Overview of the TRIUMF beam test

Christopher Hearty

University of British Columbia/IPP

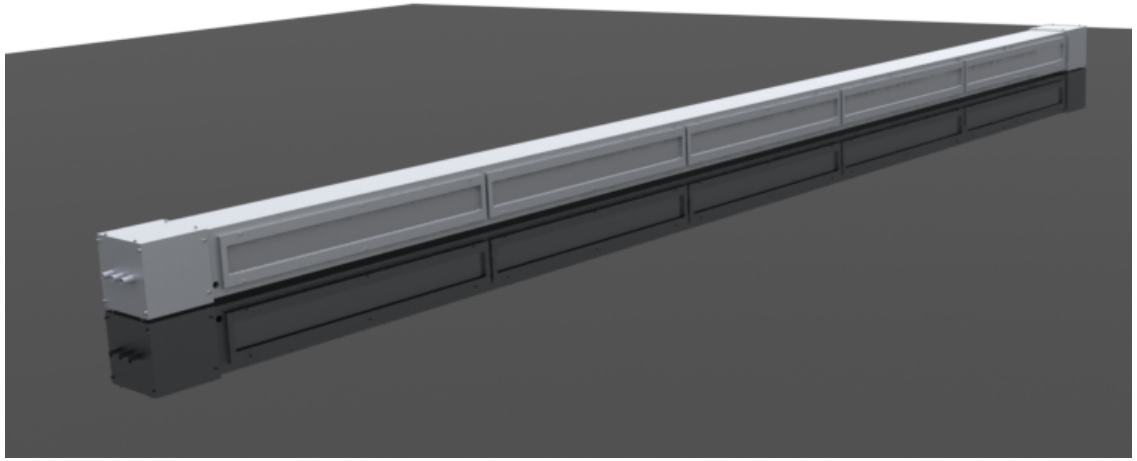
13-Dec-2011

Goal

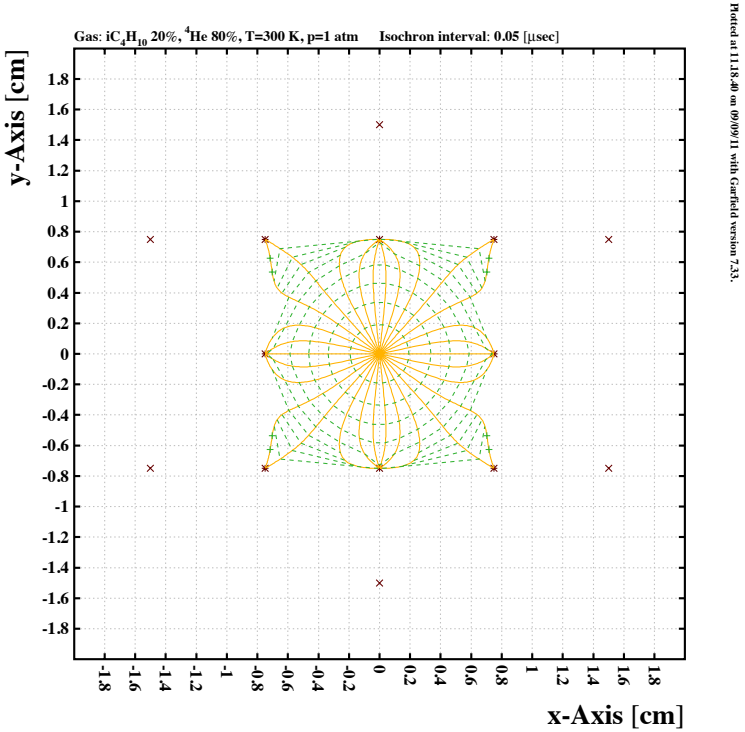
- Test the particle ID performance of a full-length single-cell drift chamber prototype using a prototype amplifier.

