UPDATE ON THE FORWARD PROTON DETECTOR

DØ Collaboration Meeting

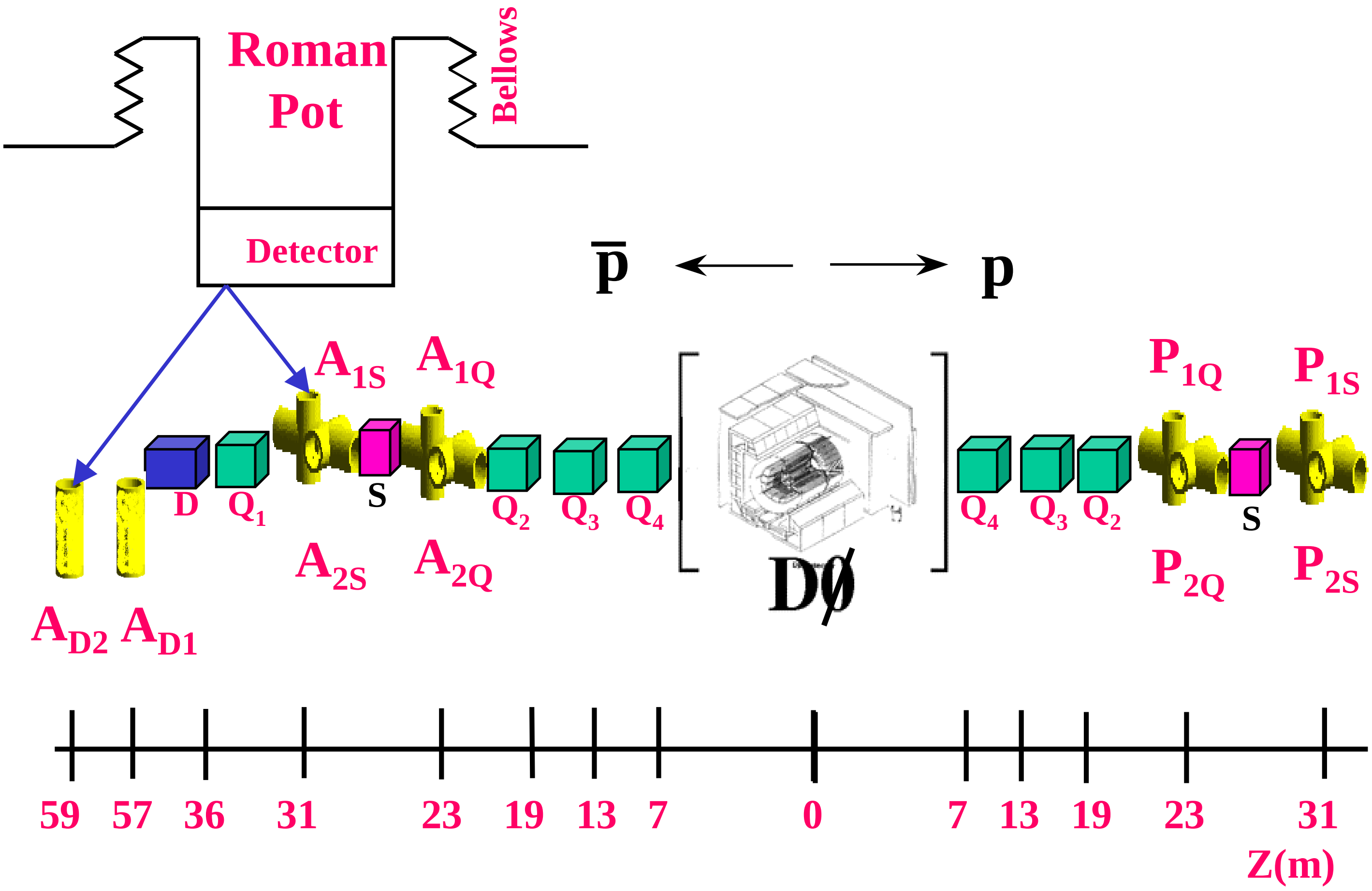
Gilvan Alves

Lafex/CBPF

- Introduction
- Accelerator
- Roman Pots
- Detector
- Future Plans

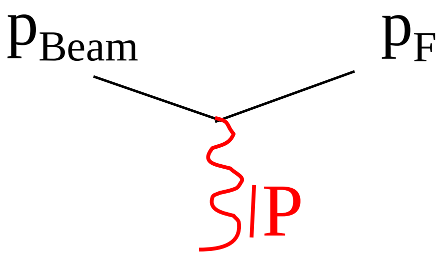
April 1, 1998 (no kidding)

FORWARD PROTON DETECTOR



Series of 18 Roman Pots forms 9 independent spectrometers 1 Dipole Spectrometer ($\bar{p}$) $\xi > \xi_{min}$
8 Quadrupole Spectrometers (p or $\bar{p}$, up or down, left or right) $t > t_{min}$

