# ADAM IC installation and test at 160 MeV

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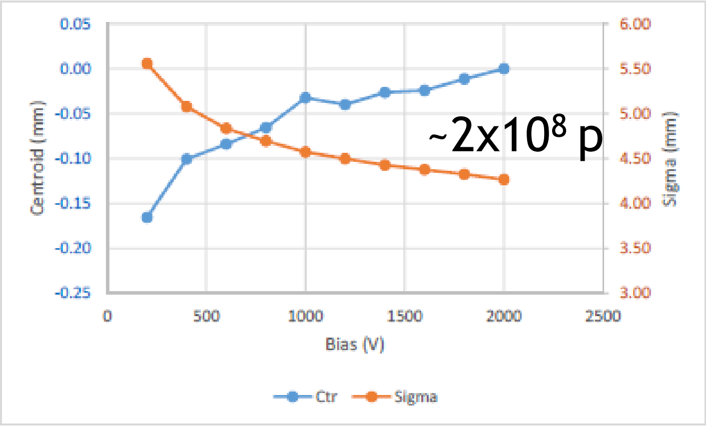
# IC Test @ 50 MeV (Dec. 2015)

- Goals
  - Understand the linearity, stability and repeatability of dosimetry measurements for LIGHT
  - Explore measures to improve performances (smaller electrode gaps and higher bias voltages, different fill gas)
- Issues
  - No definitive independent measure of the pulse charge
    - Issue with ACCT measurements (large 2 MHz interference)
  - Time structure of LIGHT pulses not fully reproduced
    - Short pulse superimposed on a much broader base
- Results
  - Recombination effects in the IC were observed
  - Changing to Helium filling appeared to help, but we experienced arcing inside the IC





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# Main goals @ 160 MeV

- Repeat measurements with a better charge quantitation setup
  - Use a Faraday beam collector to measure the beam pulse charge and time profile
- Try nitrogen and helium with a quench gas mix (He with 5% methane)
- Try the ACCT again with some means to eliminate the 2 MHZ interference
  - analogue notch filter at 2 MHz between the amplifier and the scope
  - new location (further from the source)
- Evaluate use of a diamond detector