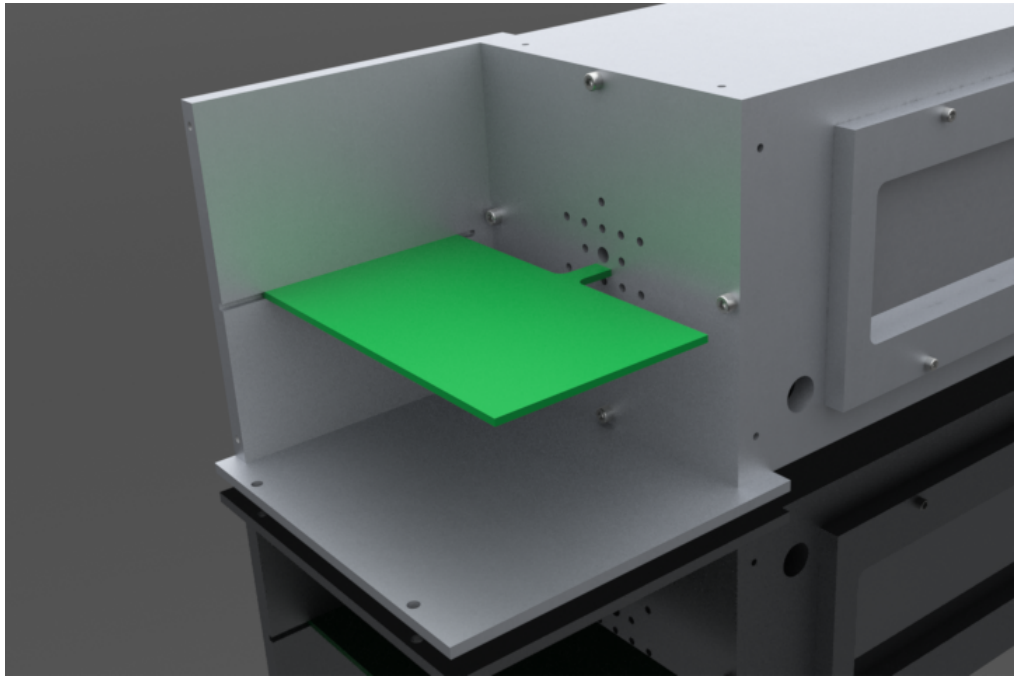
Prototype

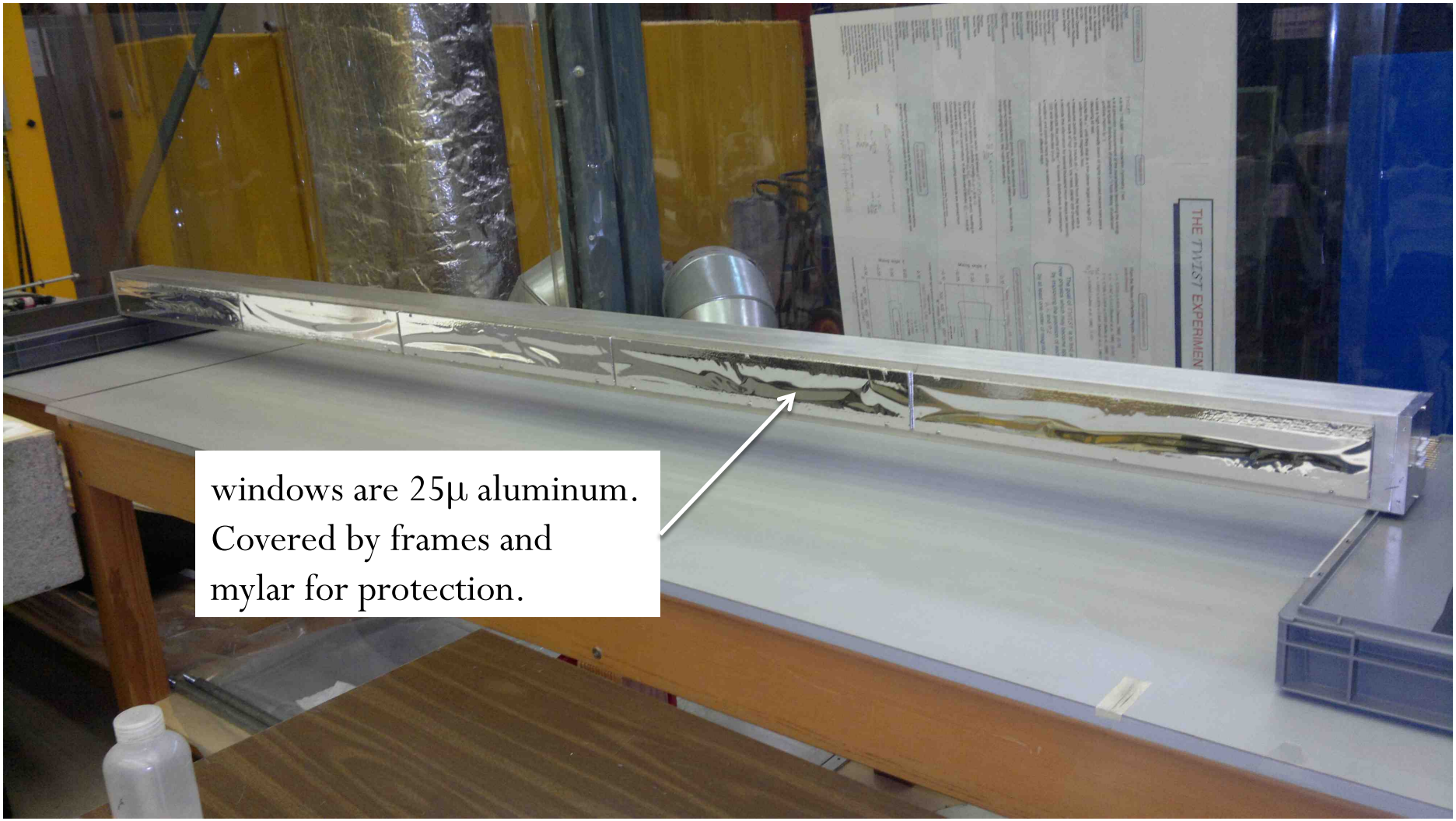
- 2.7m long, single cell.
- 15 mm x 15 mm square cell, 3:1 field/sense
  - 80 micron gold-plated aluminum field and bias wires. 86 g tension.
  - 25 micron gold-plated molybdenum sense wire. 27 g.
- Bias wires are adjusted to make the field map in the cell look like a large chamber.
- Five windows (25 micron aluminum), protected by mylar.
- Amplifier prototype produced by Jean-Pierre Martin (Montreal). Some data also collected with a commercial amplifier (Wenteq).

