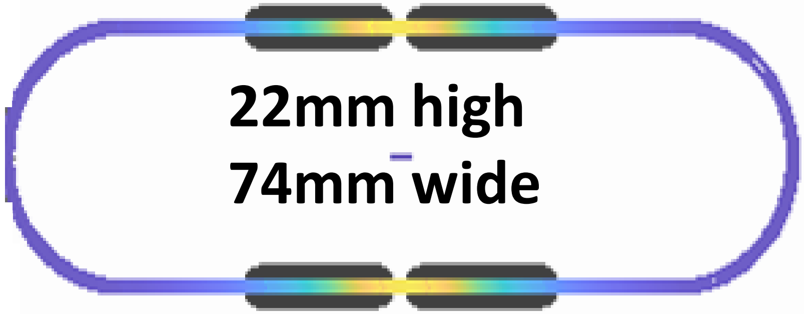
BPM pickups for Diamond II

Alun Morgan

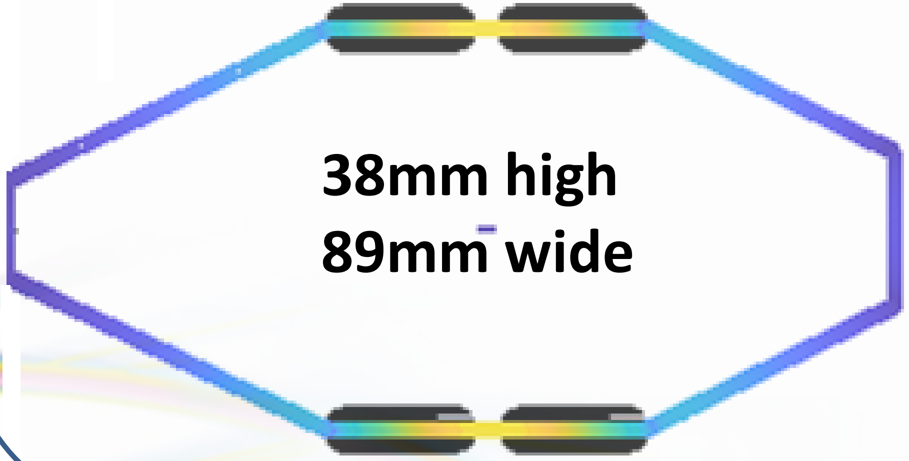
Evolution of button geometries

Diamond-I

Primary BPM (straights)

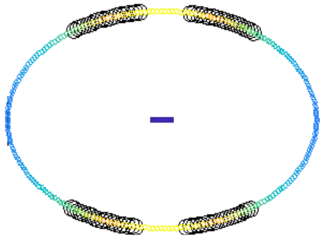


Secondary BPM (arcs)