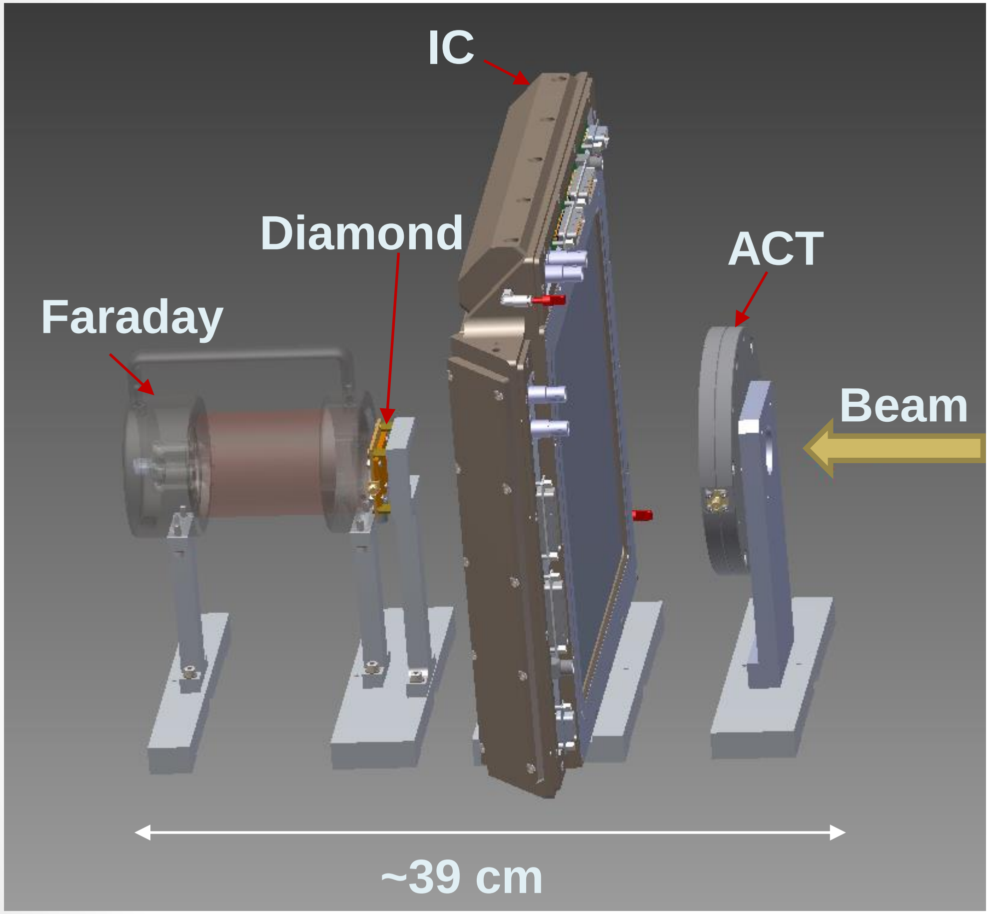
# Reminder: beam requirements



- Pulse length: ~2us
- Beam spot size: Gaussian distribution with $\sigma \approx 3mm$
- Pulse integrated charge: ~$10^6$ -$10^9$ p
- Trigger signal 200 µs before the beam pulse (every 1.2 seconds)

→ Linac4 operating well outside its normal envelope
(No direct measure of pulse charge from Linac4 diagnostics)

