Status and Future of Fermilab Test Beam Facility

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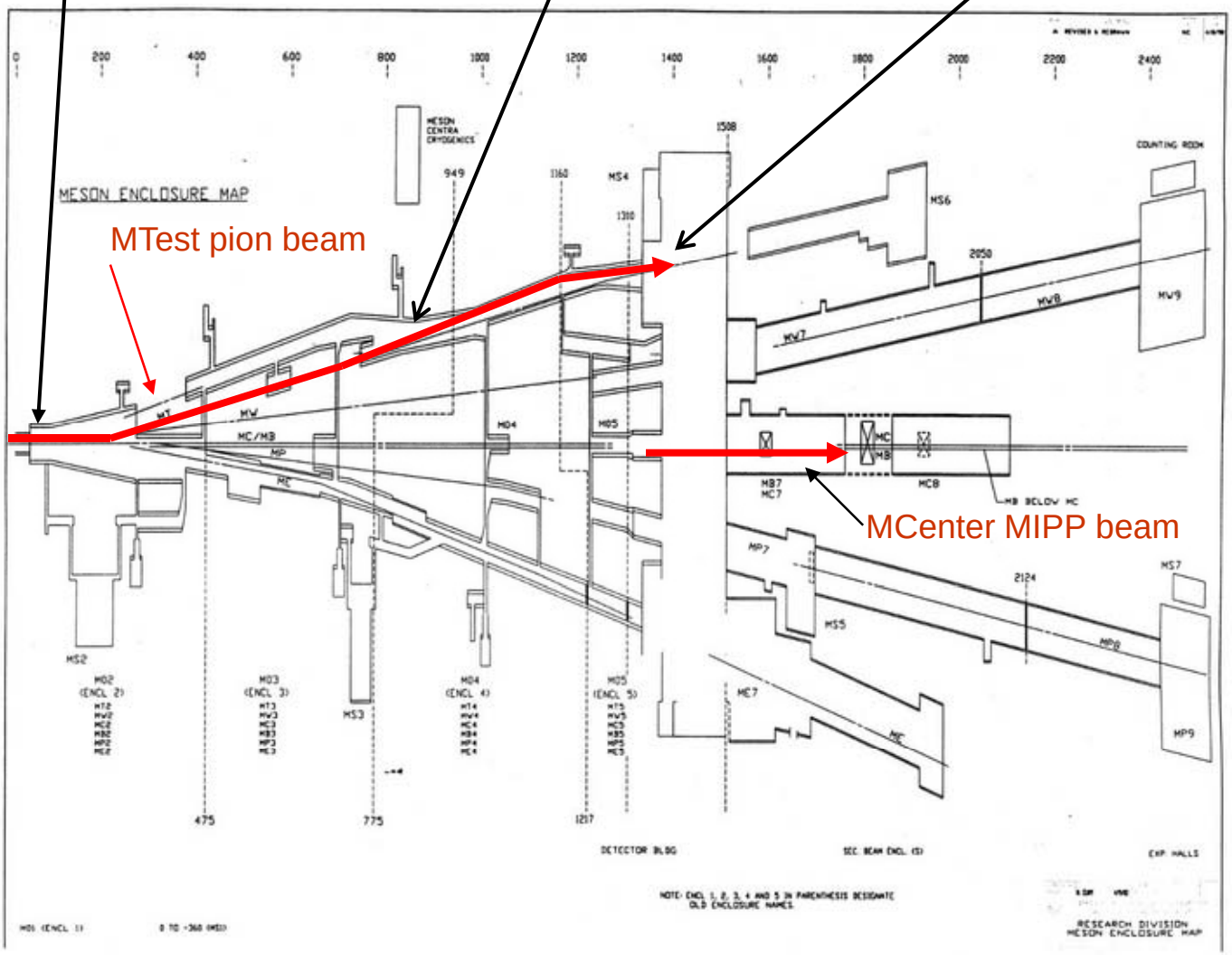
LCWS07

- Performance of New Beamline
- Tracking, Cerenkov and TOF
- CALICE and MINERVA tests
- Potential ILC Time Structure

MTest Beam Layout and Modes



Proton Mode: 120 GeV protons transmitted through upstream target

Pion Mode: 8-66 GeV beam tuned for secondaries from upstream target

Low Energy Pion Mode: 1-32 GeV beam tuned for secondaries from new downstream target

