with stationary waves
- Optical sensor for mechanical centering to within ±0.01mm
- 352MHz sine wave
- Data acquired in steps of 0.2mm

Possibility to get ask LINAC4 beam diagnostics to test both their shorted stripline and a prototype NTG button design with a 324MHz sine wave?

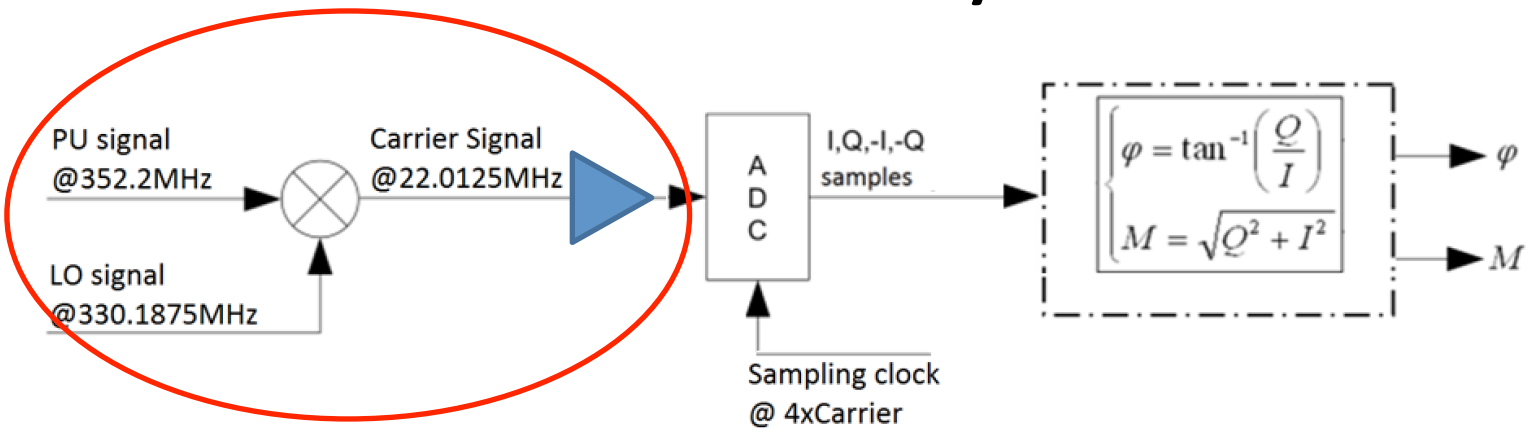


