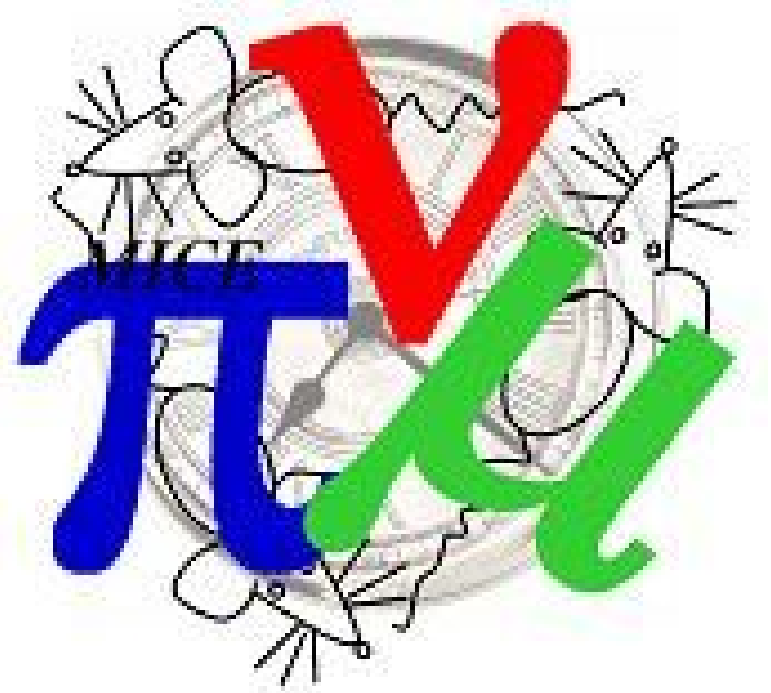
The MICE detector system



Pietro Chimenti
for the MICE collaboration

Università e I.N.F.N. di Trieste

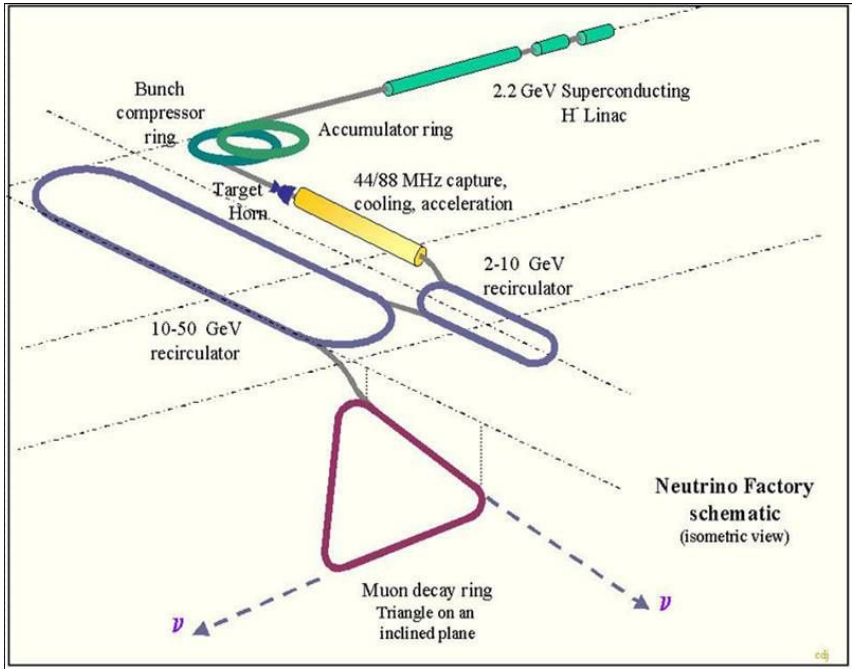
http://hep04.phys.iit.edu/cooldemo/

MICE: Muon Ionization Cooling Experiment

Aim of the experiment:

- To show that one can design, engineer and build a section of a cooling channel capable of giving the desired performance for a Neutrino Factory
- To place it in a muon beam and measure its performance in various modes of operation and beam conditions, thereby investigating the limits and practicality of cooling

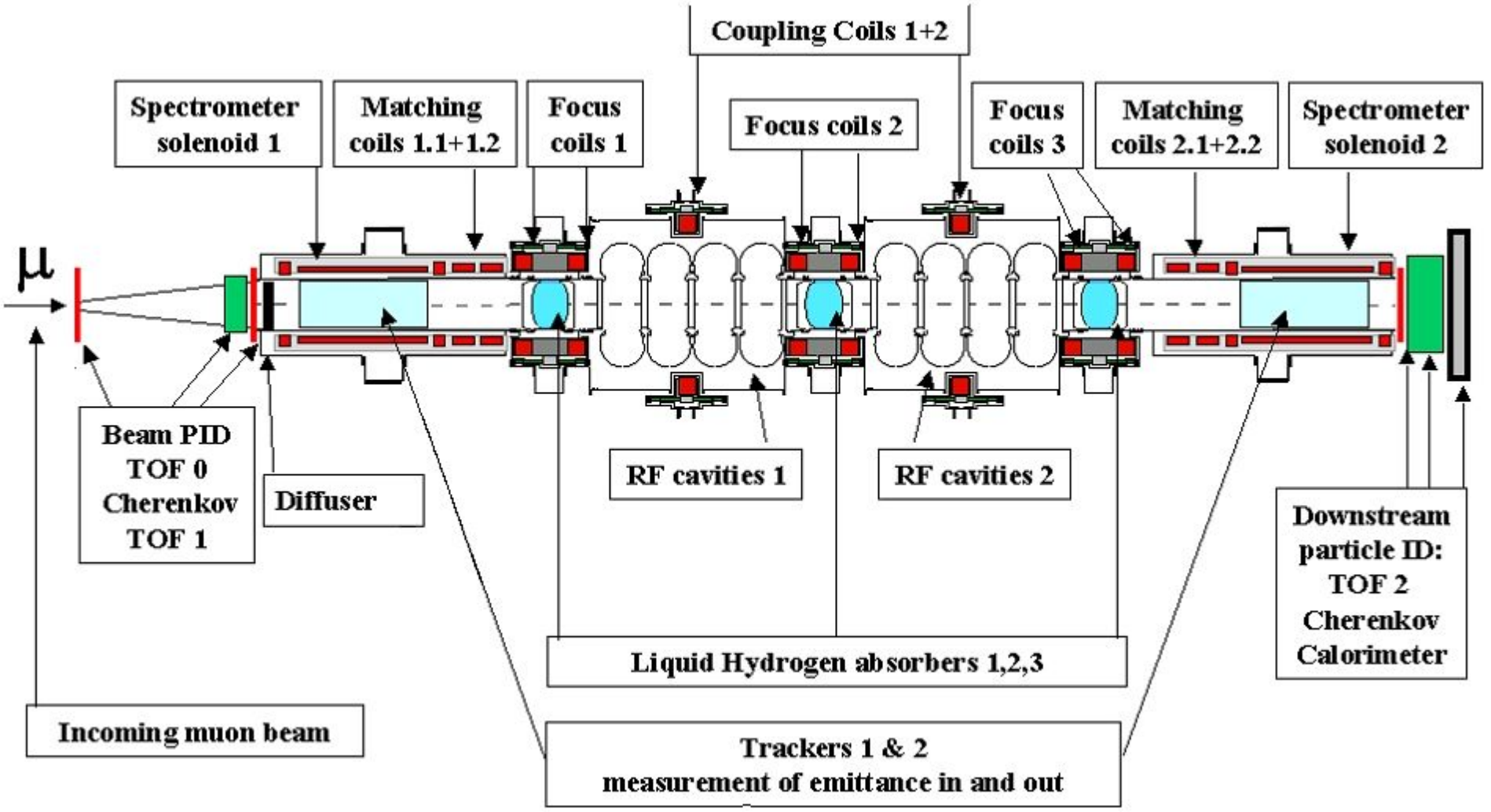
The cooling session can account for 20% of the total cost of a Neutrino Factory and improve the number of accelerated muons up to a factor 10



Conceptual Design

Precise beam emittance measurements are needed:

