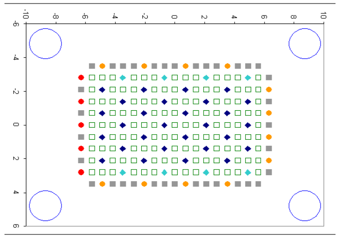
DCH Summary

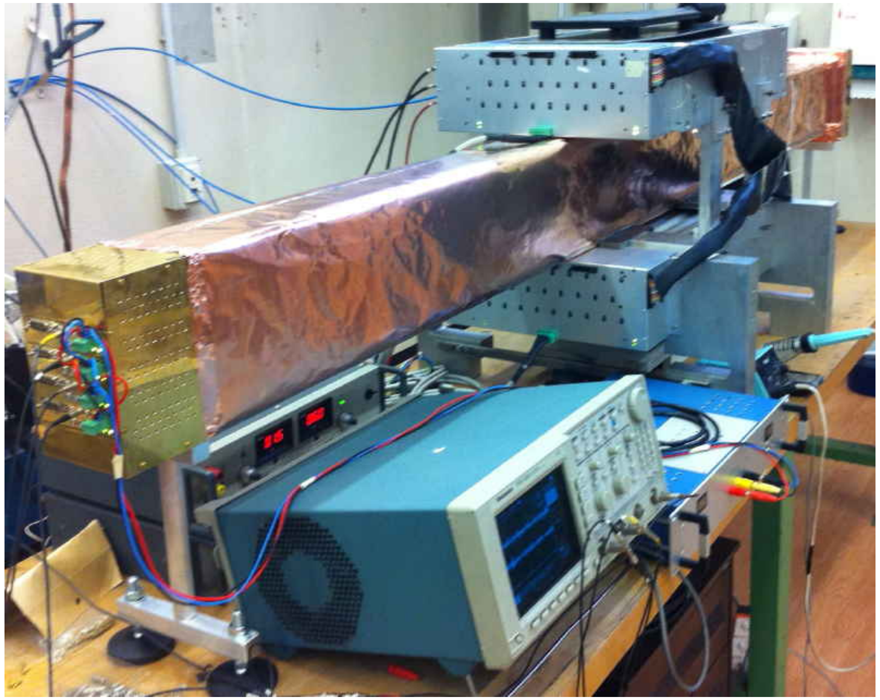
1st SuperB Meeting – London, 15 September 2011

G. Finocchiaro – M. Roney

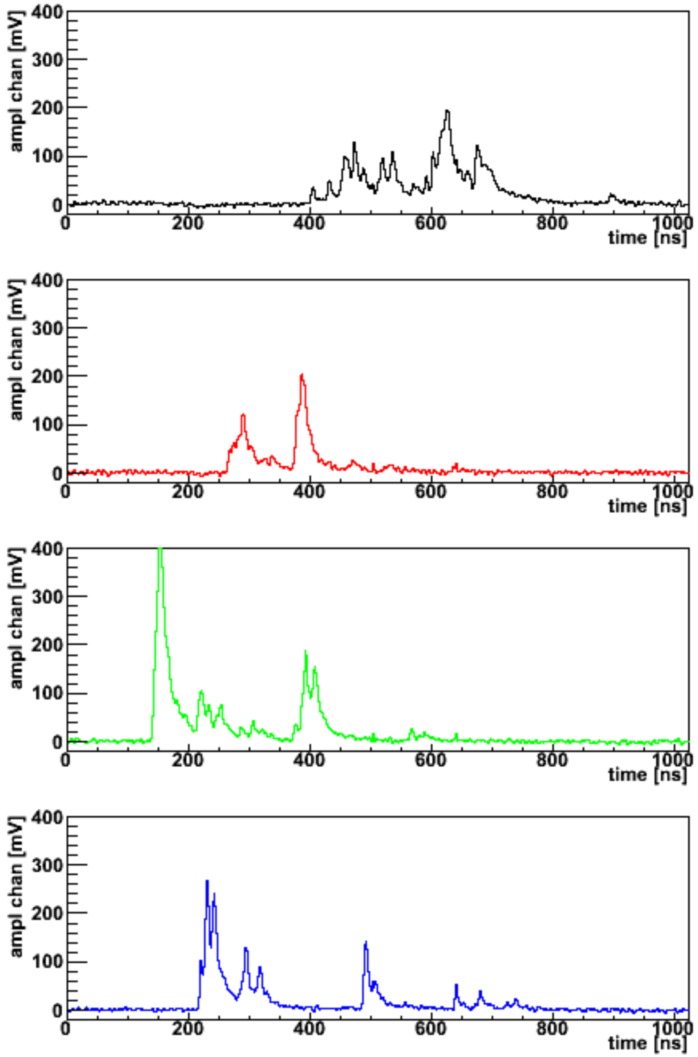


Prototype 2

- Full-length prototype to:
  - study cluster counting under realistic conditions (discrete-cathode cells, **L=2.5m**)
  - serve as a test bench for the final FEE
  - test implementation of 1st level DCH trigger Track Segment Finding
    - Read-out boards provide independent analog output for the trigger system
- 28 square cells (1.4cm side, Rfs=3:1), on 8 staggered layers (3-4-3-4-3-4-3-4 cells)

