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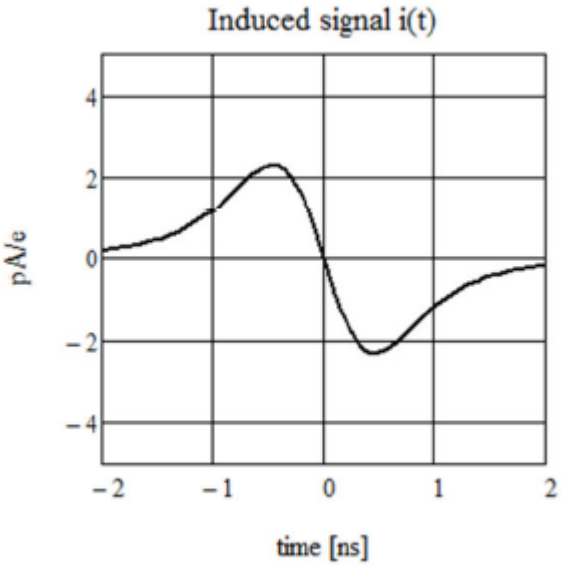
A possible BPM pickup for FETS

FETS Meeting

13th March 2013

Motivation:

As well as giving beam position information, (some of) the pickups will be used as ‘fast’ RF monitors to give (limited) info about bunch shape, charge etc.
Commercial devices such as the NTG buttons are ‘too fast’ ie the cut-off frequency is well above 324 MHz leading to a strongly differentiated signal.



Bunch shape not obvious without processing.
Bunch centre is at zero crossing
- for a bunch train there are two zero crossings per bunch.

Possible solution:

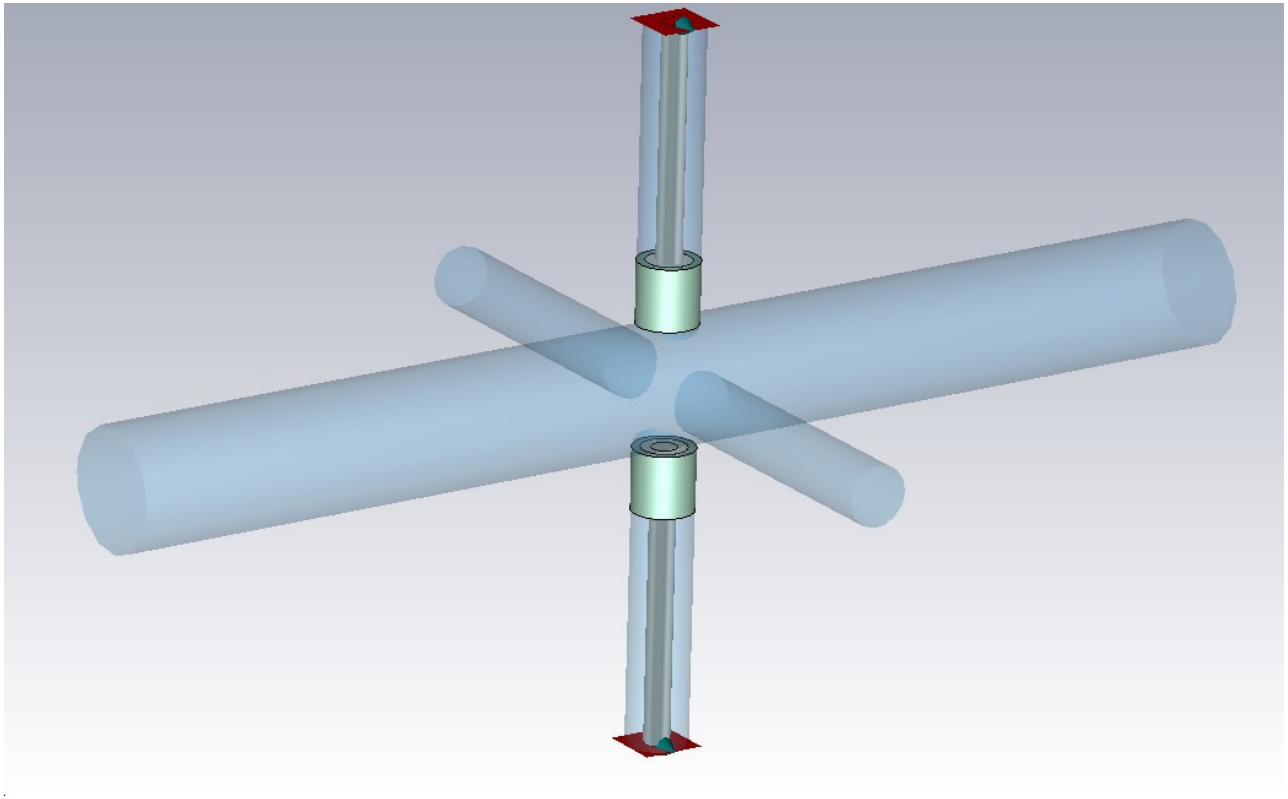
To reduce the cut-off frequency below 324 MHz means increasing the capacitance of the button.
Increasing the button size is possible but we want a compact device with reasonable resolution.
More effective is to add dielectric ie Alumina (AL_2O_3), $\varepsilon_r \approx 10$