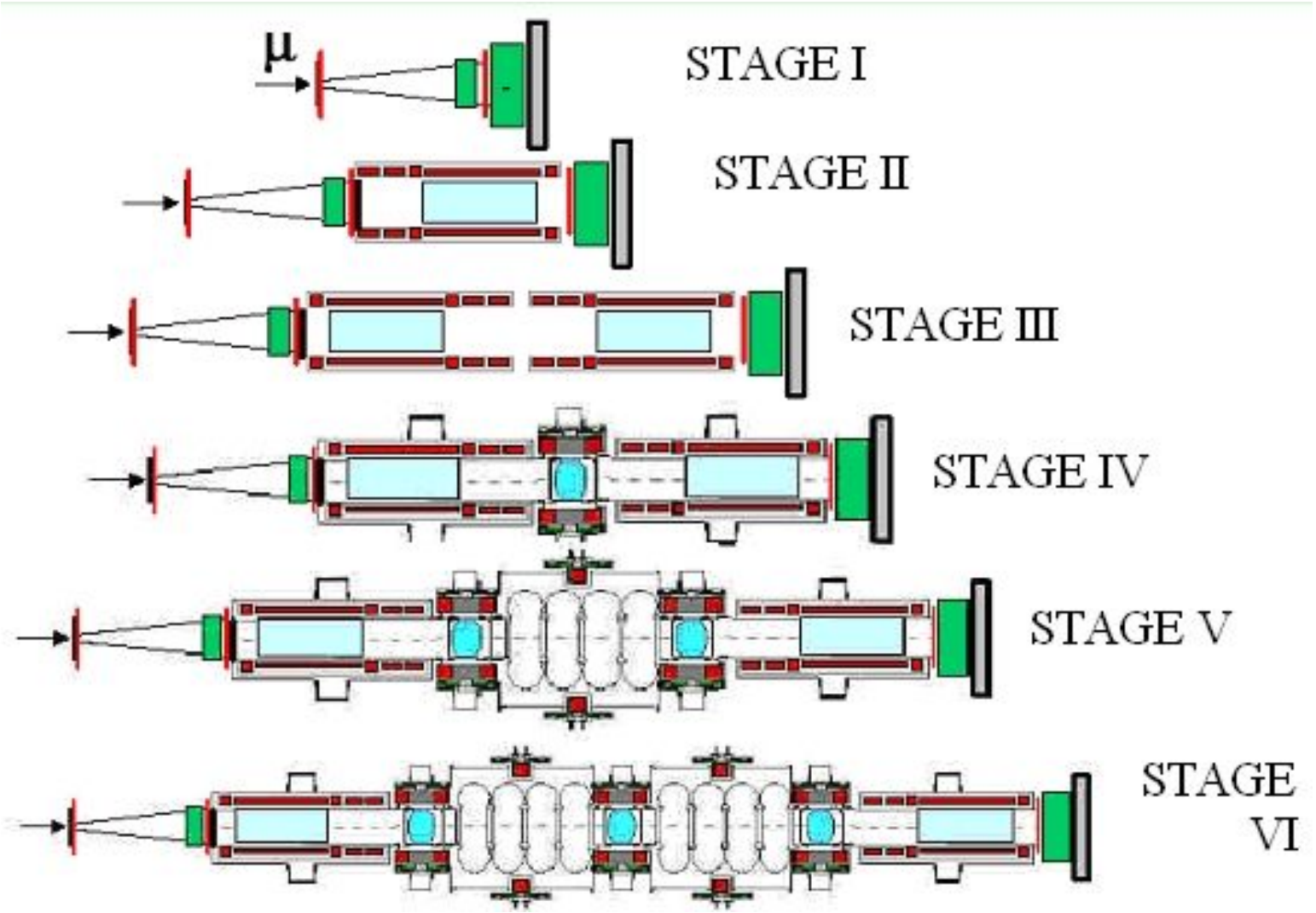
MICE tracks and identify single particles traversing the cooling channel!!



Staging the experiment

- Better control of systematic errors
- Better understanding of the cooling and accelerating phases