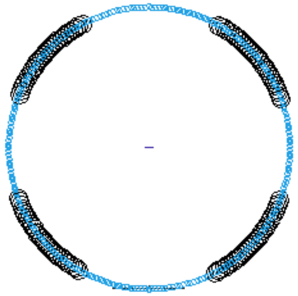
DDBA upgrade

18mm high
27mm wide

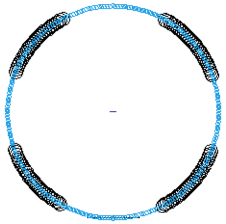


Diamond-II

26mm diameter



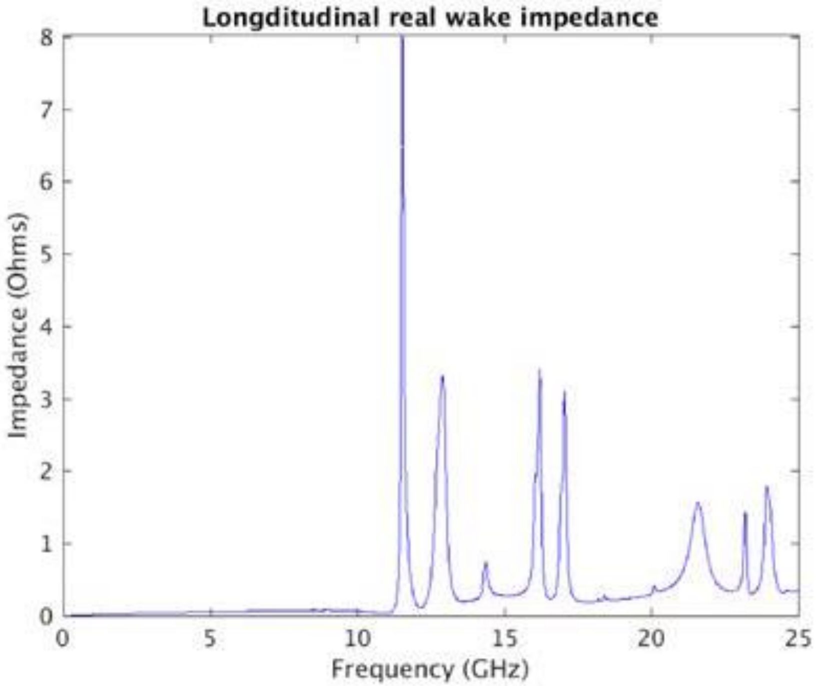
20mm diameter

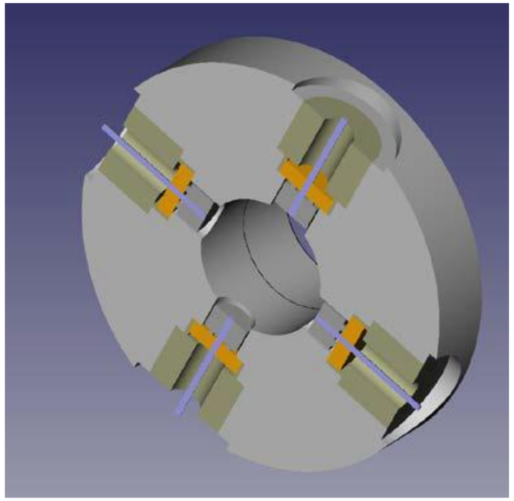


BPM pickups

Basic dimensions (*based off DDBA buttons as used in the CDR*)	
Button diameter	**6 mm**
Button thickness	**4 mm**
Button gap	**300 µm** *(current prototypes have 250 µm. Investigating reducing to 200 µm)*
Vessel inner diameter	**20 mm** *(new diameter for arc buttons is now 26mm)*
Materials	**316L casing, Molybdenum button**

Simulation results	
Button capacitance	**2.33 pF**
Geometrical scale factor	**7.3 mm**
Estimated noise limited resolution in 0-10 kHz	**27 nm**
Longitudinal wake loss factor (whole block)	**2.0 mV/pC** *(However this will be increased by the close surrounding bellows)*





