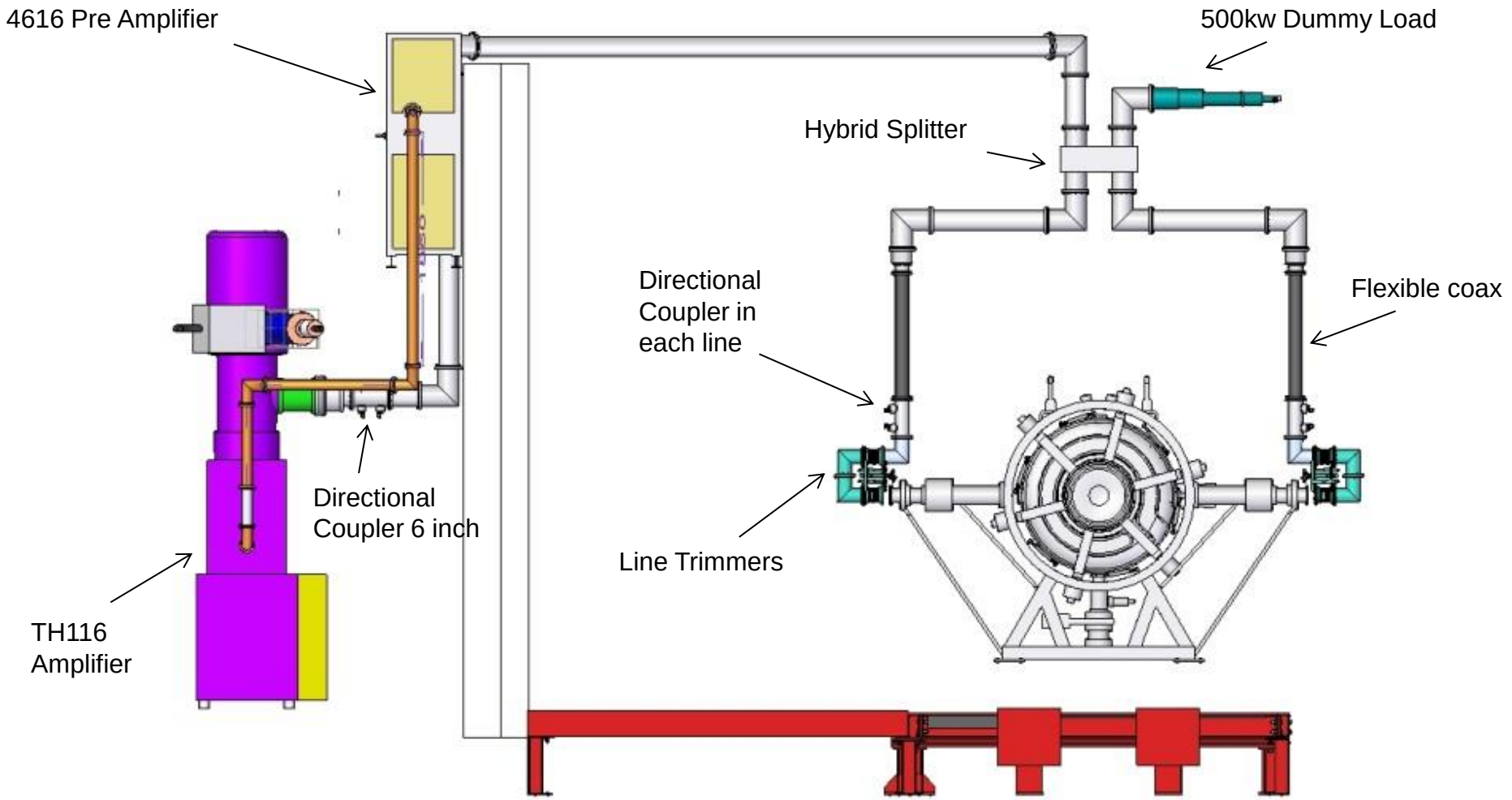
Science & Technology
Facilities Council

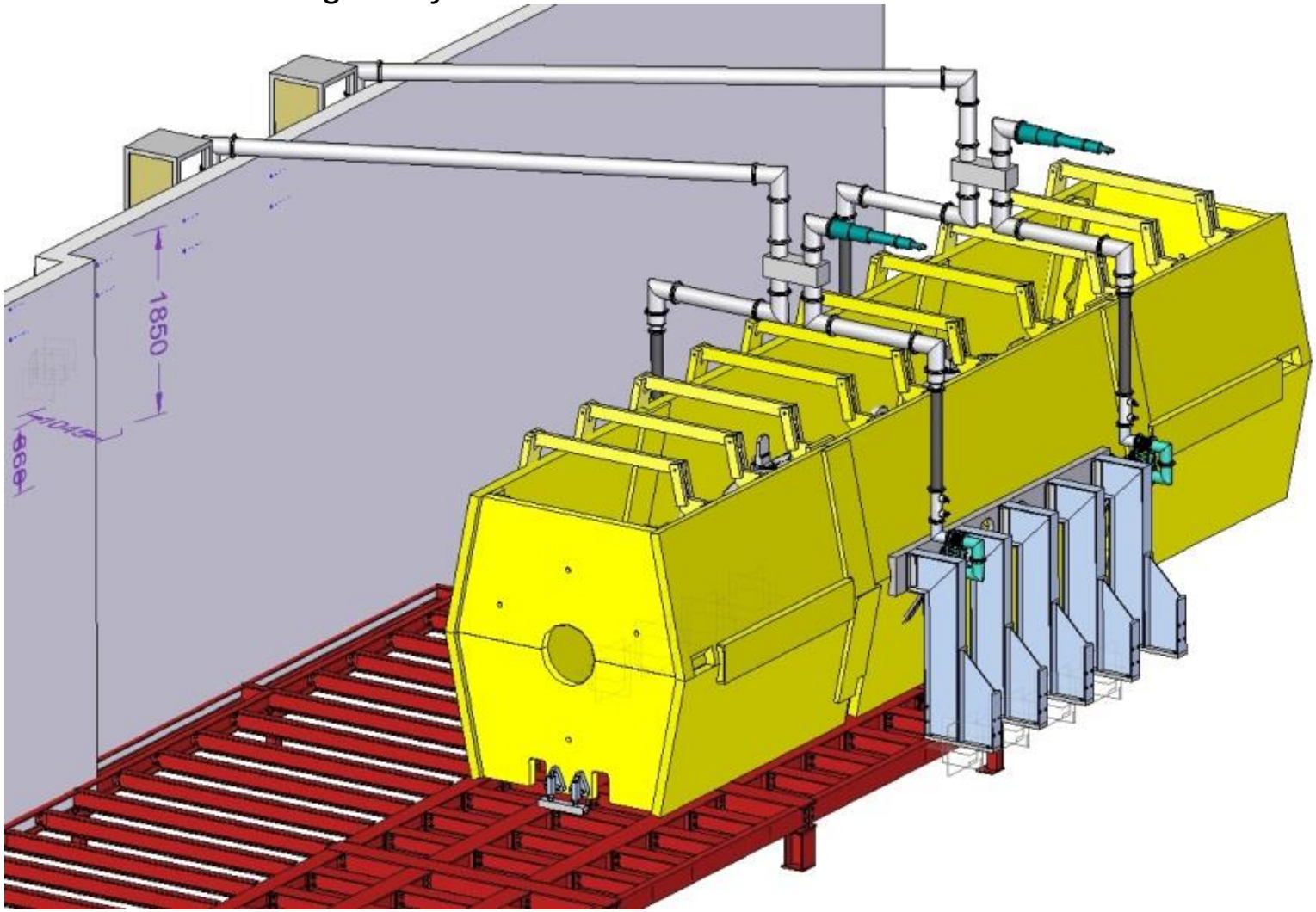
RF distribution/diagnostic update

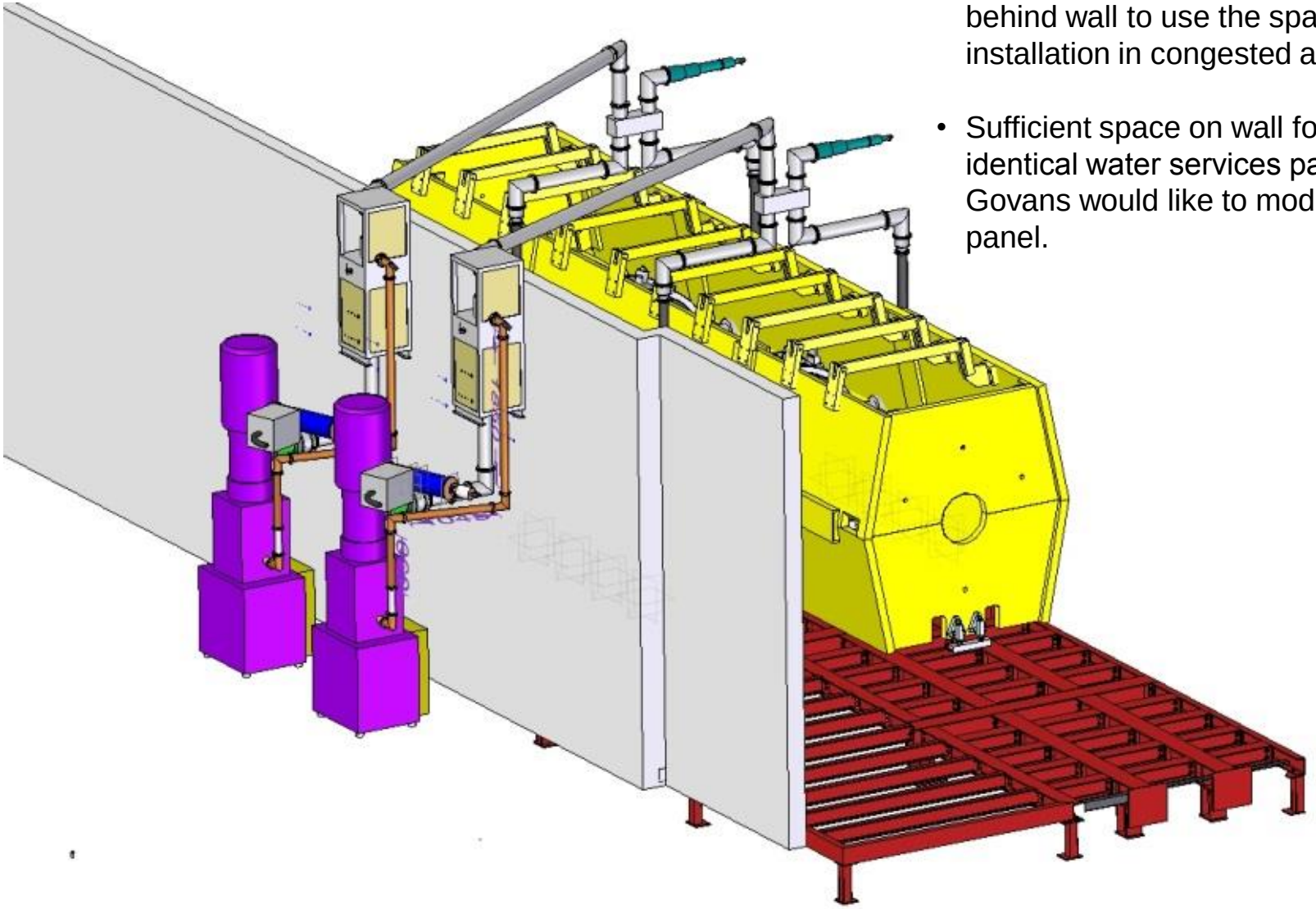
- Output line from amplifier is lower than the