Diffractive Kinematics

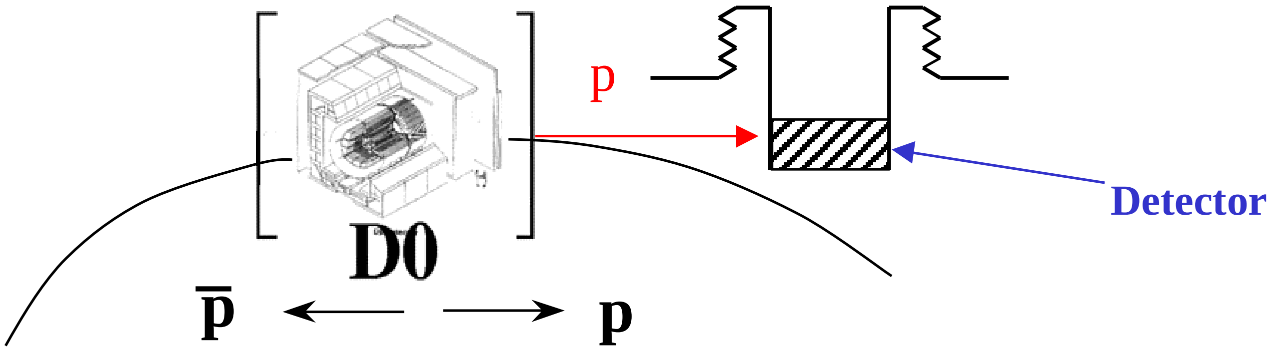


$$t = (P_{Beam} - P_F)^2$$

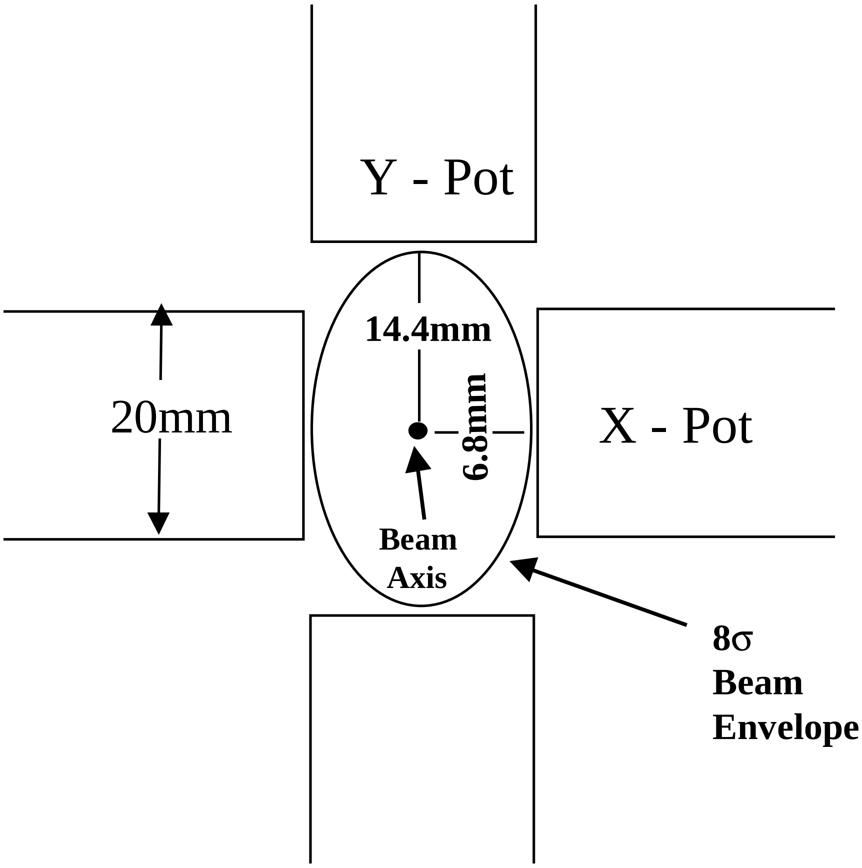
$$\xi = 1 - x_p = \frac{\Delta P}{P}$$

$$M_x = \sqrt{\xi}\sqrt{s}$$

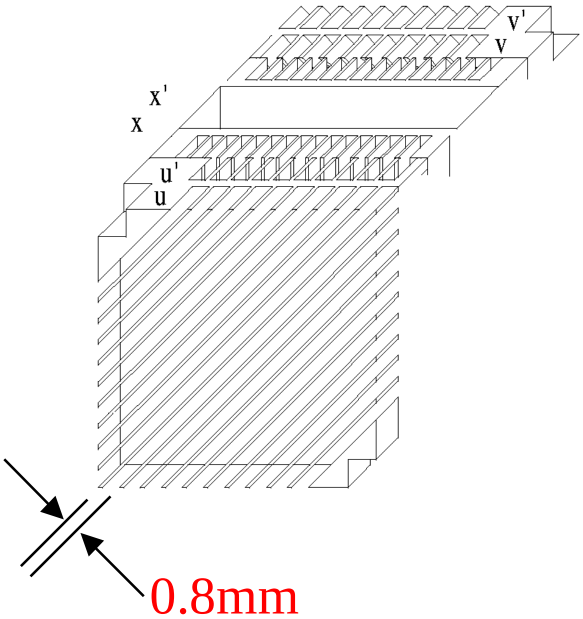
- Rapidity Gap Approach
- Need to Tag and Measure p($\bar{p}$)



The Detector



UVX Planes



PROPOSAL FOR A FORWARD PROTON DETECTOR AT DZERO (P-900)

Andrew Brandt

FNAL/DØ

1) PHYSICS MOTIVATION

2) FPD DETAILS

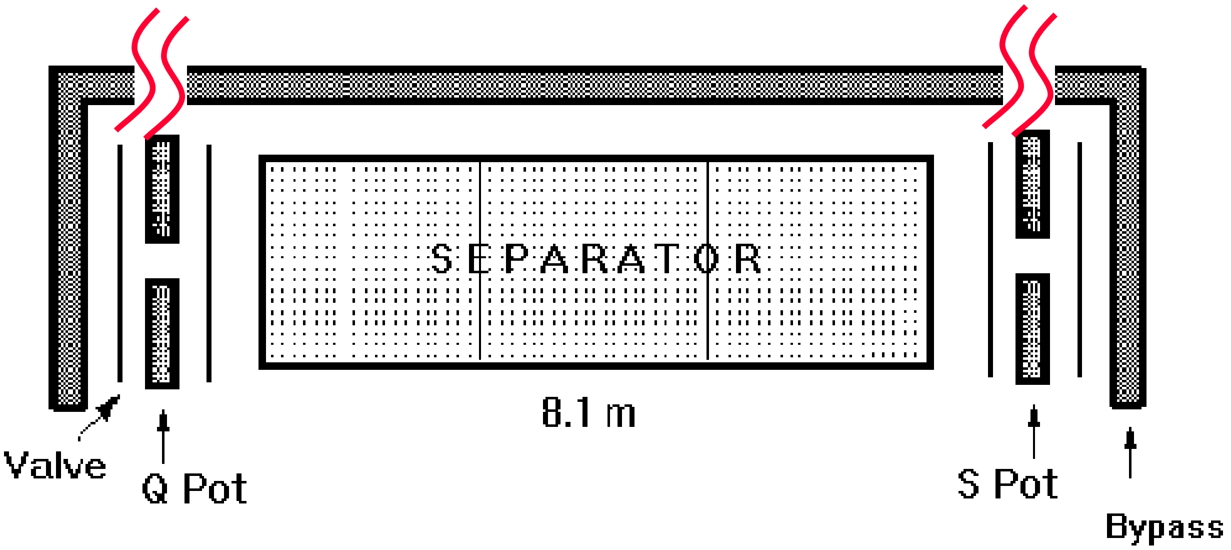
Fermilab PAC meeting
Fermilab
October 17, 1997

ACCELERATOR MODIFICATIONS

1) Move low beta quadrupoles ~ 2/3 meter closer to the interaction point.
   Requires modified quadrupole supports.

2) Insert pots in electrostatic separator region.
   Requires bypass extension.

Bypass extended



ACCELERATOR MODIFICATIONS

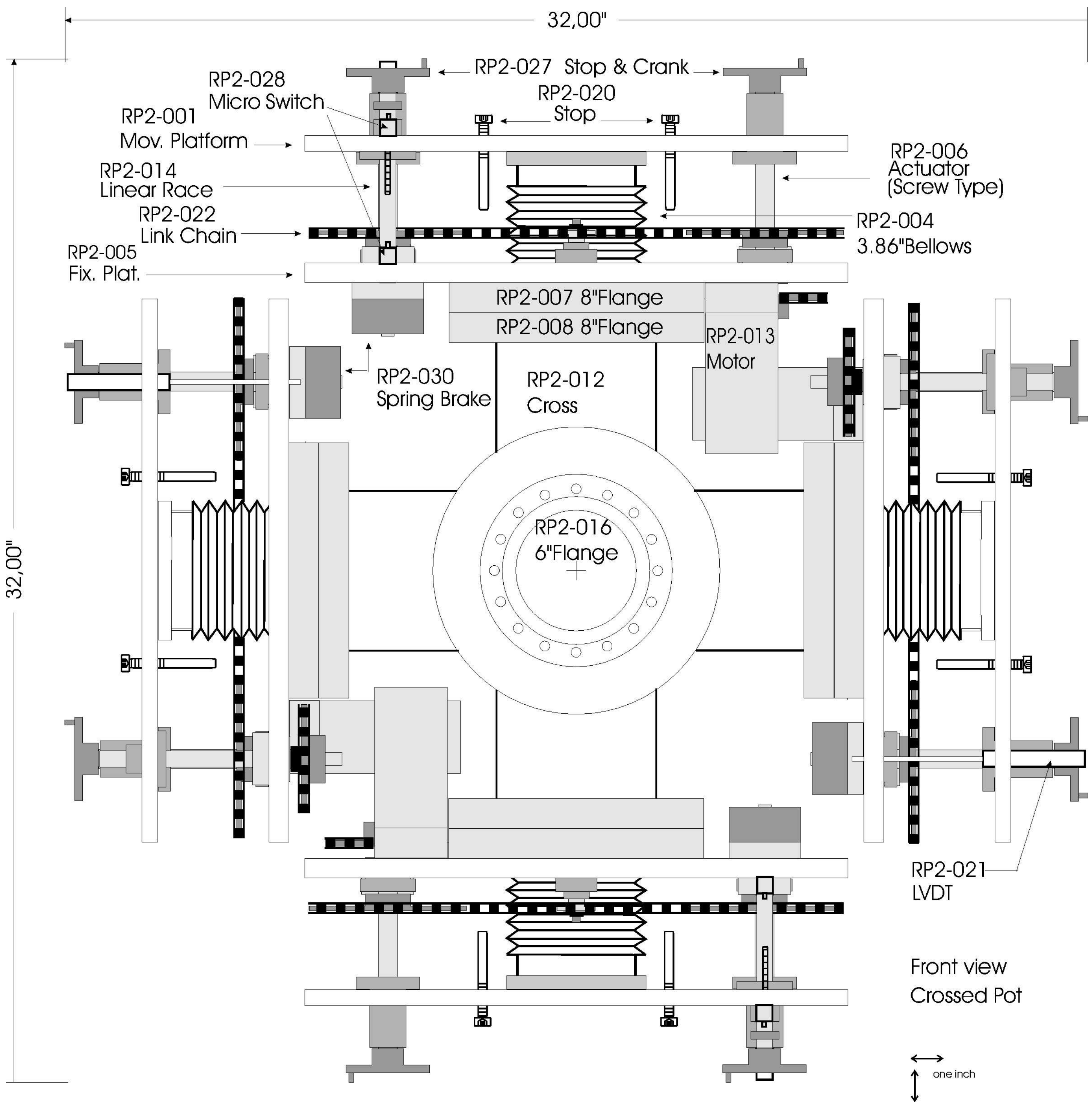
3) Dipole Spectrometer does not require modifications $\Rightarrow$ Warm section exists.