Other constraints:

- Simple (cheap)
- Compact

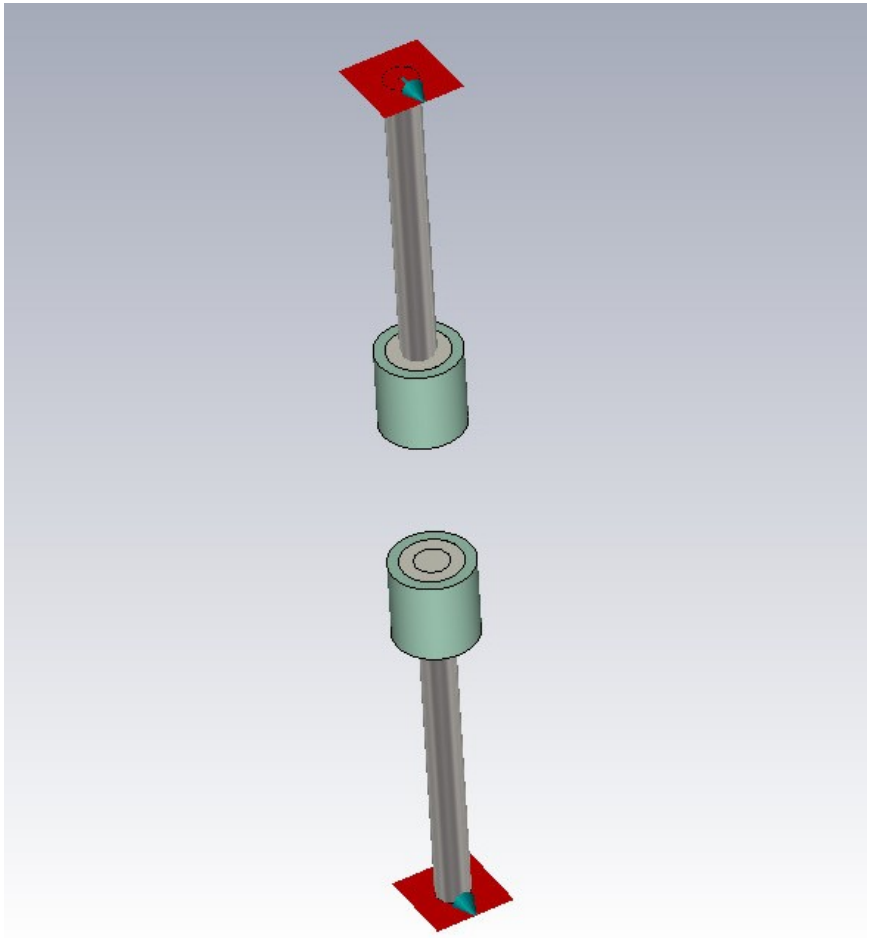
A possible solution modelled in CST.