Upstream target will be installed on a motion platform to improve rates x10

Some measured rates in the MTBF beamline

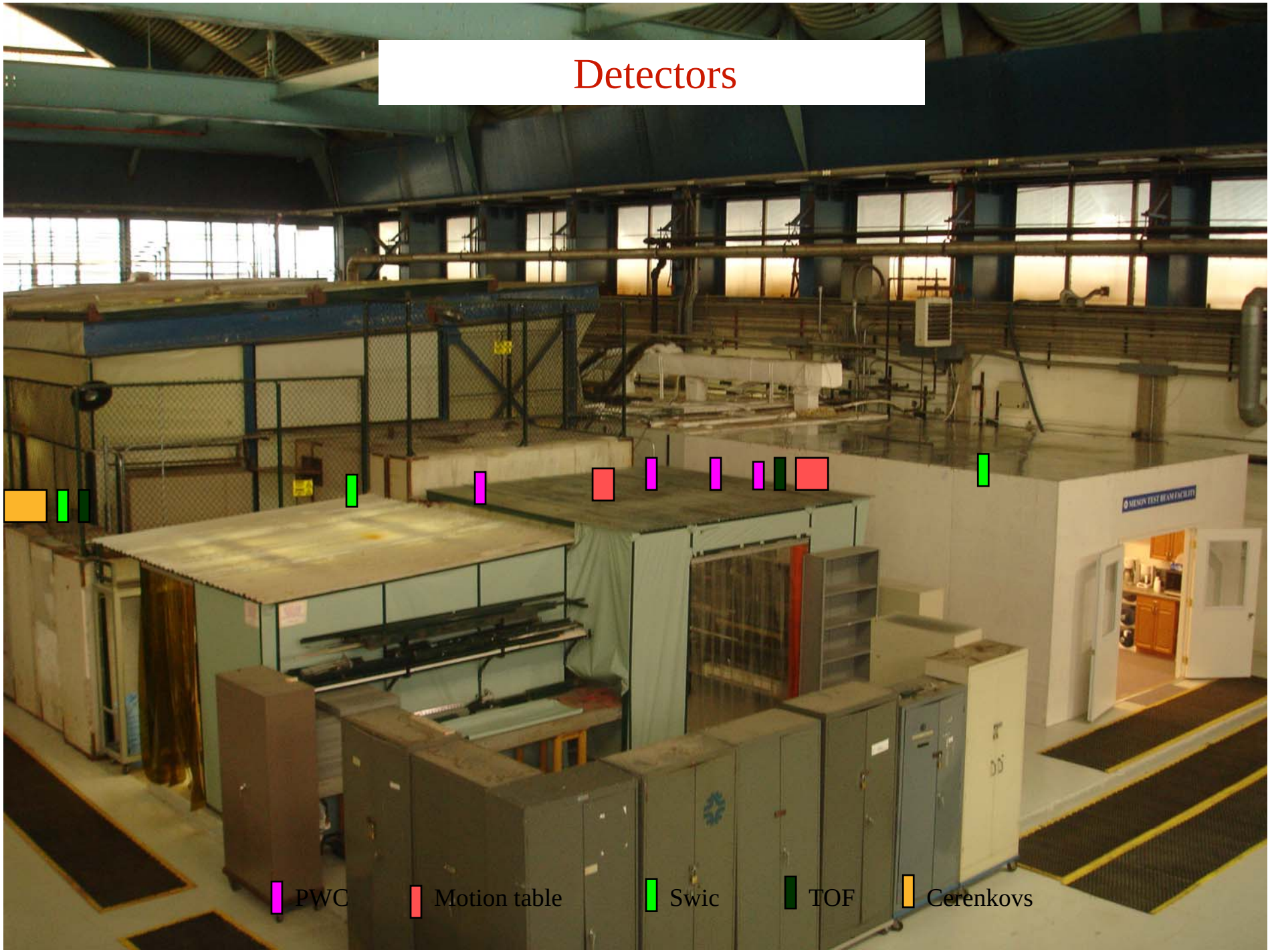
Tune (GeV)	Rate in MT6/spill*	e^- fraction	Resolution
120	800,000	0	-
66**	90,000	0	-
33	40,000	0.7 %	1.0 %
16	14,000	10 %	1.2 %
8	5,000	30 %	-
4	500	60 %	2.4 %
16***	72,000	20 %	5 %
8	44,000	30 %	5 %
4	27,000	80 %	5 %
2	7,000	>90 %	5 %
1	7,000	>90 %	10 %

*(Rates are normalized to 2.4E12 protons in Main Injector)