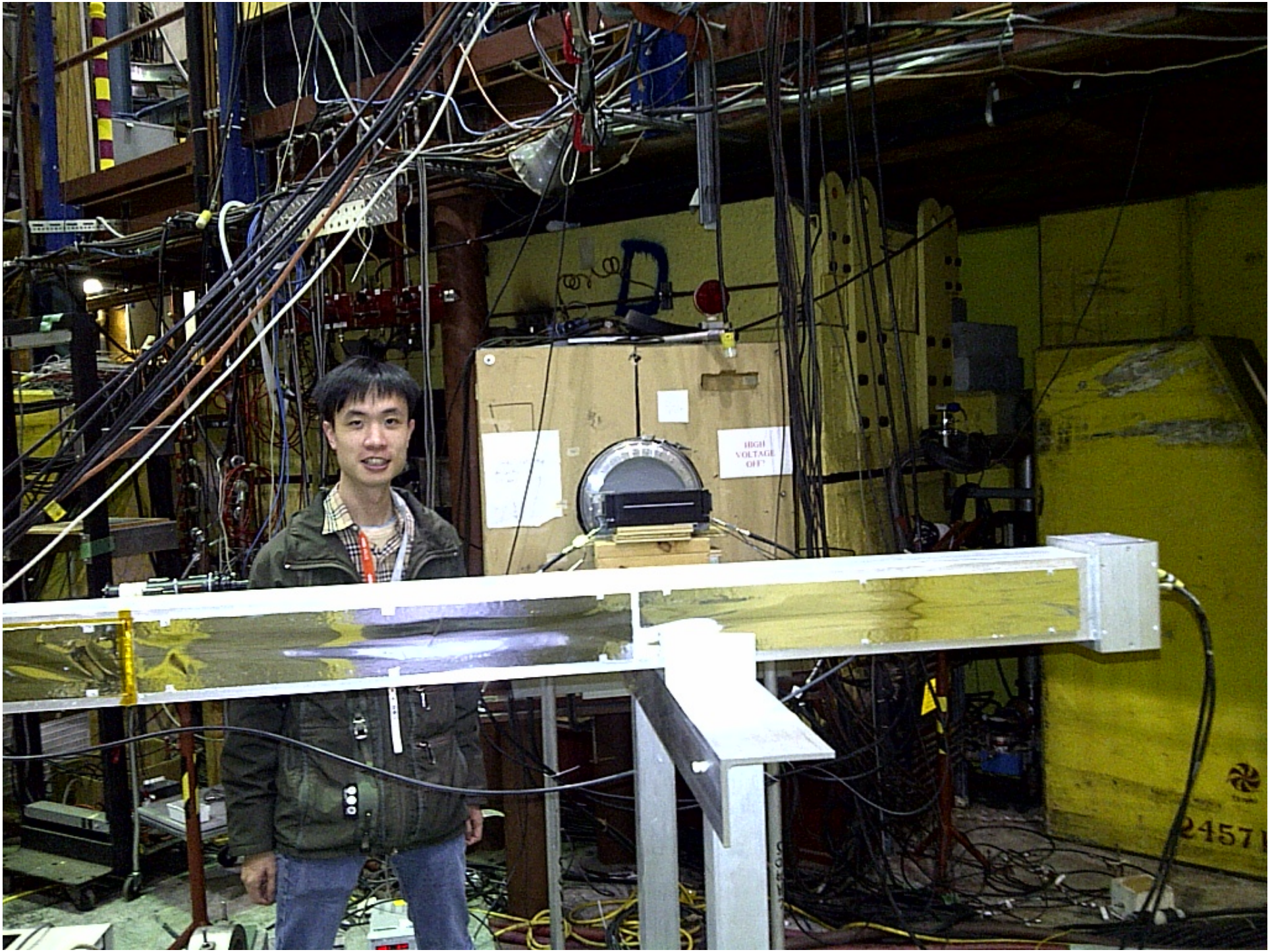


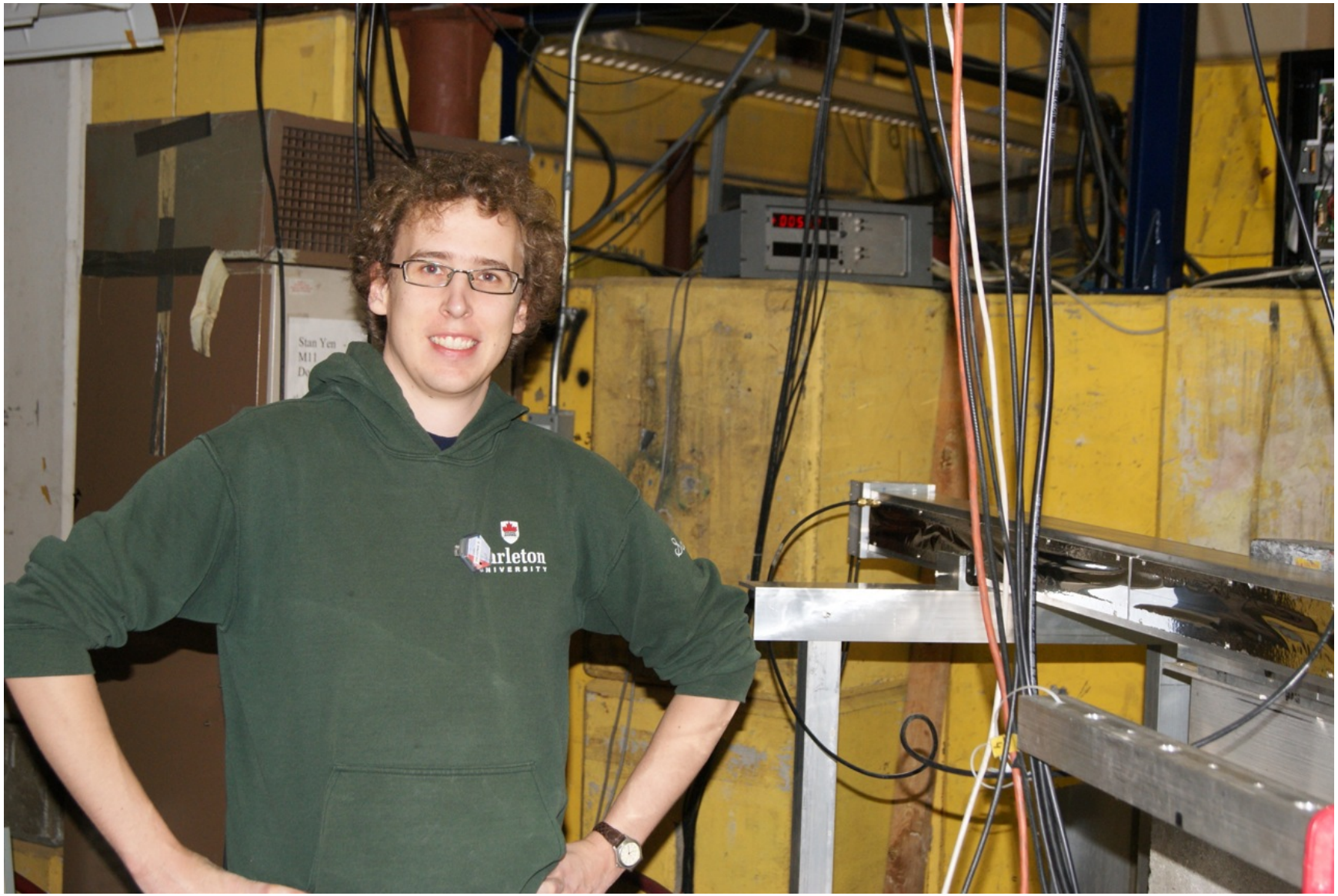
Positron drift lines from a wire

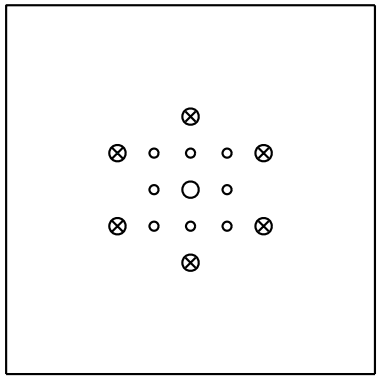





windows are 25μ aluminum.
Covered by frames and
mylar for protection.