- Feasibility and Cost Studies done in conjunction with Beams Division (see Memo).
- No interference with Tevatron operation
- Total Cost ≈ $500k (Mostly Engineering Labor).

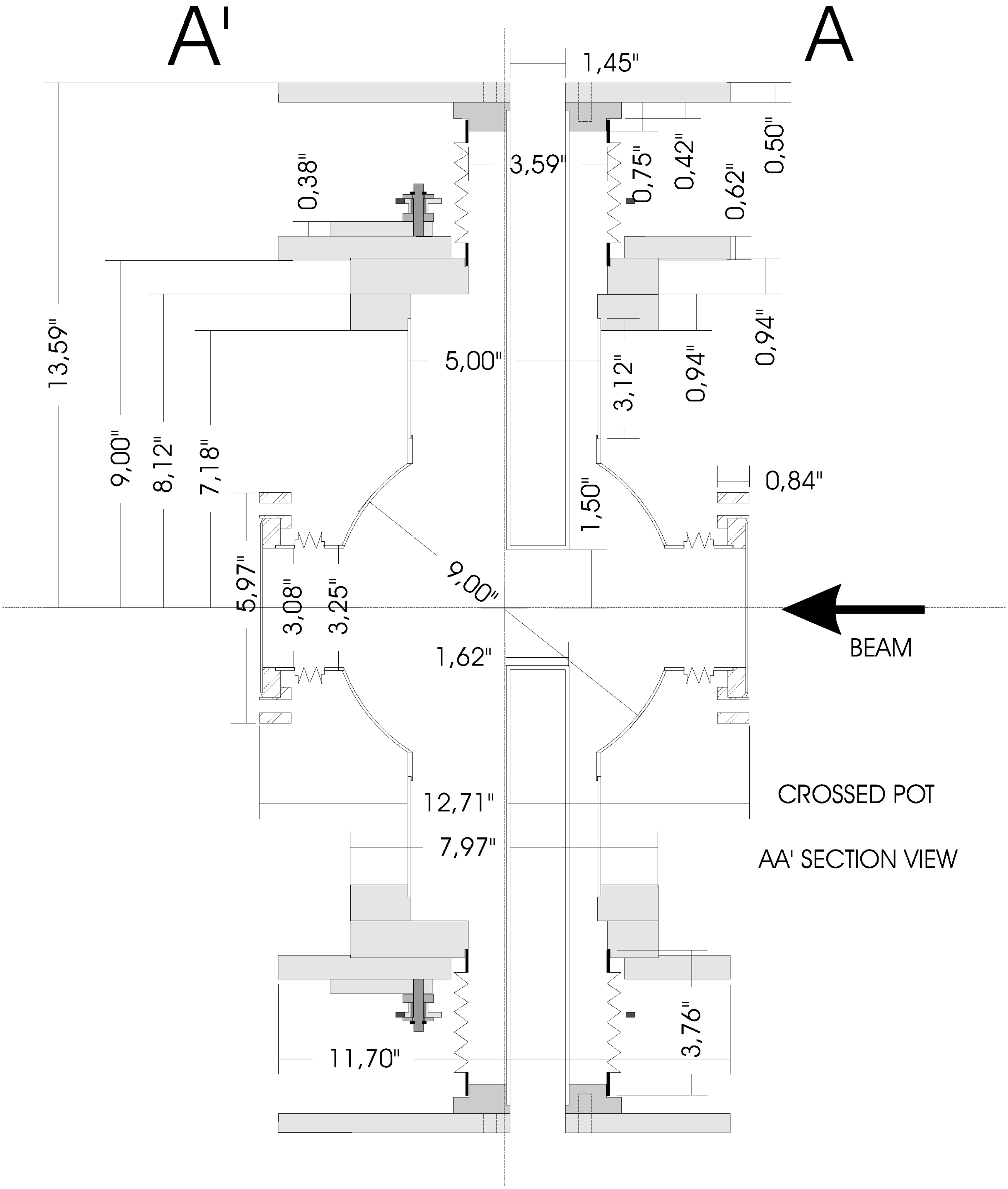
- An Engineer from Brazil will work with the AD on the modifications.

- Mike Martens has joined the FPD group and will act as the Beams Division Liaison Person for this project.