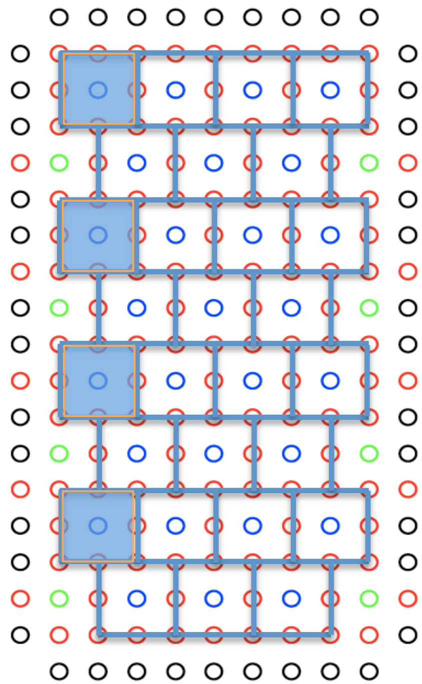


Proto2 - sample waveforms

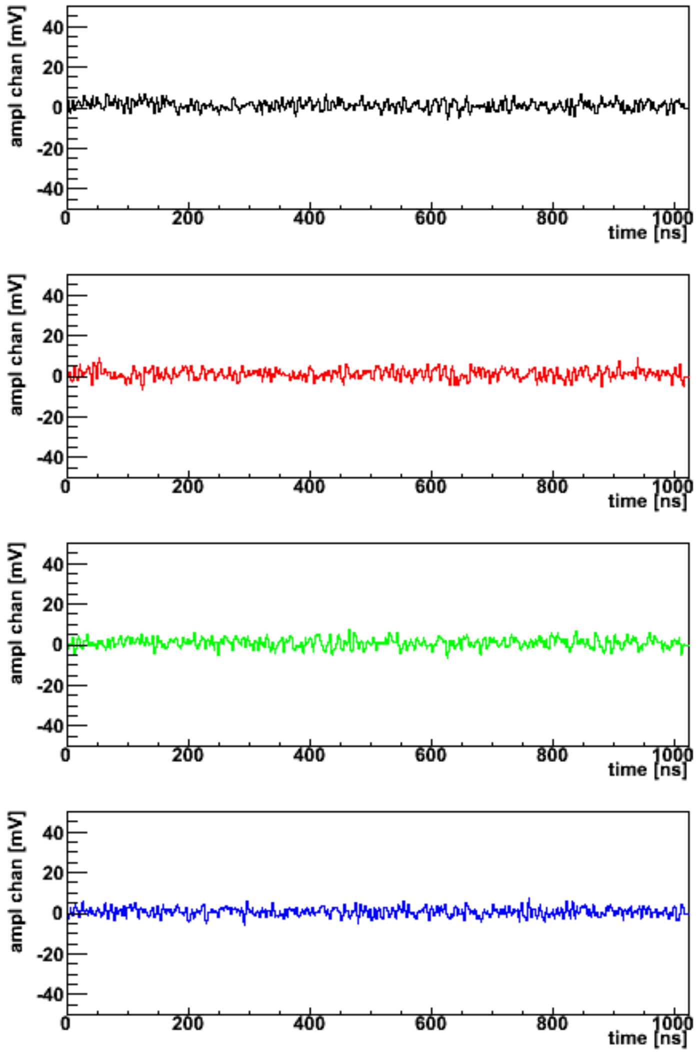


90%He-10%iC_4H_{10}
HV=1775V
Run “A”

“#1 cells"



Sample waveforms – noise level



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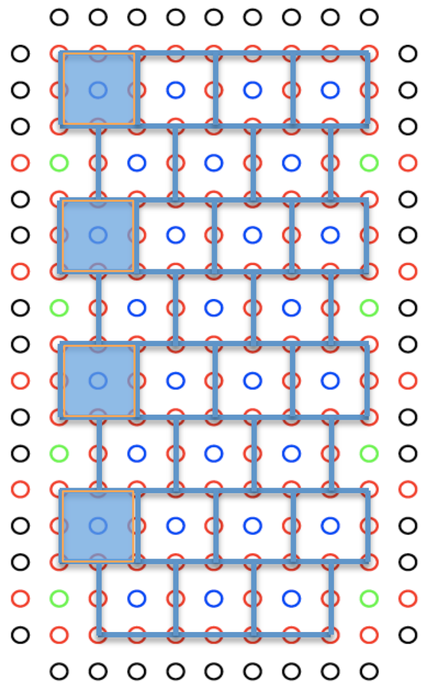
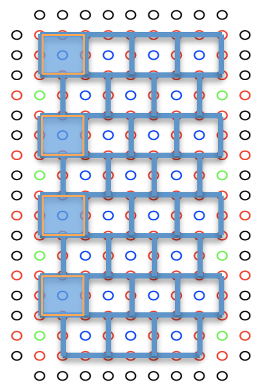
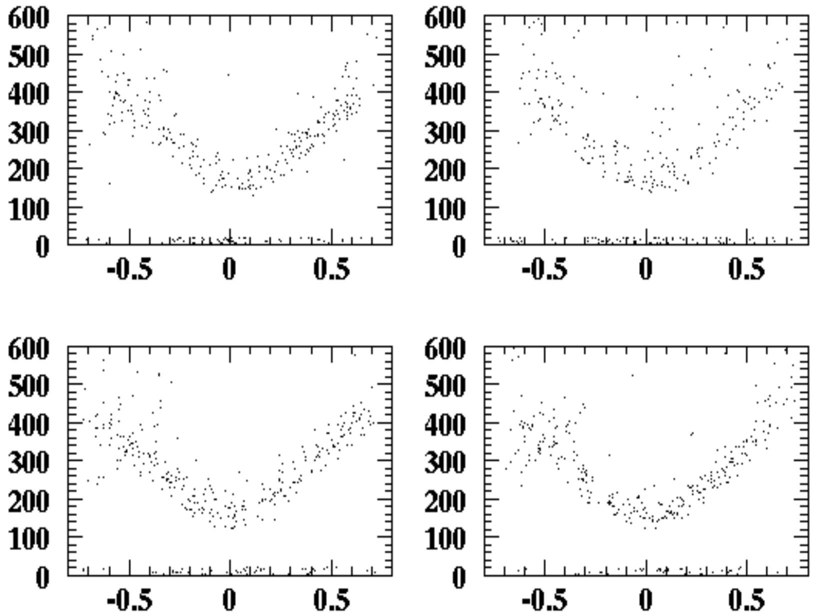
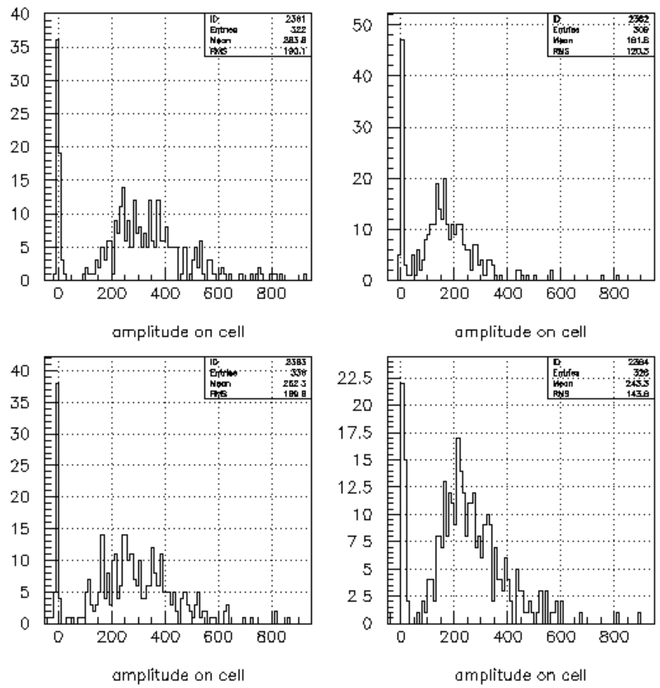


