Bandwidth and noise

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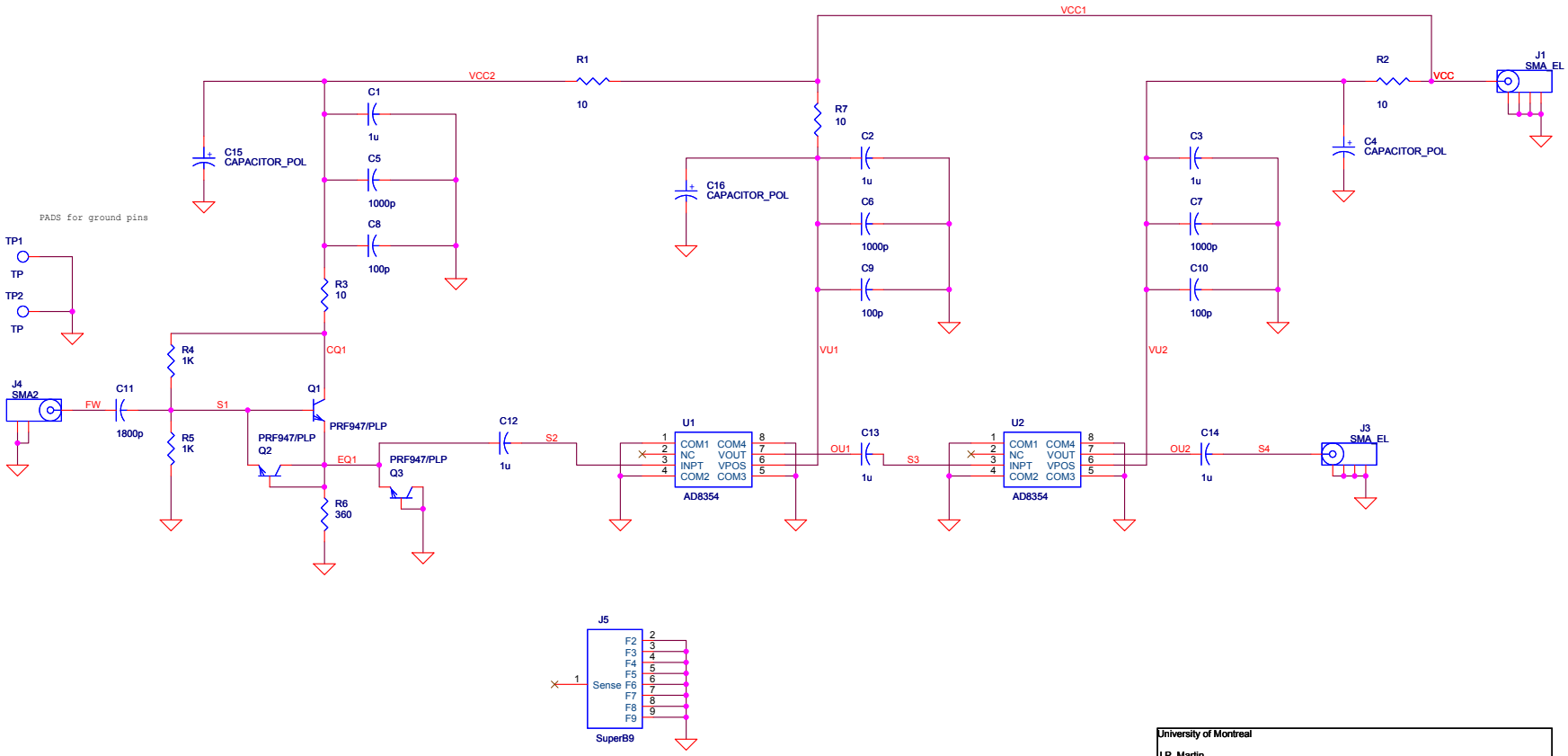
Overview

- One of the primary goals of the TRIUMF November beam test was to evaluate the amplifier prototype produced by Jean-Pierre Martin (Montreal).
- I will discuss bandwidth and noise issues with respect to the amplifier and the overall system design.

power consumption = 30 mA @ 3.5V
= 100 mW



Bandwidth

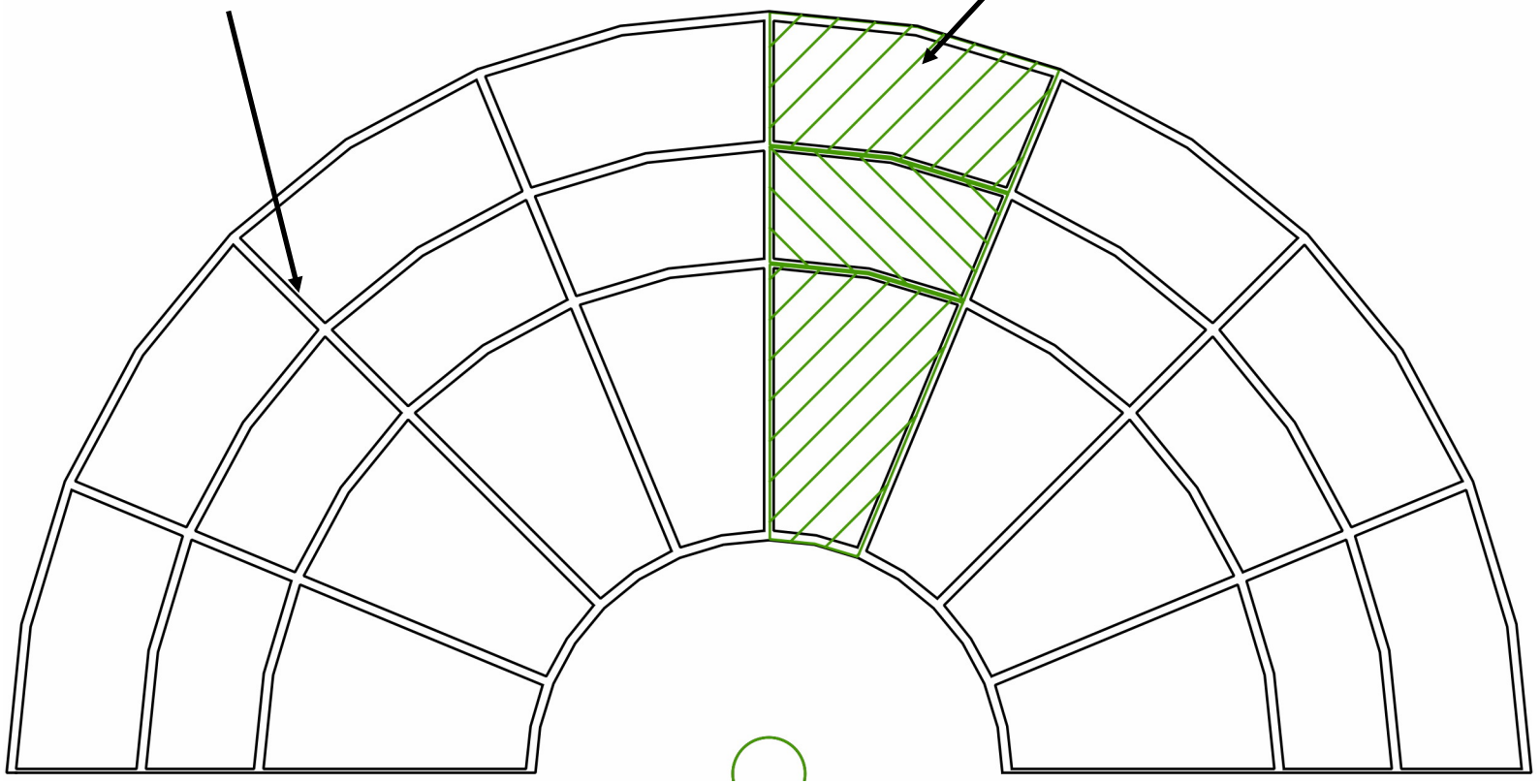
- Bandwidth specification has significant impact on overall design. e.g. cables and connectors.