Stages I-II-III almost completely funded



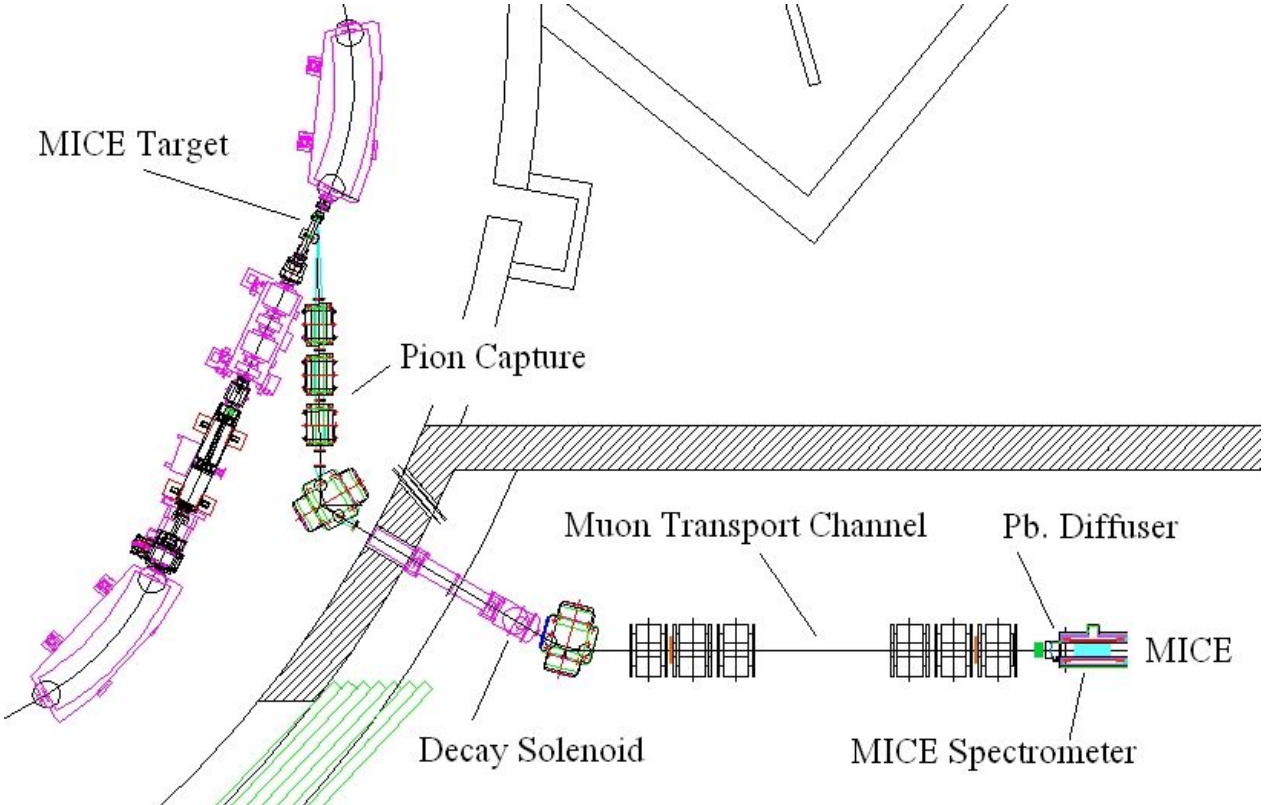
The beam from ISIS

~1ms long bunches at 1 Hz
~600 good muons per bunch in mice

nominal beam momenta:
180-280 MeV/c

beam contamination from pions and electrons at the 1% level

The beam structure imposes strong requirements on the read-out electronic speed

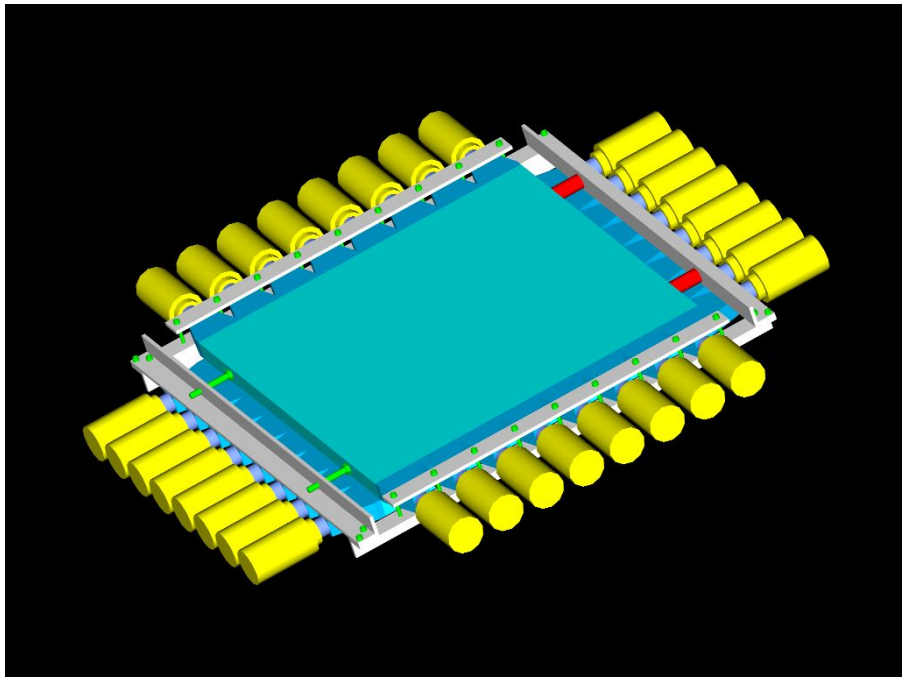


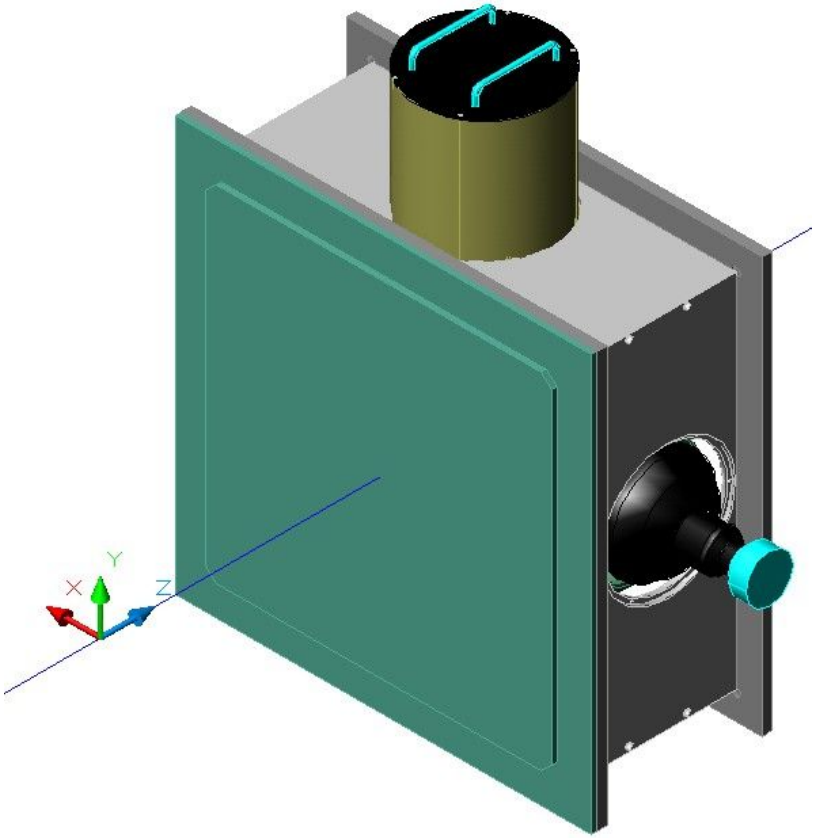
Up-stream particle identification

The upstream particle identification is based on:

- two time of flight station ~10 m apart with a time resolution of ~70ps
- two Cherencov counters with different thresholds

To measure the longitudinal emittance at the required precision it is necessary to calibrate the TOF resolution at the 10% level

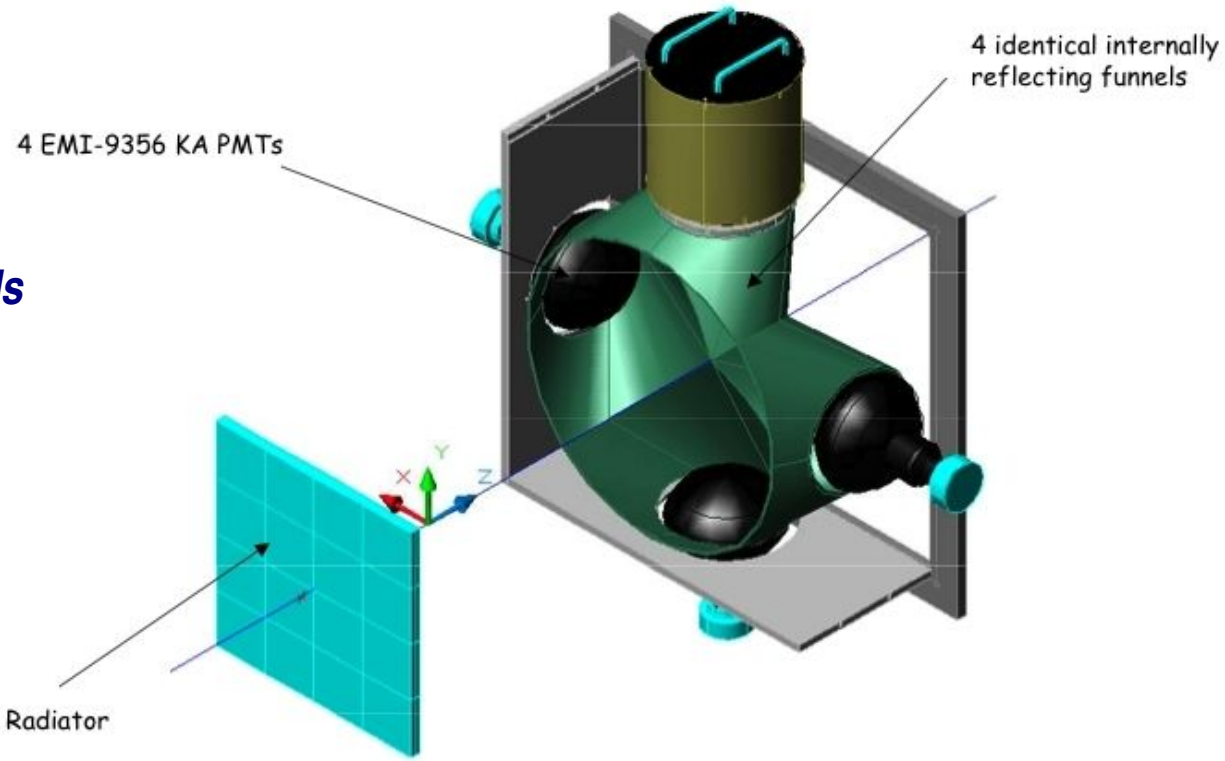


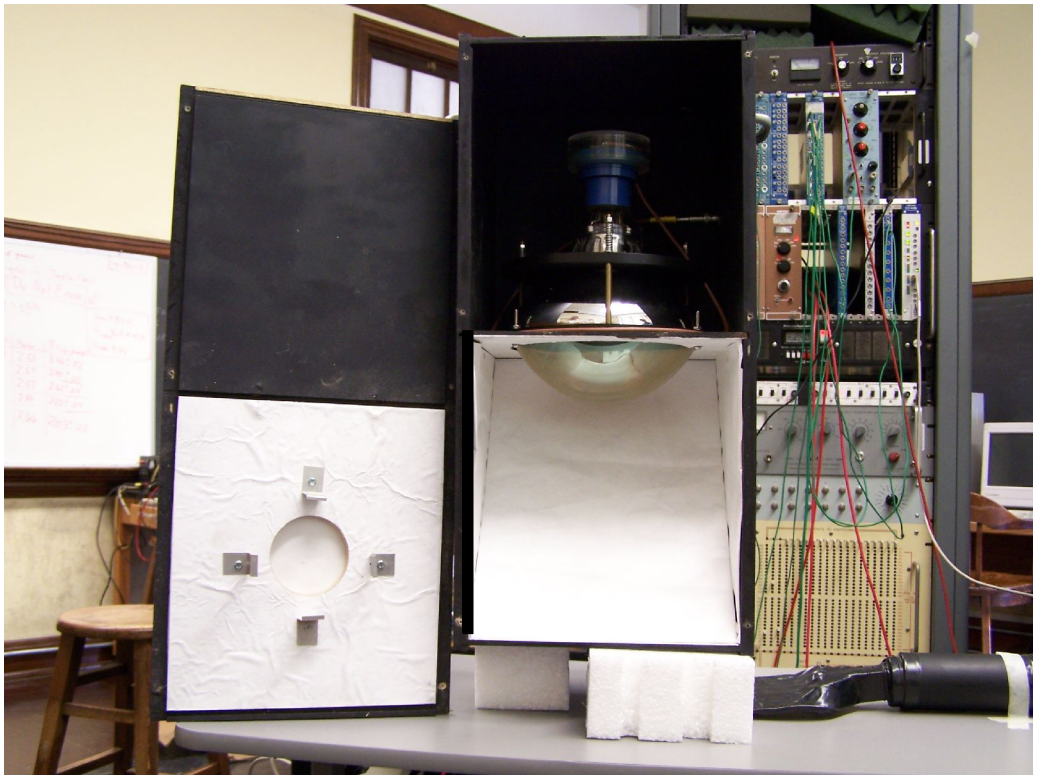


Cherenckov counters

Aerogel indexes and momentum thresholds

n	*Pth(mu)*	*Pth(pi)*
1.12	*210MeV/c*	*275MeV/c*
1.07	*265MeV/c*	*365MeV/c*





Tests on a prototype have been done

Final design almost complete

Construction will start soon

TOF counters (upstream)