Alumina loaded capacitive buttons with 50Ω output impedance.



Beam pipe diameter = 30 mm

Only the vertical buttons have been modelled.



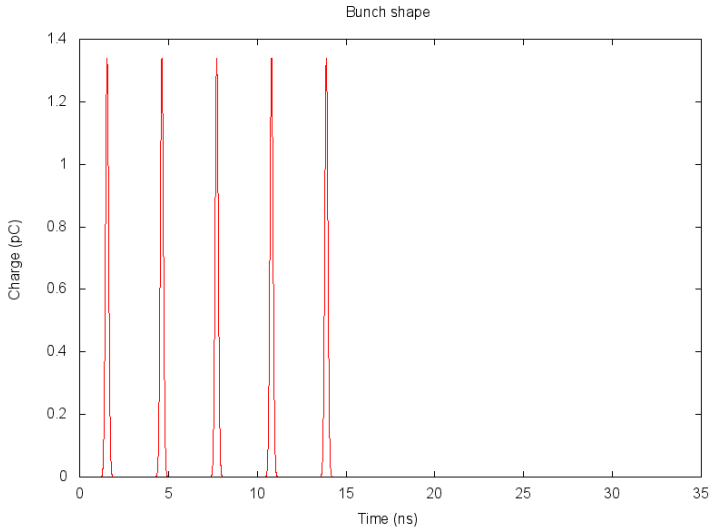
Based on commercially available Alumina tube and weldable N-type feedthrough.

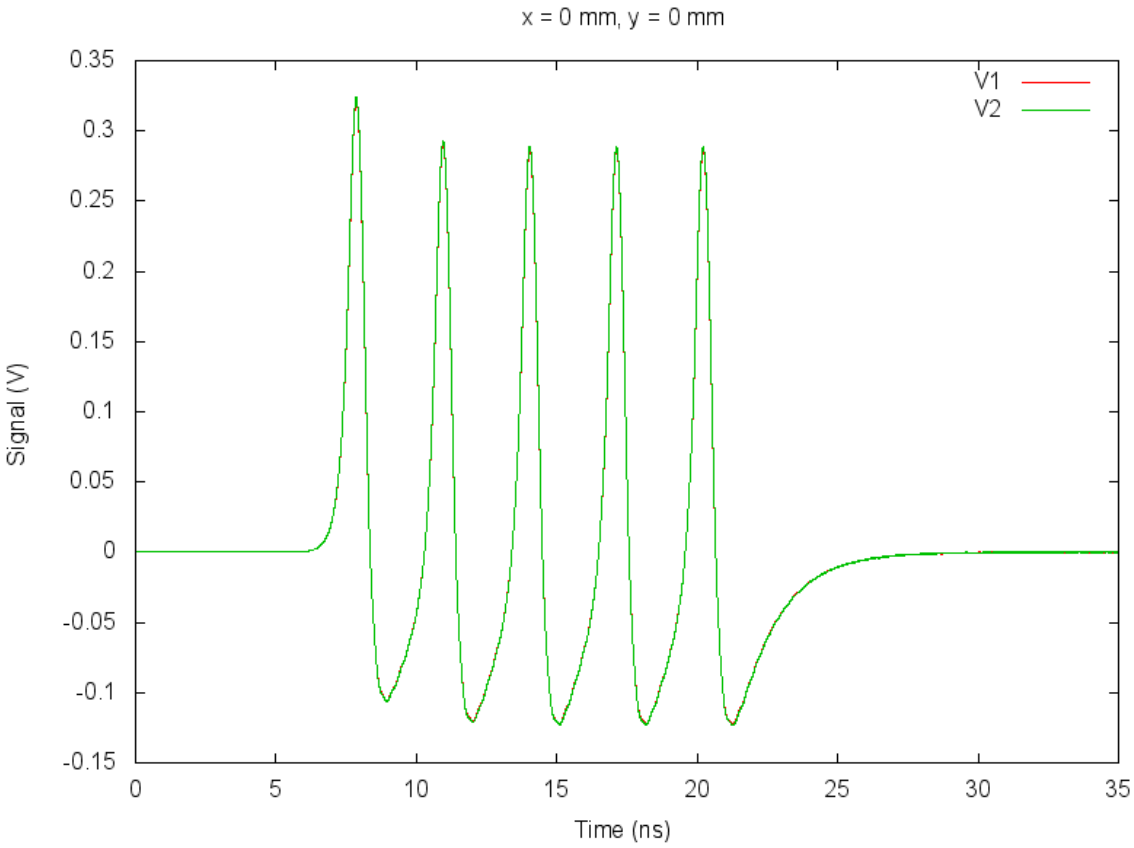
Button diameter = 11 mm
Alumina collar OD = 14.99 mm
Button length = 15 mm
C ≈ 27 pF