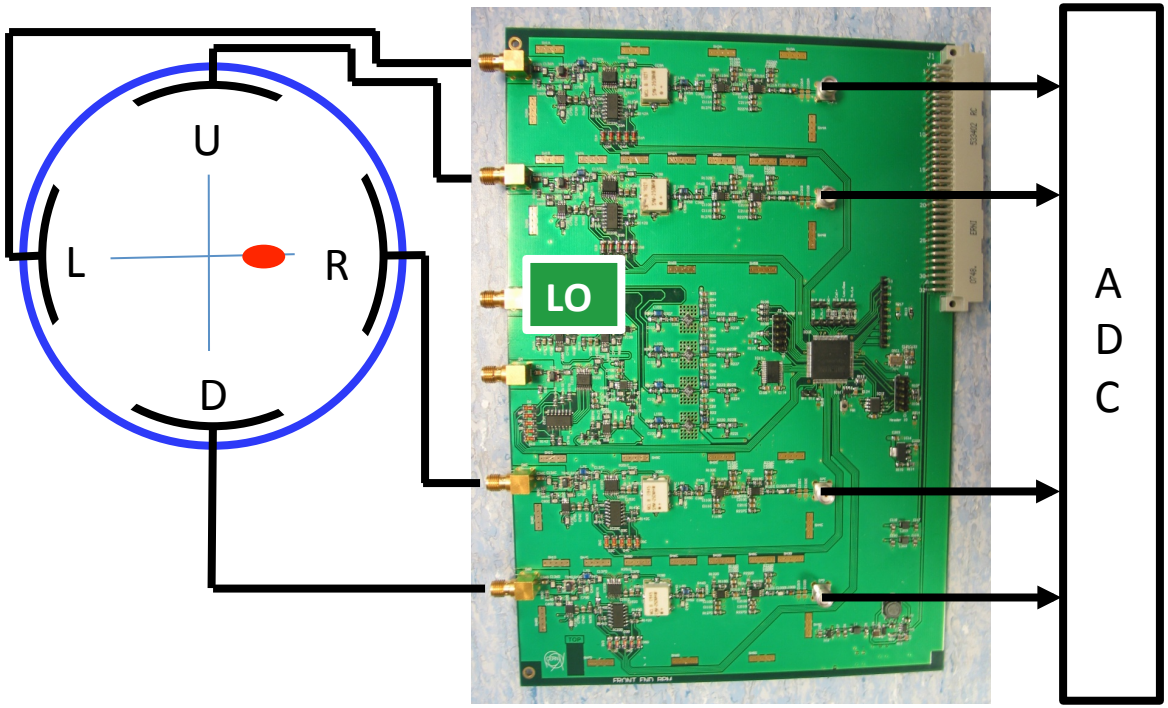
CAD drawings



- Extensive CAD drawings were shared - J. Tan and R. Jones are happy for us to borrow and test a pre-built BPM once the collaboration agreement is signed.

Electronics layout





PROCESS:

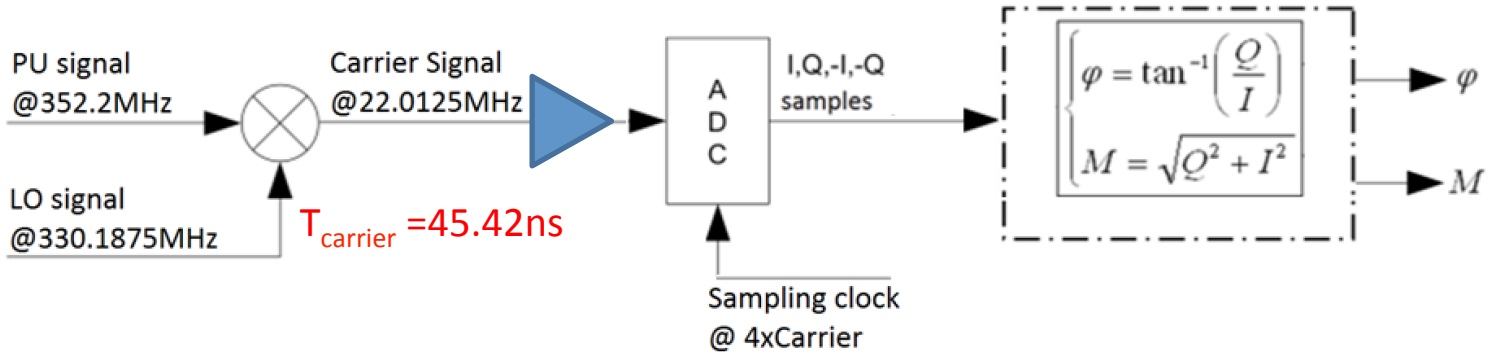
Low pass filtering@1GHz (artifact of the cabling)