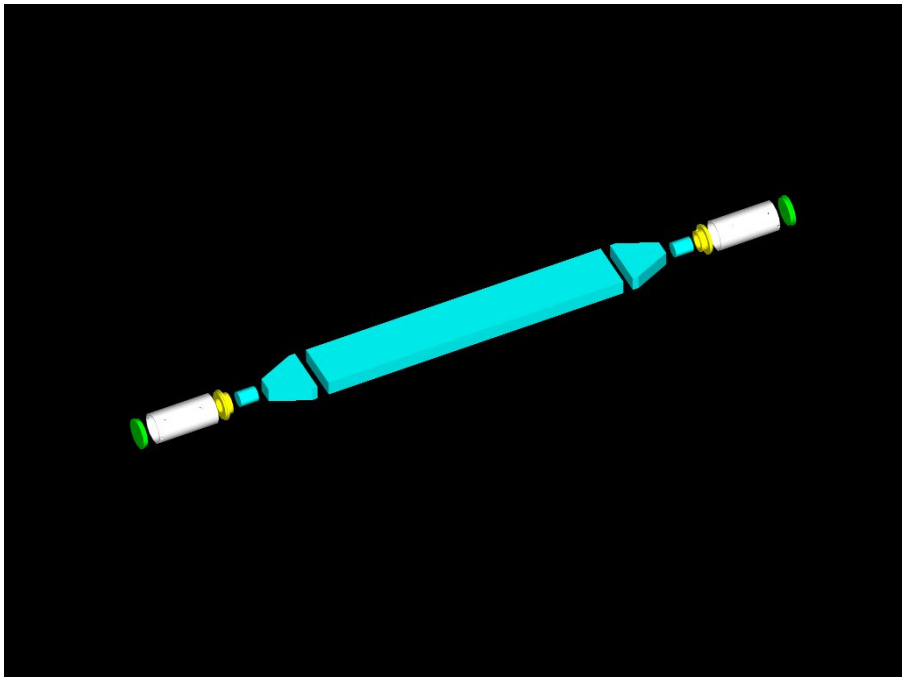
two stations, two plane per station.

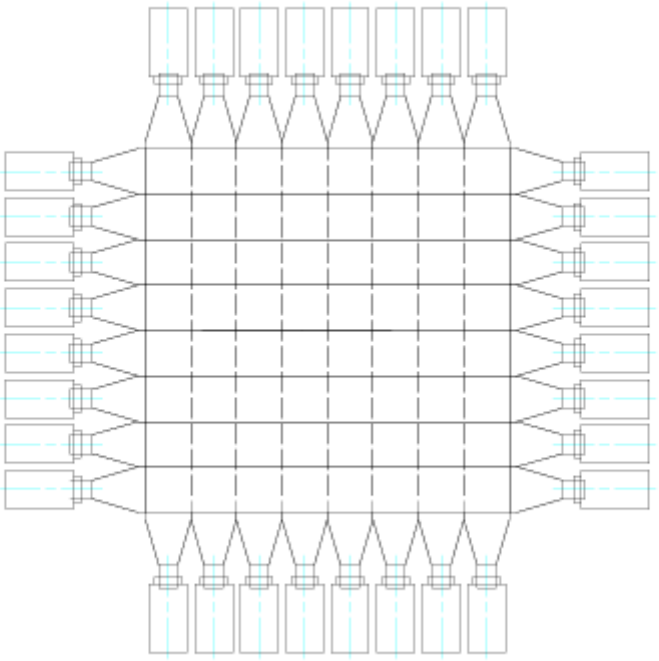
8 bars for each plane

48x6x2.5 cm^3 each bar

scintillator: bc-404 best choice but other option available

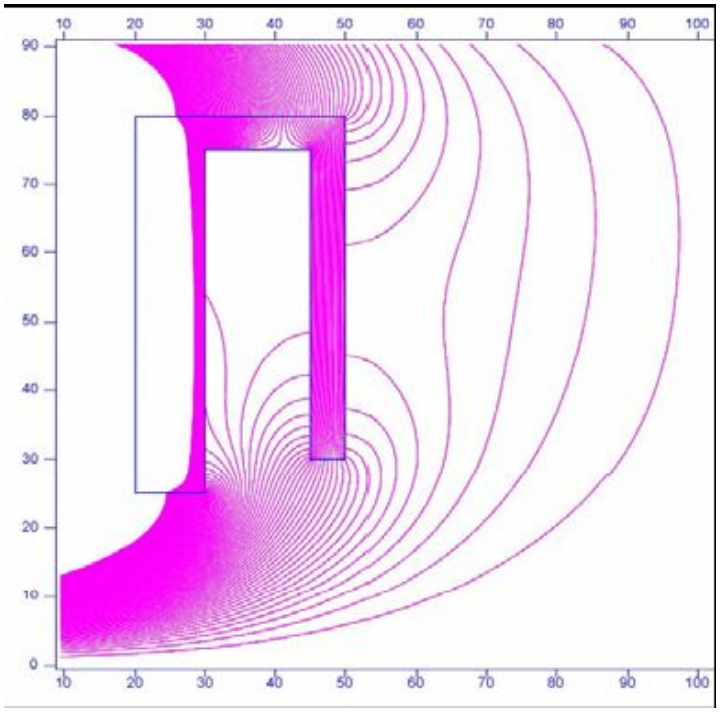
phototubes: hamamatsu R4998



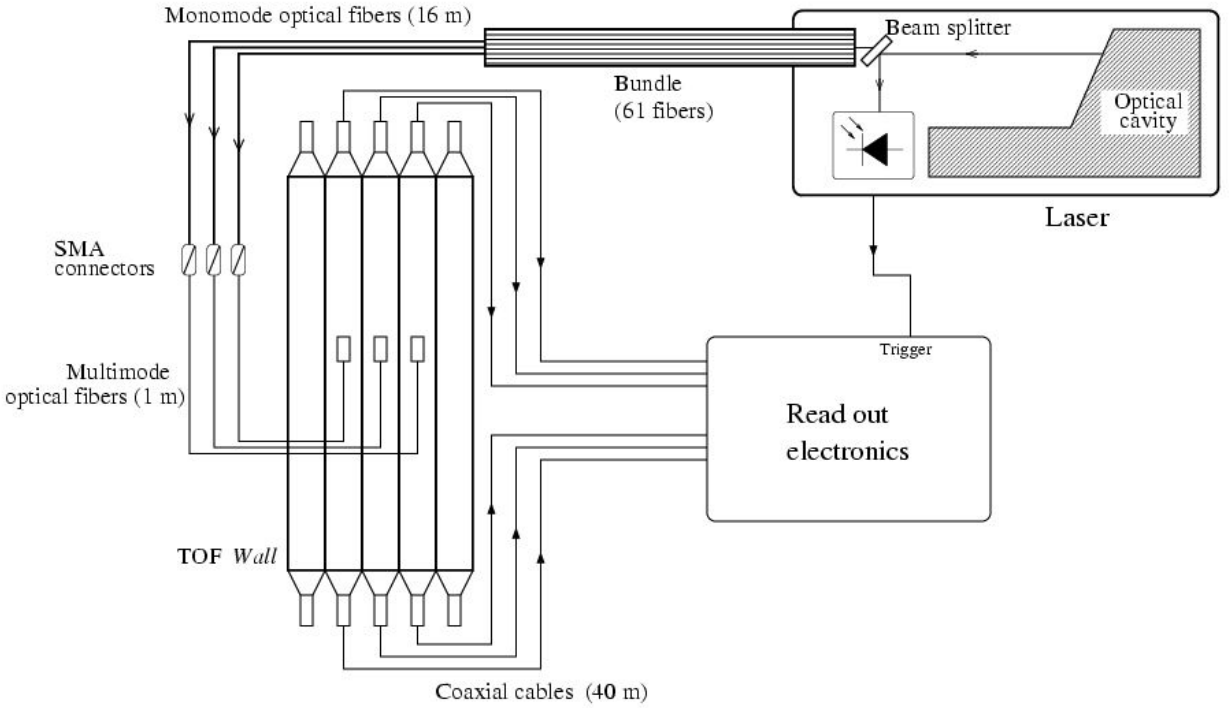


TOF shielding and calibration

Shielding from stray field of solenoids: two connected iron rings surrounding a station plus a local shield for each pmt