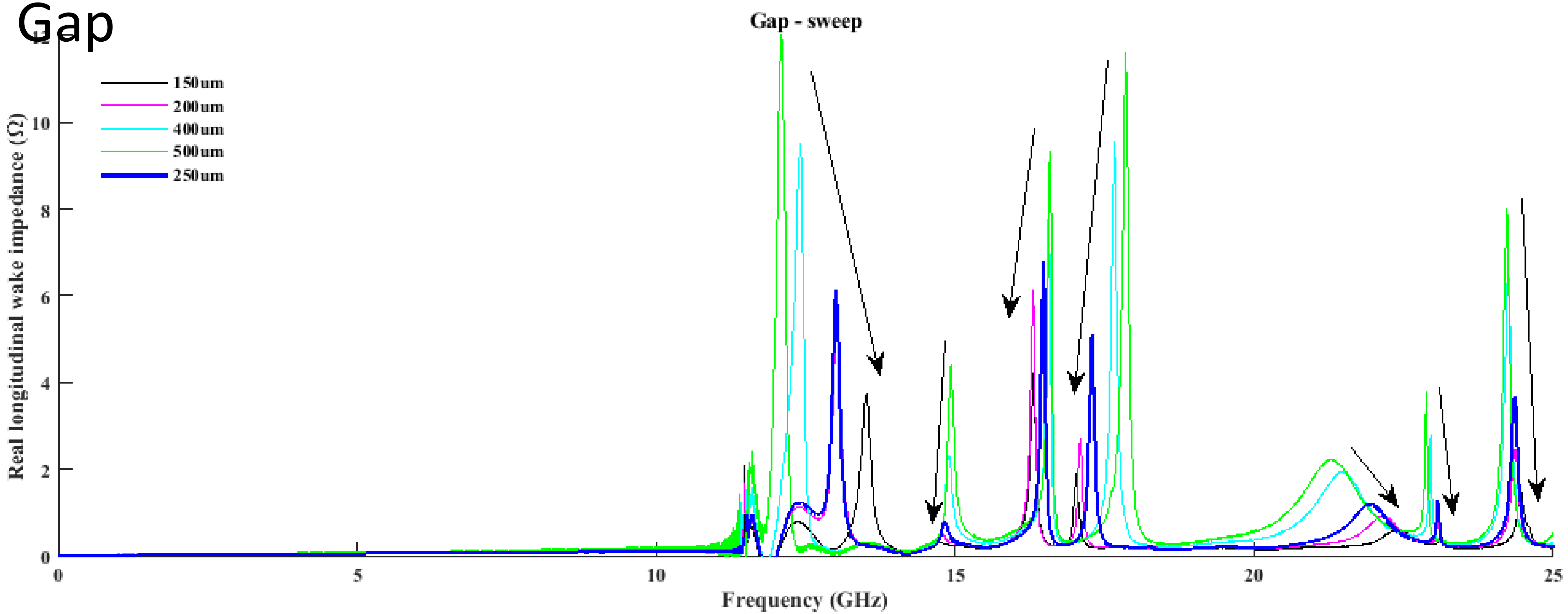
Improvements to the CDR design

- After the BPM workshop various modifications to the button head were investigated…
  - Gap
  - Button thickness
  - Button shape
  - Button head curvature
  - Button concentricity

These were mainly looking at the effects on the wake impedance. However in future s-parameter studies are also being considered.