# New layout with in-air Faraday collector and diamond detector

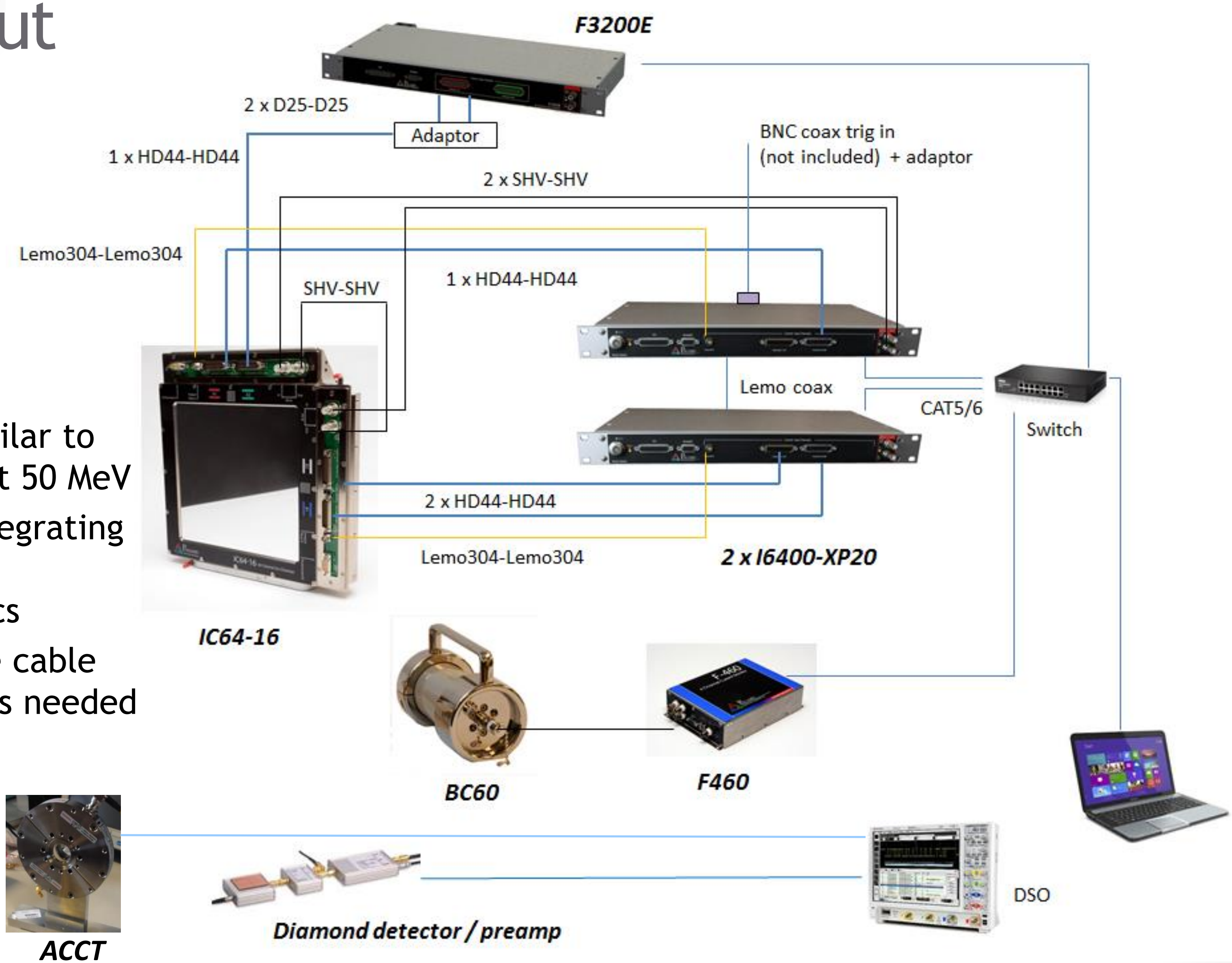



**BC-60 Faraday**
(provides independent absolute measure of the beam charge)

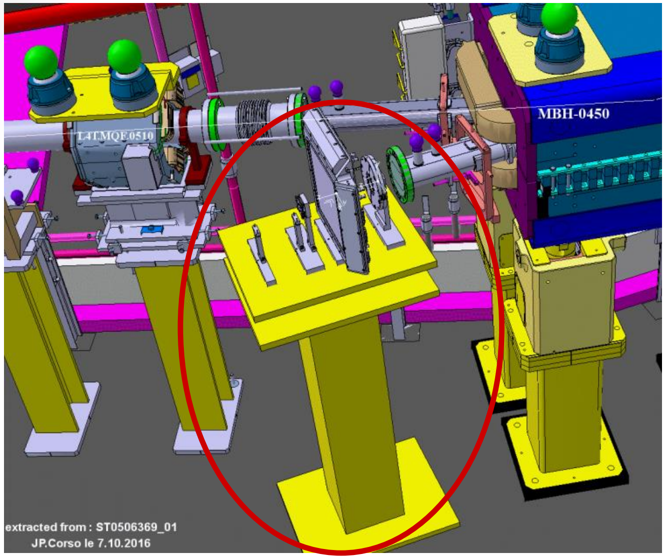
The parts will be installed in a new support (under design)

# Readout

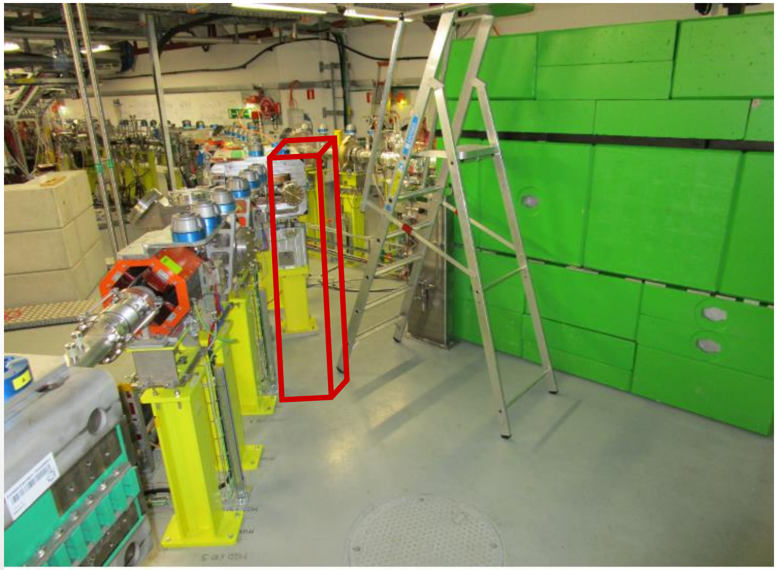
- Setup similar to the one at 50 MeV
- Mix of integrating and fast electronics
- Few more cable extensions needed