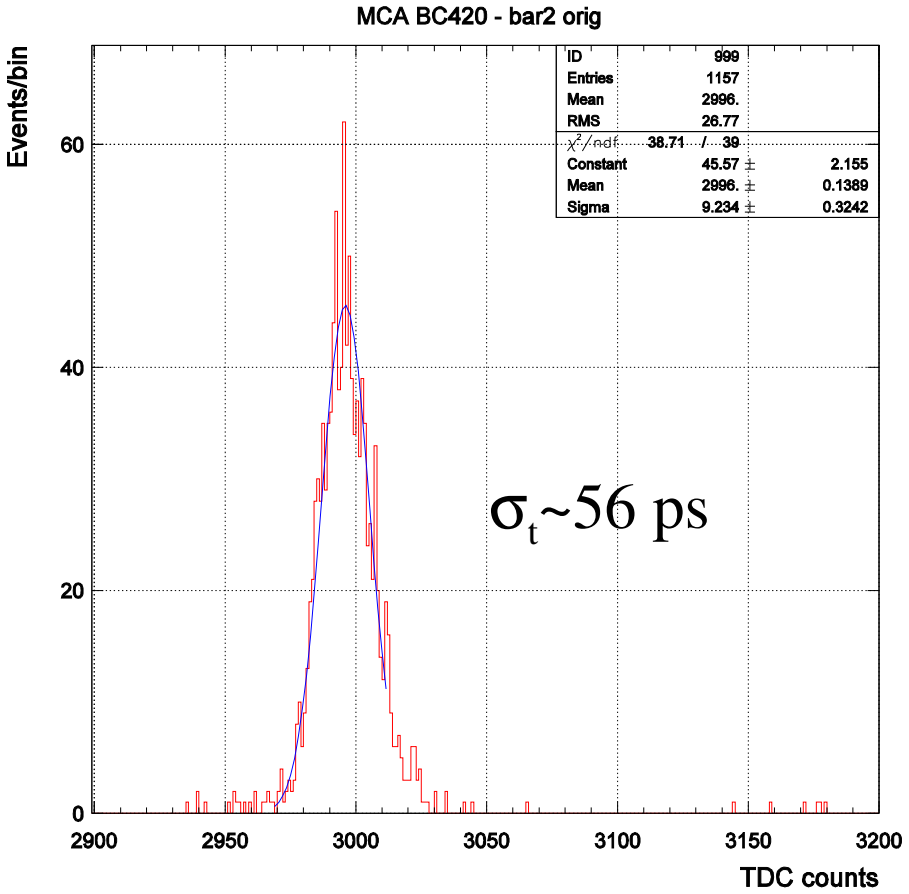
calibration system based on TOF redundancy and laser system (as in HARP)

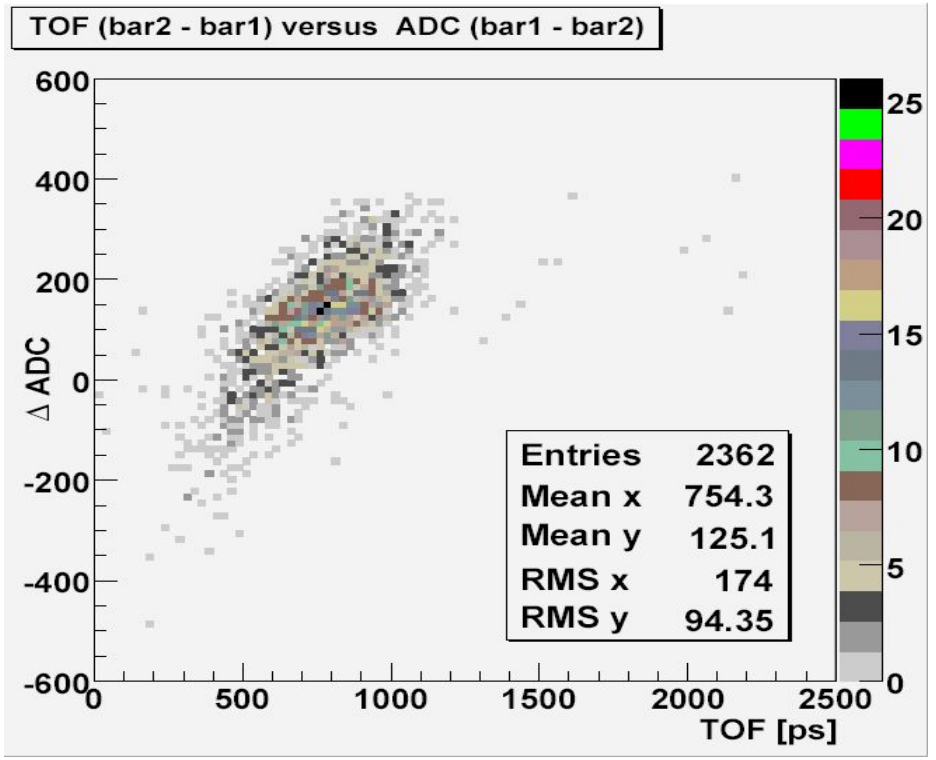


TOF tests at the BTF

Tests showed very good timing resolution BUT indicated the need of a time-walk correction

Final choice for front end electronics not yet done

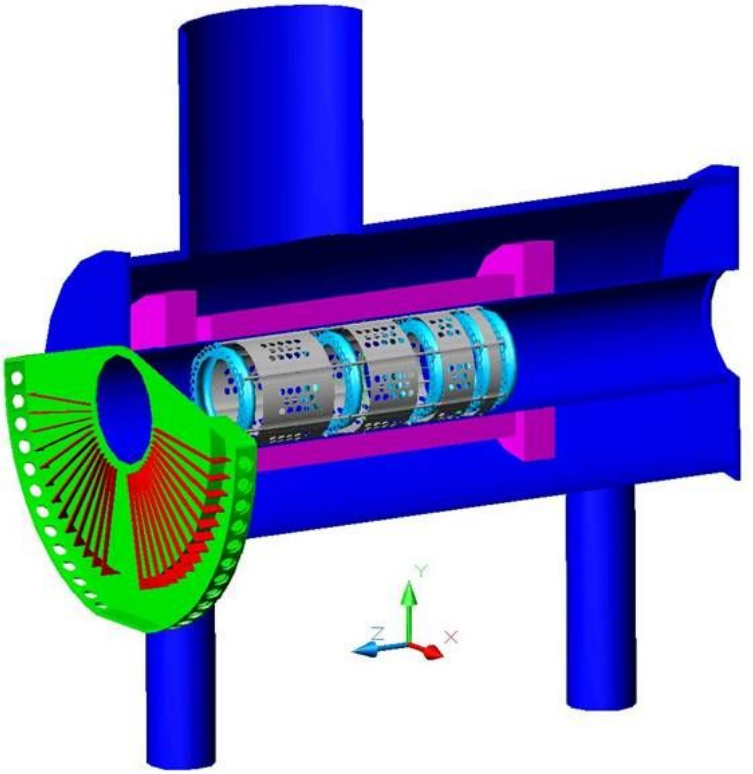


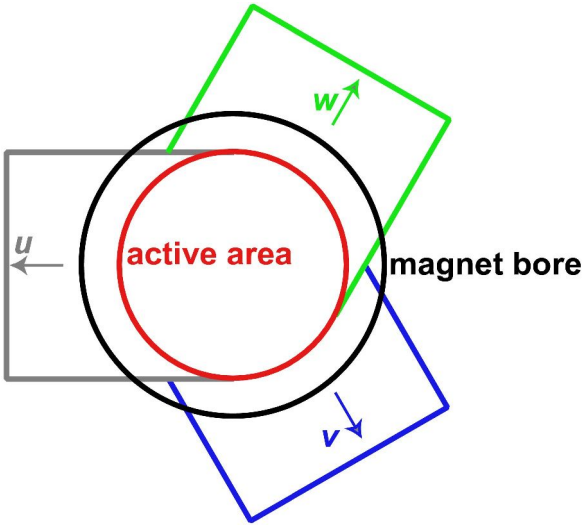


Tracking system

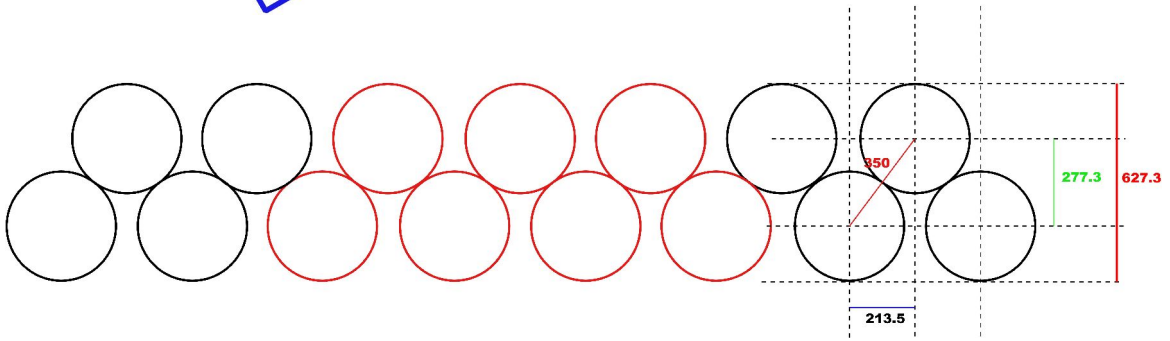
fiber tracker with 0.35 mm diameter fibers