PRY, needs to go high to clear PRY to couple to South RF couplers
- Already have the 6” coax to go over the wall
- No advantage in going through the wall



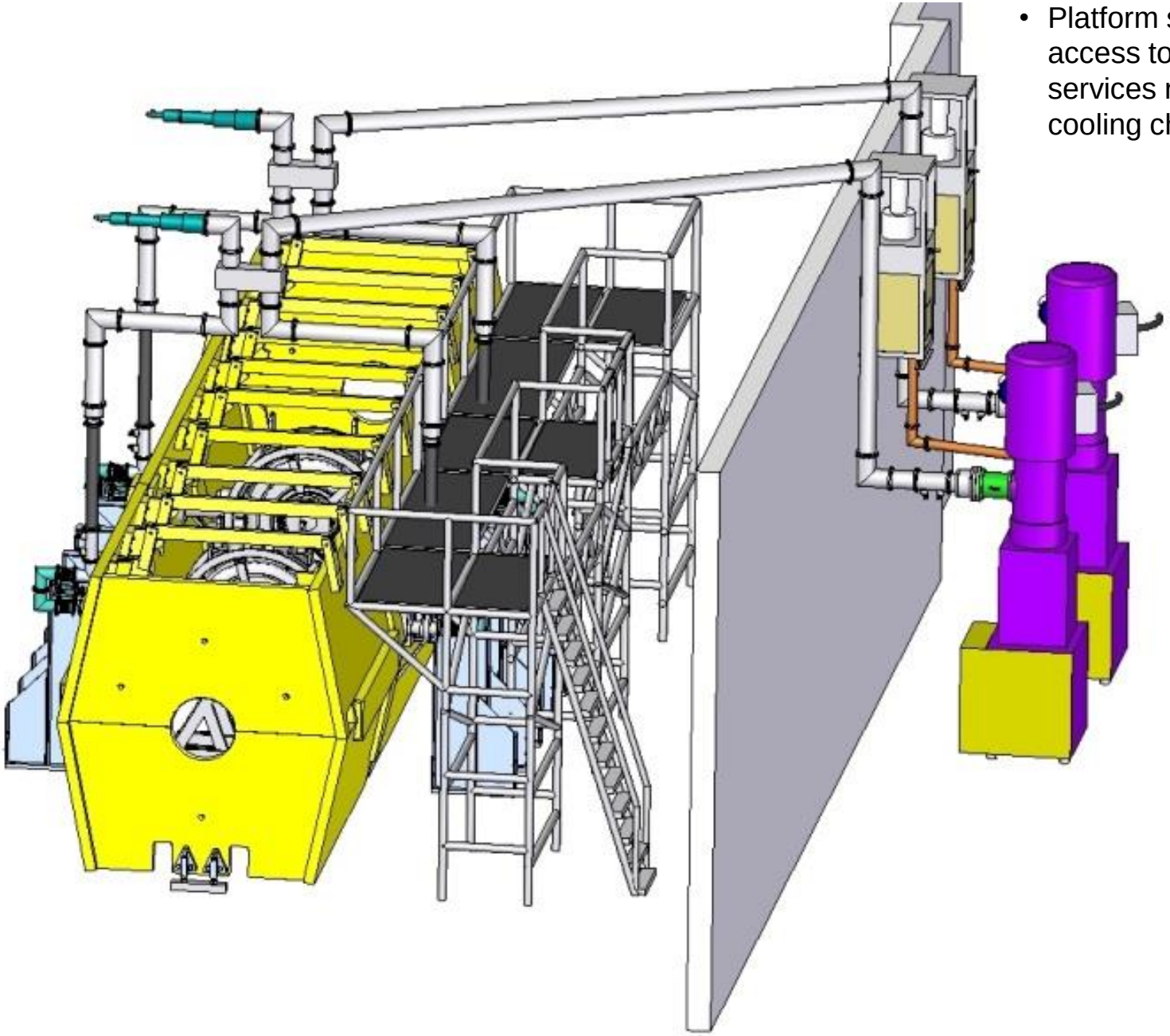
RF Distribution – Neglecting Vacuum Support Platform