First data are being analysed



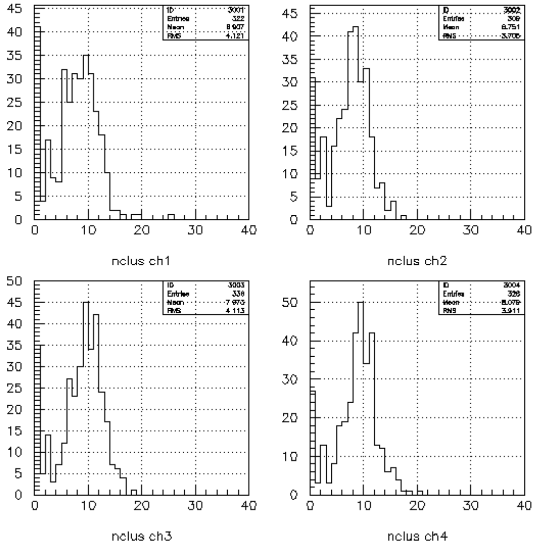


Space-time relations

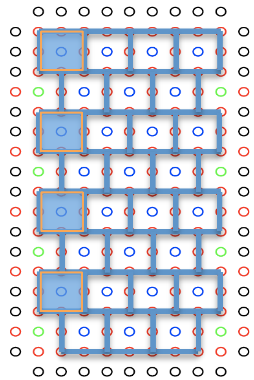


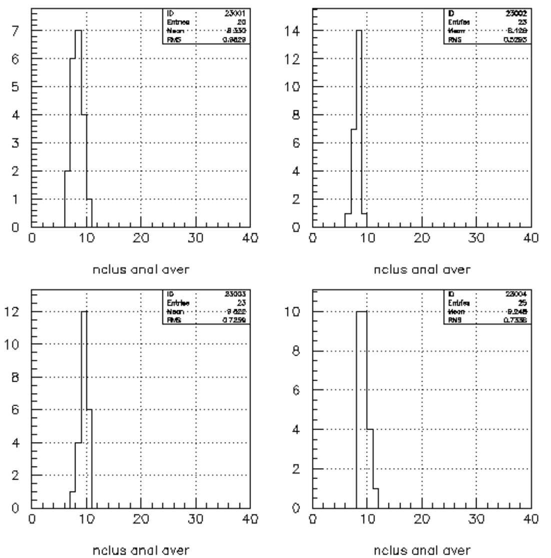
Total amplitude

First data are being analysed

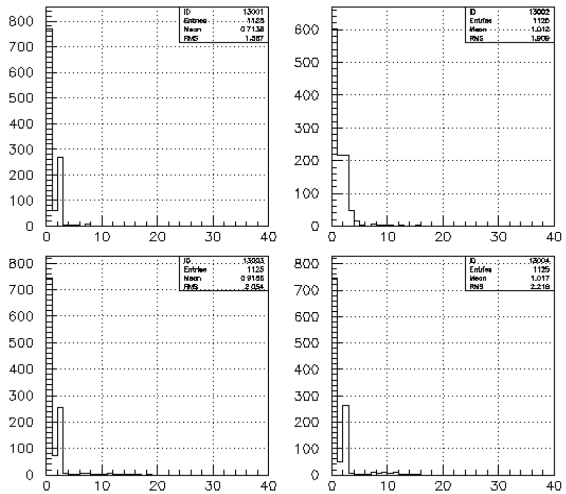


Counted Cluster



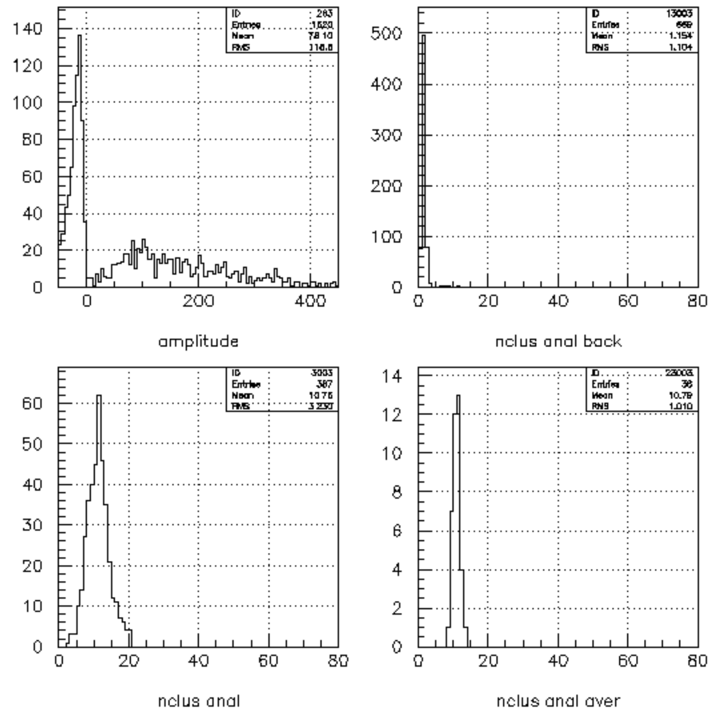


Statistical scaling: simulated 10-cell long tracks


Noise level: clusters found when track |DOCA| > 3cm

Proto2: Summary

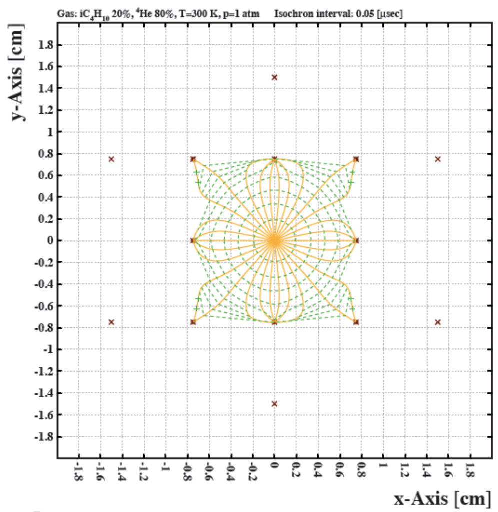
- The commissioning of Prototype 2 is still ongoing
- Encouraging results from first data
  - e.g., noise level not as high as one could fear because of the full scale detector size (2.5m long wires, discrete cathode structure, 28 channels…), and faster preamps