2 system with 5 stations, three projection per station, two layers per projection
30 cm active area of each station
up to 4 tesla magnetic field





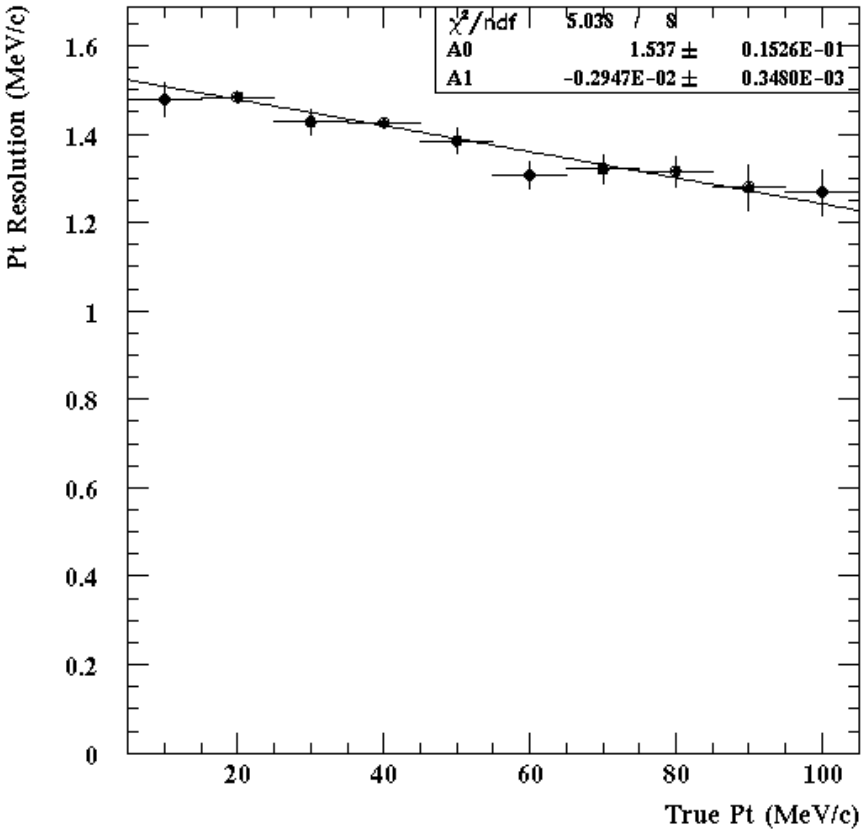
fibers are read by visible light photon counters in bunches of 7: 0.47 mm resolution in each layer

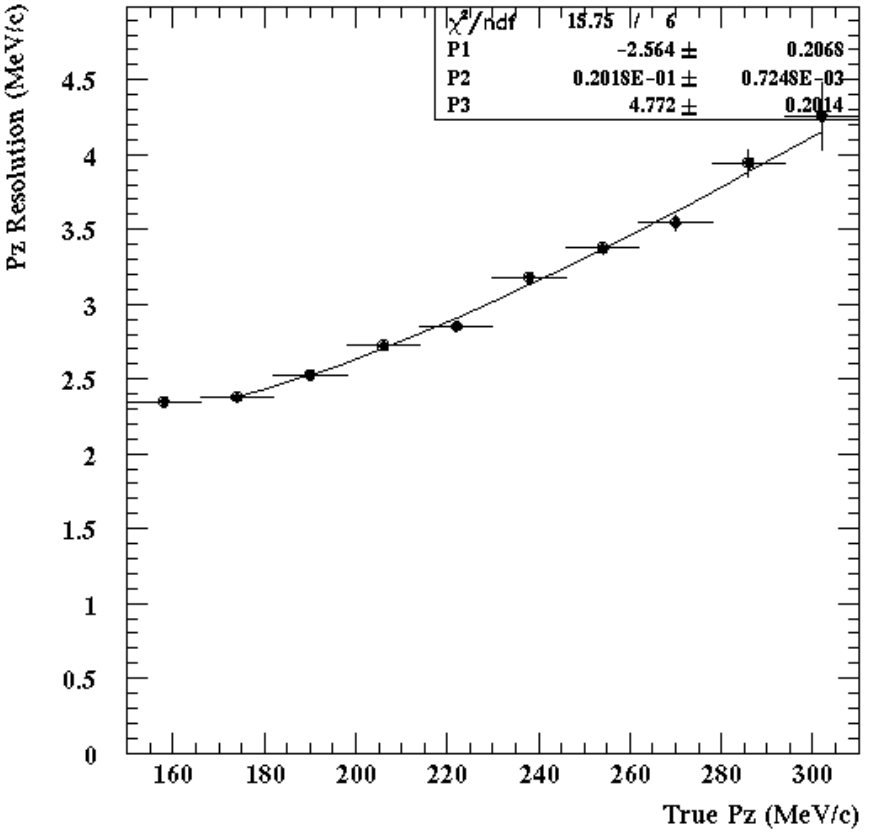


Tracking system (resolution)

The momentum resolution has been calculated simulating a MICE setting with a 200MeV/c nominal beam momentum

The resolution have been shown to be good enough to measure transverse emittance to 0.1% precision