- MTA advised not to use ‘T’ splitters, suggested hybrid splitter was a better solution as it isolated the cavity couplers from each other.
- Propose to have 1off dummy load on the hybrid splitter to each RF cavity.
- Crane hook height fully retracted does not clash with the coax over the wall.





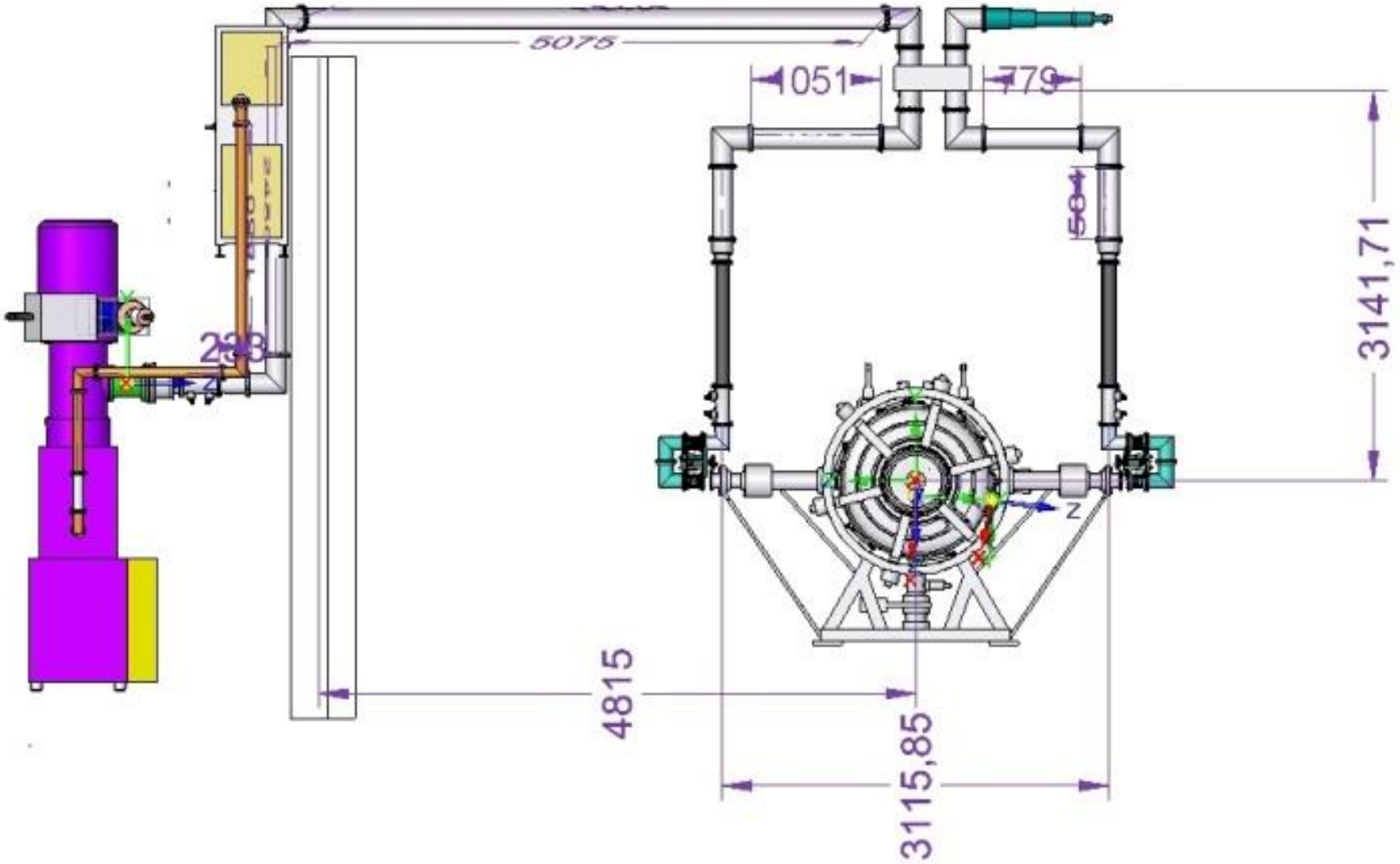
- 2nd TH116 amplifier moved to 3rd position behind wall to use the space and ease installation in congested area
- Sufficient space on wall for additional identical water services panel……John Govans would like to modify existing panel.