50Ω coaxial output

RC ≈ 1.3 ns
$(2\pi RC)^{-1}$ ≈ 120 MHz

60 mA, 3 MeV, 324 MHz proton beam with 5 bunches.
Longitudinal: gaussian, $\sigma = 10°$
Transverse: radial 3σ gaussian, $\sigma = 3$mm





Beam centred: both signals identical

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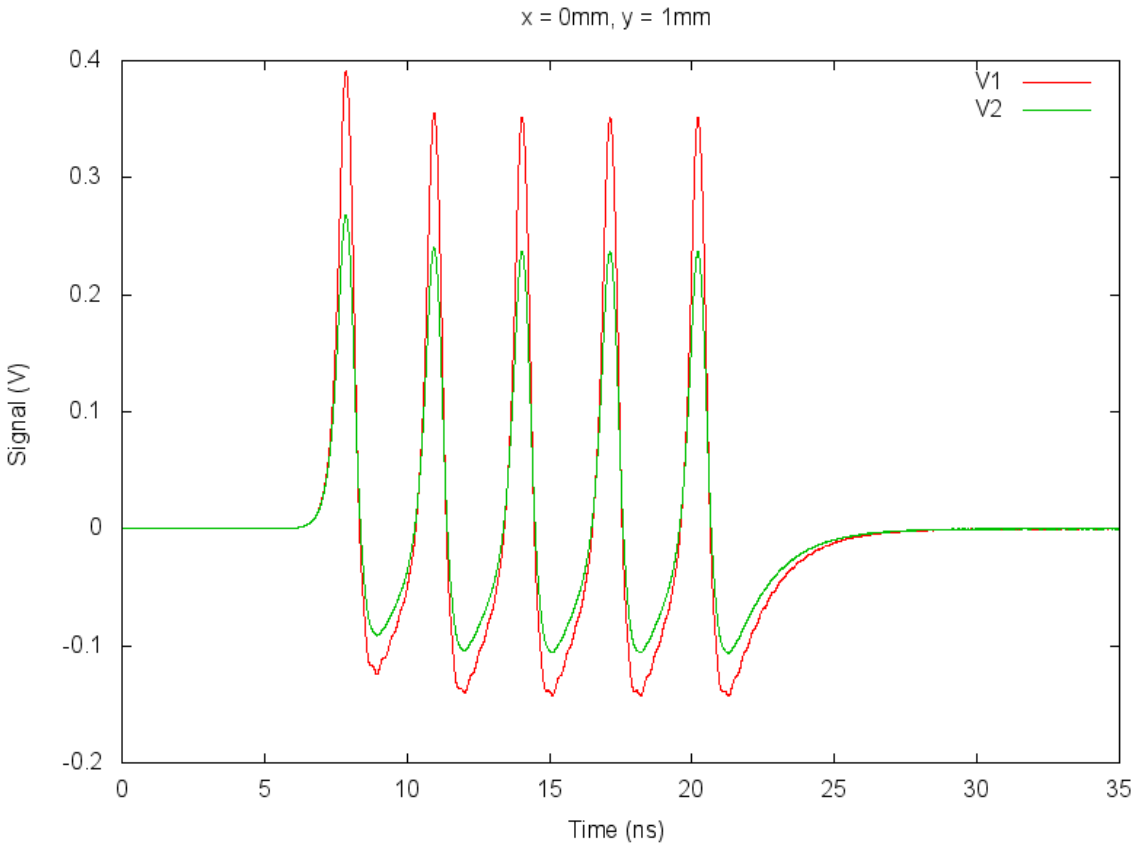