HIGH
VOLTAGE
OFF


Stan Yen
M11
arleton
UNIVERSITY

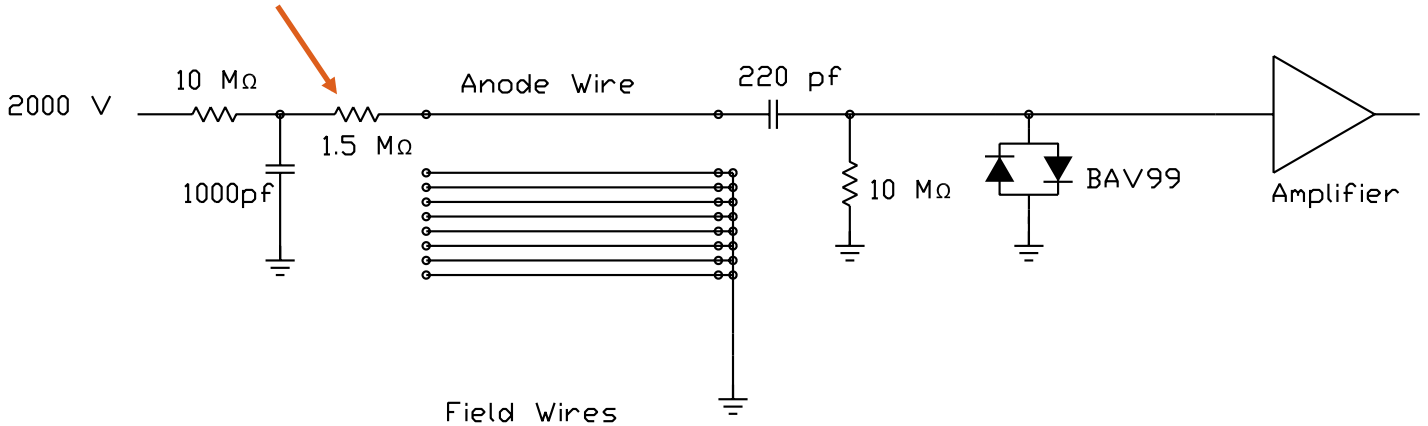


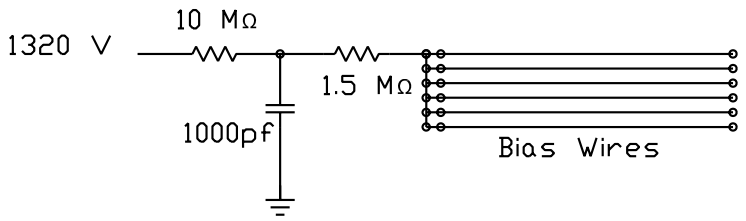
o Anode Wire

o Field Wires, bussed together and grounded

⊗ Bias Wires, bussed together and at +1320 Volts

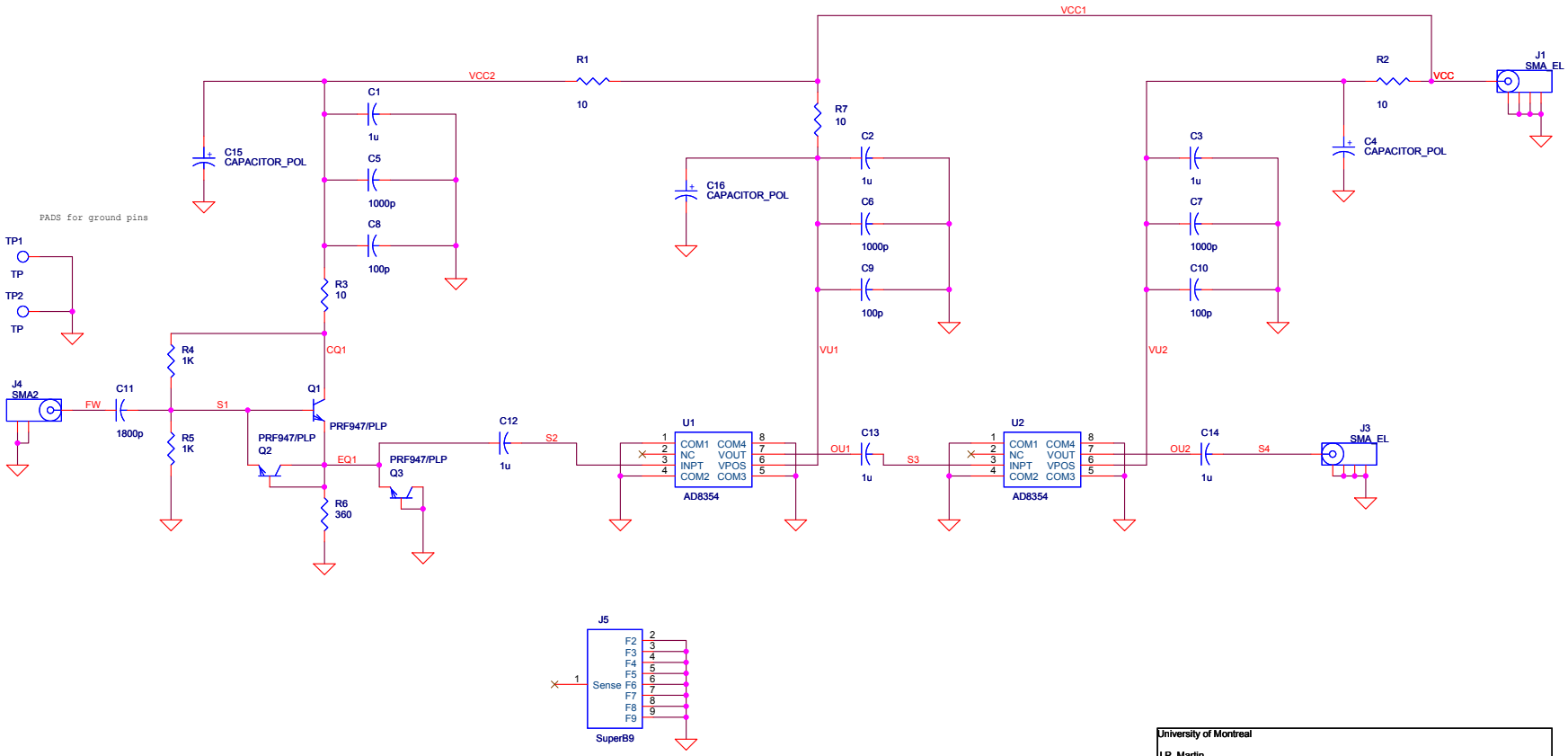
Generally terminate the non-amplifier end by replacing this with a 390 ohm resistor





Wayne Faszer
9/12/2011

power consumption = 30 mA @ 3.5V
= 100 mW



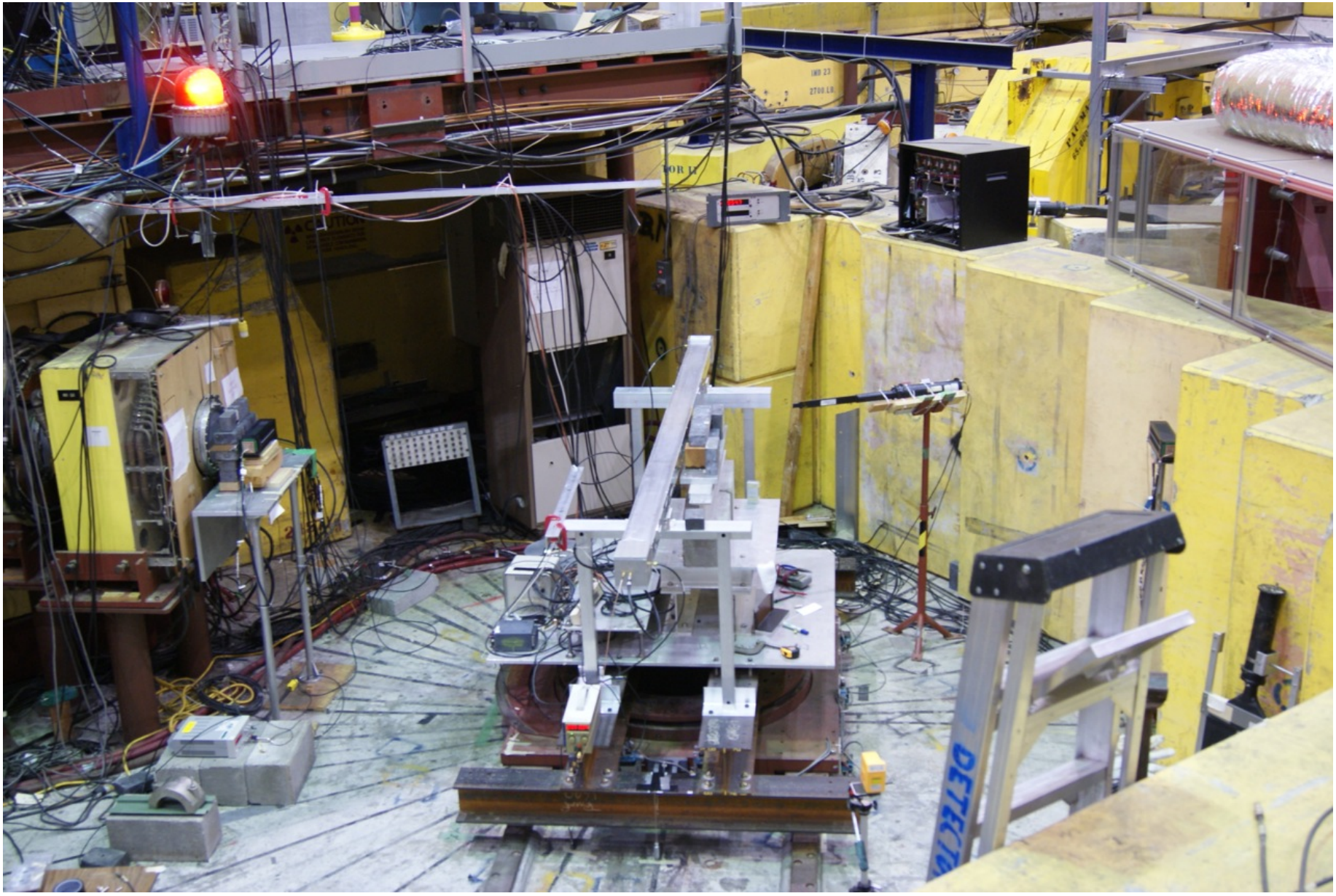
University of Montreal		
J.P. Martin		
Title: SuperB Preamplifier		
Size: B	Document Number: SuperB_PA1	Rev: 0
Date: Wednesday, September 28, 2011	Sheet 1 of 1	

Operations

- We had control of the beam from Nov 15 – Dec 5, but we actually recorded data with JP1 amplifier only from Nov 28 – Dec 3.
- Many start up problems.
  - gas system leak
  - HV problem on amplifier prototype
  - low tension in a field wire
- Most shifts taken by four graduate students: Alexandre Beaulieu, Jean-Francois Caron, Sam DeJong, and Rocky So. Plus Mike Roney, and assistance from Wayne Faszer.
  - two 8-hour shifts per day, plus a long run over night.