  - behavior consistent with the 17-mm square tube
- Intense work next weeks in preparation for scheduled beam test at BTF
- Financial request submitted to run a beam test in 2012
  - still to decide where PSI/CERN/TRIUMF/FNAL

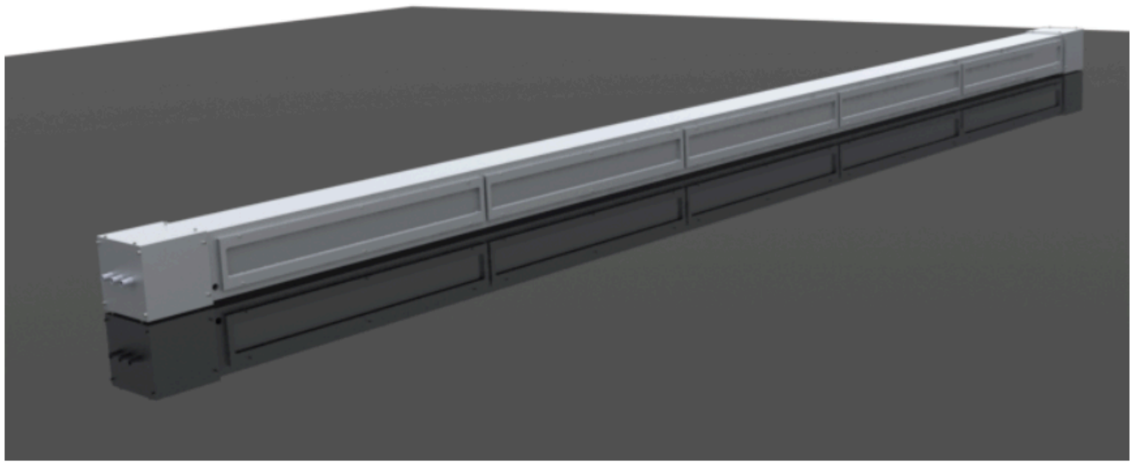


TRIUMF test beam

C. Hearty

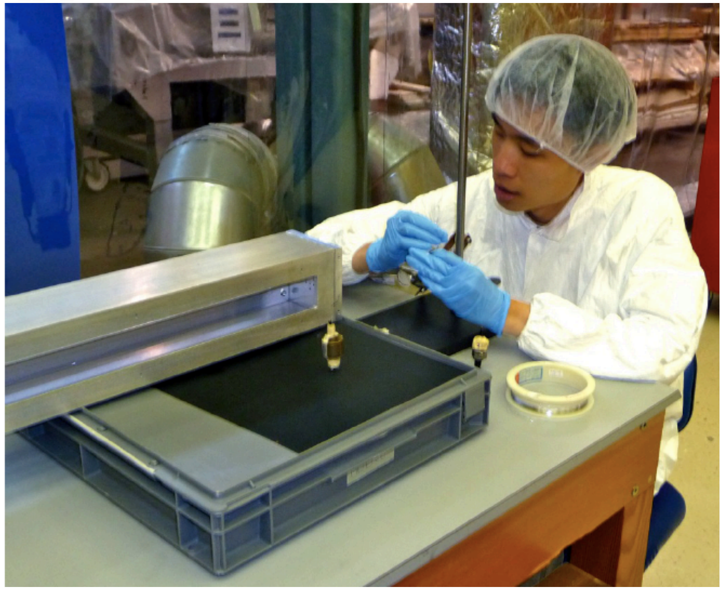
- Single-cell 2.7m long test tube to:
  - Study the performance of Jean-Pierre's preamp prototype in a realistic beam environment with a full-length detector.
  - Can we achieve the signal-to-noise and bandwidth performance required for cluster counting?
  - Compare the ability to distinguish $e/\mu/\pi$ as a function of momentum using cluster counting and dE/dx.