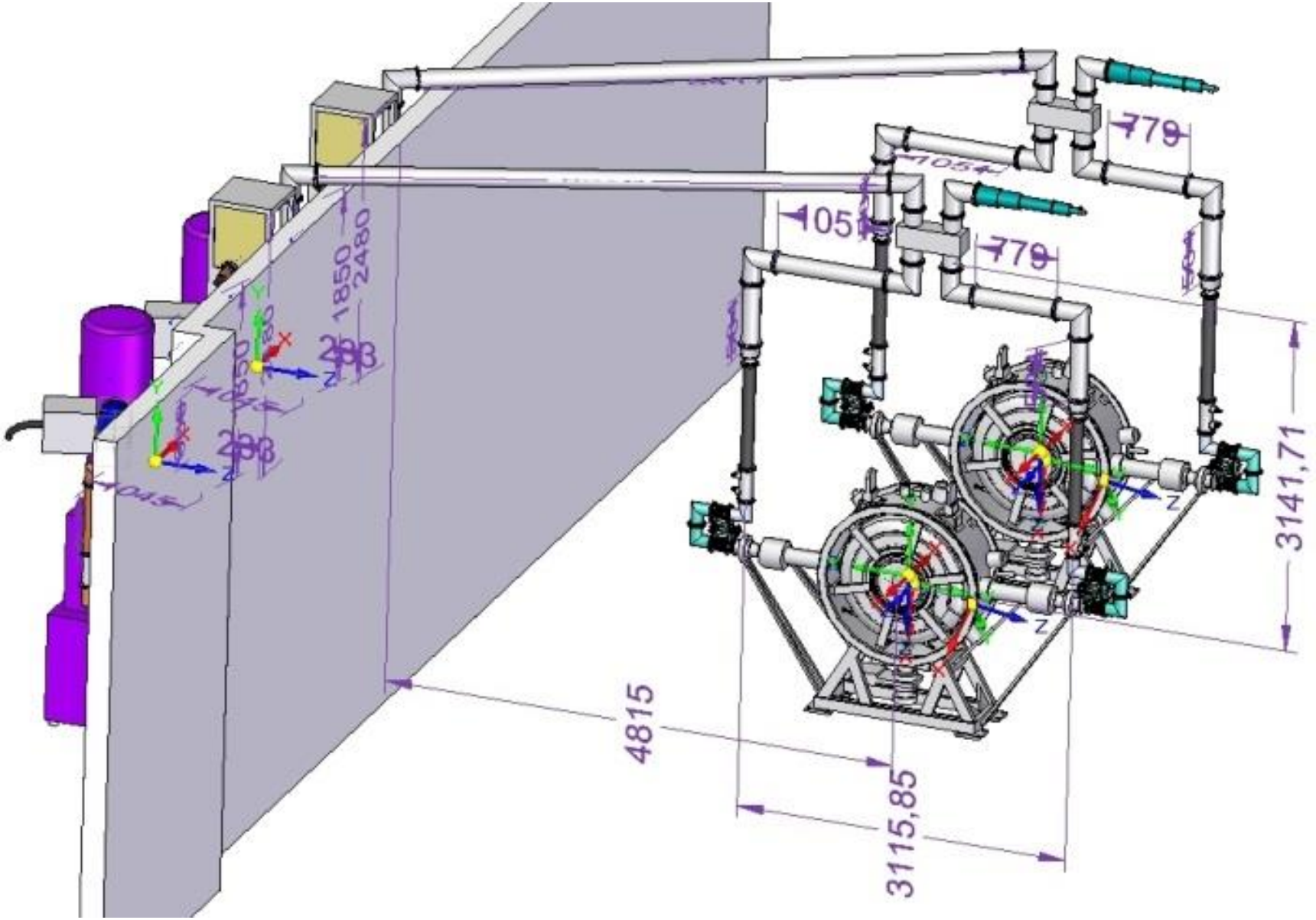


- Platform scaffolding rqd to gain access to equipment and services running on top of the cooling channel

RF Distribution – With Vacuum Support Platform

- Coax over the wall raised to avoid clash with vacuum support platform
- Crane hook height fully retracted may cause a potential clash with the coax……need to check
- Option for crane operation maybe to skate equipment under high level coax line
- Services to dummy loads not yet been considered……need to speak to Jason

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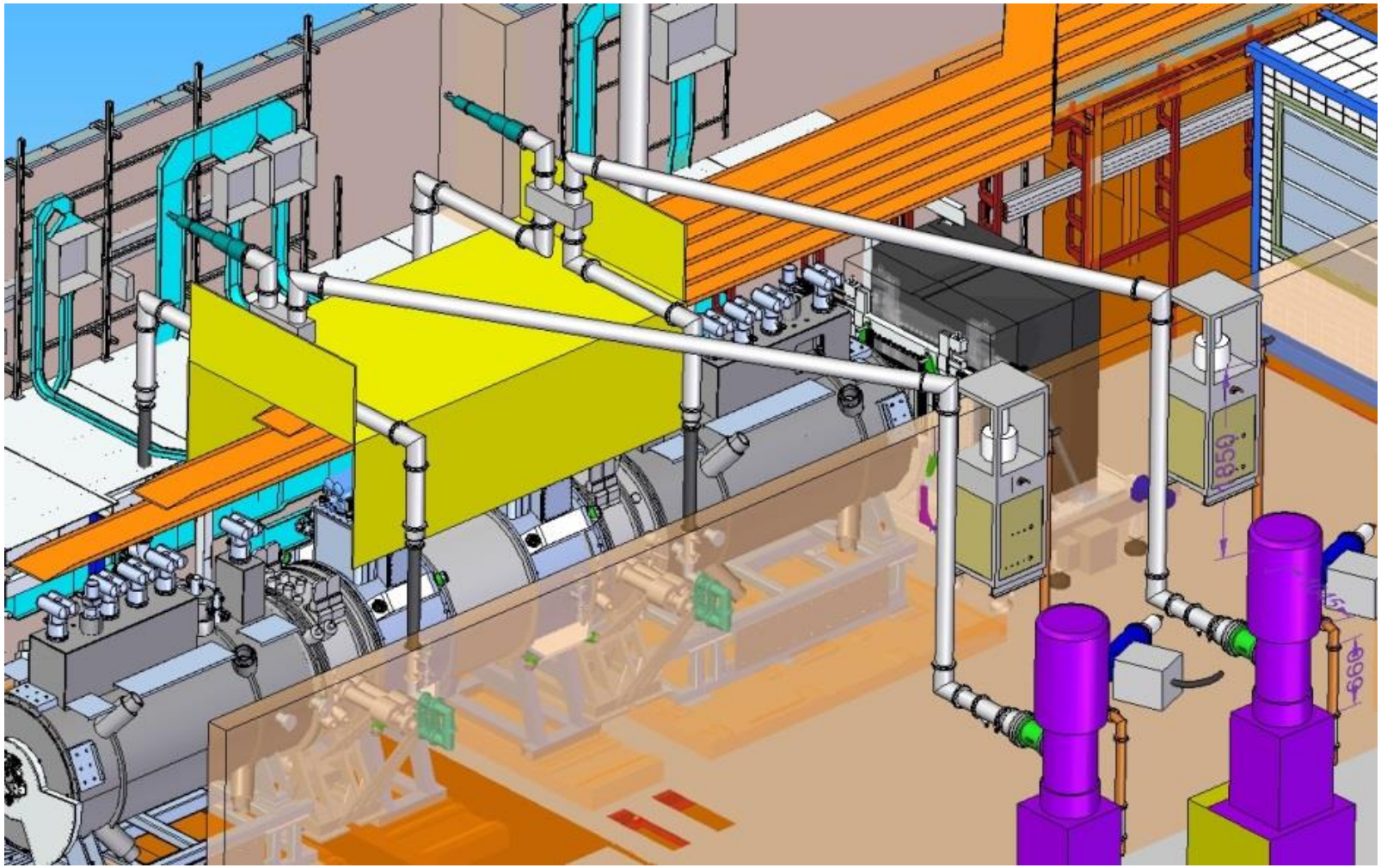
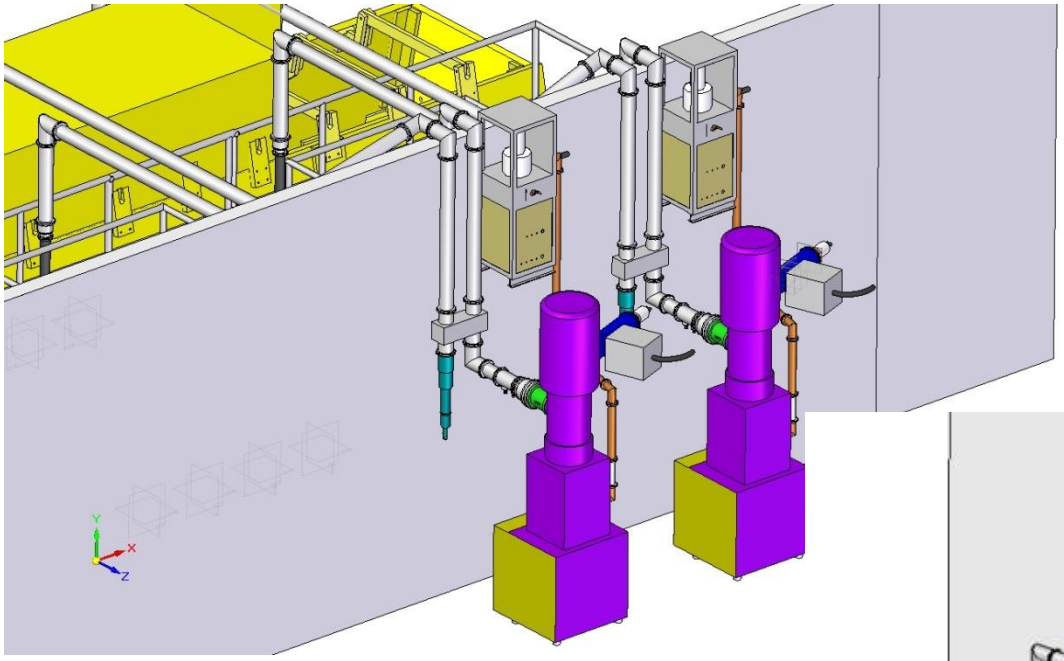
- RF components routed over SS vacuum support platform “Dog Kennel”
- “Dog Kennel” can provide shielding for RF components
- Raised the height of the coax line over the wall from 242mm to 410mm, crane height appear to allow adequate margin
- Hybrids splitters can move upstream & downstream & lowered to avoid any potential clashes, achieved by setting correct rotation angles on coax lines
- Suggest mounting coax supports off PRY steel work & “Dog Kennel”…….need to liaise with Jason & Steve Plate