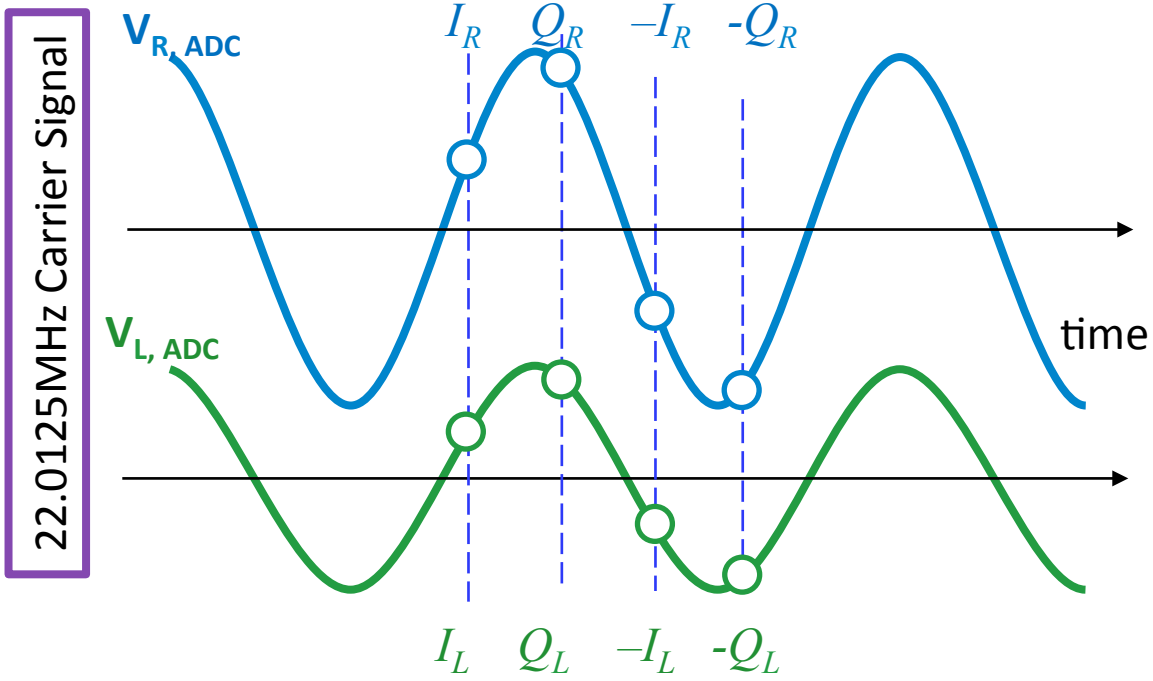
Down-mixing to 22 MHz IF

IQ sample signal at 4xIF

Δ/Σ performed on all channels

Signal processing scheme





$$\Delta x = \frac{M_R - M_L}{M_R + M_L + M_U + M_D}$$

$$\varphi = \varphi_{beam} - \varphi_{LO}$$

$$I = M_R + M_L + M_U + M_D$$

$$TOF = \varphi_{PU2} - \varphi_{PU1}$$

Analog Board characteristics

	Measurements
Gain	-0.8 dB to 30 dB
Dynamic range	±2.68 V
Input thermal noise	122.92 µV
Output thermal noise	± 3.89 mV
Crosstalk IF 17 MHz	-50.4 dBm/0.7mV
Crosstalk LO 334 MHz	-57.2 dBm/0.3mV
Central frequency	16.5 Mhz
Bandwidth	4.4 Mhz

- Broadly similar to the estimates Gary has calculated using the information given by NTG

Costing (vs. NTG)

- NTG quoted €23k (approx. £20k) for 6 button BPMs (everything up to the SMA connectors)
- Gary estimates another £17.5-20.5k for electronics and cabling (see Gary's talk)

  - Total - £40k approx.

- J. Tan estimated 30k CHF (approx. £21k) for 6 shorted stripline BPMS
- Electronics already designed, built, and tested, so approx. 4k CHF (per BPM) for the electronics, cabling, and installation

  - Total - £38k approx. (requires more rigorous costing)

Summary

- CERN shorted stripline and electronics appear a viable option for the slow BPM (as well as for the fast BPM, but only looking directly using the fast 20 GSa/s scope).
- Will the NTG buttons work as the fast BPM? Signal may be too small. Need to contact NTG.
- Benefit of LINAC4 BPM/electronics is it's already been tested and proven to work at 352MHz.
- Electronics broadly similar to Gary's design (downmixed to 10/12.5MHz rather than 22MHz).
- Similar approximate costings for both designs.
- Would like to test both the LINAC4 and NTG prototype BPMs with a 324MHz test stand. Full disclosure and co-operation dependent on the collaboration agreement.