Improvements to the CDR design

- Gap

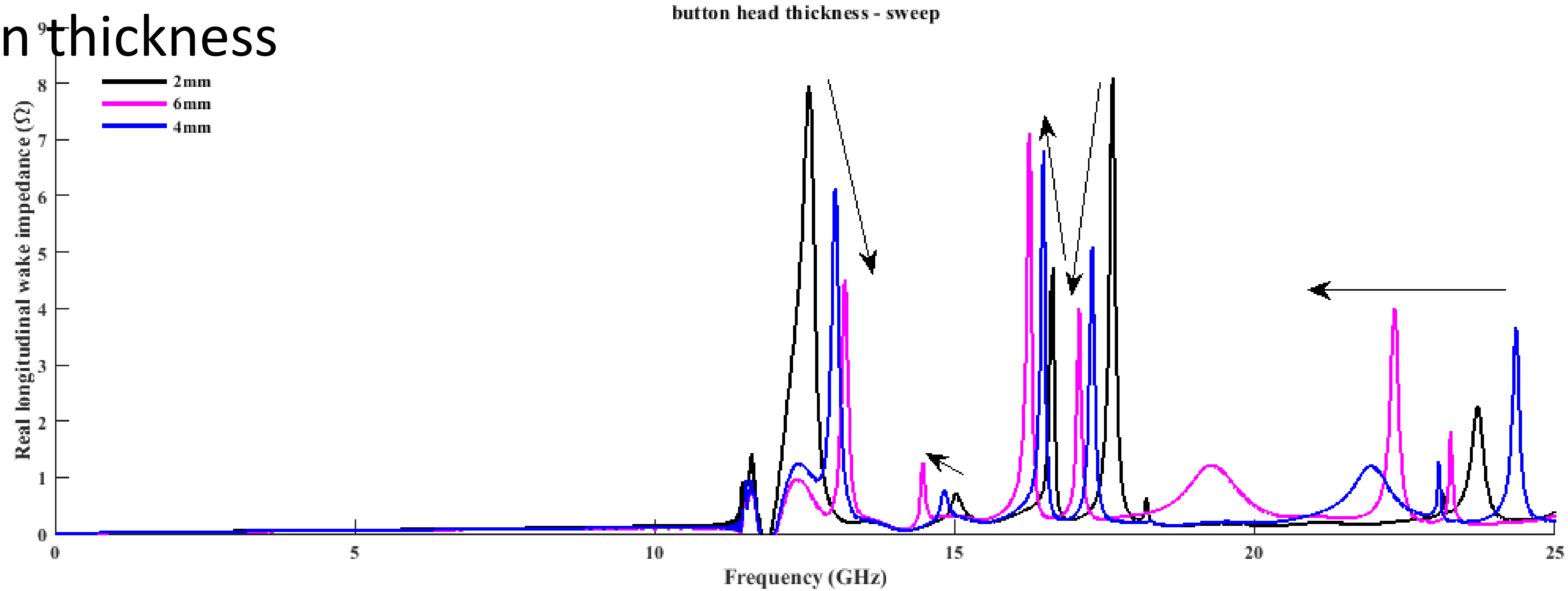


The gap has a large effect on the lowest feature. Moving it between 12 and 13GHz and changing the amplitude by a factor of three.

Generally **a smaller gap reduces the amplitude for all the features**.