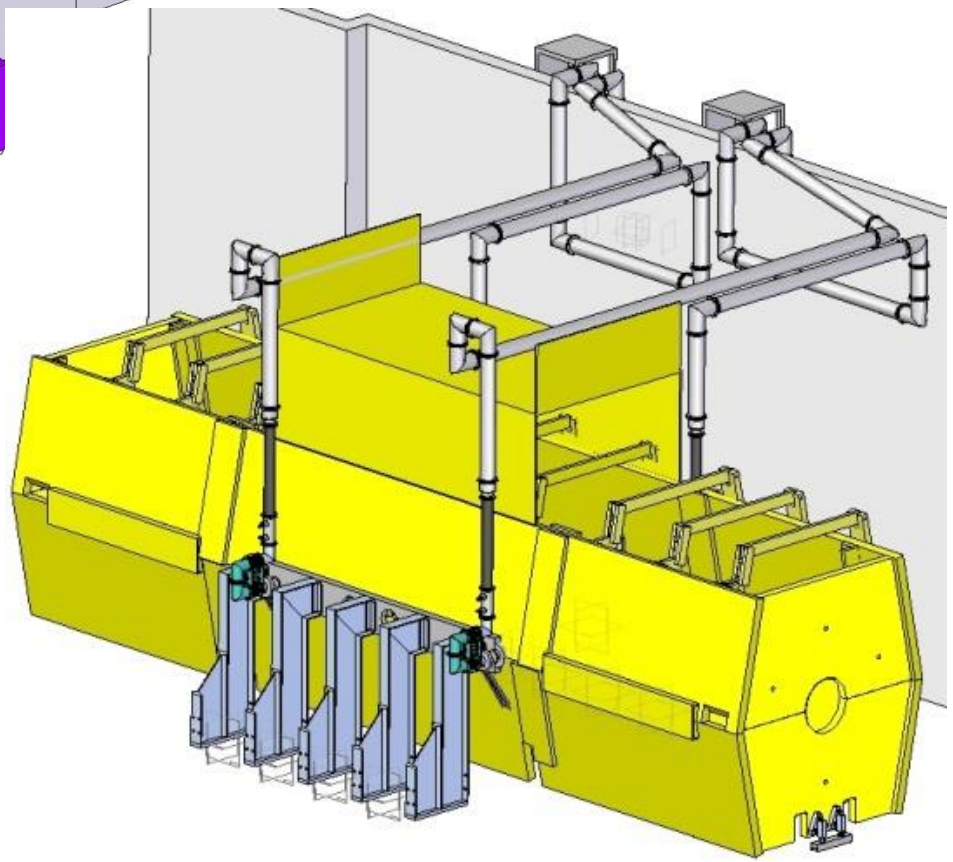


RF Distribution – Hybrids Behind North Wall



Pros

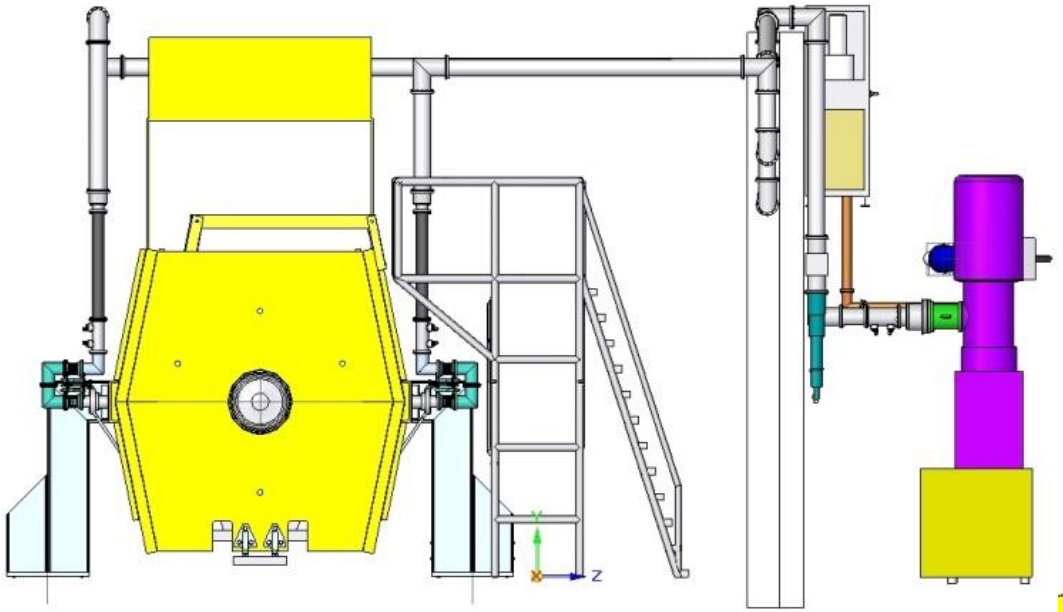
- Hybrids and elbows no longer above cooling channel reducing stray field effects…….if stray field is a problem!!!
- Coax can run lower once over the wall
- Services to reject loads might be easier