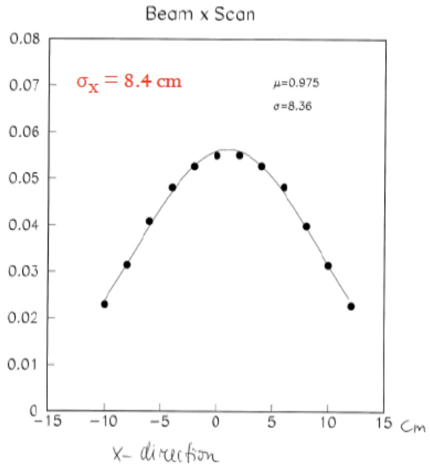
TRIUMF test beam

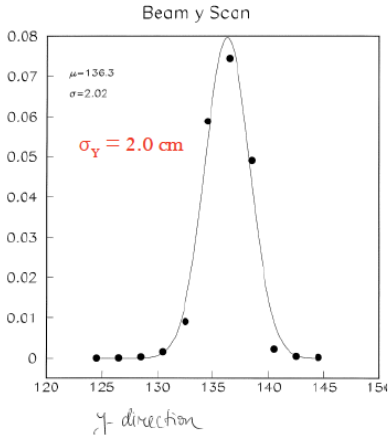
- Tube has been strung



- Preparation for exposing to M11 beam at TRIUMF is ongoing
  - $62 - 400$ MeV/c; e^+, μ^+, π^+. Significant proton contamination above 300 MeV/c.
    - can also be operated in negative mode at lower rate
  - 4 ns bunch every 44 ns
  - Expect dozens of particles per second.
  - Particle ID (discussed later) but no beam line tracking.

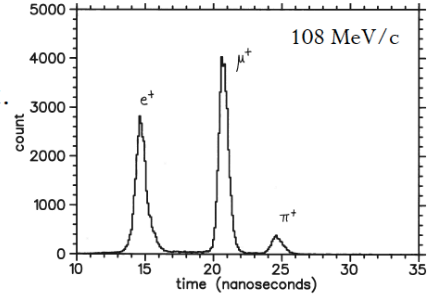
TRIUMF test beam

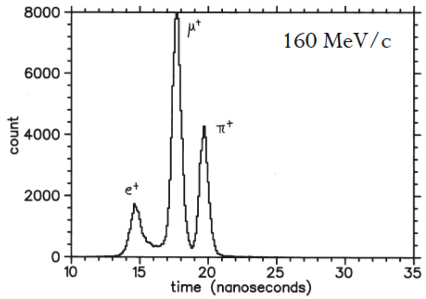


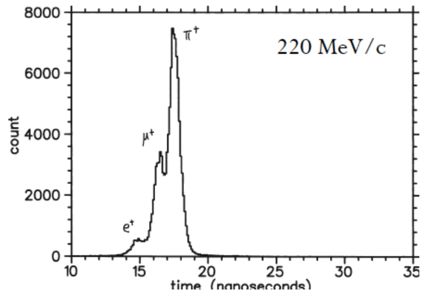


Beam line particle identification

- Primary method to identify beam particles is time of flight.
- Plots are for L = 4.43 m; only 3.8m is now available.







Run plan

- Or rather, ideas towards a run plan:
  - 5 momenta
  - 5 locations along the wire
  - 2 gases
  - 3 HV
  - 5 dip angles

J.F. Caron

PID gain from cluster counting in SuperB

- Use an existing analysis with heavy dependence on PID
  - $B \to K\nu\bar{\nu}$ with semileptonic recoil
- Parameterize effect of cluster counting on the PID, without worrying about details (for now)

In FastSim, dE/dx measurement for each DCH hit is drawn from a normal distribution with mean given by the Bethe formula.

$$\mu = \left[\frac{dE}{dx}\right] \qquad \sigma = \frac{p_1}{1.622 \times 10^{-3}} \left[\frac{dE}{dx}\right]^{p_2} L^{p_3}$$

Path length

PacTrk/Dch_SuperB_Measures.xml:

```
<device name="DchdEdx" type="dEdx"
   HitType="3"
   trunc_frac="0.7"
   dedx_par1="0.00154"
   dedx_par2="1"
   dedx_par3="-0.34" />
```

trunc_frac: Fraction kept for truncated mean, but not actually necessary.