Improvements to the CDR design

- Button thickness

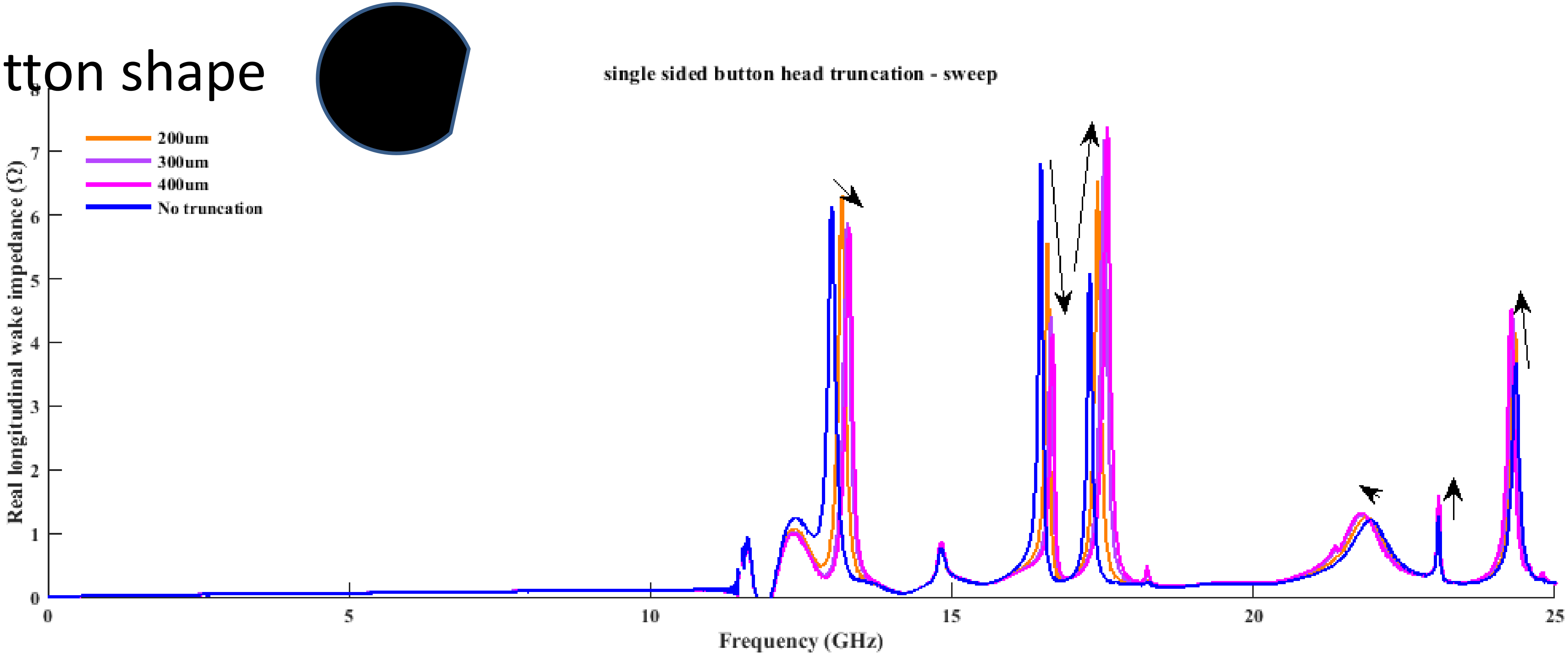


For the lowest frequency peak 6mm has the highest frequency and the lowest amplitude. Unfortunately above 14GHz there is a general enhancement and shifting to lower frequencies as the button thickness is increased.

4mm button thickness is a reasonable compromise*. However depending on our beam spectrum a 6mm button may be considered.*

Improvements to the CDR design

- Button shape

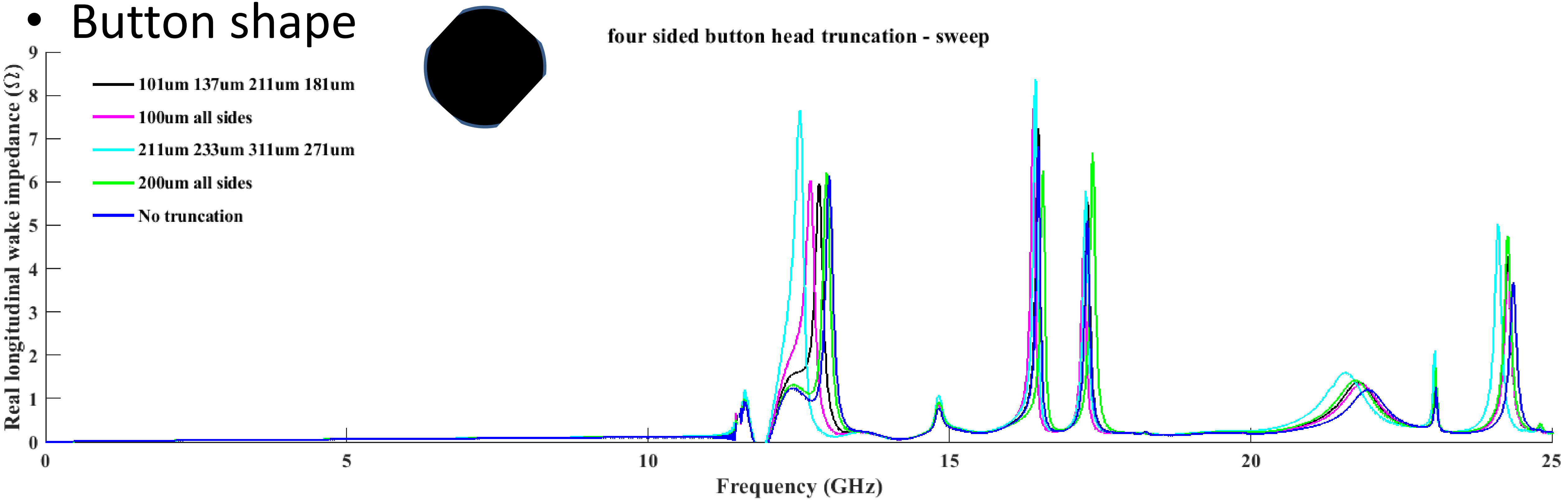


Any amount of single sided truncation shifts the lowest peak to slightly higher frequencies and lower amplitudes.