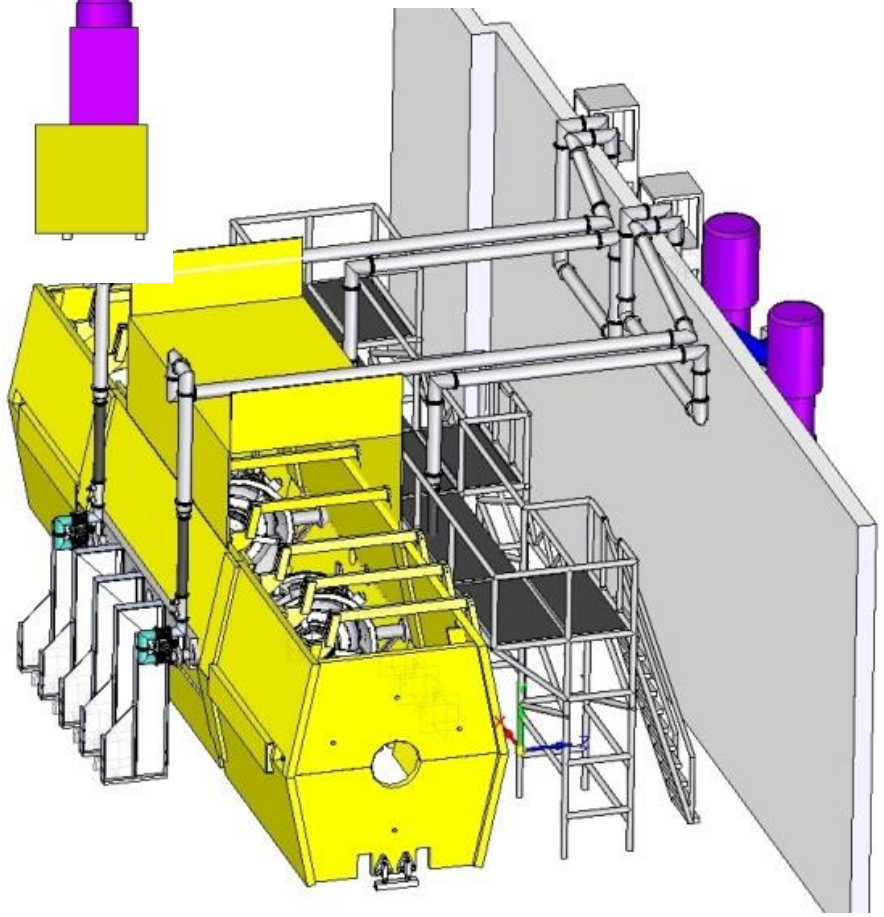


Cons

- More coax required to match lengths to each side of the cavity
- More elbows required……need same number of elbows to each side of the cavity to equalise the losses to both sides
- Generally more losses due to increased lengths of runs
- Larger SF6 volume required

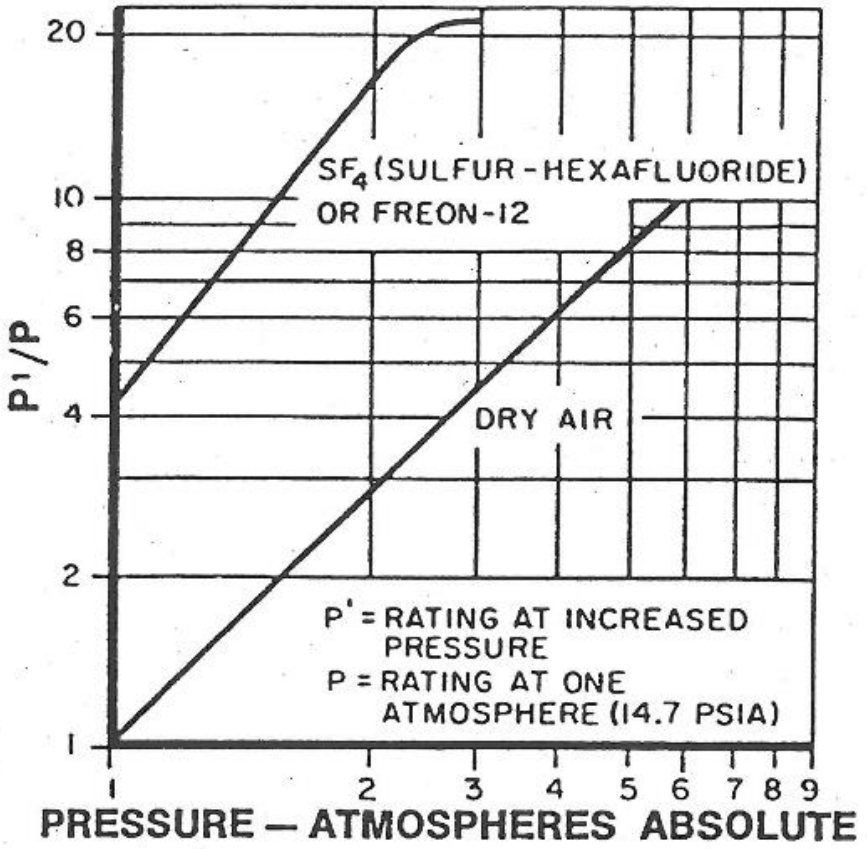
RF Distribution – Hybrids Behind North Wall





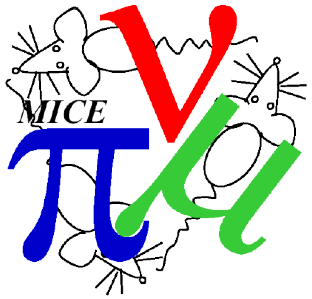
Line Specification

- The weakest points of the 4” line (Heliacs and line trimmers) rated to 1.12 MW (nominal peak power)
- In MICE power at these locations is ~ 1MW peak and 1kW average forward power
- However at start of cavity fill VSWR tends to infinity and hence peak voltage on the line doubles
  - Equivalent, at antinodes to a peak power of 4 times the peak forward power
  - Mitigate by power ramps- reduce voltage on line as VSWR declines to unity (cavity fills)
  - Mitigate by gas fill



Comments

- Output line from amplifier is lower than the PRY, so needs to go high to clear PRY to couple to South RF couplers. True for all options.
- No advantage of going through the wall.
- Crane hook height fully retracted may clash with the coax. Original height of coax above wall was 242mm, increases to 410mm for vac services platform option. May need to skate loads under high level coax lines to avoid venting and refilling with SF6.
- Directional couplers included in layout 3 in total (1 off 6 inch, 2off 4 inch)…..these have been delivered
- 4” flexible coax 1m long shown in vertical lines…..these have been delivered
- Line trimmers to take up any length corrections…..these have been delivered
- Hybrid shown with existing 500kW loads (2off) …..these have been delivered
- Moved the second amplifier to position 3 behind wall to allow more space
- Run coax in 6inch as far as possible to the flexible coax line
- Will require additional and/or modified 6inch coax line lengths
- Current scheme is 4” coax under floor, be very difficult to run 6” coax under the floor