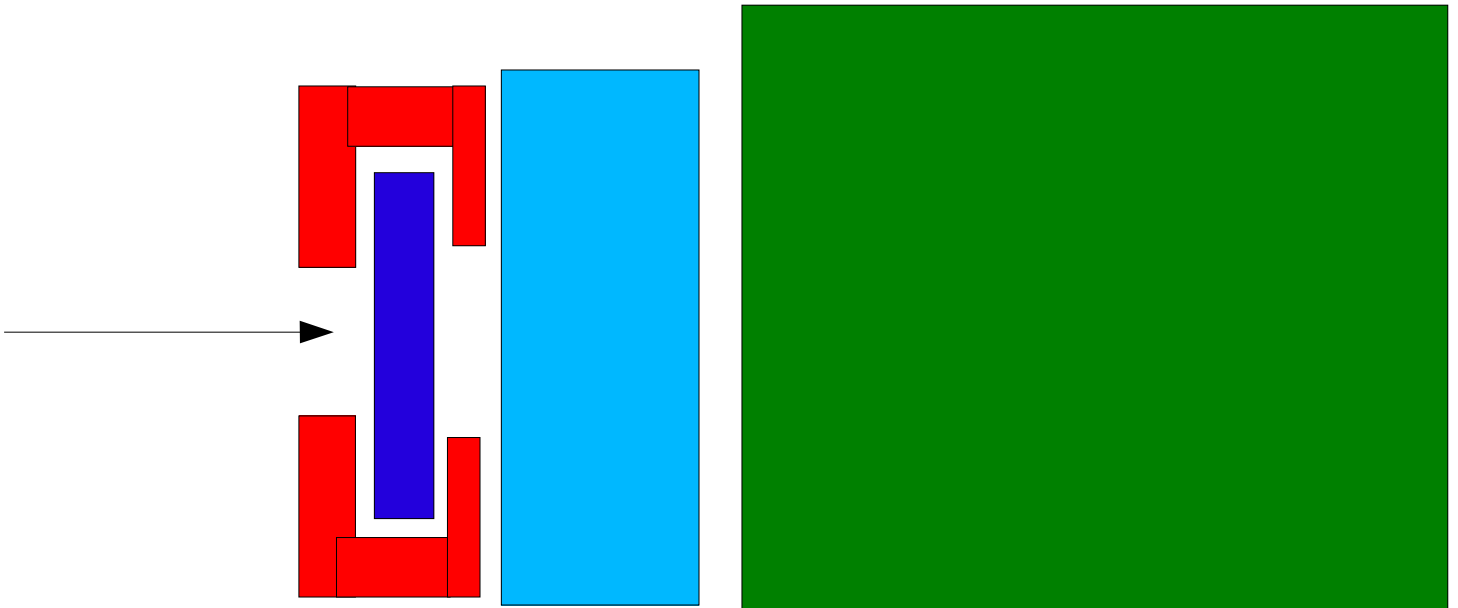
Upstream PID

detectors encountered along the beam line

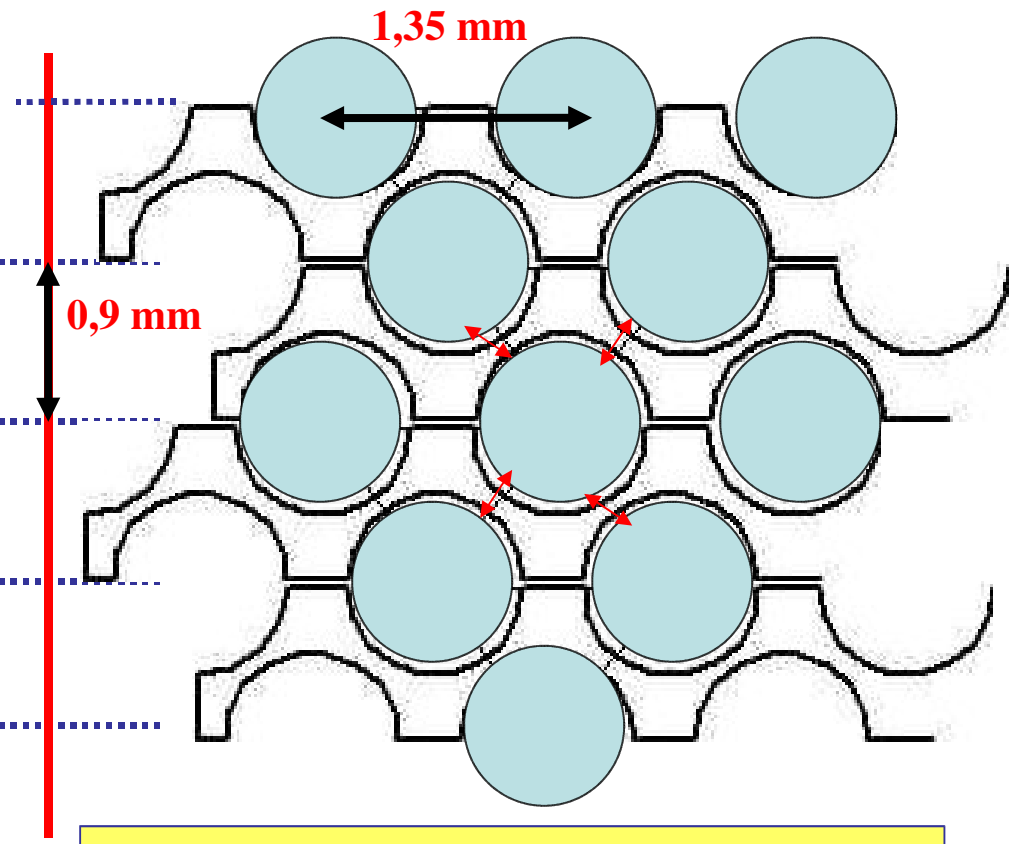
- one TOF station to measure final longitudinal emittance
- one layer of lead-scintillating fibers calorimenter to measure E.M. energy deposition
- one scintillator wall to measure muon range

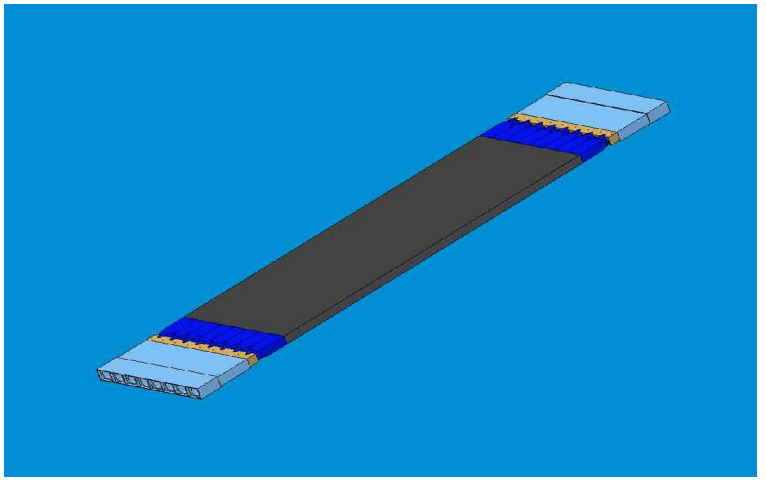
The PID strategy depend on partcle momentum

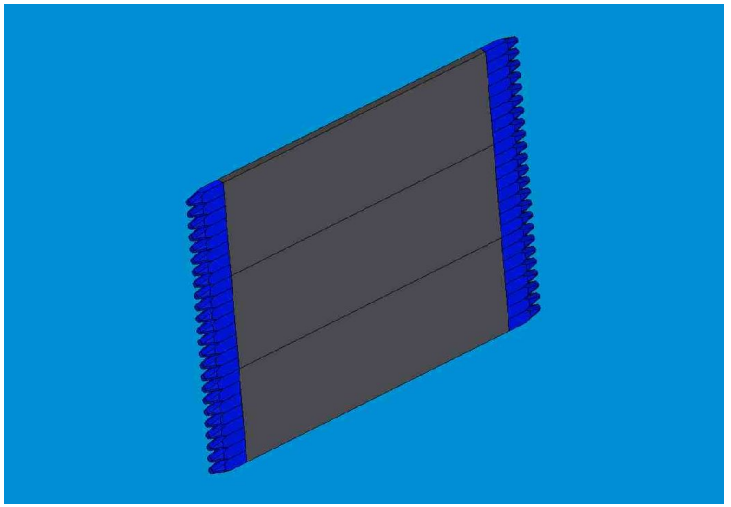
The TOF station is equal to the one upstream close to the soleniod



KL: design







≈ 0.9 mm pitch ⊥ to the beam

1.35 mm pitch of lead foil grooving

0,3 mm Lead + 1 mm Fiber

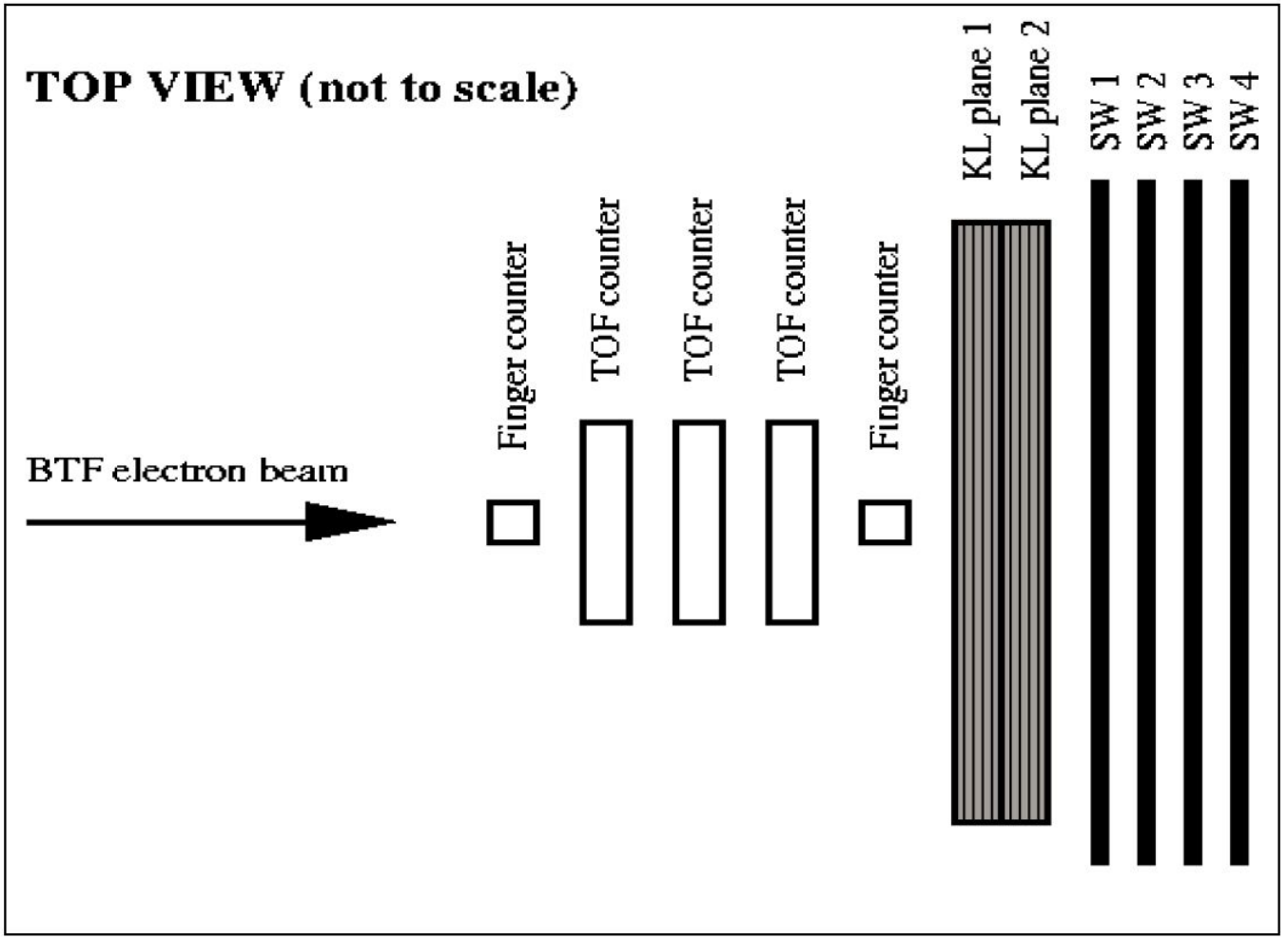
X_0 ≈ 20 mm (estimated)