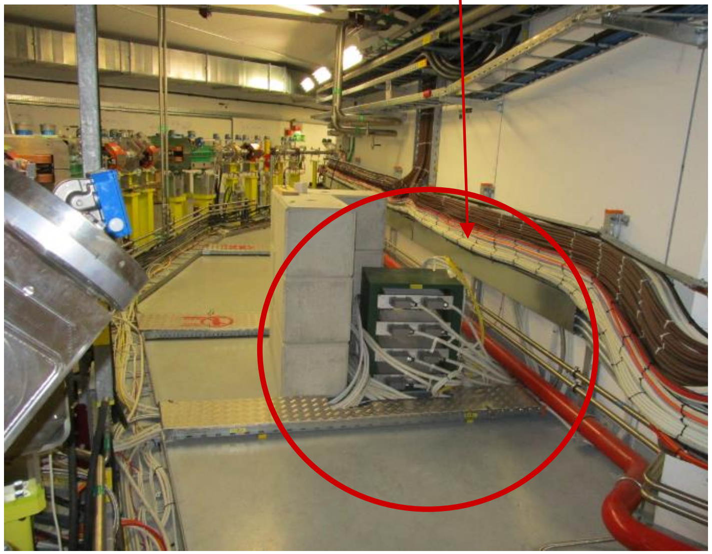
# New Position in the Linac4 tunnel




Integration study (JP Corso)