Electronics enclosure

- The electronics enclosure forms the nitrogen-filled volume that contains the amplifiers mounted on the rear endplate.
- Feedthroughs for signals, power, calibration.
- Gas, cooling.
- Our focus so far is on signal feedthroughs. Mechanical interface with endplates/outer cylinder needs to be discussed with Stefano.

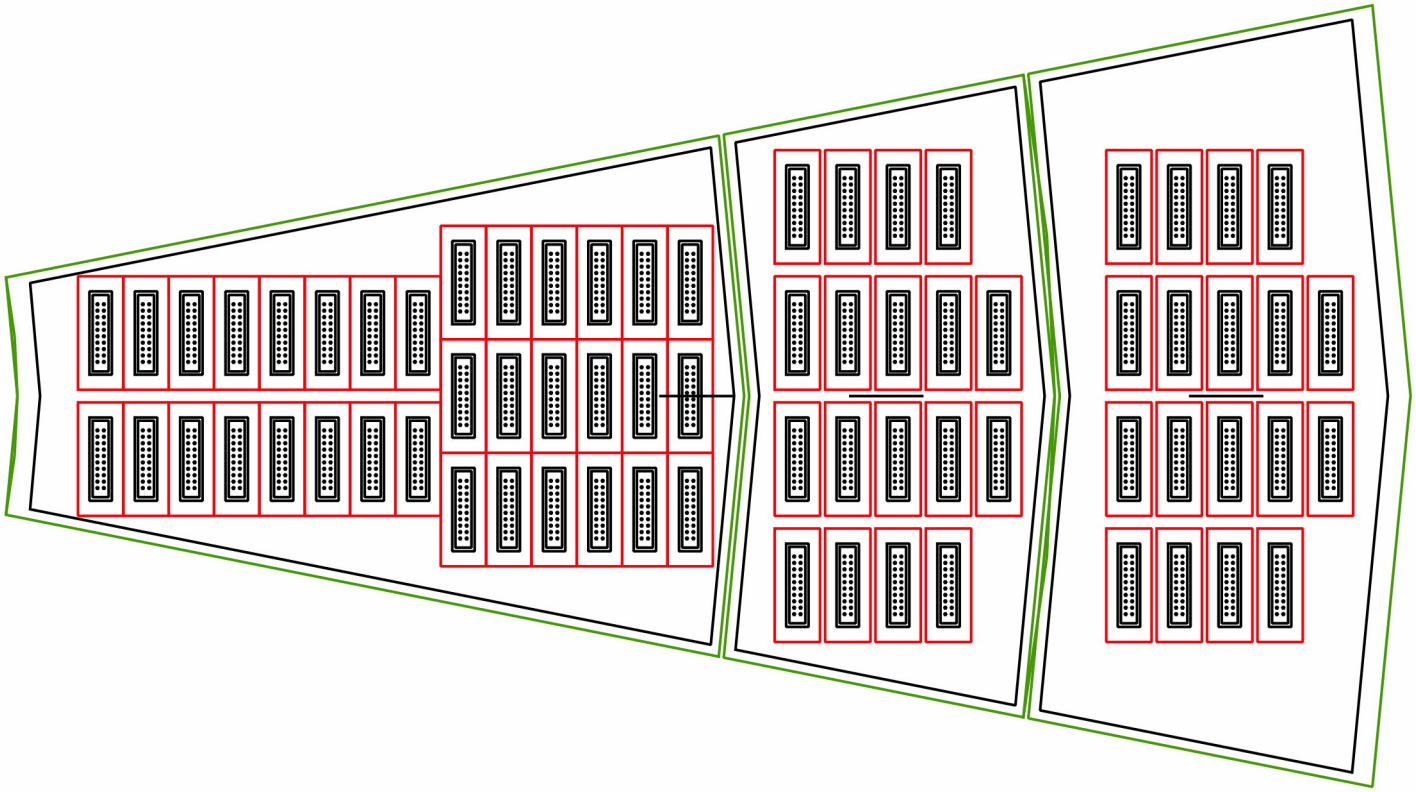
Aluminum rib structure mounted to endplate at inner and outer radius

48 removable PCBs hold electrical feedthroughs



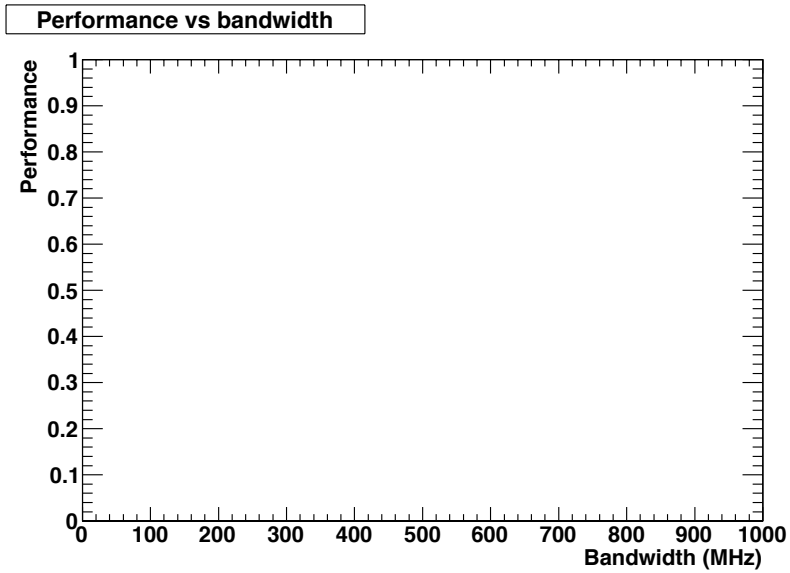
Gas lines at inner and outer radius. Cooling lines mounted to ribs. (Not shown)

- Layout is for 9216 cells ≈ 13.5 mm square, uniform size vs radius (265 – 780 mm).
- Each red box is 18 × 45 mm and contains a 20-pin 2.54mm spacing header. (8 signal + power + calibration).