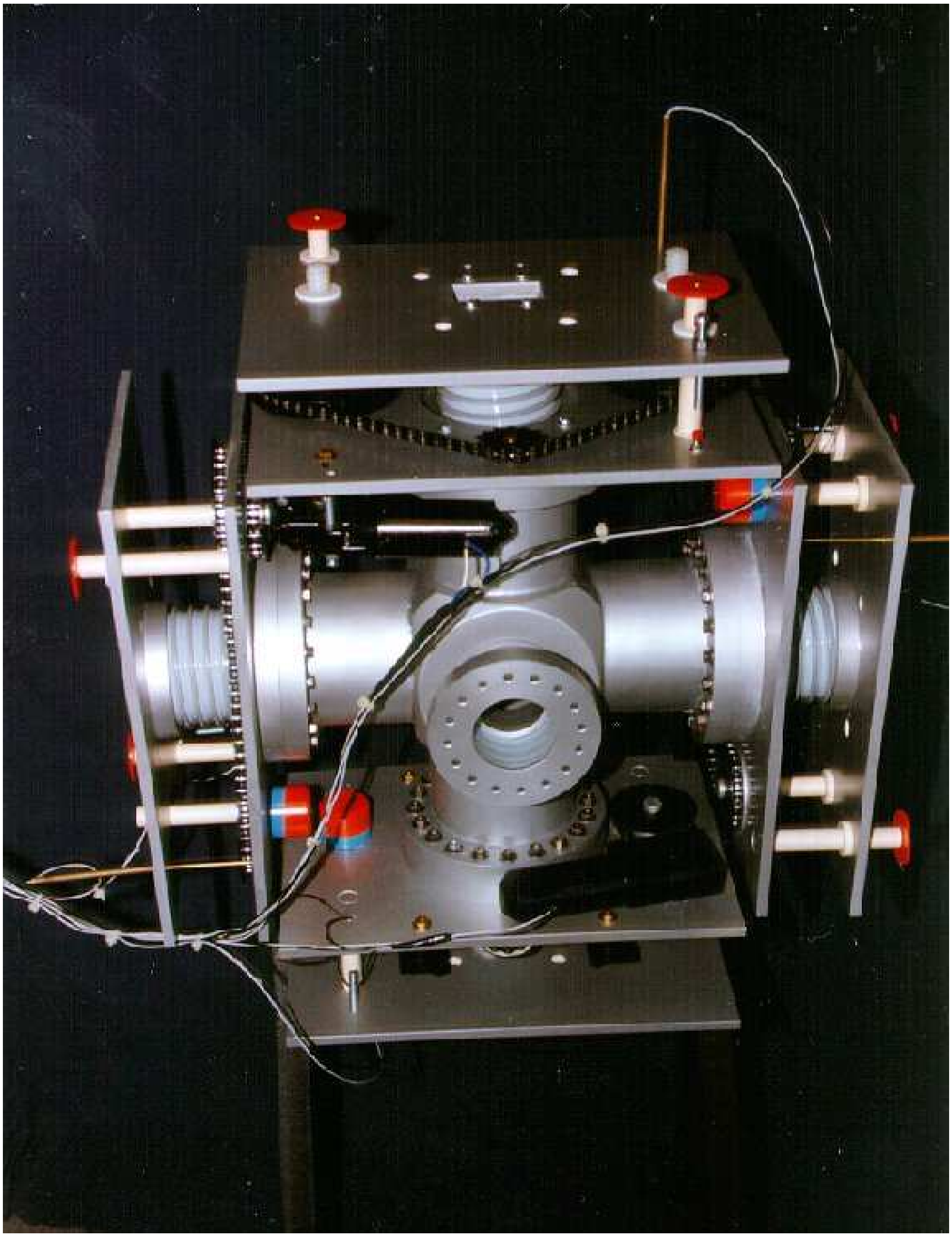
FRONT VIEW OF PROPOSED ROMAN POTS



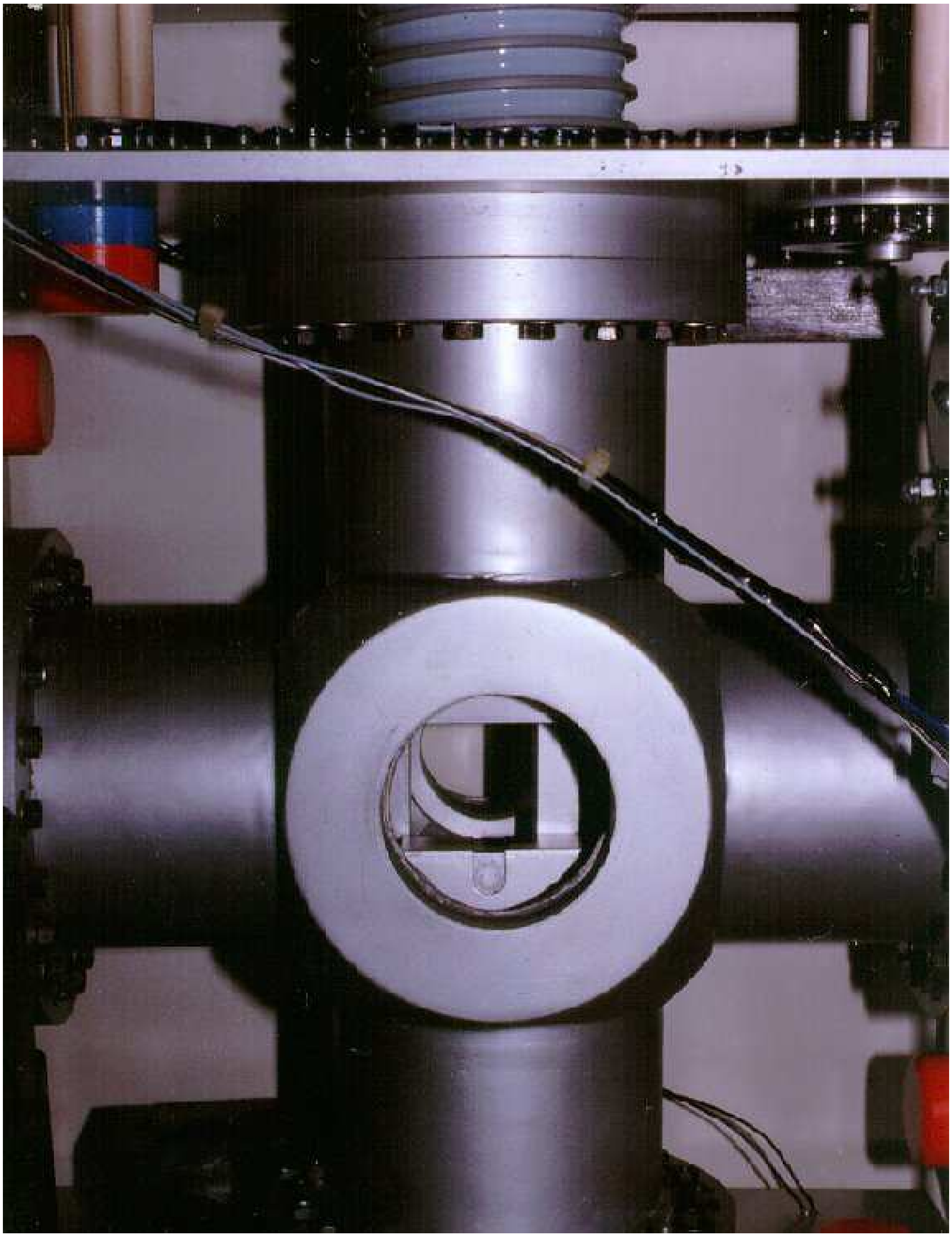
SIDE VIEW: CROSS SECTION



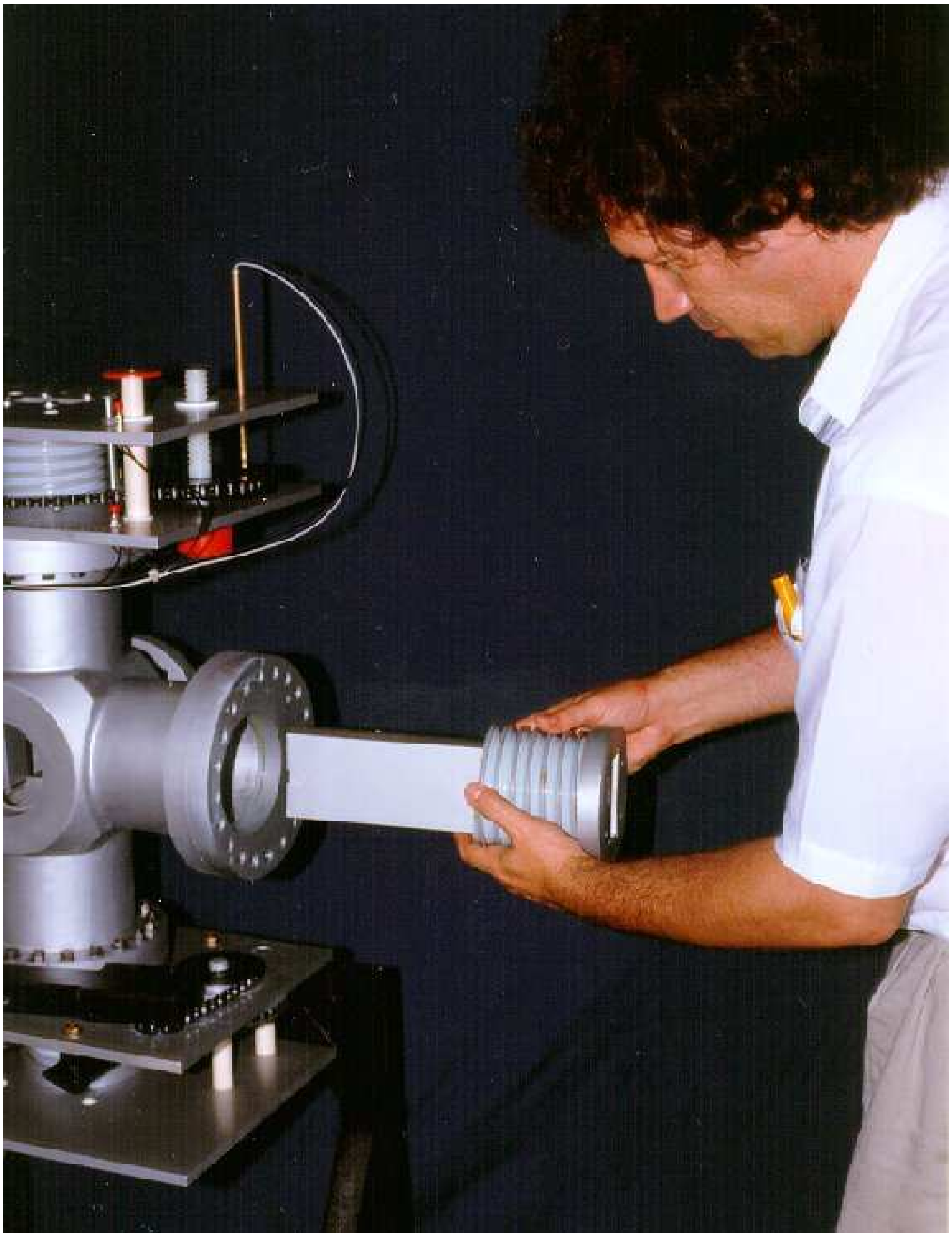
Full Scale Model Presented at Lishep98 - Rio