University of Strathclyde Science

Muon - RF Phase Determination

Alexander Dick

CM 41

Sub Nyquist Sampling

- Frequency of RF – 201.25 MHz
  - 1 Period of RF ~ 5ns
  - Nyquist limit implies ~1GSa/s for 1 ms –1MB
  - Capture, transfer and storage in 1 sec?
- Possible but signal can be reconstructed from undersampled data.
  - Bandwidth is < 5kHz
  - Sample at < 200kSa/s ?
- In Subsampling – Can we rebuild a wave with required accuracy?
- Subsampled Signals
  - Expresses a different frequency than a signal sampled at Nyquist or above
  - However signal contains all the information PROVIDING
    - The baseband is wider than the spectral width
  - There is prescriptive relationship to rebuild the signal in the Fourier domain

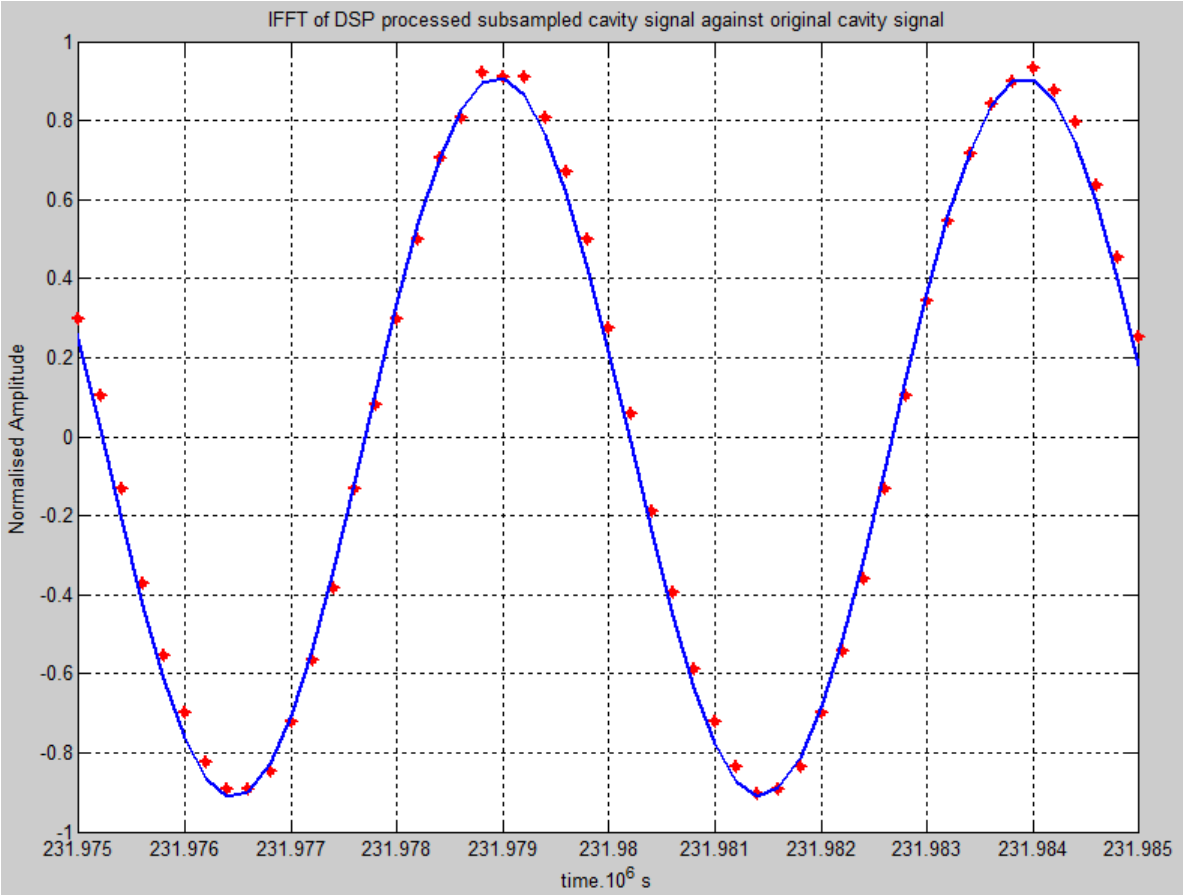
Testing with data

- Signal reconstruction tested with
  - Computer synthesised waveforms
    - Including effects of timebase jitter, bit depth resolution
  - Data acquired by 8 bit, 20 GHz, 80 G.Sa/sec DSO
    - Throw away the majority of the signal (2 G.Sa/sec -> 20 M.Sa/sec) and prove DSP Fourier domain reconstruction returns original waveform
- These have been reported on previously

- 100's GB data from tests at MTA
  - Includes real cavity probe pick up signals,
  - Recorded for ~ 200 μs duration, at 5 G.Sa/sec on high performance DSO (8 bit)
  - Test ability to Fourier reconstruct after disposing of most of the data points
    - i.e. move real 5 G.Sa/sec to synthesised 20 M.Sa/sec
  - More realistic test than mathematically 'perfect' or bench tests