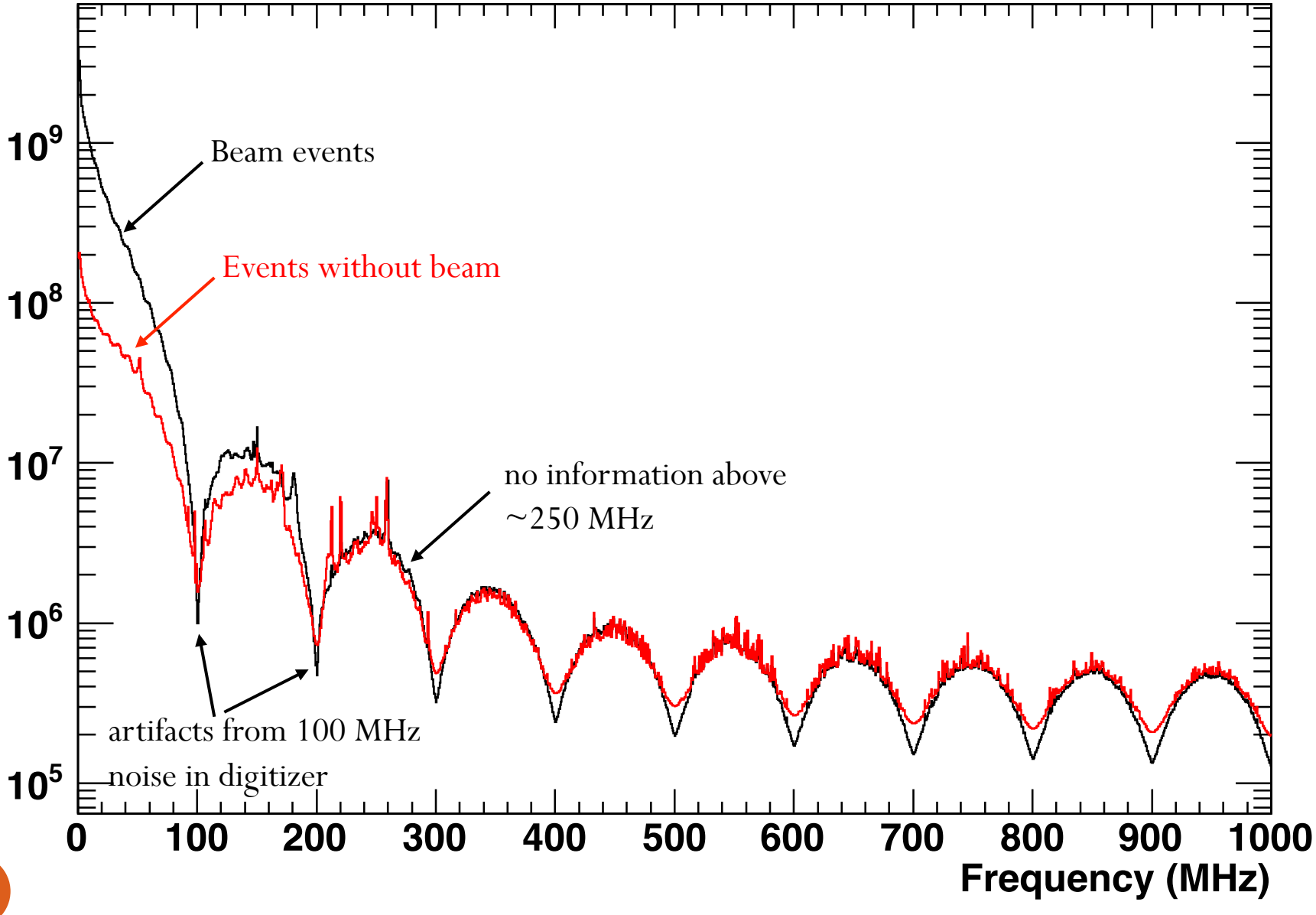


Cables / bandwidth beam test

- Jean-Pierre's recommended cable has a 4.03 mm diameter. Challenging layout for this number of channels.
- Plan is to evaluate impact of bandwidth (including cables) on performance using beam test data. Unfortunately, digitizer used in November TRIUMF beam test has only 300 MHz bandwidth.