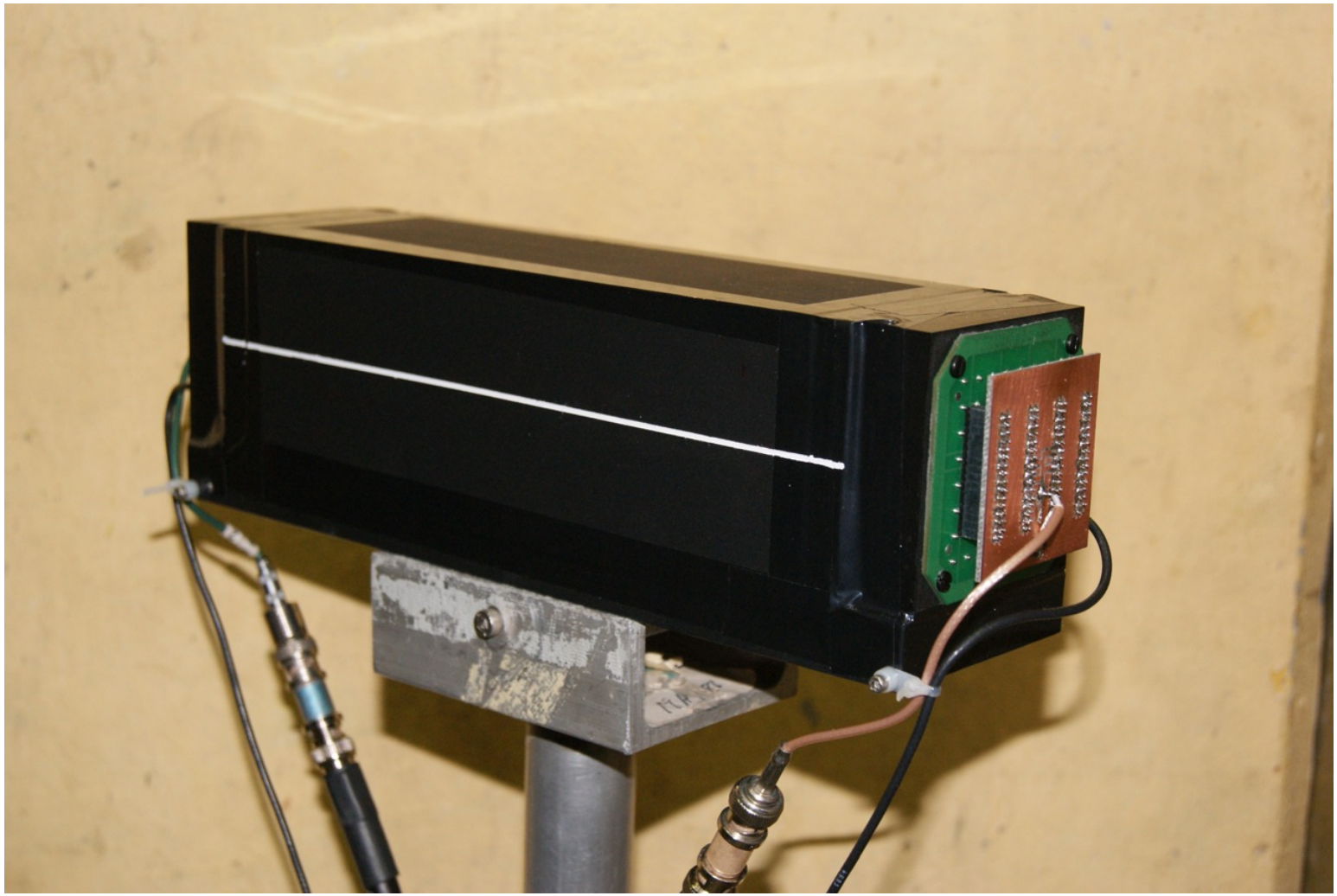
Operations II

- Three different He:Iso gas mixtures. Gain ~ 2×10^5.
  - 80:20 sense = 2100 V bias = 1195 V
  - 90:10 sense = 1800 V bias = 2013 V
  - 95:5 sense = 1580 V bias = 898 V



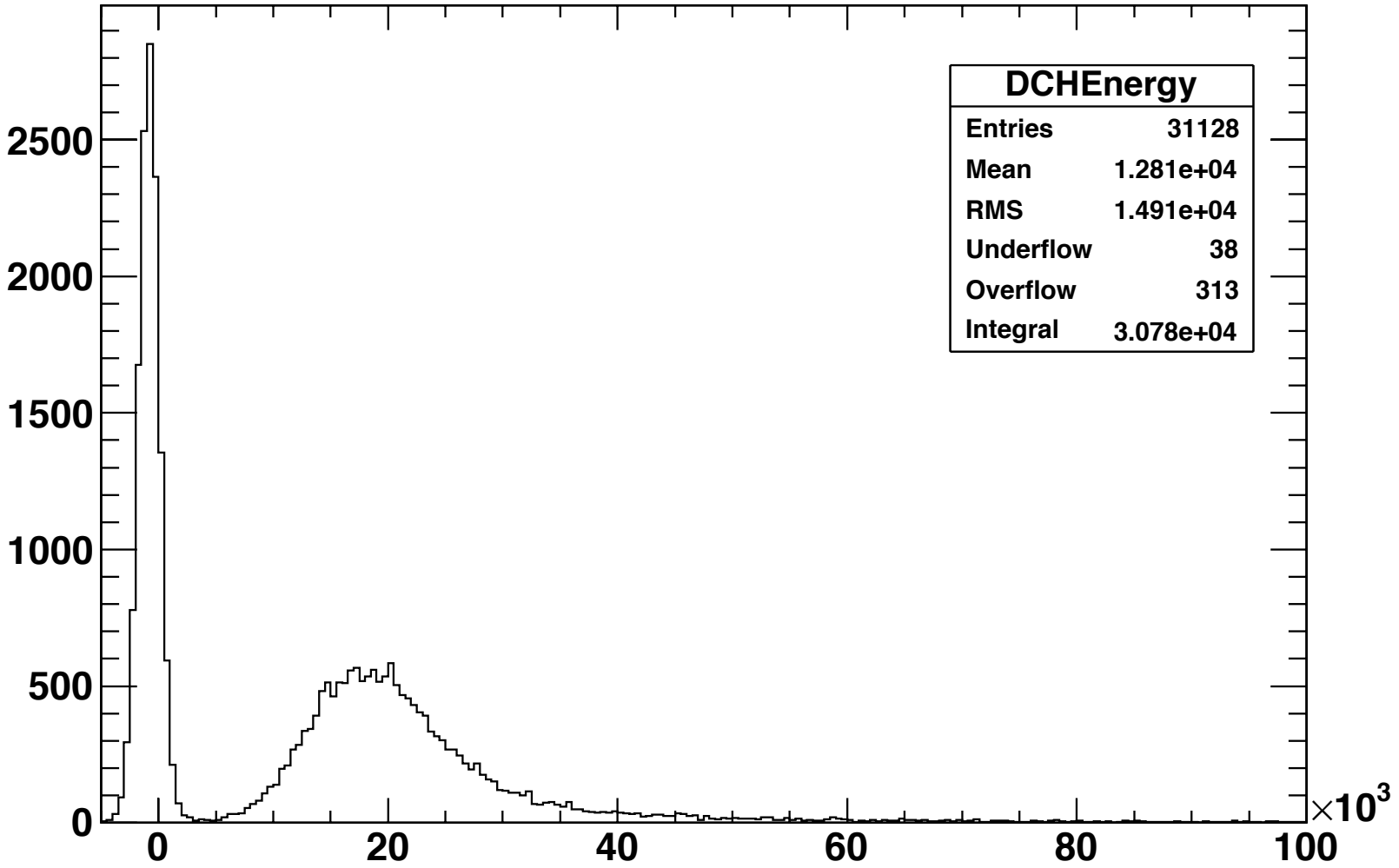
Time-of-Flight

- Two time-of-flight counters. 12.7 × 12.7 × 200 mm BC404 scintillator.
- Each scintillator viewed by two Burle micro-channel PMTs.
- Flight distance = 3.927 m
- Upstream pmts operated at lower voltage and used a 20 db 100–500 MHz bandwidth inverting amplifier.
  - aging concerns
- PMT signals split:
  - constant-fraction discriminator then TDC
  - switched capacitor array