dedx_par1: p_1

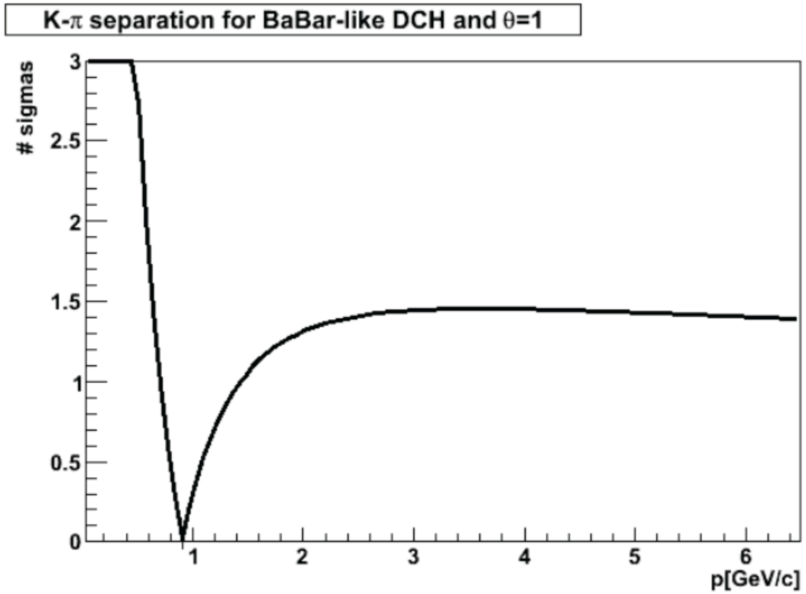
dedx_par2: p_2

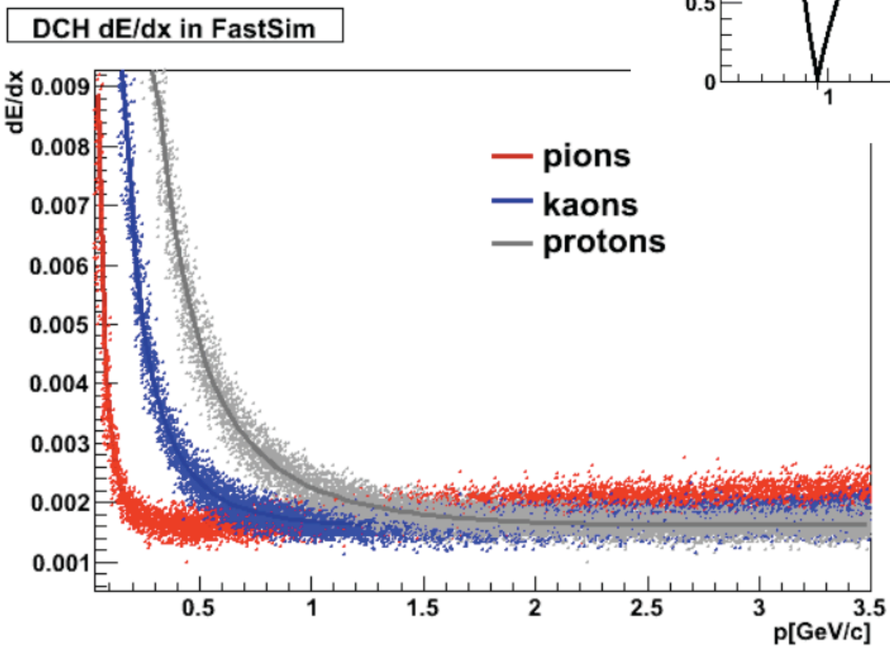
dedx_par3: p_3

Play with these numbers

PID gain from cluster counting in SuperB

From SuperB Wiki





G. Felici

Power requirement and board count

BaBar-like option

- DCH number of sense wires (guess): 9216
- Number of channels per board (guess): 48
- Power requirement/board : ≈ 30 - 35 W

Off-Detector boards: 192

VME crates (16 boards/crates): 12

Power Requirements: ≈ 6 - 7 kW

Cluster Counting option

- DCH number of sense wires (guess): 9216
- Number of channels per board (guess): 8
- Power requirement/board : ≈ 40 W

Off-Detector boards: 1152

VME crates (16 boards/crates): 72

Power Requirements: ≈ 46 kW

OFF-DETECTOR ELECTRONICS

Both boards/crates and total power requirements differs greatly for BaBar-like and Cluster Counting electronics (192/12/6 BaBar-like and 1152/72/46 Cluster Counting).

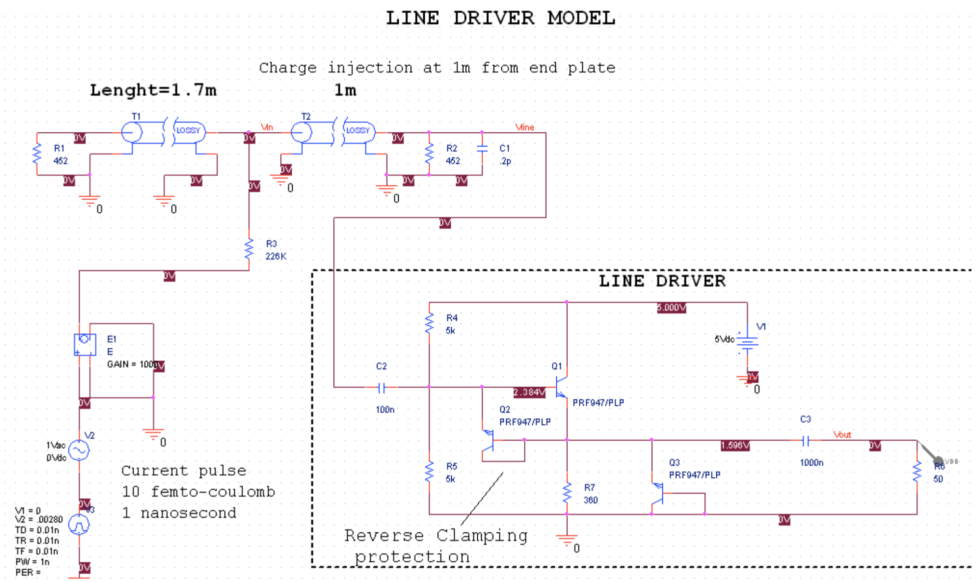
Cluster Counting FE remark: probably within a couple of years it will be possible to pack 16 - 1 GS/s digitizer, feature extraction logic and buffers in a single VME board, but at the present time the state of art are 8 - 1 GS/s channels in a (standard) VME board.