Fast Fourier Transform of 140 MeV/c beam event waveforms and events without beam

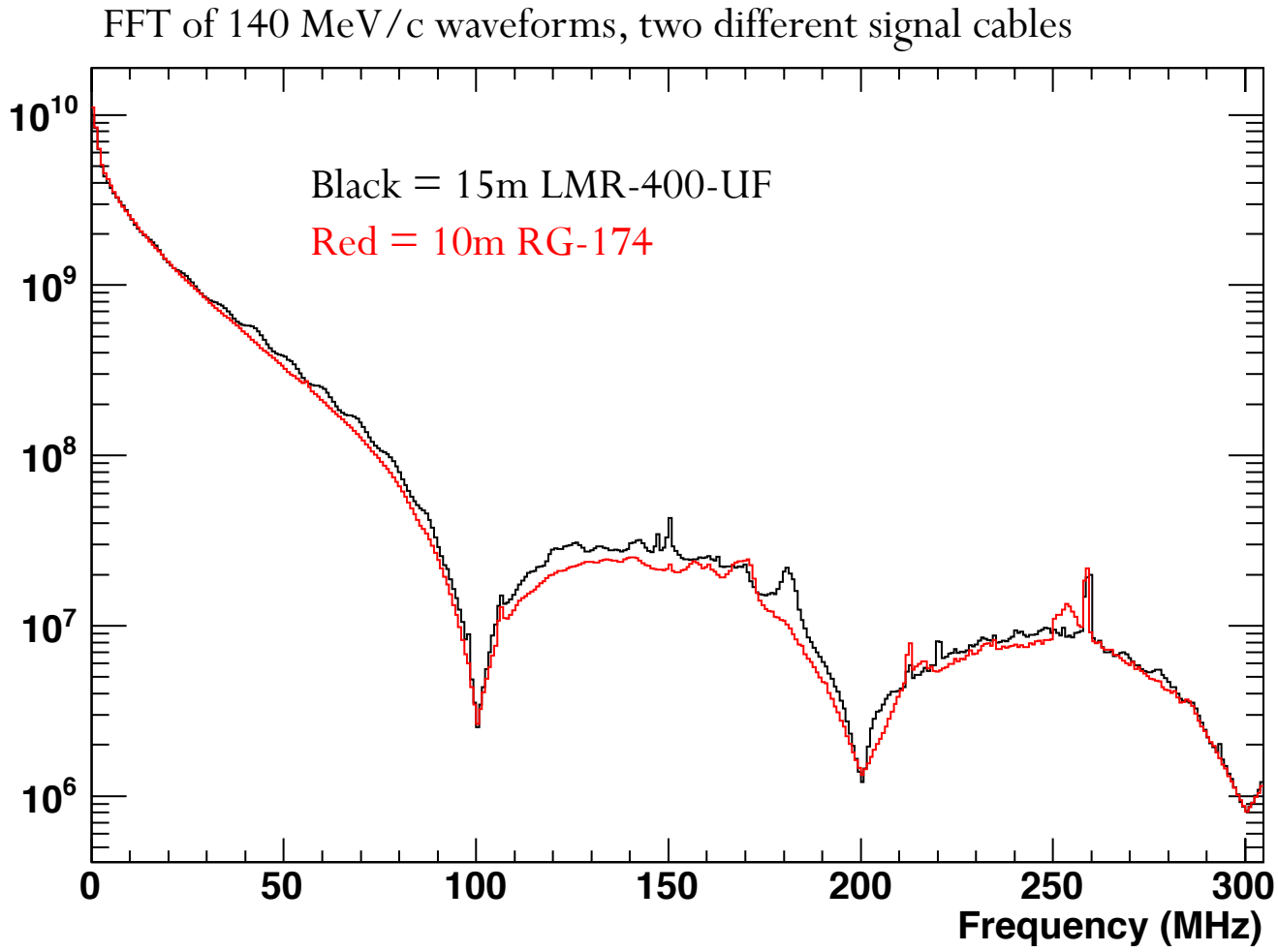


Signal cable test

- Ask for more beam test in July, if M11 is available.
- Use a 4 GHz bandwidth scope for digitizer.
- We are obtaining samples of a variety of signal cables. 10m length.

Cable	impedance (ohms)	diameter (mm)	db/10m at 1 GHz	
179DT	75	2.54	7.1	Sub-Miniature RG-59/U ← my choice
C1156	50	2.62	11.3	General Cable RG 174
1281R	75	2.9	5.3	75 Ohm Miniature Coax
1865A	75	3.81	4.6	Sub-Miniature RG-59/U
1855A	75	4.03	3.5	Sub-Miniature RG-59/U ← JP's choice
HVS	75	4.03	3.8	Holland Electronics mini coax
7806	50	4.95	3.7	RG-58
LMR-400-UF	50	10.29	1.7	Times Microwave Used in test beam

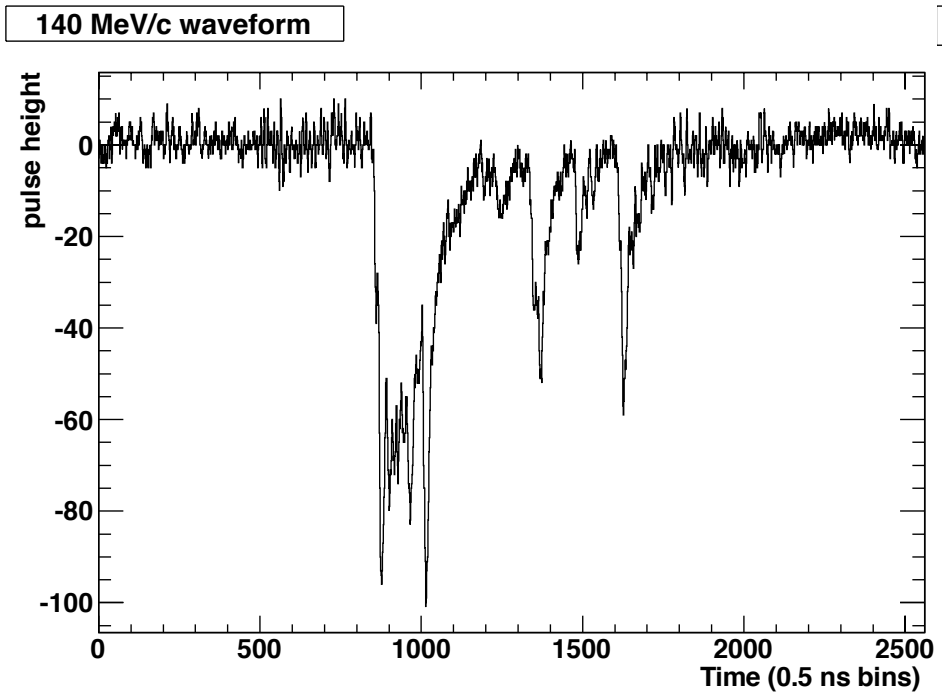
- We did test RG-174 in November; noticeably worse bandwidth than the standard cable/digitizer combination.
- I have not seen cluster counting performance comparison.