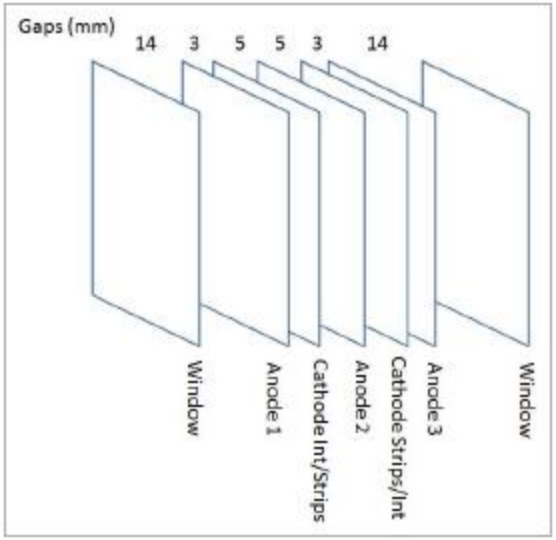


Position proposed for
small electronics devices



# Backup

# Material Budget



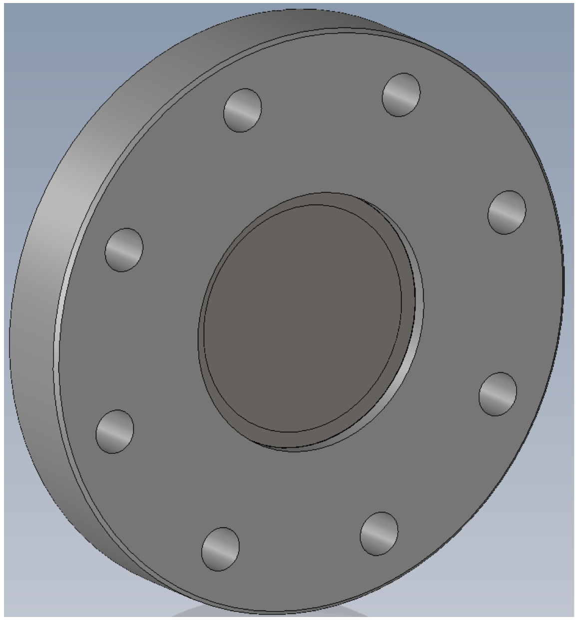

| | | |
|---|---|---|
| 1 | 12.5 µm | Polyimide foil aluminized both sides 0.1 µm (window) |
| 2 | 14 mm | Fill gas |
| 3 | 12.5 µm | Polyimide foil aluminized both sides 0.1 µm (anode 1) |
| 4 | 3 mm | Fill gas (active gap) |
| 5a | 0.1 µm | Aluminization (integral plane cathode) |
| 5b | 25 µm | Polyimide foil |
| 5c | 0.1 µm | Aluminization (strip cathode) |
| 6 | 5 mm | Fill gas (active gap) |
| 7 | 12.5 µm | Polyimide foil aluminized both sides 0.1 µm (anode 2) |
| 8 | 5 mm | Fill gas (active gap) |
| 9a | 0.1 µm | Aluminization (strip cathode) |
| 9b | 25 µm | Polyimide foil |
| 9c | 0.1 µm | Aluminization (integral plane cathode) |
| 10 | 3 mm | Fill gas (active gap) |
| 11 | 12.5 µm | Polyimide foil aluminized both sides 0.1 µm (anode 3) |
| 12 | 14 mm | Fill gas |
| 13 | 12.5 µm | Polyimide foil aluminized both sides 0.1 µm (window) |

Total effective thickness < 250 µm water equivalent

# IC Description

- Insertion length: 50.4 mm (housing face to face)
- Sensitive area: 160 mm x 160 mm
- Dimensions: 330 m x 330 mm x 78 mm
- Weight: 3.8 Kg (excluding any added mounting brackets)
- High Voltage: 2000V nominal, 3000V maximum
- Filling gas: dry atmospheric air (N, He)
- Operating environment: clean and dust-free, 0 to 35 C (15 to 25 C recommended, < 70% humidity
- Material
  - IC body is Ni-plated aluminum
  - Details (see backup slide)

# Vacuum windows



- 50 um stainless steel window (DN63CF flange)
  - Already used during the tests at 50 MeV

# Issues with ACCT measurement

- Bergoz AC transformer installed in air
  - read out by fast digital scopes with built-in filtering functions (LeCroy and Pico)

- ACCT signal hidden in a large 2 MHz interference generated by the ECR ion source
  - Signal pulse could be seen only after filtering out the noise