Full Scale Model Presented at Lishep98 - Rio



Full Scale Model Presented at Lishep98 - Rio



Further Development in Progress

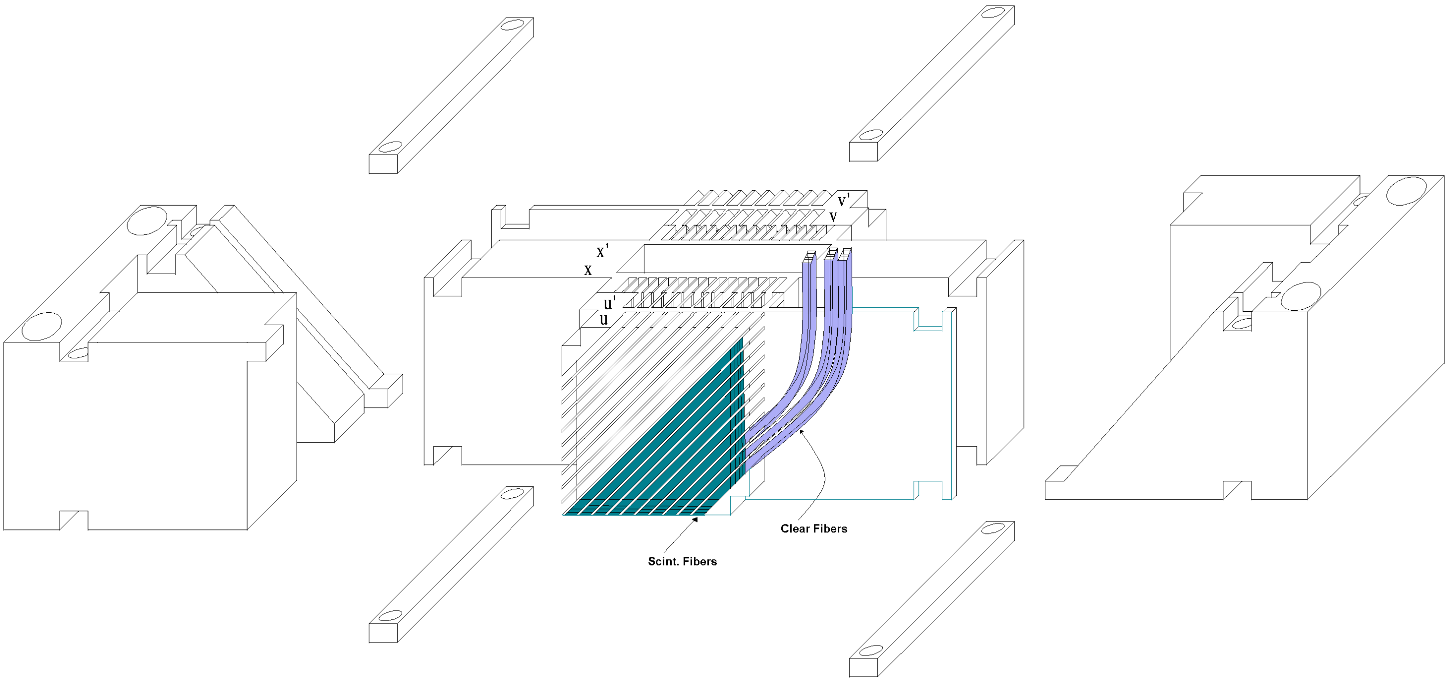
- Reducing Pot "Long Neck" Size
- Interface with Pumping Devices
- Chainless Design

✔Agreement Signed with LNLS for
Prototype building this spring
LNLS - National Synchrotron Lab

☺ Helps on Funding

☞ Prague group is Helping with
design & Vacuum expertise

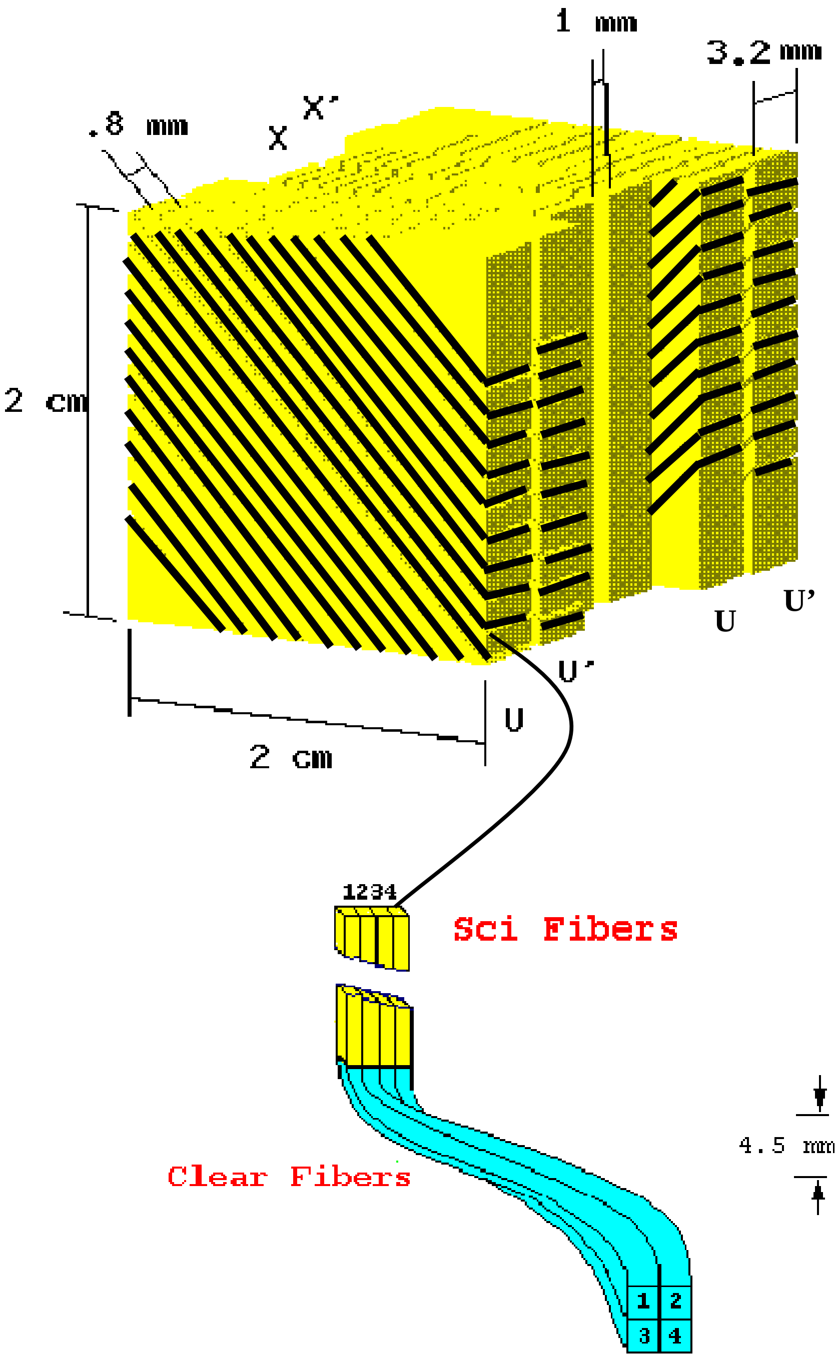
THE DETECTOR



20 channels/plane(U,V)'
16 channels/plane(X,X')
112 channels/detector
2016 total channels
80 μ theoretical resolution

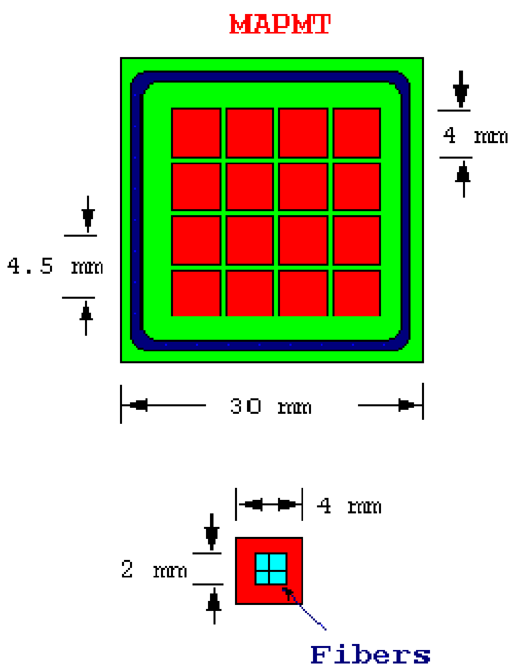
Six planes (u,u',v,v',x,x') of 800 μ scintillator fibers (') planes offset by 2/3 fiber