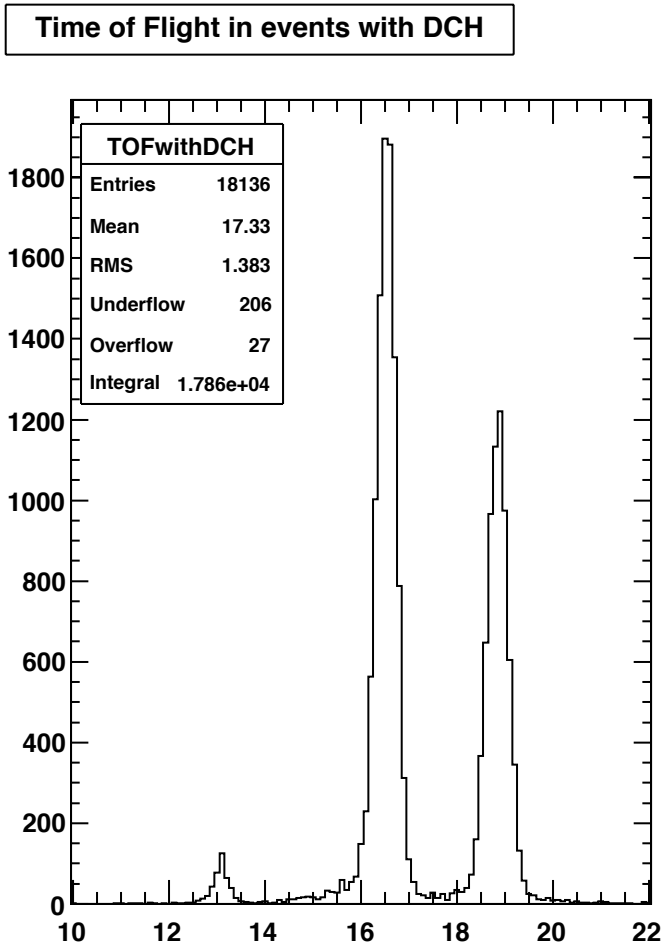


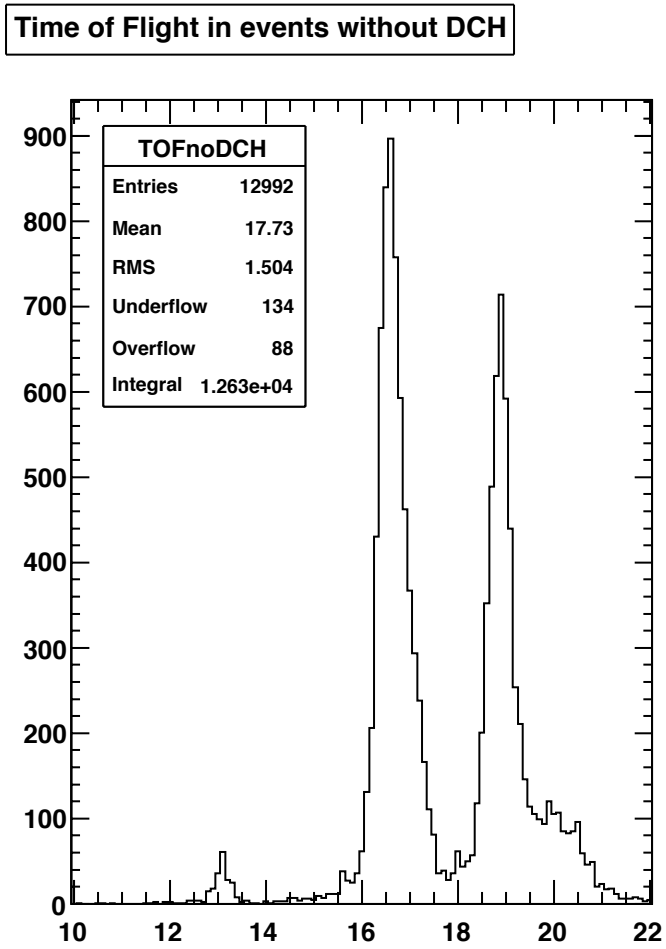
Trigger

- Trigger was a coincidence of the four PMTs. Upstream counter ~1 kHz; downstream 10's of Hz; trigger ~20 Hz; DAQ 10–15 Hz.
- A straight line passing between the scintillators would necessarily pass through the active chamber volume. Nevertheless, ~40% of the events had no DCH activity.


DCHEnergy
Entries 31128
Mean 1.281e+04
RMS 1.491e+04
Underflow 38
Overflow 313
Integral 3.078e+04
2500
2000
1500
1000
500
0
0
20
40
60
80
100
×10^3

- TOF distribution for events with and without chamber info:

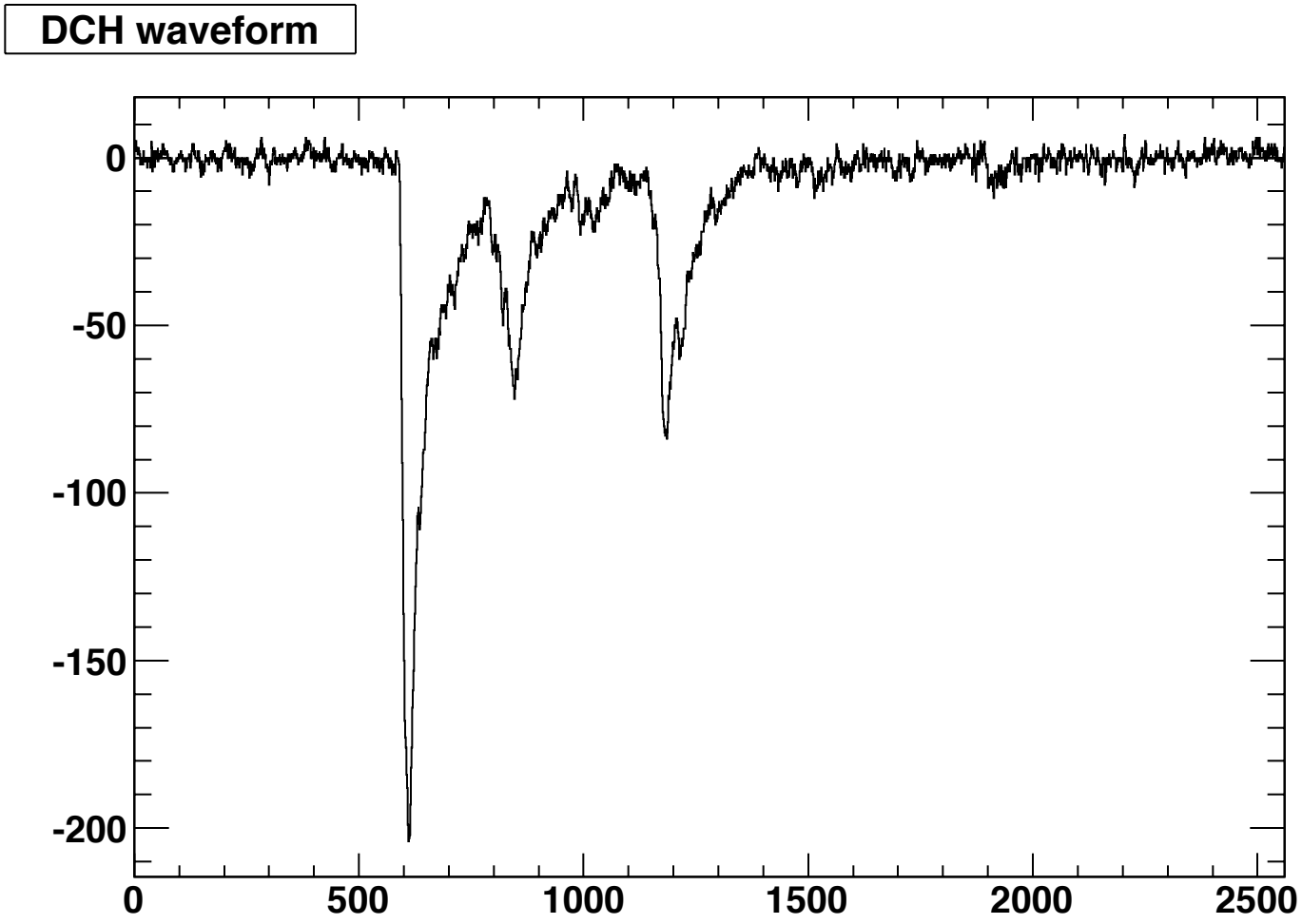




- Shoulder at high end is consistent with scattering ~90 cm below the chamber.