There is a small benefit to breaking the cylindrical symmetry in one place. However ***the gains are small and may not be worth the extra mechanical complexity.***

Improvements to the CDR design

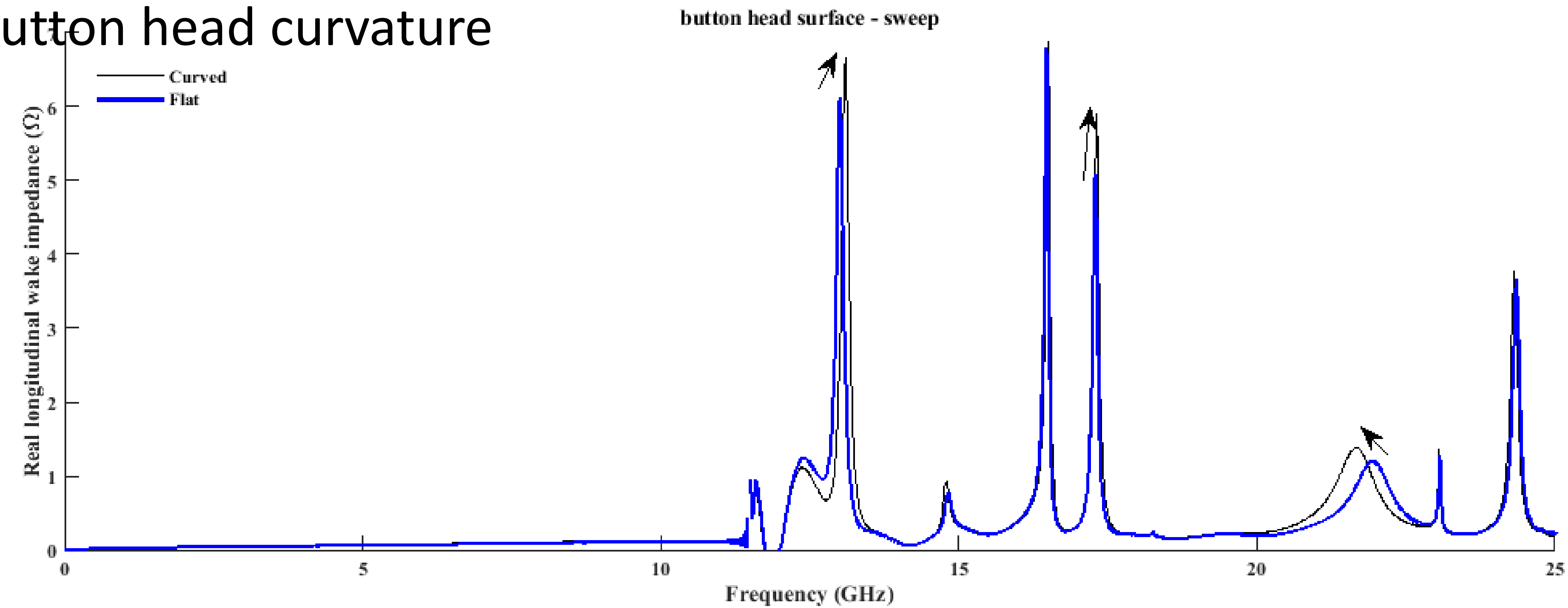
- Button shape



Any level of four sided truncation pushes the lowest feature to a lower frequency.
This is undesirable
Breaking the button head symmetry in multiple places can make things worse.

Improvements to the CDR design

- Button head curvature



The curve does move the frequency of the lowest feature slightly higher. However this is at the cost of higher peak impedance.

Curved buttons are not worth the additional mechanical complexity.

Improvements to the CDR design

- Button concentricity
  - Depending on the direction the situation can be made better or worse by a small amount.
  - *These are of limited use in terms of design optimisation.*
  - *However they could be useful in terms of sensitivity analysis.*

- Summary

  The gap changes have the largest impact on wake losses.

  The existing 4mm button thickness is still a good value.

  With care, breaking the symmetry of the button can be slightly beneficial, but runs the risk of degrading performance.