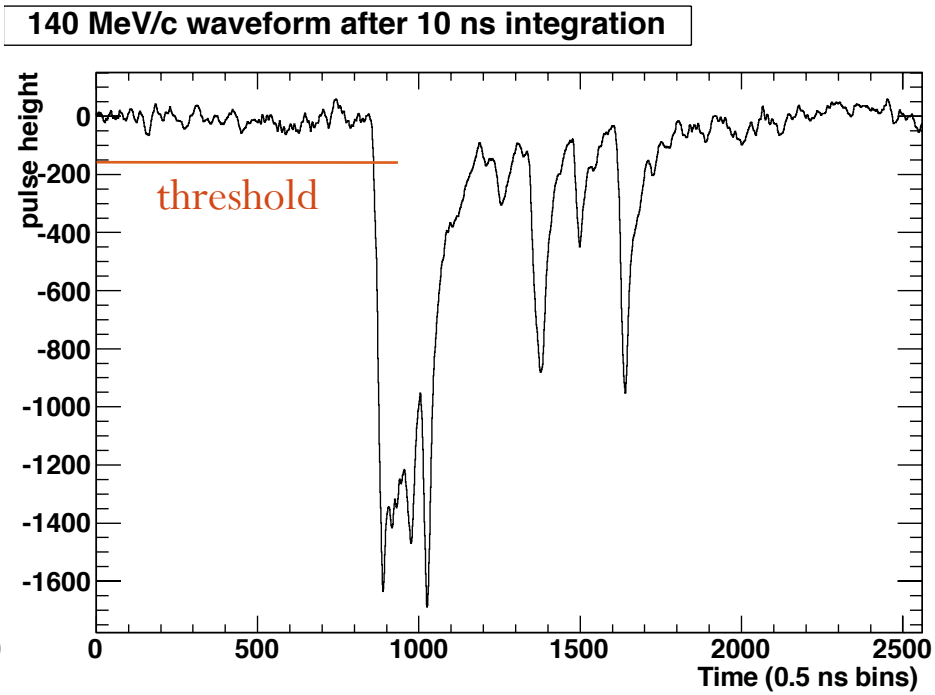


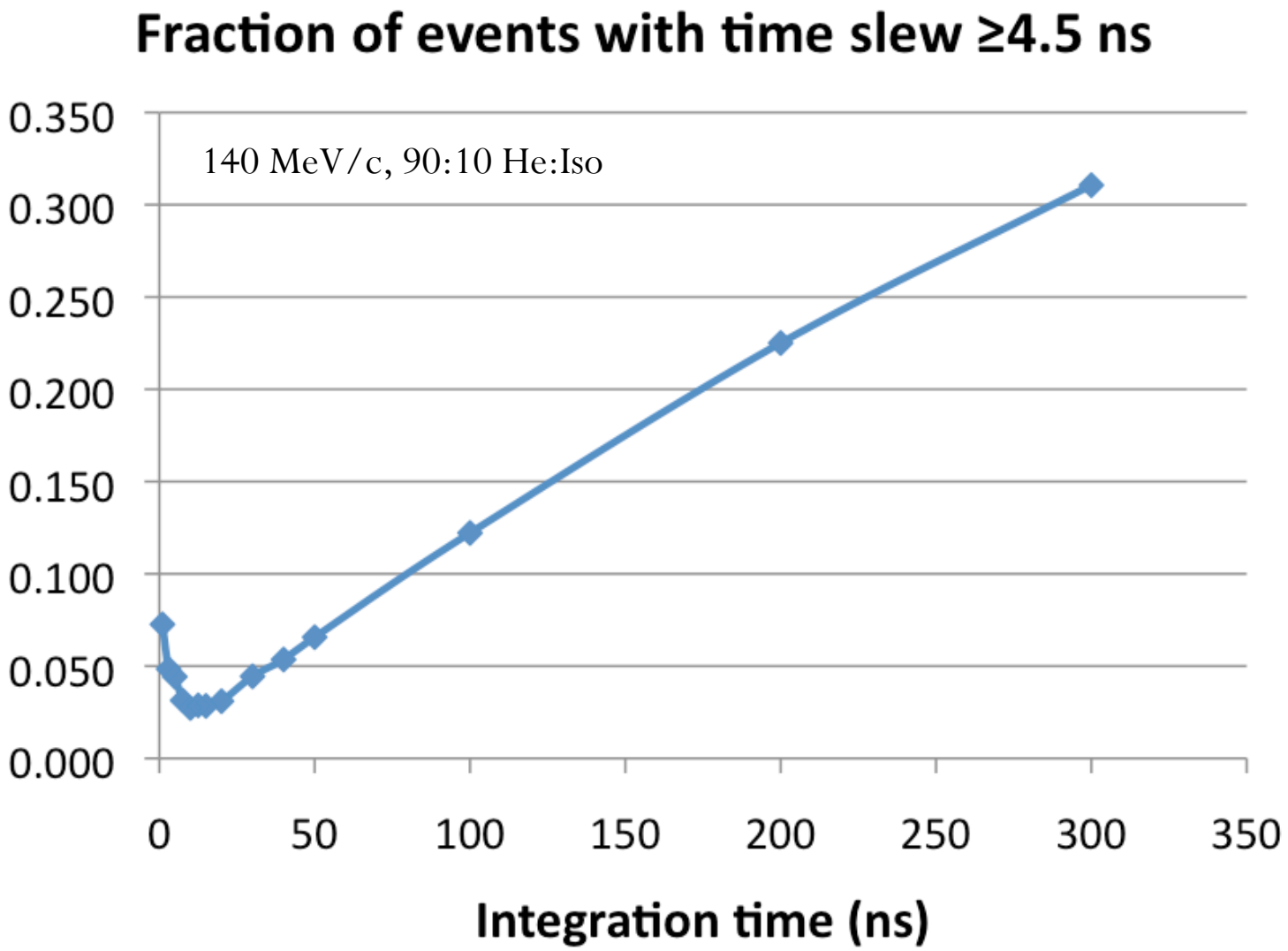
Noise

- Is the noise performance of the amplifier prototype adequate? And was shielding (25μm aluminum) adequate to suppress pickup?
- Evaluate using measurement of drift time t_d, defined as the time that the integrated waveform exceeds threshold (nominally $5\sigma_{noise}$)
- Do this for various integration times.
- Slew is defined as change in t_d as threshold is varied from $4.5\sigma_{noise}$ to $5.5\sigma_{noise}$.
- Hits with slew greater than 4.5 ns are considered lost.