Data Acquisition

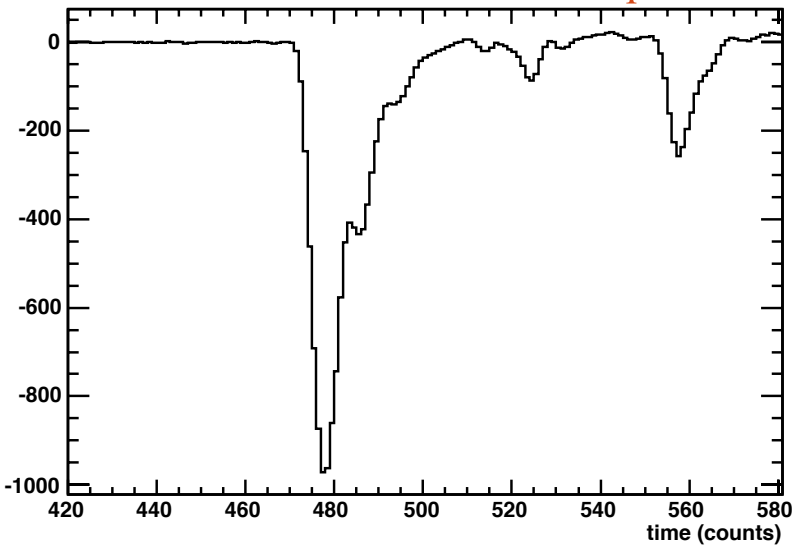
- TRIUMF provided a MIDAS-based data acquisition system:
  - CAEN V1190b TDC
  - CAEN V1729 4-channel switched capacitor array (two units)
    - one of these was noisy, which affected one of the TOF PMTs.
  - Temperature and pressure
    - although the temperature is probably useless