THE DETECTOR

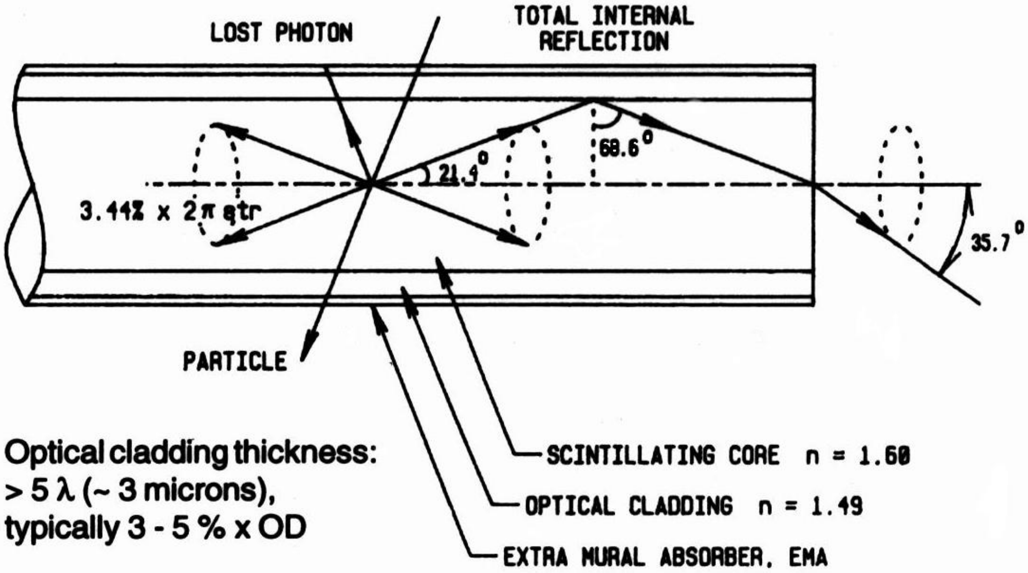


4 Fiber bundle fits well the pixel size of H6568 16 Ch. MAPMT

7 PMT's/detector (most of the cost)



A Typical Round Scintillating Fiber



Optical cladding thickness: > 5 λ (~ 3 microns), typically 3 - 5 % x OD

$$LightYield\,(Y)$$

$$Y = Y_0 \bullet F \bullet A \quad (1)$$

$$Y_0 \Rightarrow Initial\,Yield$$

$$F \Rightarrow Trapping\,Eficiency \approx 0.04$$

$$A \Rightarrow Fiber\,Attenuation$$

$$Y_0 = \frac{dE}{dx} \bullet \Delta x \bullet V \bullet C_s \bullet \left(\frac{Q_s}{\Delta E_{eff}}\right)$$

where

Δx *is the effective path lenght of the particle in the fiber*

V *is the fractional volume of the fiber core*

C_s *is the sci. fiber light conversion efficiency*

Q_s *is the sci. fiber quantum efficiency*

ΔE_{eff} *is the effective energy to generate a photon*

Photon Detection Device
Quantum Efficiency
Light ⇒ Charge

- VLPC (≈ 80%)
- APD (≈ 70%)
- Image Intensifier
    - CCD (≈ 20%)
    - Low rate

- MAPMT (≈ 20%)

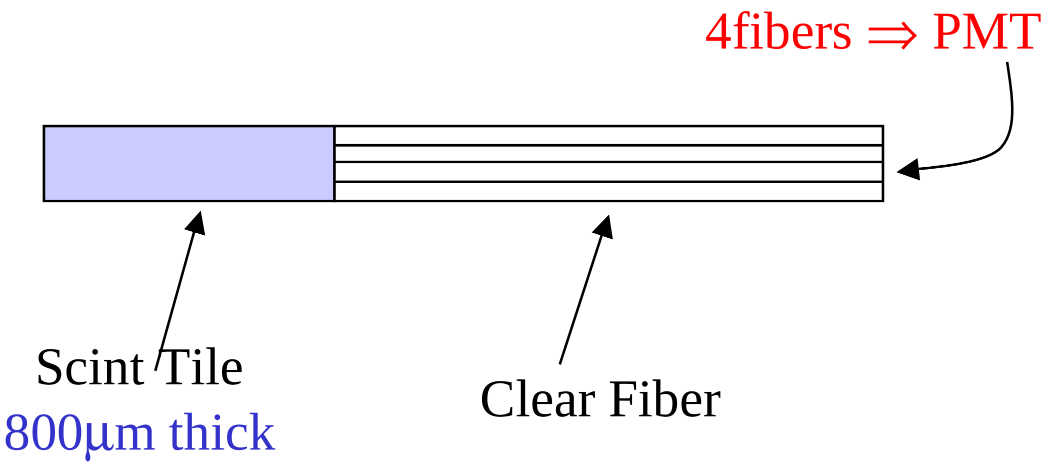
VLPC the best option
But... cryogenics$$$

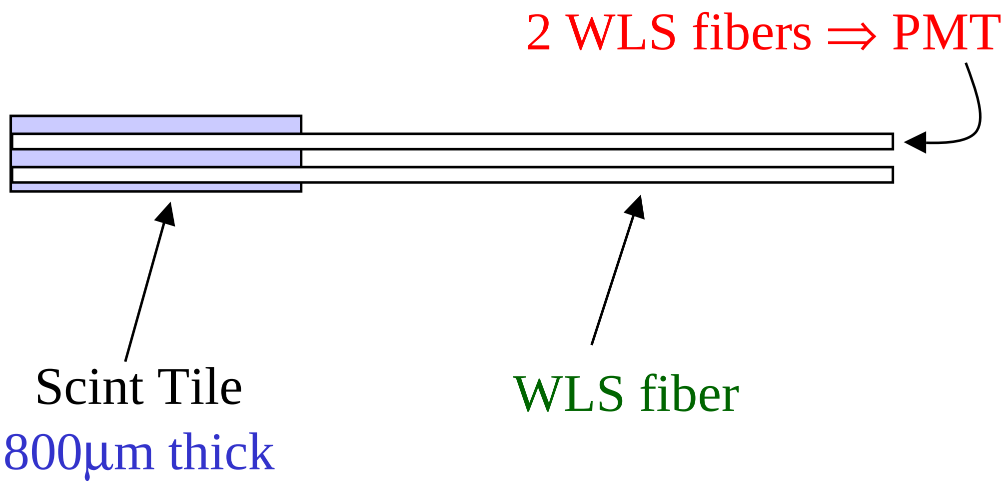
DETECTOR OPTIONS

Fiber Options Investigated

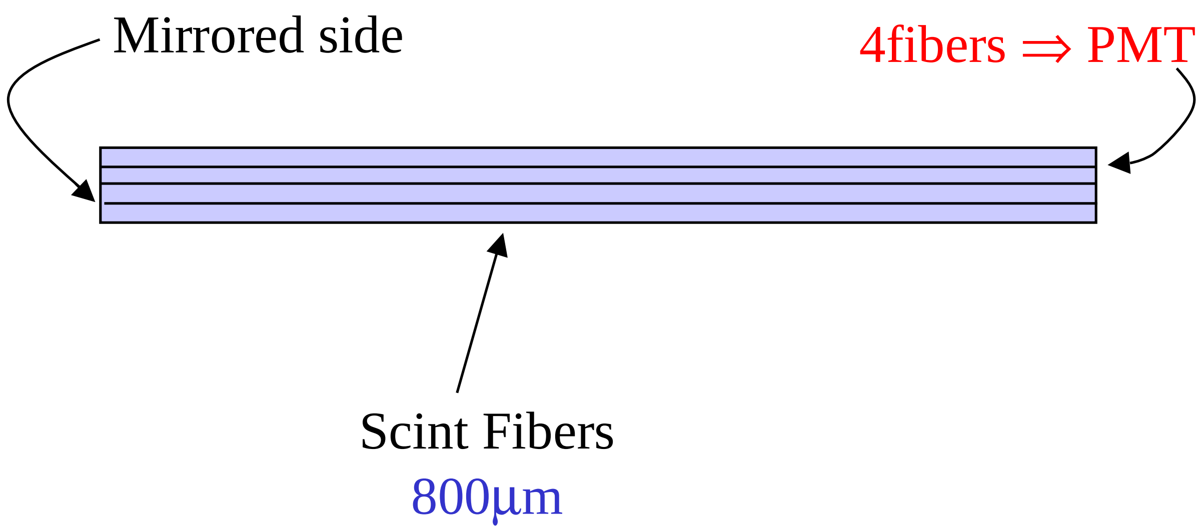
- Scint. Tile to Clear Fiber
- Scint. Tile to WLS Fiber
- Scint. Fiber Straight
- Scint. Fiber to Clear Fiber
- Round vs. Square Fibers