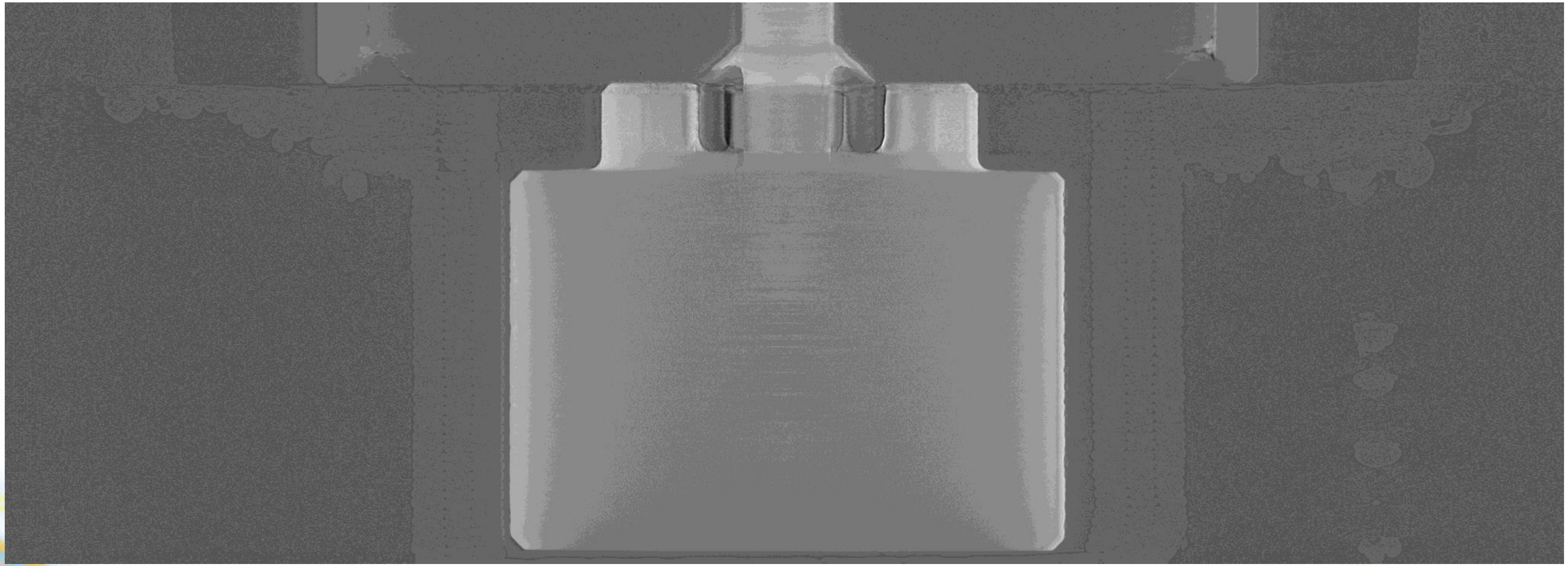
Other lessons from the BPM workshop

- We need tracking of individual buttons through the manufacturing and testing processes.
  - Laser etching is being investigated

Other lessons from the BPM workshop

Based on the work done by the ESRF – EBS team which discovered the problem with bulk steel quality.

- Can we investigate materials / button structure quality?
  - Have done a proof of principle beamline experiment using our spare DDBA buttons.



Other lessons from the BPM workshop

- Need to get experience with alternative suppliers
  - Also alternative sealing technology (ceramic braze vs glass sealing).
- Develop in house testing procedures