140 MeV/c
He:Iso 90:10
0 deg dip angle
center window
Run 175



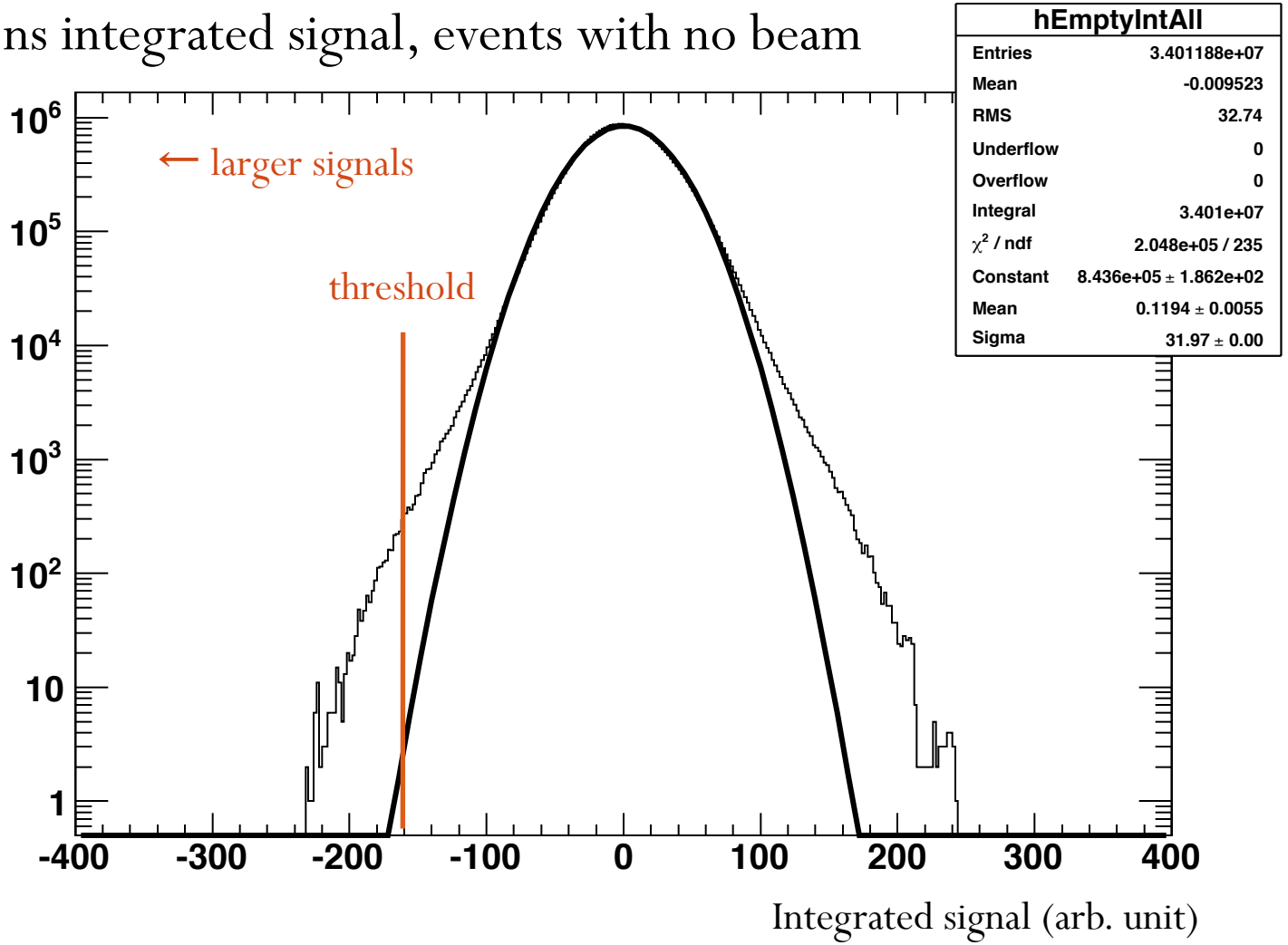




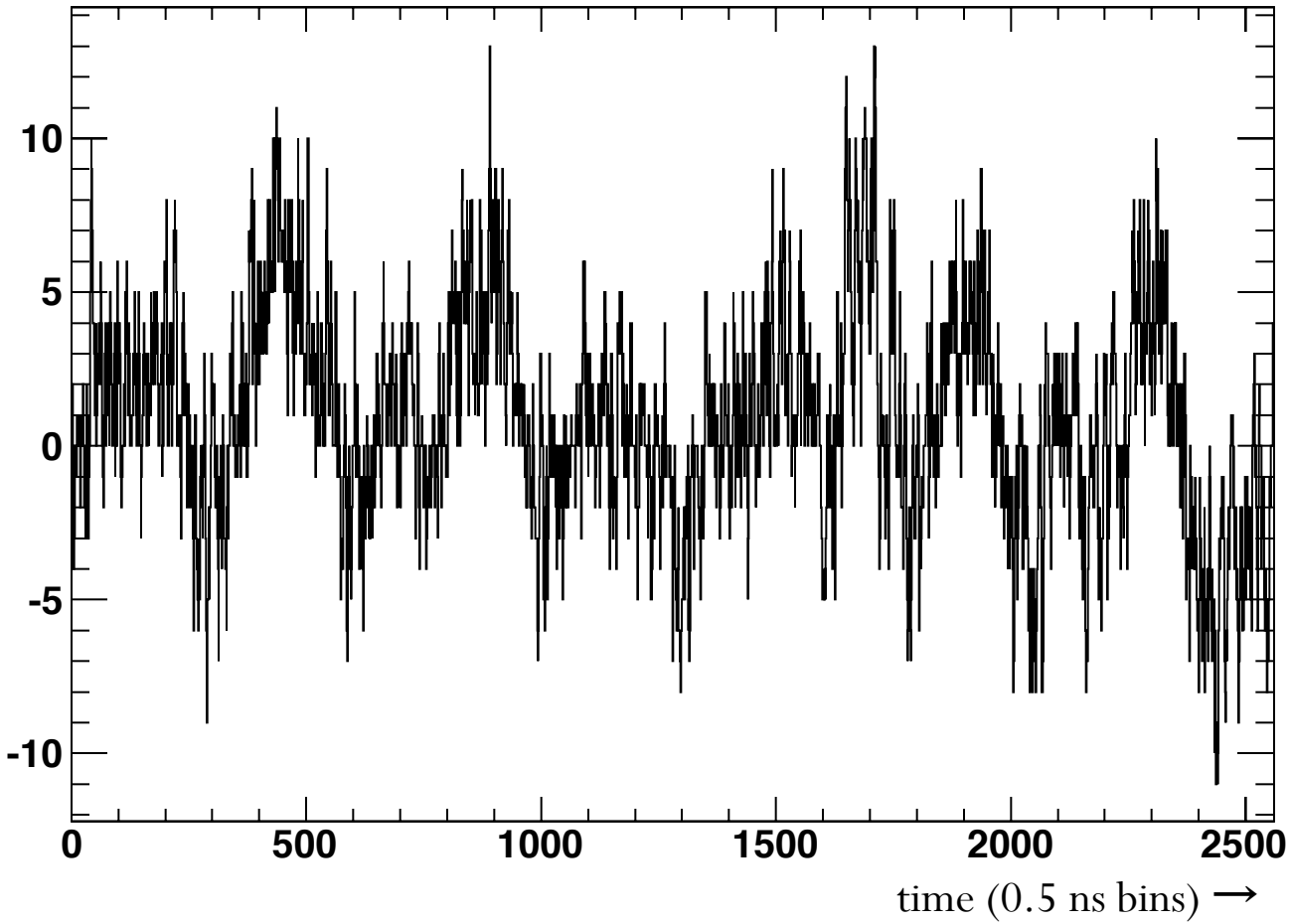
- 10 ns integration time is optimal
- Loss is 2.7%, comparable to BaBar.

- 1.25% of no-beam events satisfy threshold during 1.28 μs waveform.