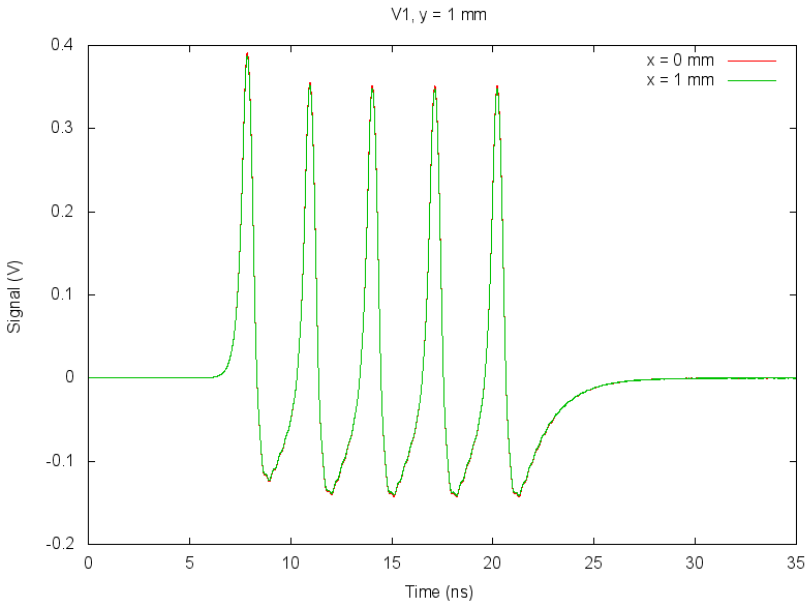
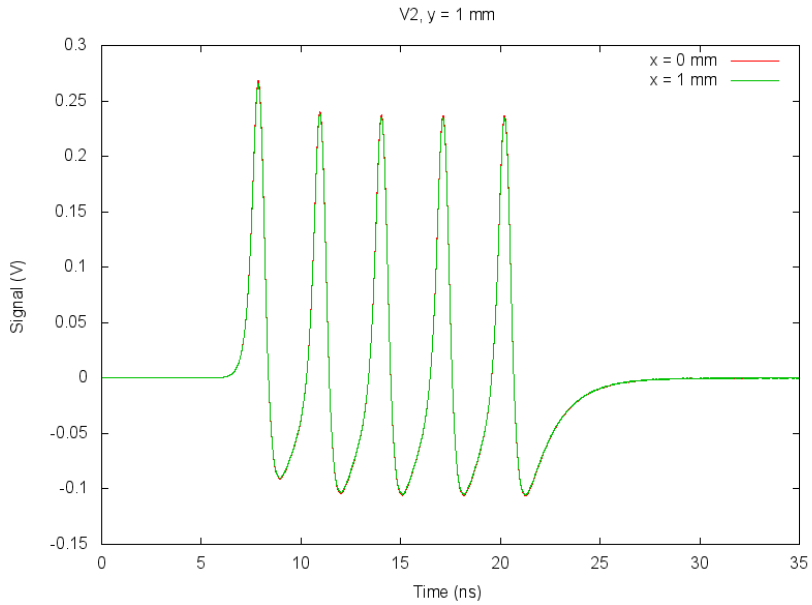
Beam offset 1mm vertically.



$\Delta V \approx 100$ mV

Beam offset 1mm vertically & 1 mm horizontally.





Horizontal offset produces <1% change in vertical signals.

Preliminary engineering design.