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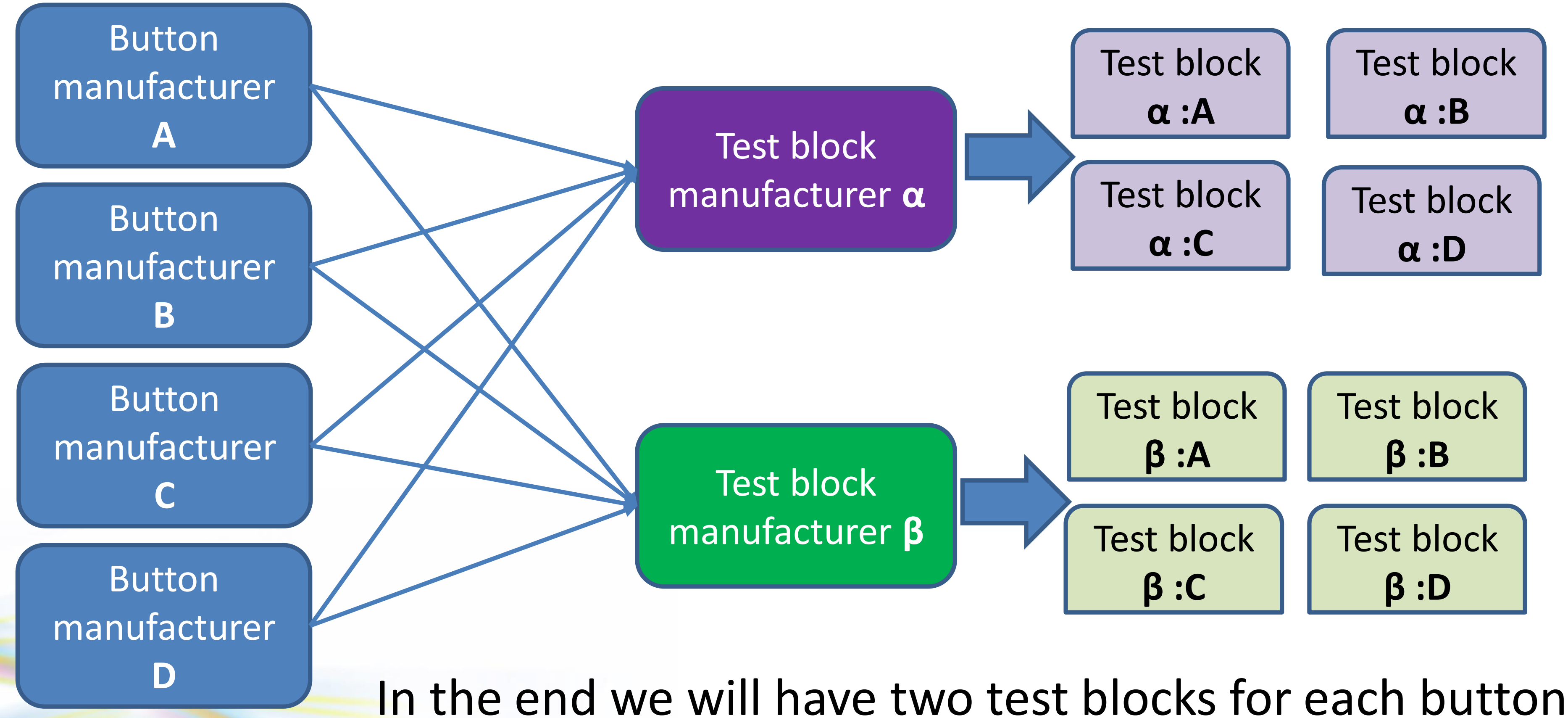
Prototypes

BPM pickups - prototypes

- We have asked four manufacturers to make 25 buttons each.
- We have asked two manufacturers to make four test blocks each.
- Each test block will have 8 buttons from a single button manufacturer installed in them.



In the end we will have two test blocks for each button manufacturer (one from each block manufacturer)

BPM pickups – prototype testing

- Individual button tests (pre installation)
  - We are having them checked for geometric errors. [1 of 4 sets done]
  - We will leak check the individual buttons. [Test rig being designed]
- Block tests
  - 1 of 2 test blocks from each button manufacturer to be vacuum tested thermally cycled etc. (how can we break it tests)
  - 1 of 2 test blocks from each button manufacturer kept for potential beam tests on Diamond I.
- Remaining buttons kept for possible additional studies
  - Tomography [initial beamline test complete]

Wider considerations

- Thermals
  - The new design should heat much less than the Diamond-I BPM buttons thus we should not need the additional cooling we use at the moment. However in locations where the buttons are between two bellows the effect of creating a cavity may dominate and additional cooling required.
- Referencing
  - The Diamond-I primary BPMs were intended to be referenced to a thermally stabilised pillar. However the noise generated by the length encoder data worsened feedback performance. They have never been used operationally.
  - Is the floor our most suitable reference point?