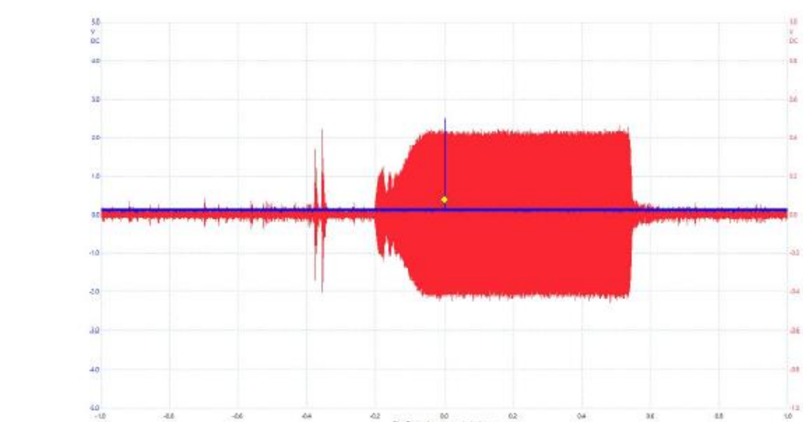


*Fig 5. Burst of 2 MHz noise seen on AC transformer. Red signal, blue trigger.*

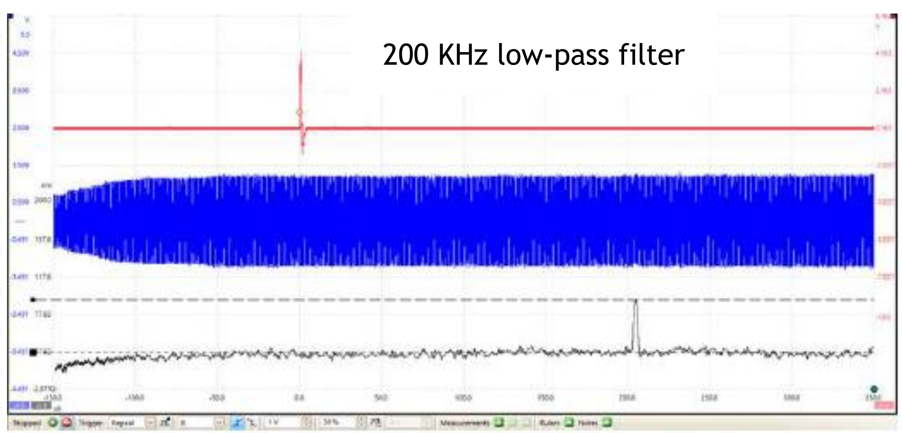



*Fig 10. AC transformer pulse recovered by low-pass filtering. Setting S5*





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# Issues with pulse structure

- The requested short pulse was superimposed on a much broader base that preceded and followed the short pulse and was convolved with the IC ion drift. This compromised attempts to extract information on the actual current density
- Inconsistency between beam pulse charge estimated based on IC readings at maximum bias voltage plus calculated gains, and integrals of filtered AC transformer data. This probably reflects incomplete signal recovery from noise for the ACT, but may also indicate some multiplication occurring in the helium (Zwaska et al, IEEE Trans Nucl Sci, 50.4, (2003) 1129).

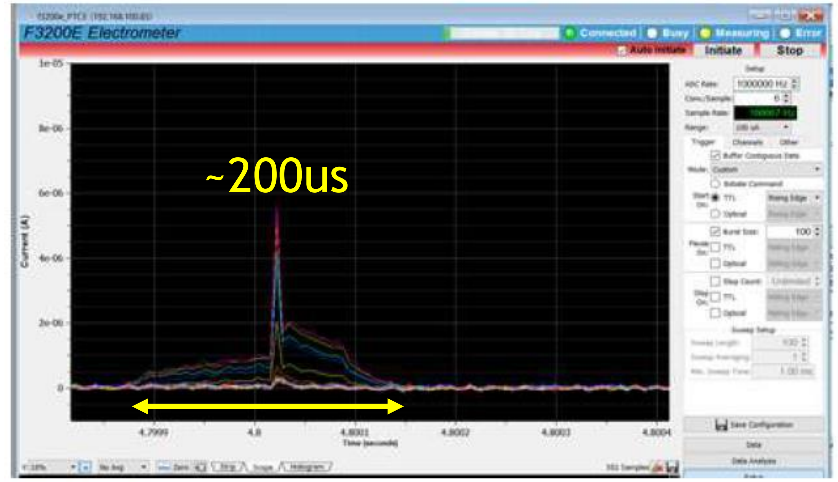


*Fig 12. IC response with small mesa.*

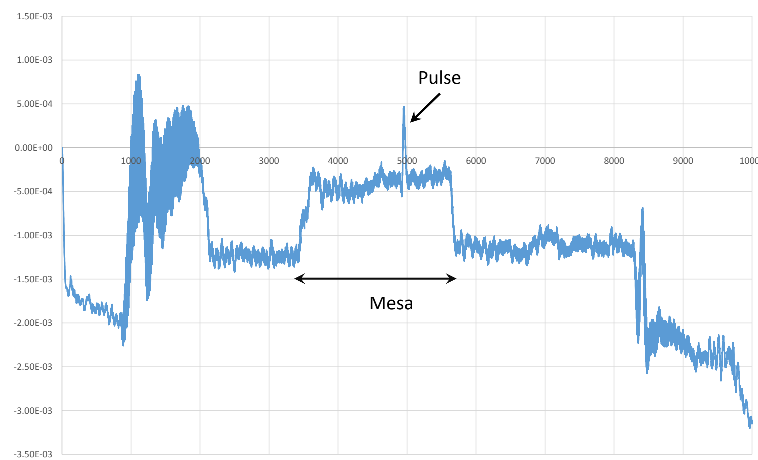


*Fig 11. AC transformer pulse recovered by low-pass filtering (LeCroy). Setting S18*