10 ns integrated signal, events with no beam

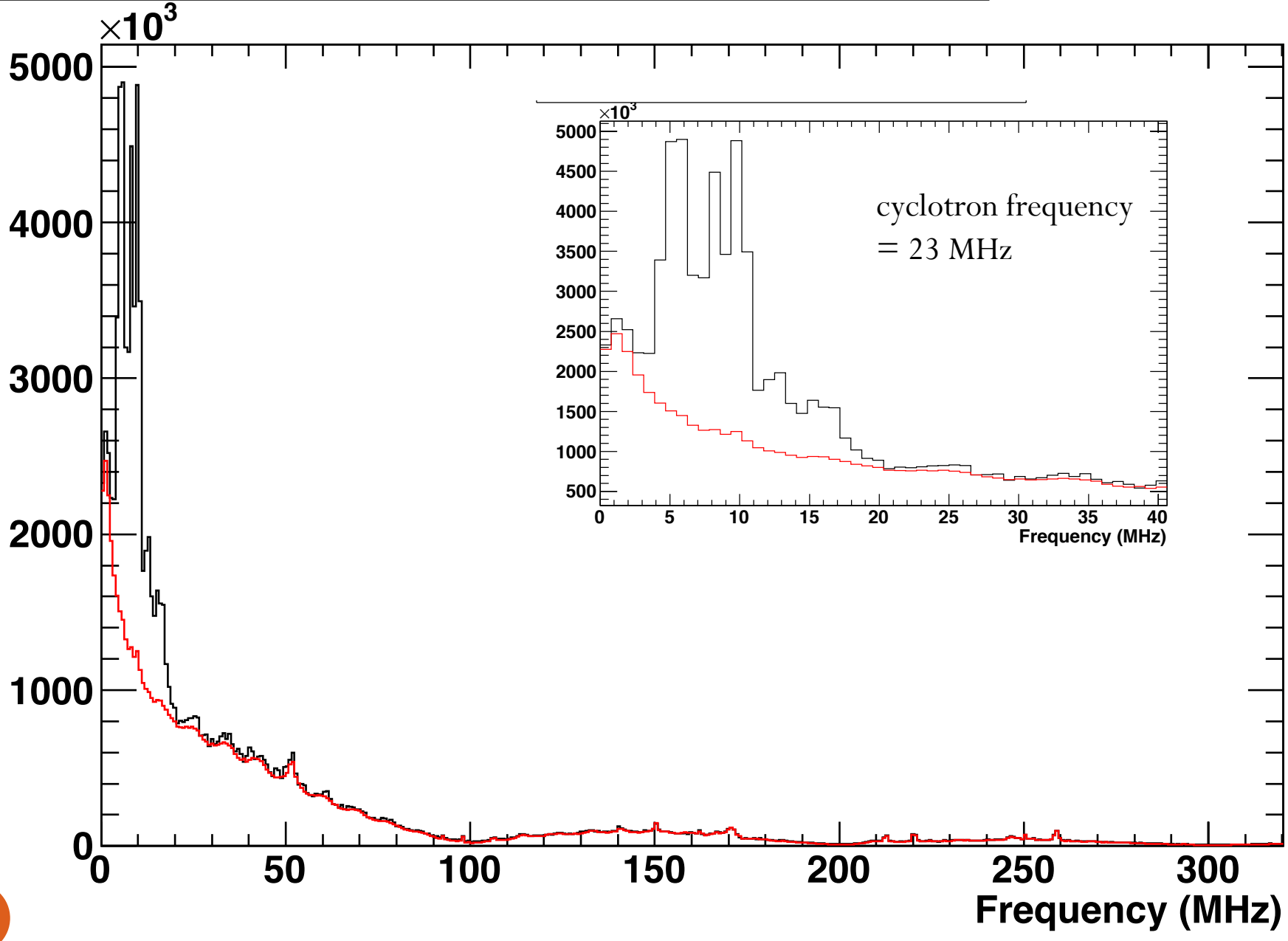


Example of a no-beam waveform that exceeds threshold



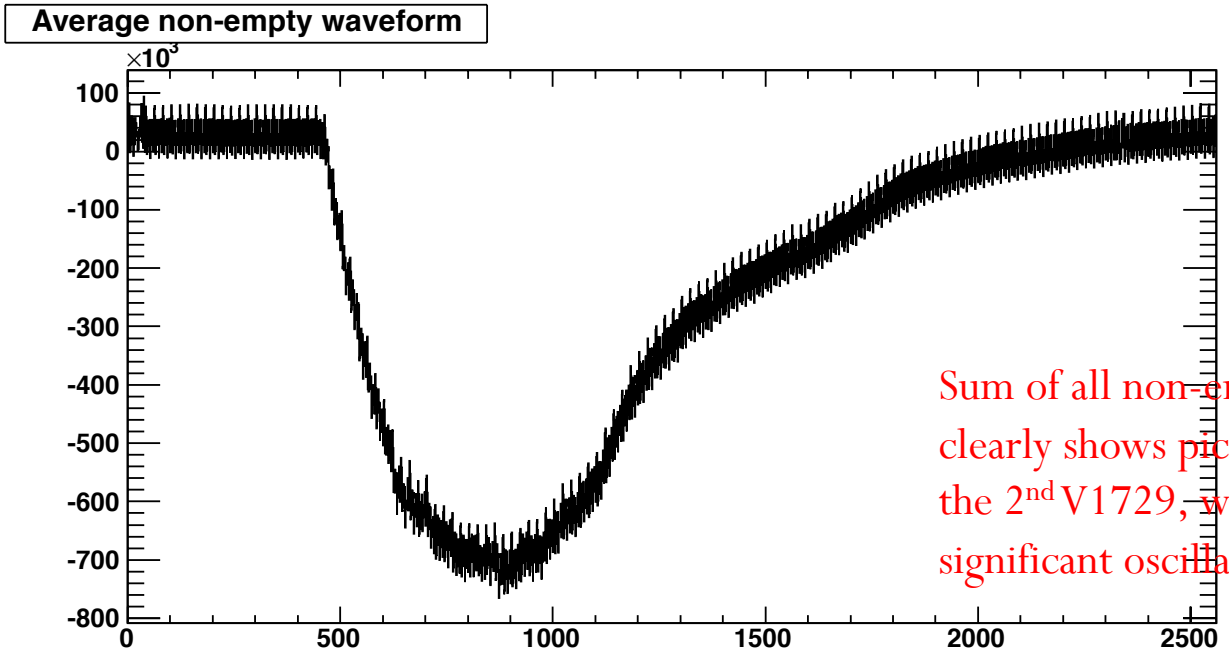
- Easily rejected by pattern recognition; total charge ≈ 0.