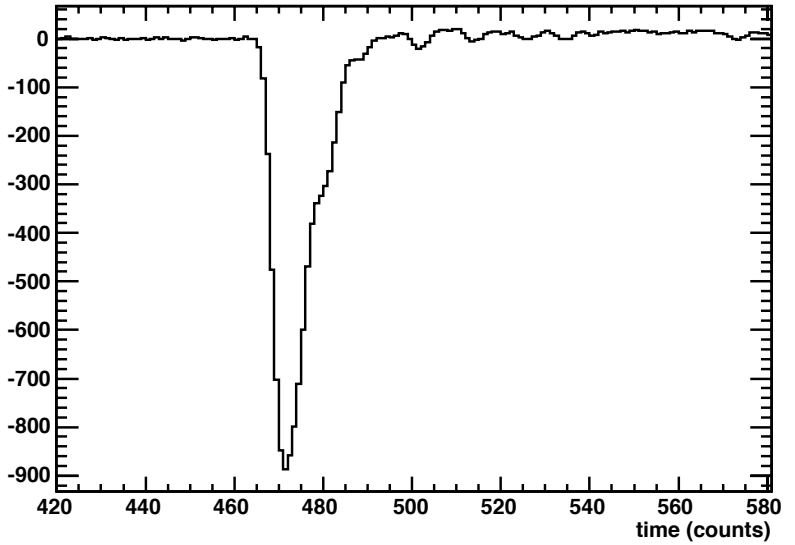
2560 bins, 0.5 ns per bin

PMT 0

Downstream PMTs, no amplifier

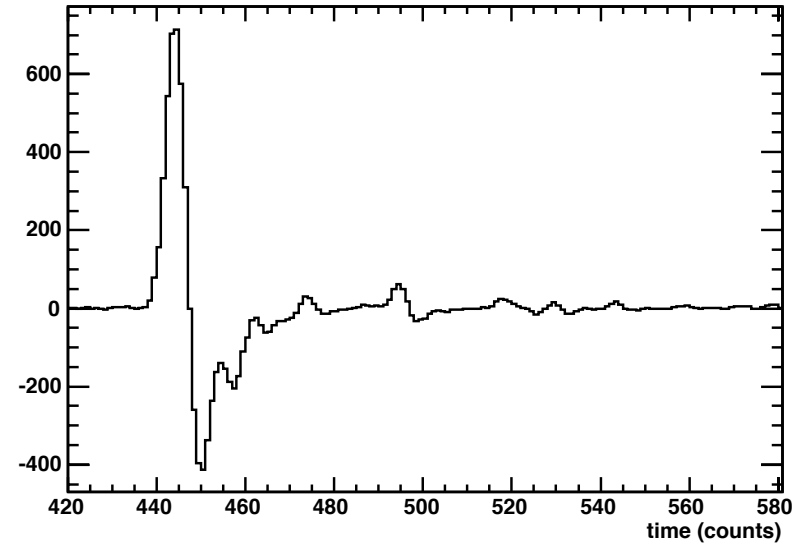


PMT 1

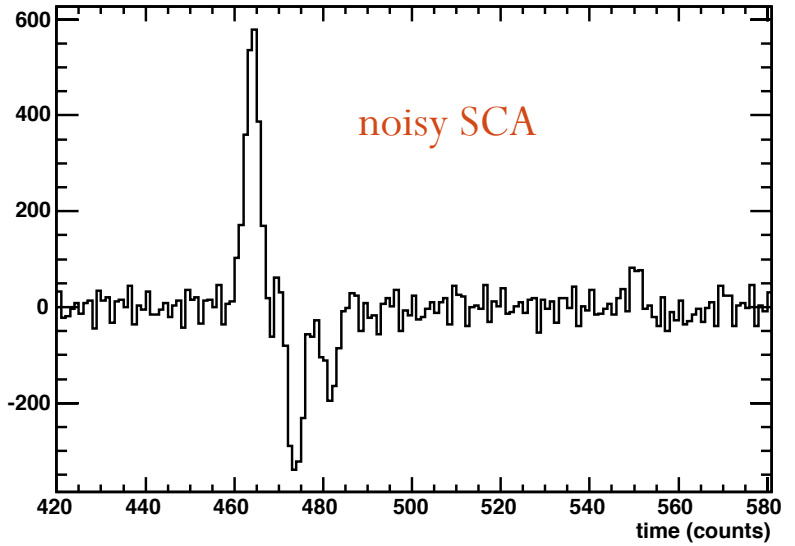


PMT 2

Downstream PMTs, with amplifier



PMT 3

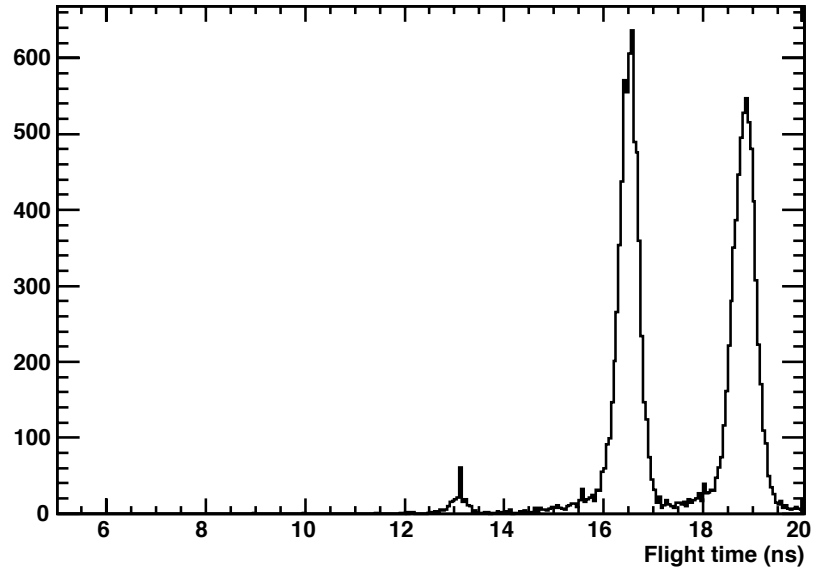


2560 bins, 0.5 ns per bin

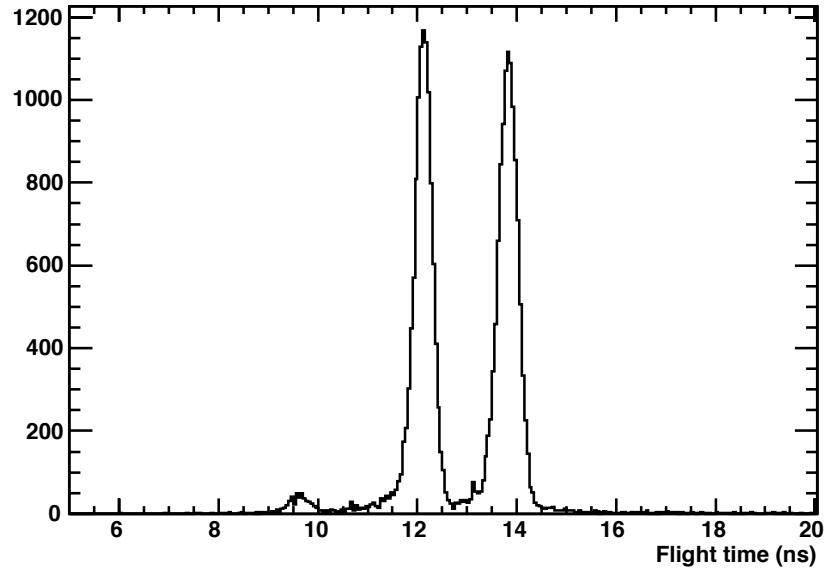
Time of flight calibration

- Need two constants to convert TDC counts into flight times.
- On the last day, took data with different flight distances, with and without amplifiers on the upstream scintillator counter, no drift chamber. Use electron data so that β is known.
- Results consistent with 98 ps /count.
- Muon and pion peaks indicate momentum 137 $\pm$ 2 MeV/c for nominal 140 MeV/c beam.
- Flight time resolution ~200 ps using CFD output / TDC with no walk corrections.
- Could possibly do better analyzing the recorded waveforms, although the noisy SCA makes this problematic.

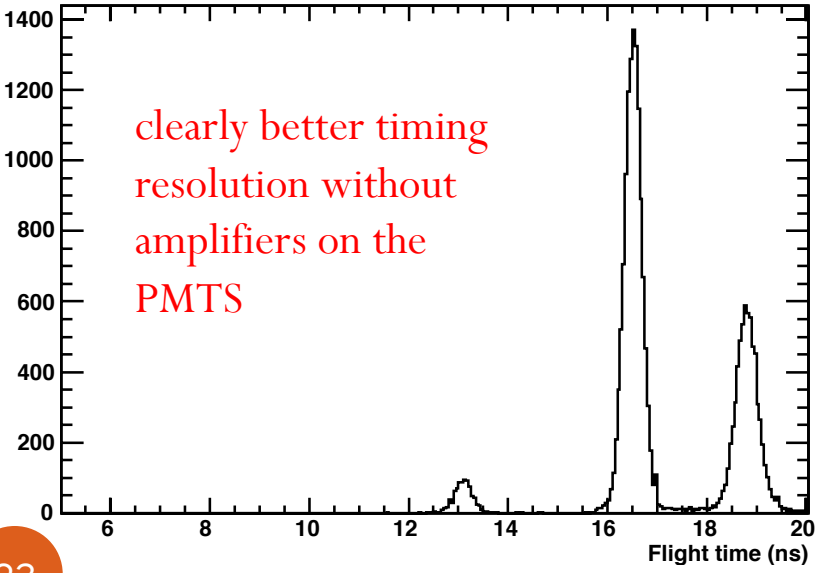
Flight Time 3.927m 140 MeV/c amplifiers



Flight Time 2.888m 140 MeV/c amplifiers

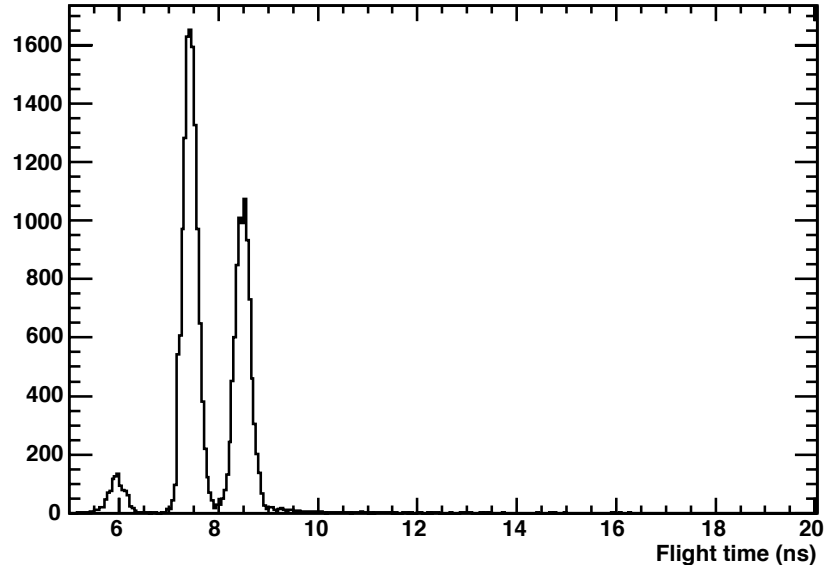


Flight Time 3.927m 140 MeV/c no amplifiers



clearly better timing resolution without amplifiers on the PMTS

Flight Time 1.784m 140 MeV/c no amplifiers



Data

- Three different gas mixtures
- four locations along the wire
- two dip angles (0 and 45 degrees)
- momentum from 130 MeV/c – 330 MeV/c nominal
- Tried at 400 MeV/c, where both muons and pions are minimum ionizing, but we could get nothing but off-momentum protons.
- Few other cases (non-terminated, 10 m RG174 cable instead of the 13 m RG8 cable used otherwise.)

Data

- Google Docs summary of all runs:
- https://docs.google.com/spreadsheet/ccc?key=0AkOokiozZns7dDhuZURBaTZ2NlJPcUxSTXhhLXNCSHc#gid=0
- Rocky has made ntuples of all runs.

Lessons for next time, if there is a next time.

- Improve the trigger to reject empty events by adding a third counter close to chamber
- Interlock DCH HV to DAQ (one trip during run).
- Interlock or alarm M11 vacuum valve. Spontaneously closed three times.
- Measure temperature of the chamber, instead of a random power supply near by.
- Get rid of PMT amplifiers; better collimators upstream of the first counter.
- Get SCA repaired

- M11 is available in 2012, but not after that.