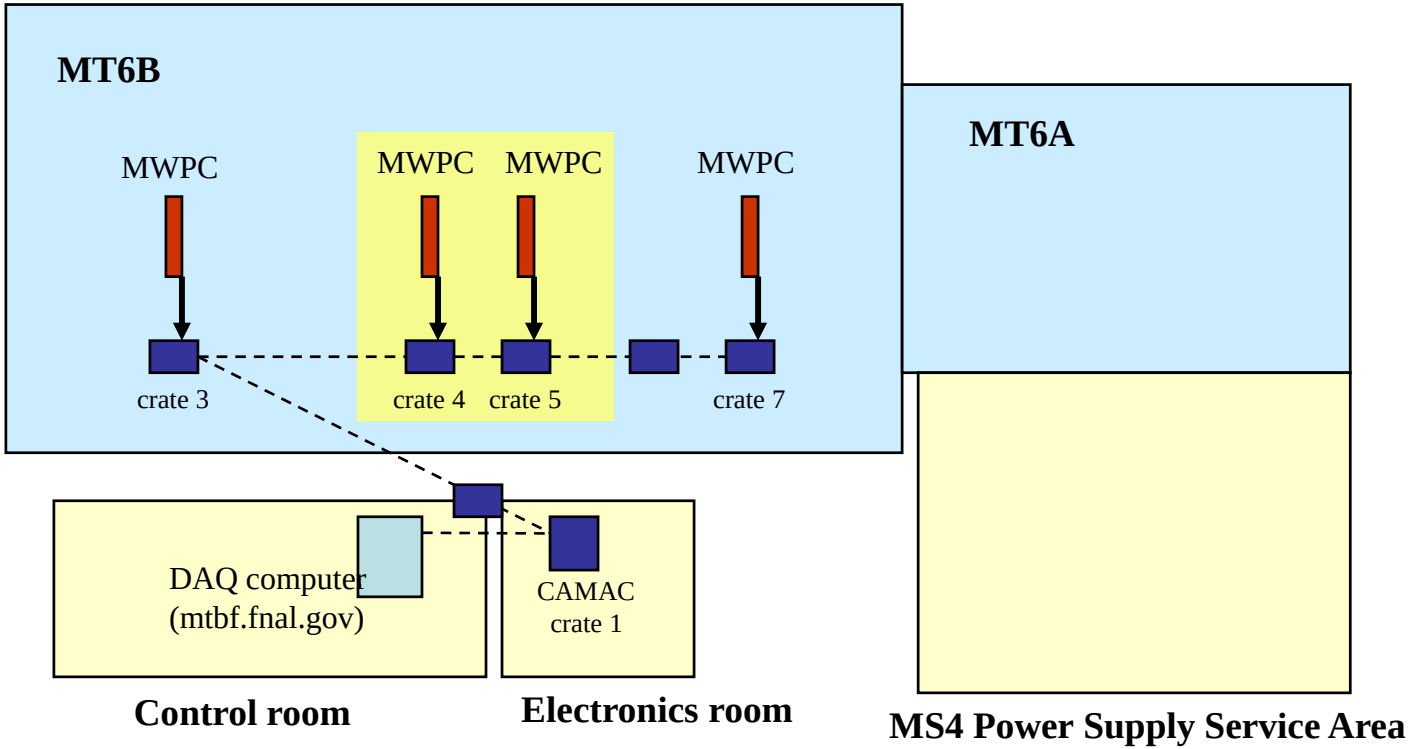
**(Rates in green are for pion mode)