FFT no-beam events Run 219 (Black = noisy)

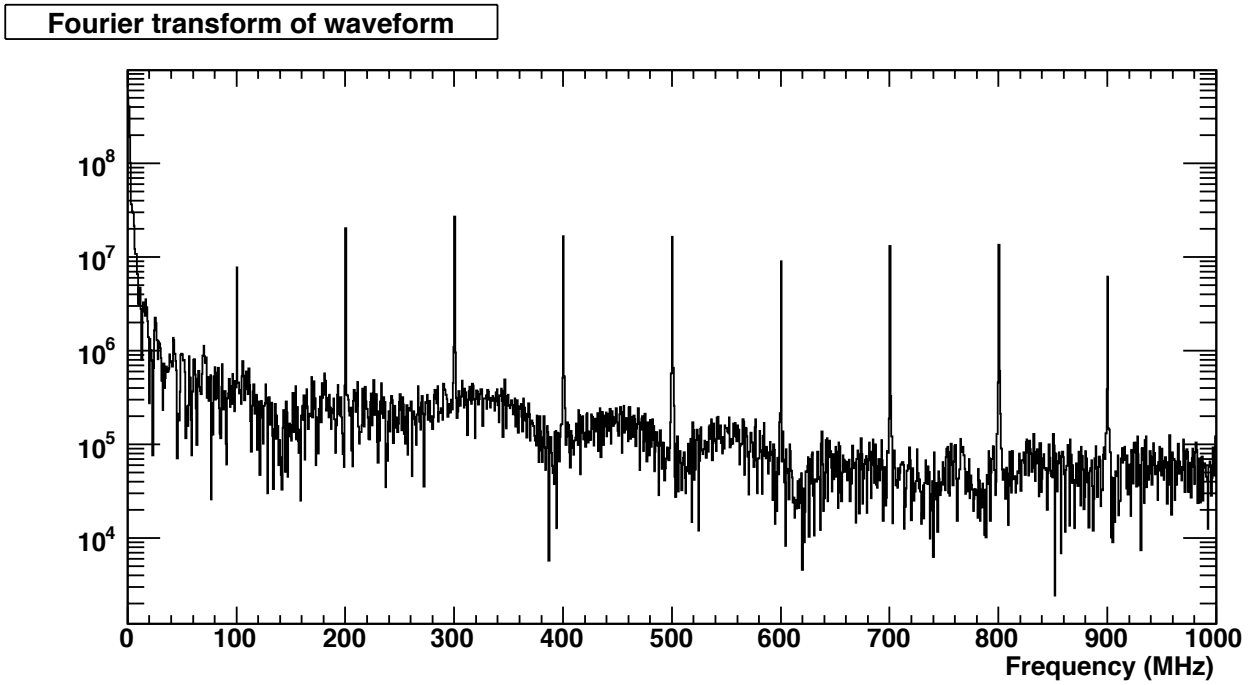


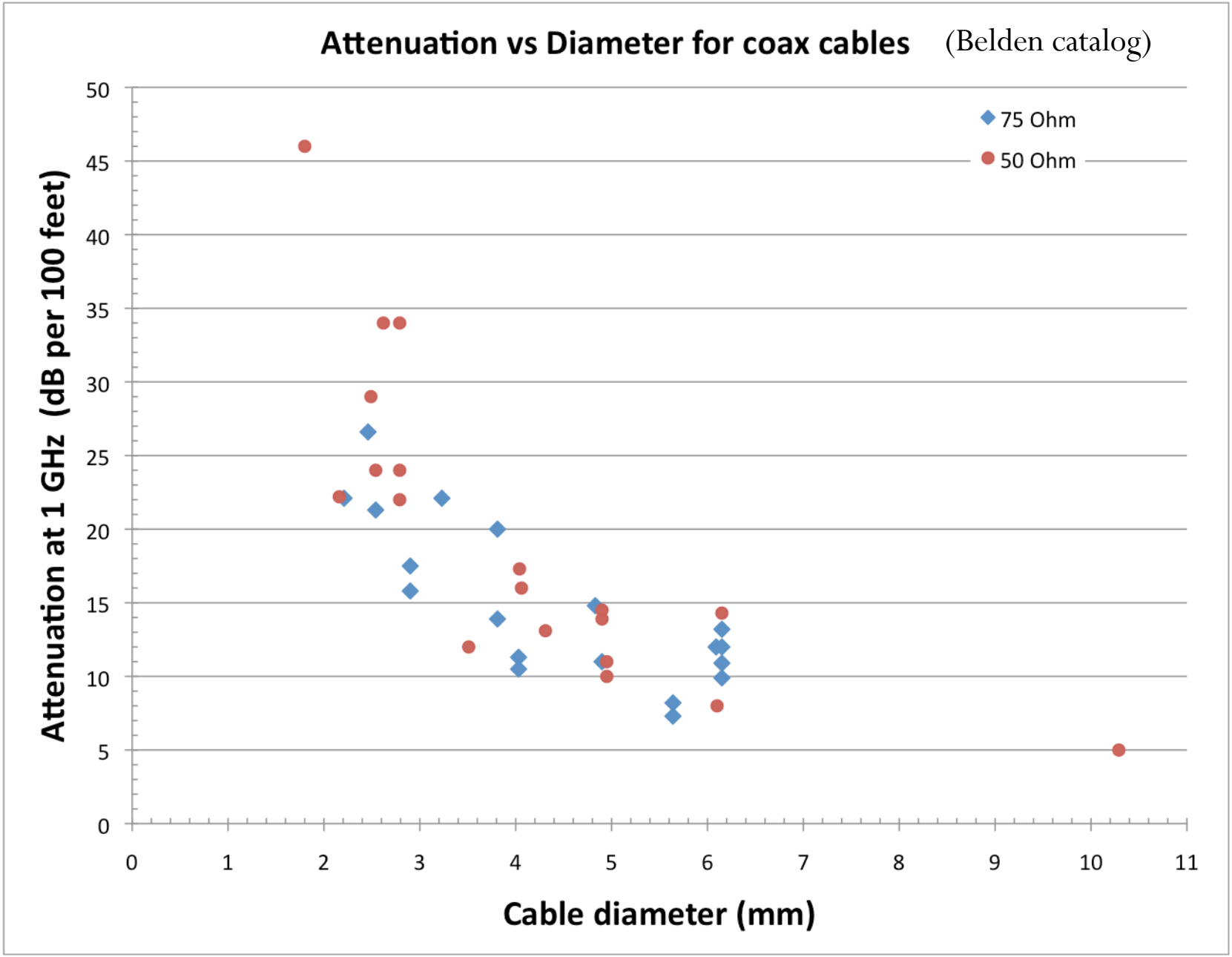
Summary

- Noise performance of amplifier is comparable to BaBar. Probably adequate.
- On the second prototype, we have seen that the noise observed on the scope depends on details of grounding and shielding. Including some ringing.
- Important to test packaging appropriate for the real chamber.
- Bandwidth studies have started, but we probably need more data.



Sum of all non-empty events clearly shows pickup from the 2nd V1729, which had significant oscillations




Attenuation vs Diameter for coax cables
(Belden catalog)
75 Ohm
50 Ohm
Attenuation at 1 GHz (dB per 100 feet)
Cable diameter (mm)
0
5
10
15
20
25
30
35
40
45
50
0
1
2
3
4
5
6
7
8
9
10
11