Prototypes tests at BTF

detector configurations:

- 1 or 2 KL layers
- several scintillator types for TOF
- two different scintillators for SW

Scan in momentum 75-350 MeV/c

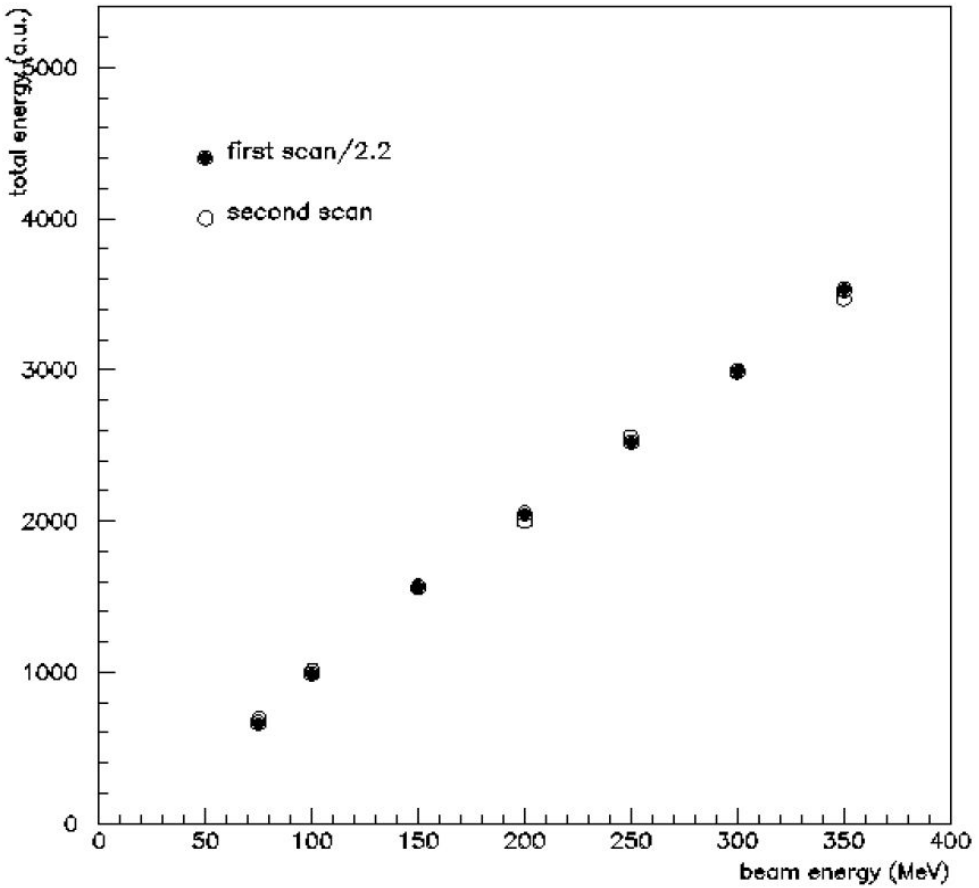


Several FEE scheme :

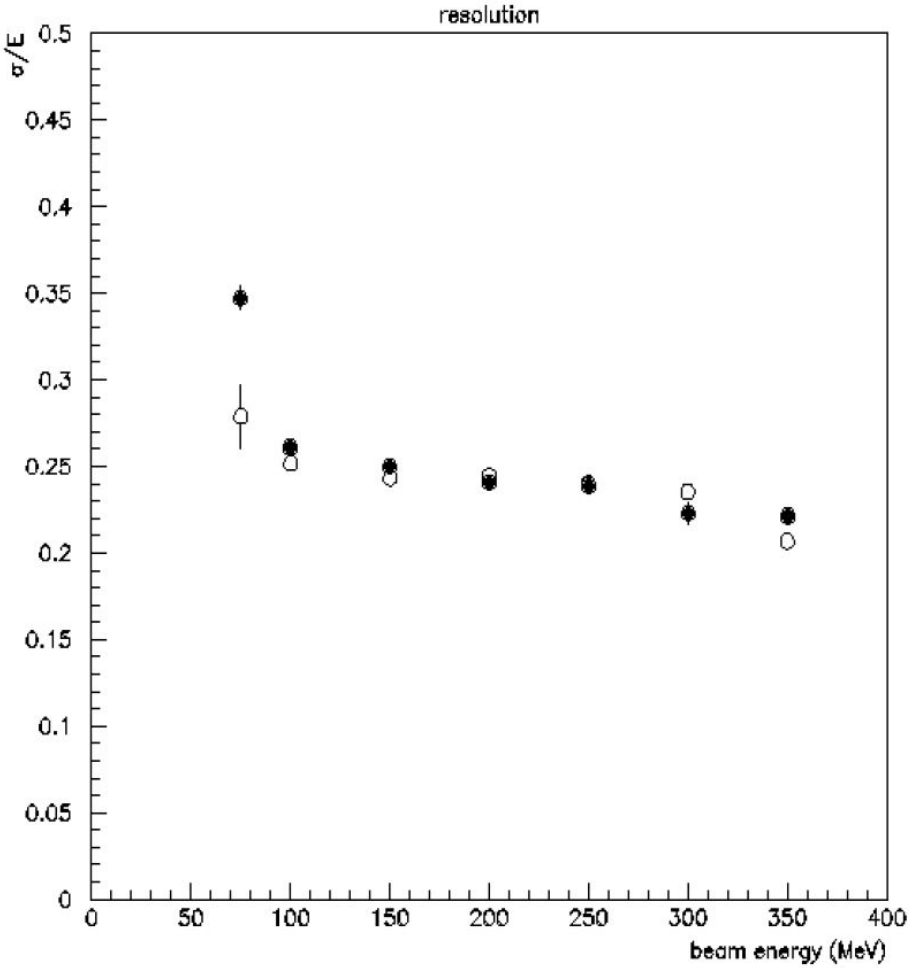
- just ADC (KL)
- splitter + ADC + TDC
- different discr. options

KL performances

Visible energy V beam momentum
(measurements of longitudinal leaks)



Energy resolution
High or low momentum points
suffere from different systematic
effects



Comparison between PID designs

Initial mom.	No cal., with TOF	KL, no TOF	SW, no TOF	KL, with TOF	SW, with TOF
140±14 MeV/c	0.24%	0.20%	0.093%	0.19%	0.093%
170±17 MeV/c	0.17%	0.19%	0.17%	0.16%	0.12%
200±20 MeV/c	0.14%	0.15%	0.091%	0.073%	0.044%
240±24 MeV/c	0.089%	0.088%	0.022%	0.050%	0.020%
TURTLE				0.070%	

Not meeting req. Meeting basic req. Meeting safety req.

Detailed SW design in progress

Conclusions

TOF:
- prototypes have shown good performances
- two station funded
- the third is needed in the second MICE phase

Cherenckov:
- prototypes built and tested
- design being finalized
- construction will start soon

Tracker:
- prototype constructed and tested
- good performances obtained
- construction under way

Calorimenter:
- KL prototypes built and tested
- KL modules being built
- SW design still to be finalized