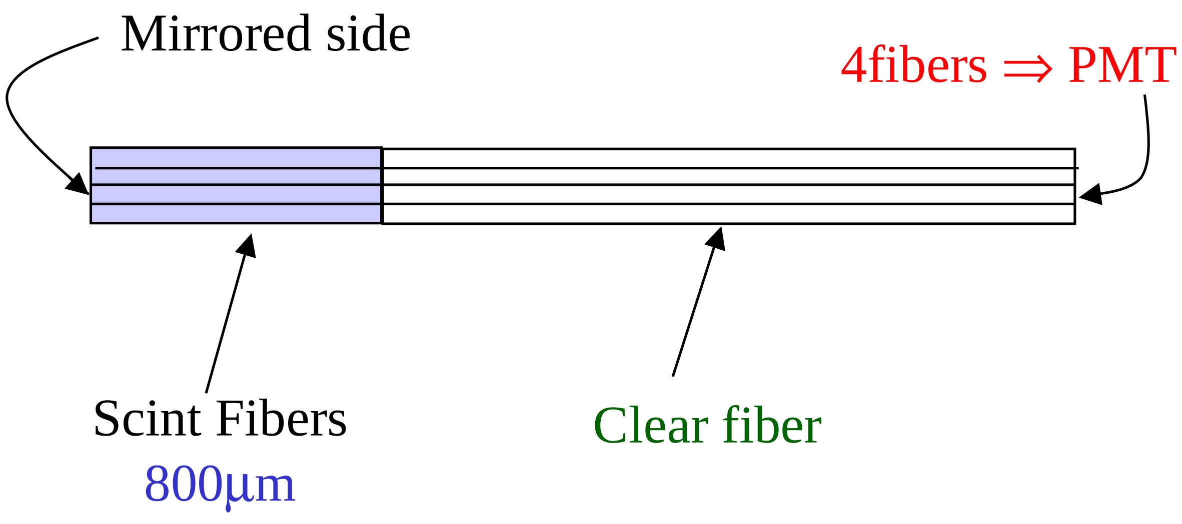
DETECTOR OPTIONS





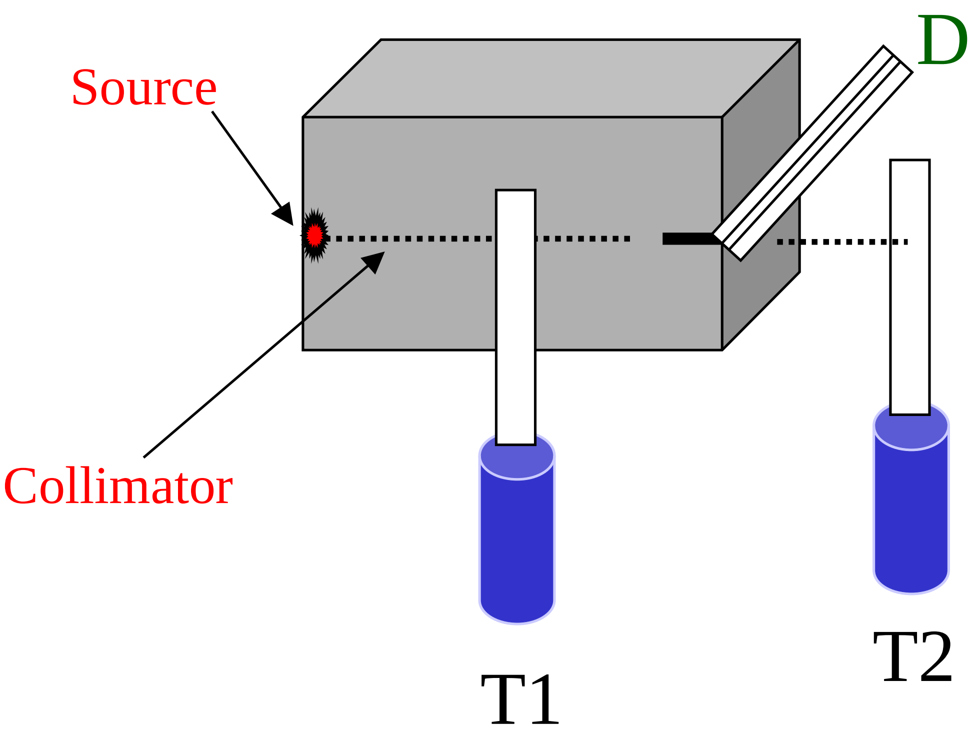
DETECTOR OPTIONS





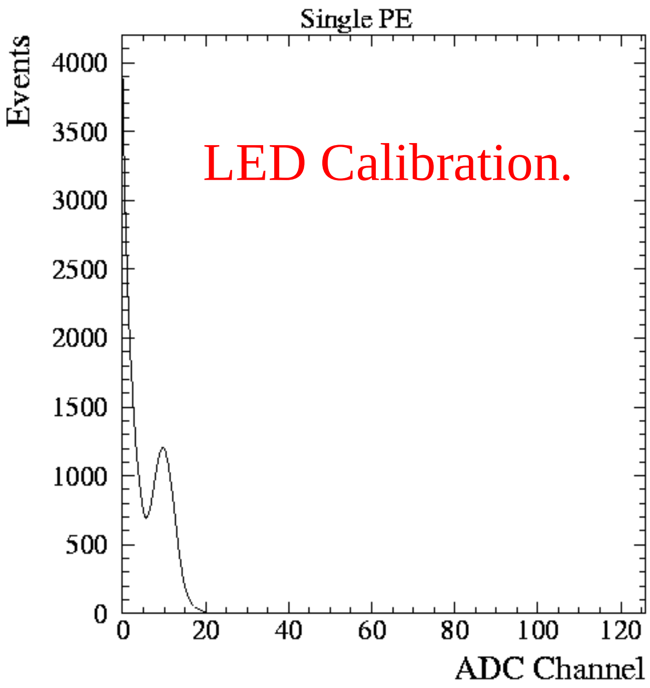
Detector Test Setup

Use $^{106}_{44}Ru$ 3.5 MeV e^- Source



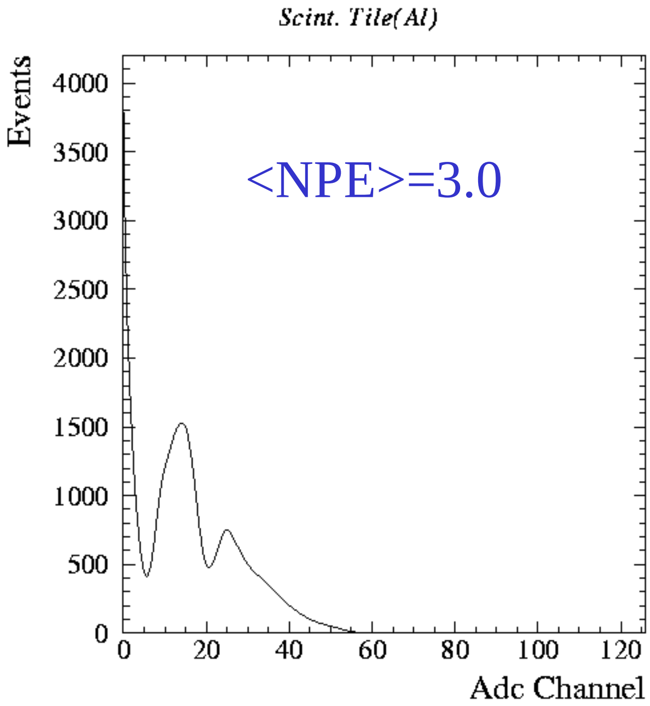
D - Detector Cell

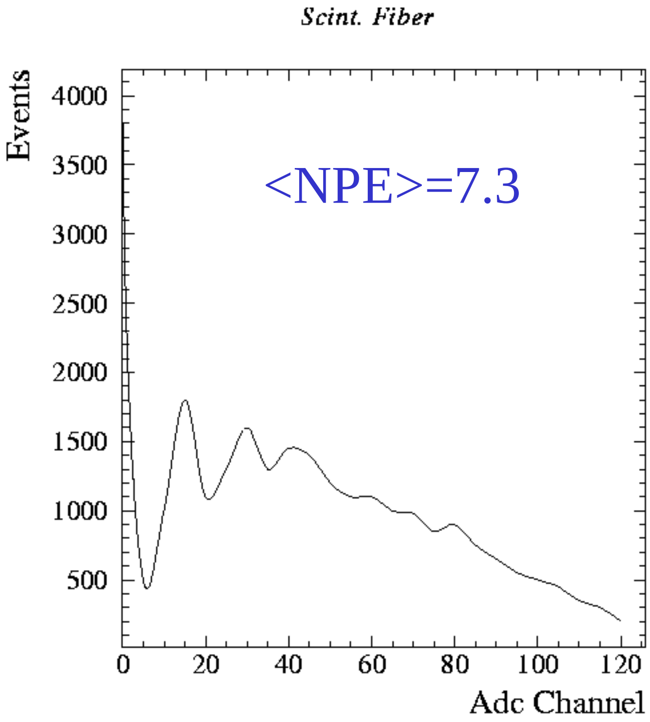
T1&T2 - Trigger Scintillators



Single PE Measurement H6568

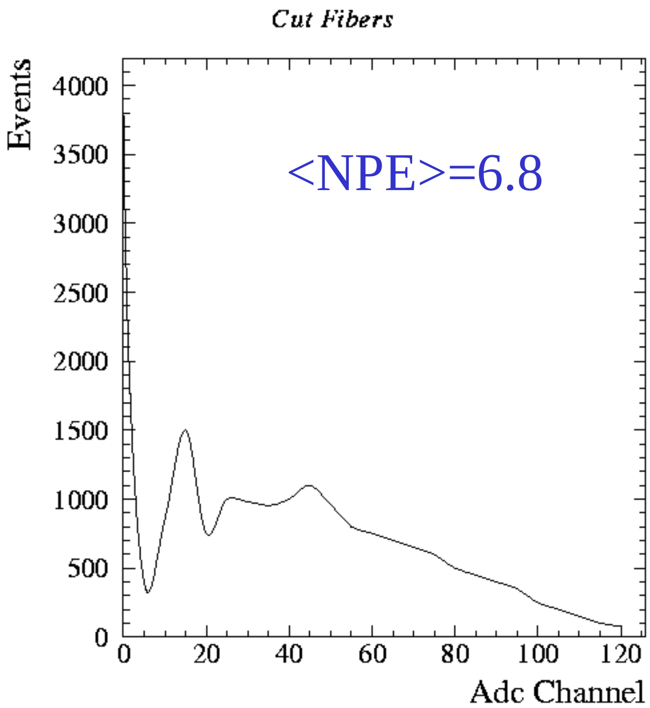
Scint. Tile
+
Clear Fiber

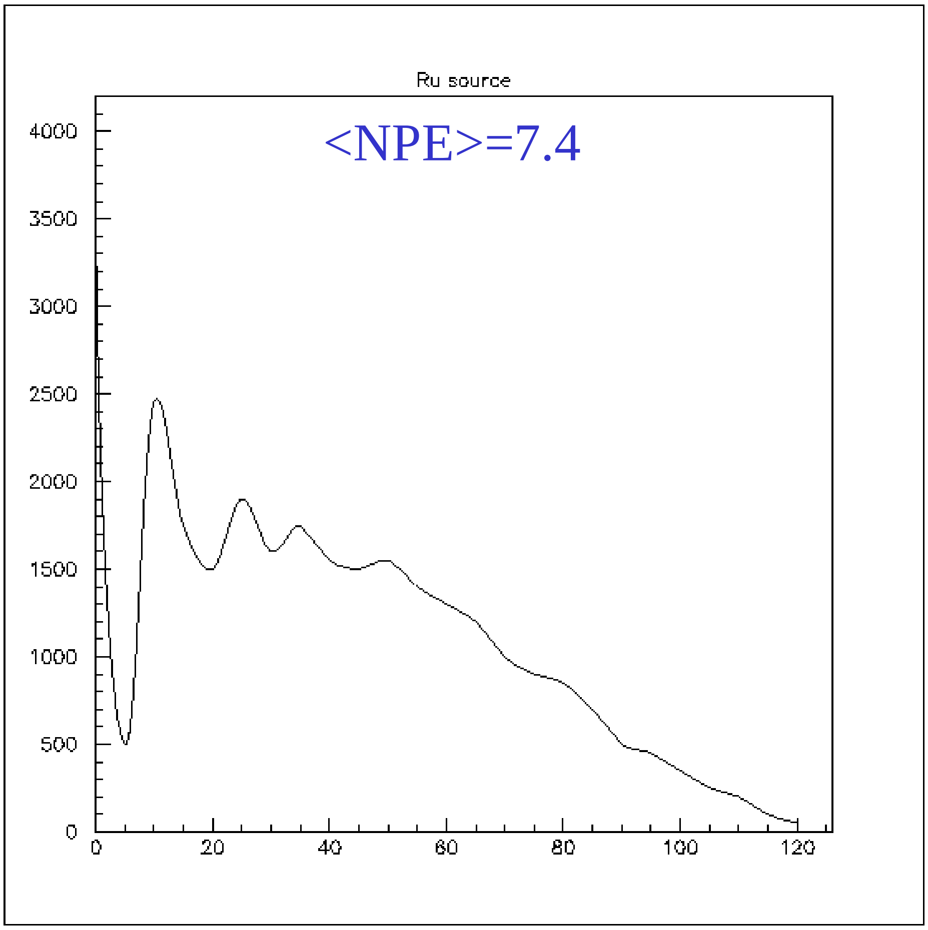




Scint. Fiber Output H6568

Effect of cutting Fiber at 45°





Scint. Fiber
+ Clear Fiber
Output
H6568

Similar to Uncut Straight Fibers

Gain → Attenuation length

Losses due to

- Cutting Fiber at 45° (5%)
- Fiber Splicing (5-10%)

Preferred Option
- Accelerator Background
- Cross Talk

Current Developments

- 0th order Fiber detector Prototype being tested
- DAQ for prototype testing has been assembled
- Modifications to Splicing Machine being made
- Work on adapting CFT Trigger System
- Work on FPD Trigger strategy in progress

1998 Plans

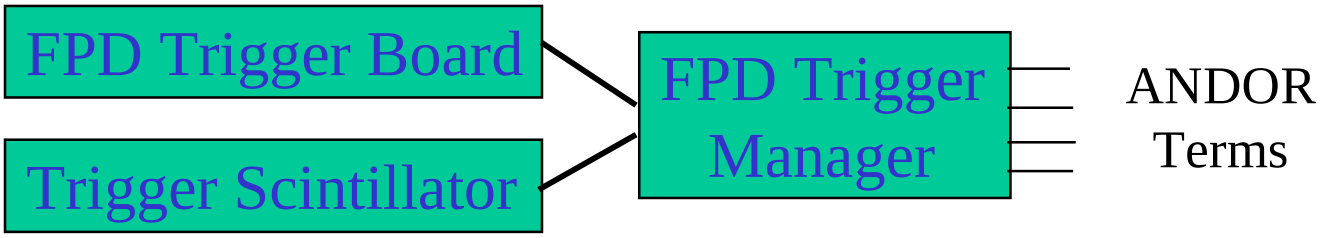
- Finalizing Detector and Pot Designs
- Both Prototypes Ready by Fall
- Request for National Grant within Brazil
- Project Integration within accelerator and D∅

DØ Interface Issues

- MAPMT Signals → Amplifier → Cables →