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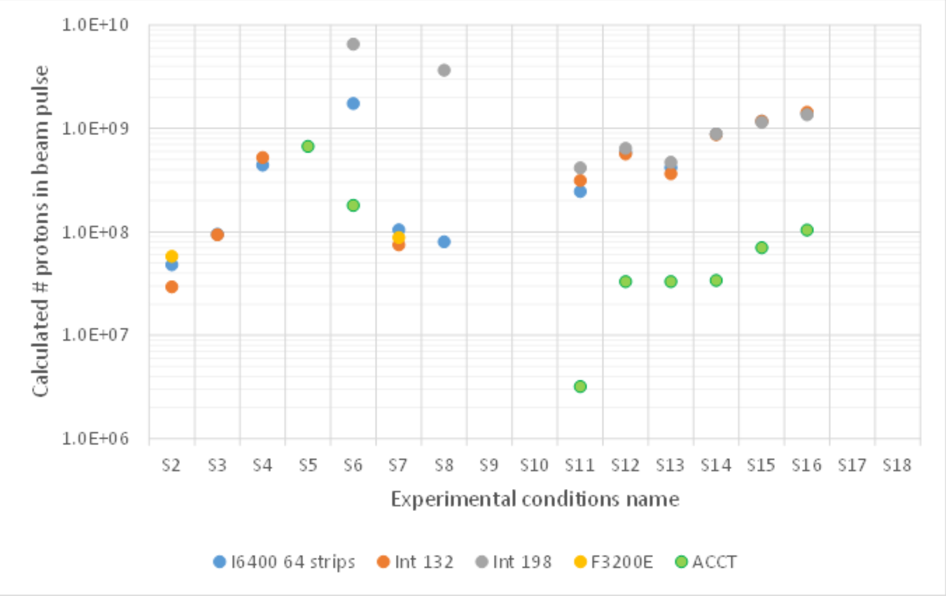
# Inconsistent pulse charge information

- In the absence of a reliable independent measure of the charge in the pulse, we tried to recover information from the device under test (the IC) using theoretical gains. The results were inconsistent and unsatisfactory, so we must introduce a reliable means of measuring the charge in each pulse for any further tests.

| Setting | ACT | I6400 64 strips | Int 132 | Int 198 | F3200E | ACCT |
|---|---|---|---|---|---|---|
| S2 | | 4.80E+07 | 2.93E+07 | | 5.80E+07 | |
| S3 | | 9.46E+07 | 9.38E+07 | | | |
| S4 | | 4.43E+08 | 5.23E+08 | | | |
| S5 | | | | | | 6.72E+08 |
| S6 | | 1.75E+09 | | 6.53E+09 | | 1.80E+08 |
| S7 | T13 | 1.05E+08 | 7.50E+07 | | 8.83E+07 | |
| S8 | T15 | 8.01E+07 | | 3.65E+09 | | |
| S9 | T17 | | | | | |
| S10 | T18 | | | | | |
| S11 | T19 | 2.46E+08 | 3.14E+08 | 4.14E+08 | | 3.20E+06 |
| S12 | T20 | 5.88E+08 | 5.67E+08 | 6.44E+08 | | 3.30E+07 |
| S13 | T21 | 4.18E+08 | 3.65E+08 | 4.69E+08 | | 3.30E+07 |
| S14 | T22 | 8.84E+08 | 8.70E+08 | 8.85E+08 | | 3.40E+07 |
| S15 | T23 | 1.17E+09 | 1.18E+09 | 1.14E+09 | | 7.05E+07 |
| S16 | T24 | 1.39E+09 | 1.43E+09 | 1.36E+09 | | 1.04E+08 |
| S17 | | | | | | |
| S18 | T25 | | | | | |