BaBar-like FE remark: 48 channels in a VME board is a (very) prudent estimation. A real one could be 64 (using micro coax or twisted pairs signal cables). In such a way the boards/crates counts would decrease to 144/9.

Preamp studies

J.P. Martin, P.Taras

- Preliminary discrete-components preamp design with
  - input impedance adapting stage
  - high BW amplifier stage



CONCLUSIONS

Output noise of circuit, for 1m position : 43 μV in 50 ohms load
Input referred noise with a
50 ohms post amplifier : 90 μV
Output amplitude, 10 fc 1ns pulse : 950 μV
S/N Ratio : **10.5**

S/N Ratio without matching to
50 ohms amplifier:

0.001m	:	5.6
1.0m	:	**4.0**
2.7m	:	0.95

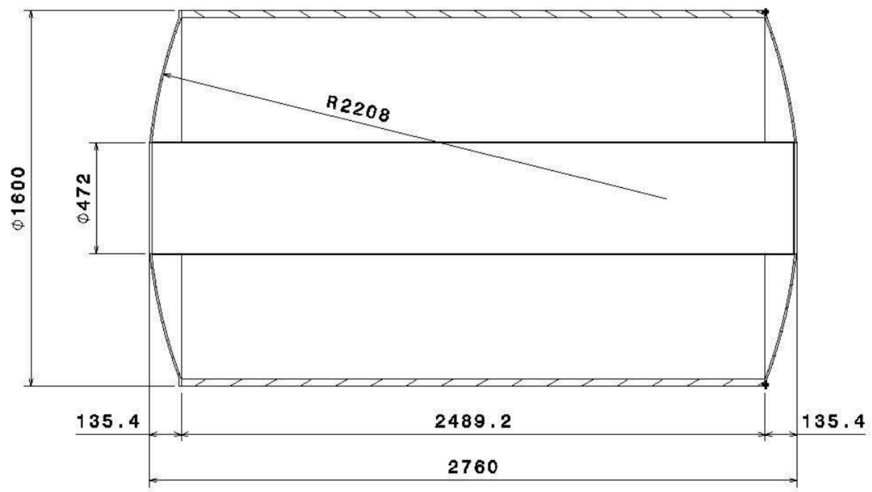
==➔ Ratio of signal amplitude/RMS noise can be improved by a factor 2.5

Mechanical structure

S. Lauciani

- Preliminary studies on the SuperB DCH Mechanical Structure
- Specifications:
  - total load on endplates ~2ton
    - “Tolerable” endplate deformations (to be defined)
  - Possibly non-load-bearing inner cylinder
    - less material
  - Stringing operations

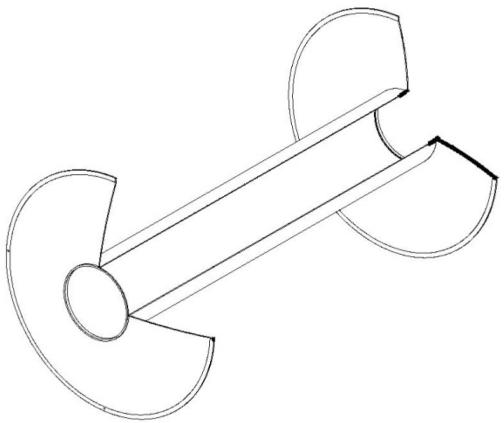
Dimensions



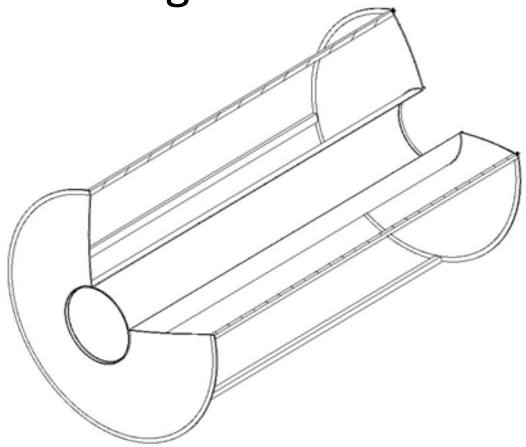
Max. diameter of DCH (mm)	1600
Min. diameter of DCH (mm)	472
Total max length (mm)	2760
Radius of endplate (mm)	2208

Two load configurations

- On inner cylinder



- On outer cylinder
  - e.g. with struts as in KLOE



- Shaped endplates result in much smaller deformations for fixed thickness
  - e.g. for given load and thickness almost 2 orders of magnitude smaller than flat plates
- Convex spherical endplates used in the following