  → FPD Trigger Board

- Amplifier Development by Mario's Group
- Connector to Cables Development by Mario's Group
- Connector to Trigger Board Development by Mario's Group or FNAL

- FPD Trigger Board = CFT Trigger Board with different charge divider and FPGA Logic
- Trigger Scintillators read out by LM Board



- Space: Platform PW02 → L1 Electronics
  MCH MC13 → Low Voltage (Amplif., Step Motors?), Pulser
  HV (In Existing Crate)
- Other Issues Starting to be Considered:
  Calibration, Online Monitoring

Project Cost + Funding

- Roman Pots + Detectors ≈ 600k $
- Accelerator Modifications ≈ 300k $
- FNAL: Accel. Mods + Some R&D/Travel
- Brazil: Pronex Project May 1, Reply by Aug. 1
  Full Funding Possible
  Other Funding Being Pursued
- NIKHEF: ≈ 100k $ Hardware

Issues for Discussion

1) FNAL R&D Budget

2) Official Communication with Beams Division

3) Official + Internal Status of the Project

4) Reviews

Detector Update & Issues

- Partial Prototype (1/2 Plane) Efficiency = 98%
  Geom. Inefficiency Due to Wide Angle Cosmics

- Modifications to Splicing Machine Done
  Calibration Difficult → Home made, designed for round fibers + shrink tube
- Commercial Solutions Being Sought

- Under Development:
    - LED Pulser for monitoring/calibration
    - Trigger Scintillator Readout
    - Detector interface to Roman Pot