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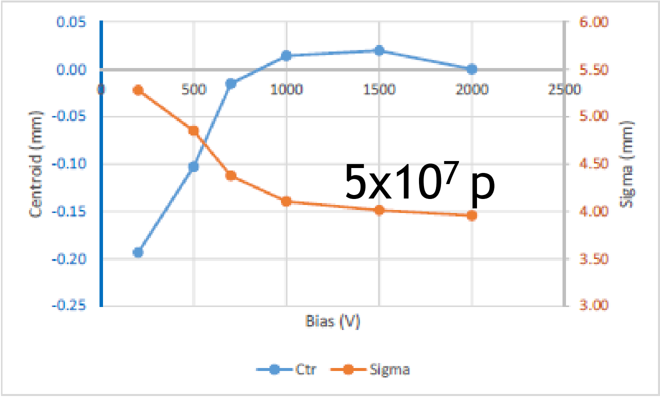
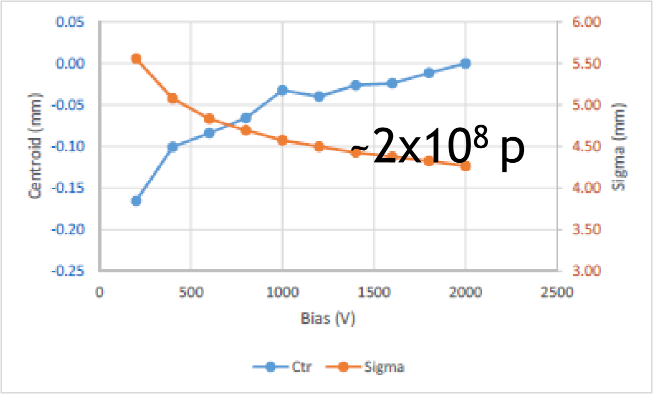
# Test results

- Recombination effects in the IC can be seen to affect the measurement of beam charge, beam position and beam width.




- Changing to Helium filling appeared to decrease the gain and extend range considerably, but we experienced arcing inside the IC.  There may also have been unanticipated gas multiplication, but it was hard to deconvolve the competing effects.

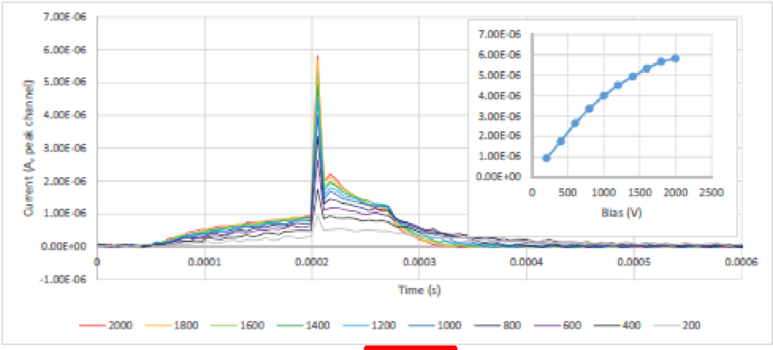



*Fig 14.  IC saturation and pulse profile, air filling, setting S2*

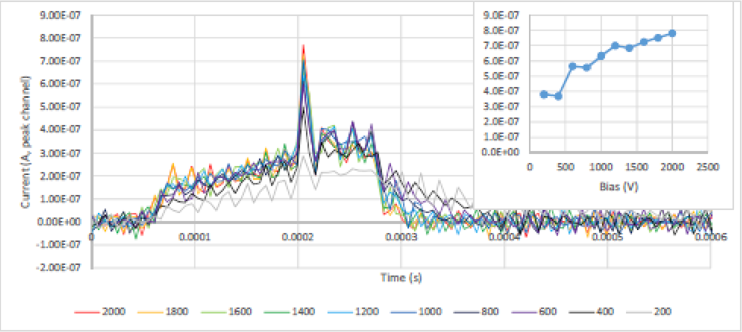



*Fig 15.  IC saturation and pulse profile, helium filling, setting S7*