Preliminary FEM analysis

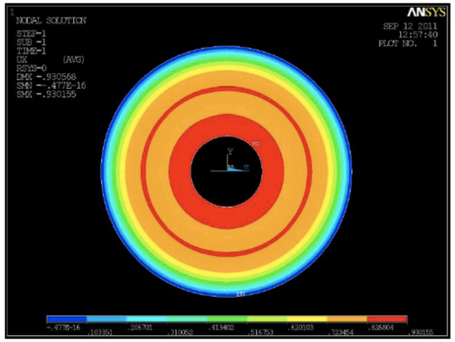
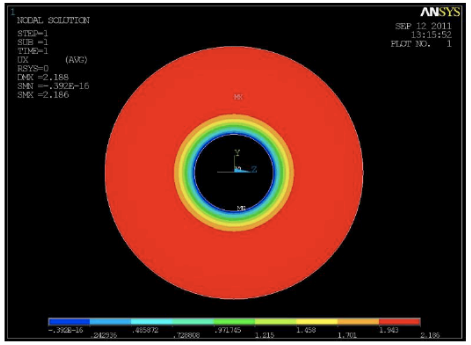
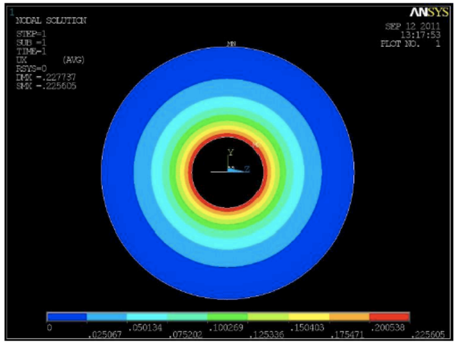
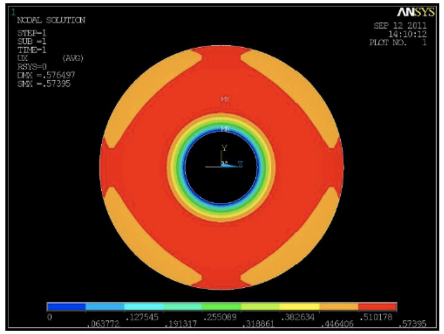
- Intermediate modulus isotropic CF laminate chosen to have ad idea of the material properties
- Total load, due to wires, is 30kN ≈ 3ton
- Plates thickness: 8mm

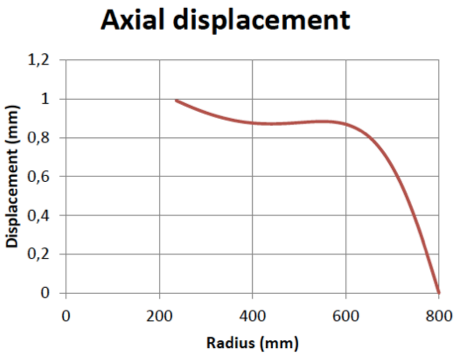
Ply#	Lamina Type	Thickness(m)	Angle (deg)
1	Graphite/Epoxy	1,27 E-04	0
2	Graphite/Epoxy	1,27 E-04	90
3	Graphite/Epoxy	1,27 E-04	45
4	Graphite/Epoxy	1,27 E-04	-45
5	Graphite/Epoxy	1,27 E-04	-45
6	Graphite/Epoxy	1,27 E-04	45
7	Graphite/Epoxy	1,27 E-04	90
8	Graphite/Epoxy	1,27 E-04	0

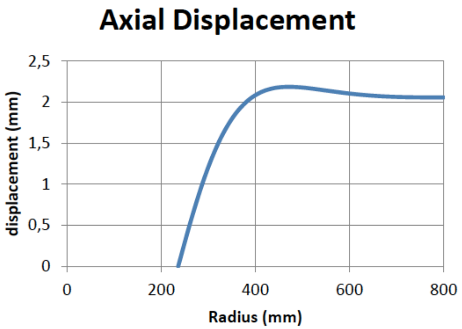
Properties	
Ex(MPa)	56300
Ey(MPa)	56300
Nuyx	0,2962
Nuxy	0,2962
Gxy (MPa)	21820

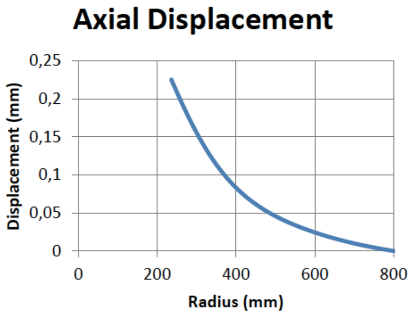
Deformations

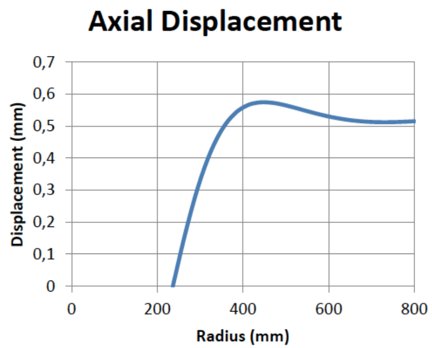
Endplates supported on:

Outer radius	inner radius	outer radius	inner radius
			









Radial displacement:

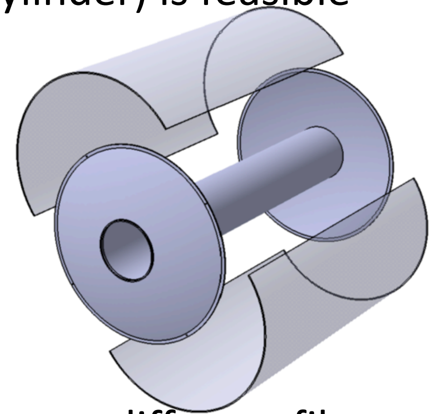
Allowed	allowed	non allowed	non allowed

Maximum z diplacement

1.0mm	2.2mm	0.22mm	0.57mm

Summary and outlook

- Convex endplate configuration strongly reduce the axial displacement in comparison with flat plate
  - more shapes will be studied to optimize deformations and stability
- Using only one load bearing structure (struts or inner/outer cylinder) is feasible
  - ongoing discussion on best option, including stringing fixtures



- Optimization of CF laminate (higher moduluIs, sandwich structure, different fiber orientation)
- Effect of the feed-through holes
  - will require tests on drilled samples
- Improve endplate geometry to realistically model the fixed edge conditions
- Improve FEM model to take into account the orthotropic material and understand the behaviour on the CF plies
- Deformation and stability (buckling) analysis to be performed simultaneously on all structure elements (cylinders, endplates (struts))