Sampling Sub-Nyquist
Testing with Cavity signal from SCTS

Red – SCTS Signal
Blue – Undersampled Signal
after FD reconstruction

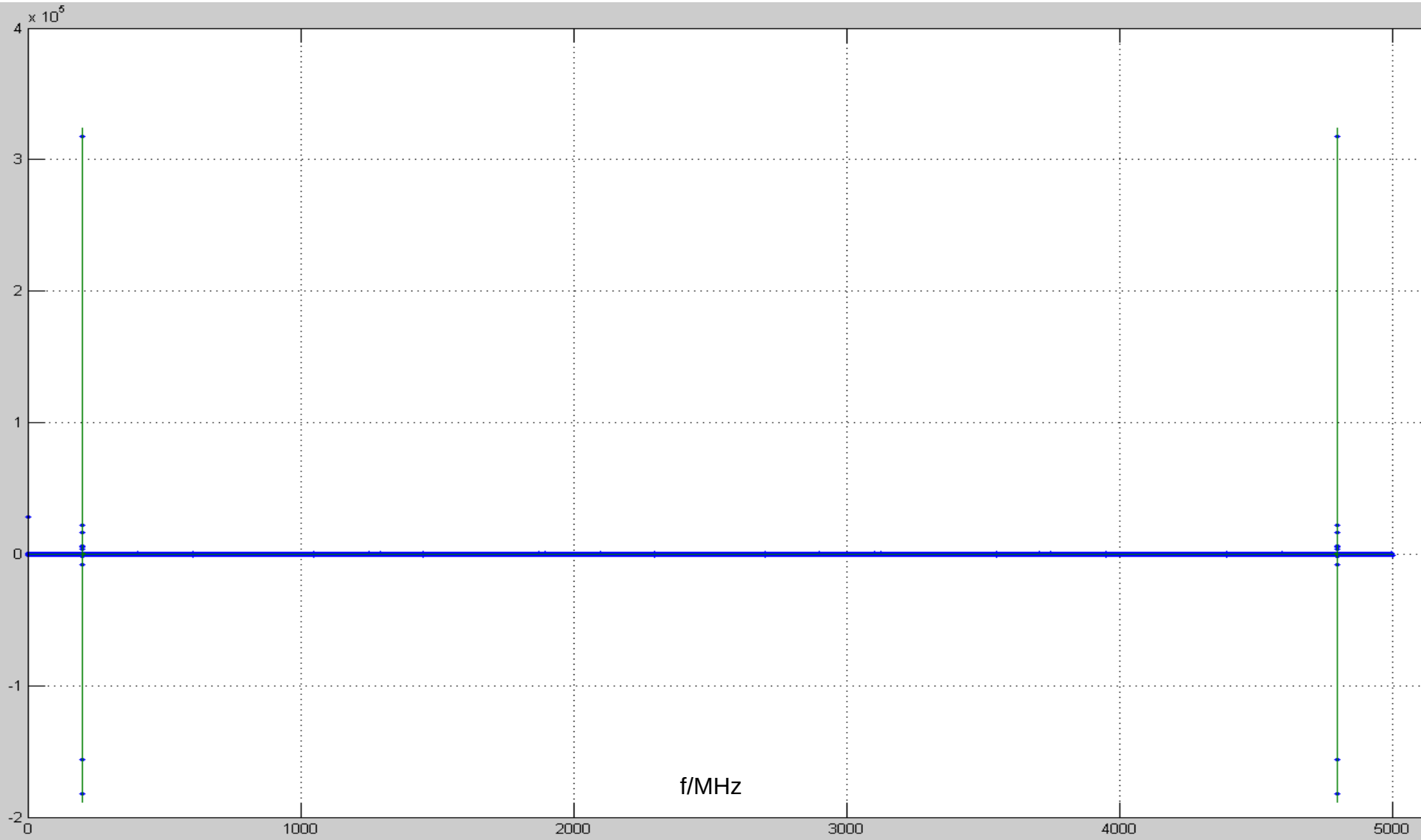


Slight and largely consistent phase shift.

- Apparently a systematic offset
- Work ongoing to see if consistent phase delay or if method/data density can be improved
- Slight differences in amplitude detail?

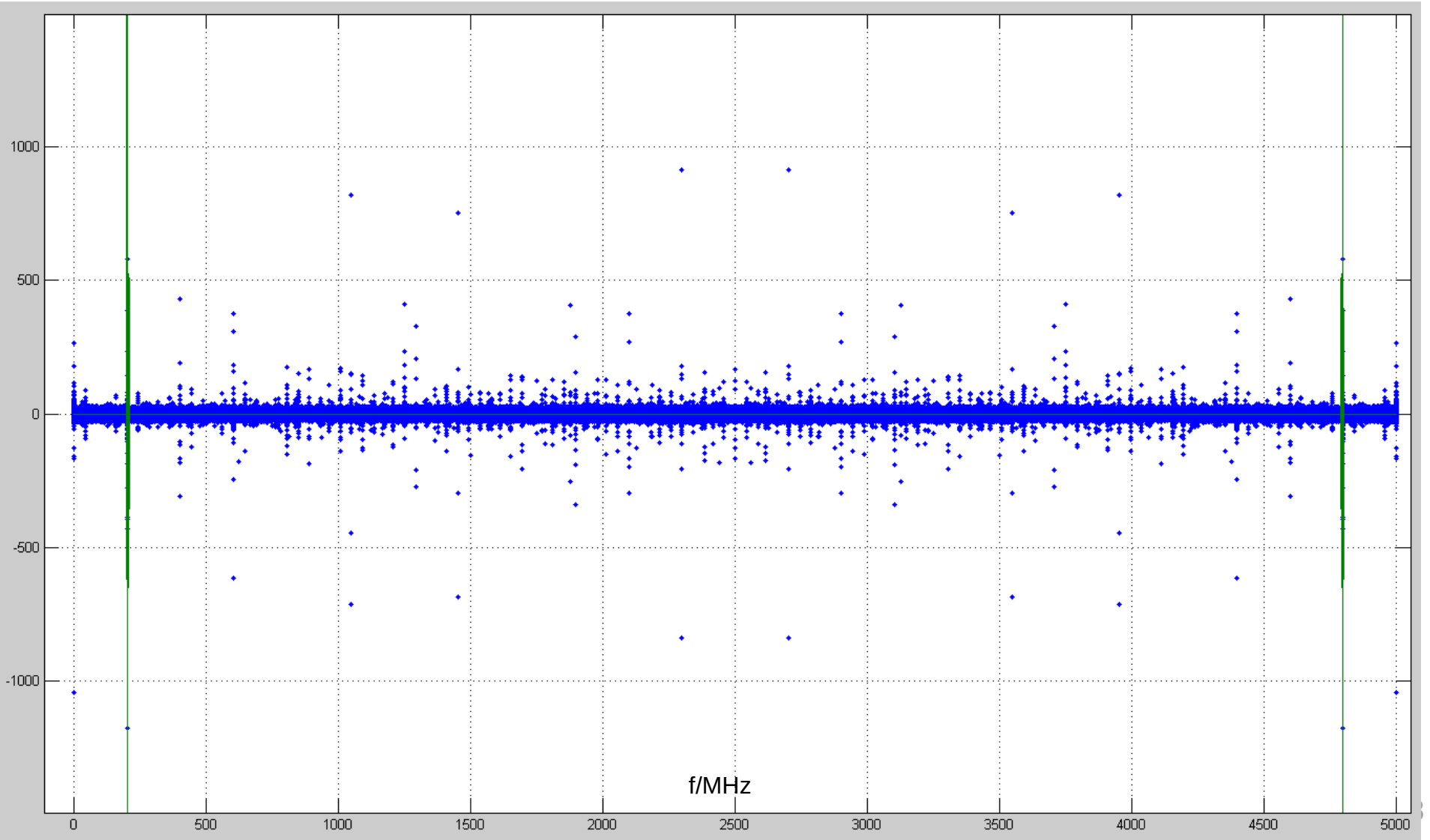
Sampling Sub-Nyquist

Frequency comparison of SCTS 5GSa/s FT and 20MS/s Undersampled FT



Sampling Sub-Nyquist

Frequency comparison of SCTS 5GSa/s FT and 20MS/s Undersampled FT (Zoomed)



Summary

- Subsampling at 1:100th Nyquist gives:
  - Correct frequency, amplitude and pulse envelope
  - Slight phase shift- being investigated
  - Misses slight perturbations in amplitude (misses out-of baseband energy)

- Does look feasible to capture representative signals
  - Providing the phase shift issue can be addressed
  - This will be assessed using the large data set from the MTA

- Would reduce data levels for an RF pulse to ~20 kB

- Equipment being assembled for hardware tests