***(Rates in red are for low energy pion mode. These rates can improve x10 with upstream target removal.)

Detectors



Setup of Meson Test Beam Facility tracking DAQ

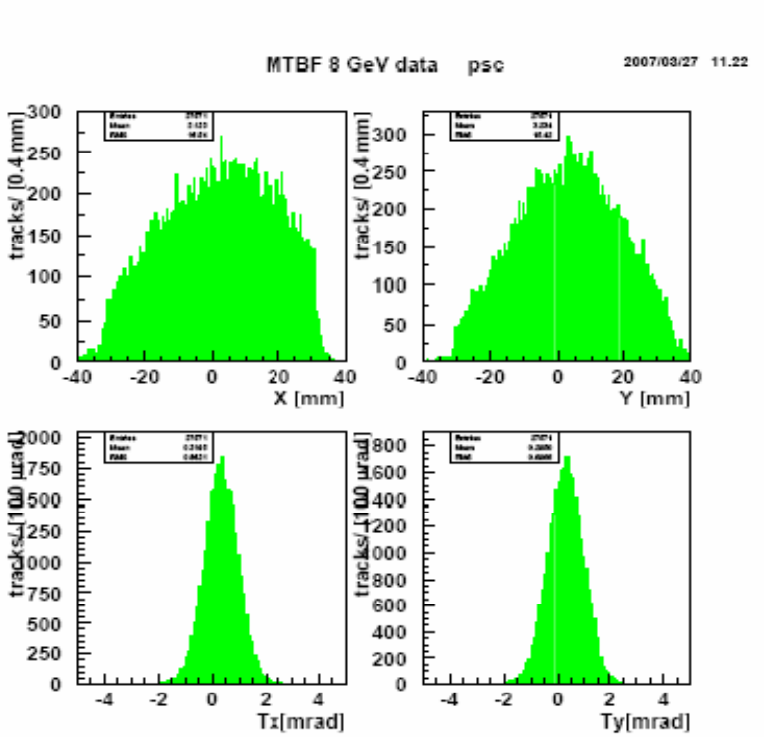


Modest CAMAC data acquisition: 4 station tracking; 1.5 kHz; 1400 channels
Output is ASCII text. Full tracking software has been written.

Using the tracking system to monitor the beam

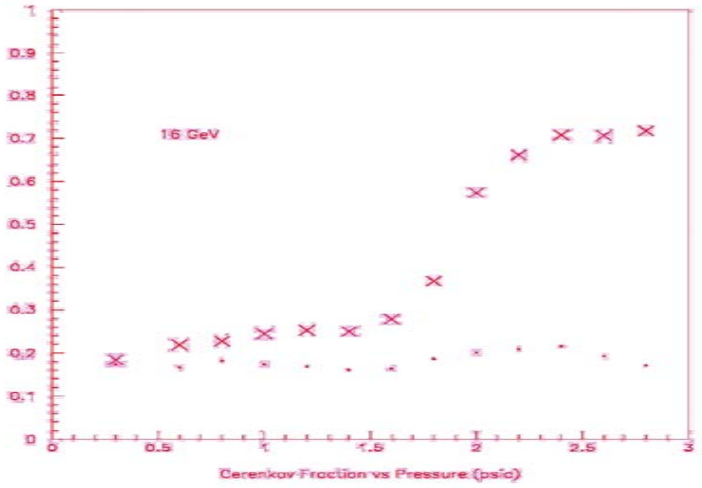
- The 4 station tracking system has a total of 20 planes of wires, each plane with 64 wires of 1 mm spacing.
- Peter Cooper has analyzed data to determine the characteristics of the beam
- The tracking code gives 50% efficiency, 120 micron pointing accuracy and 30 microradian resolution.

- At 120 GeV: beam width is 2-3 mm RMS, and divergence is about 200 microradians
- At 8 GeV: beam width is 16 mm RMS, and divergence is 660-700 microradians



Cerenkov Measurements

- There are 2 Cerenkov detectors at the end of the beamline.
- Both are currently threshold. One will be converted into differential.
- Gas control system is based on MIPP's design - excellent!

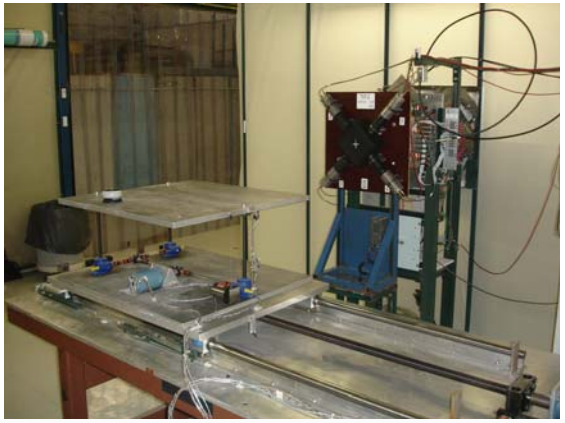


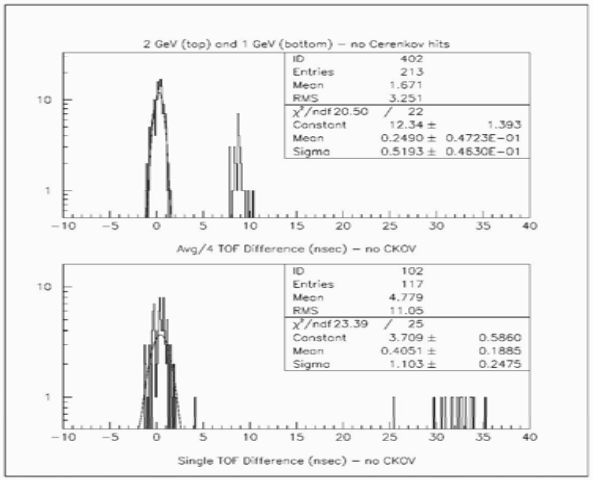
Composition of the beam at moderate E:

- At 16 GeV -
  - 20% positrons
  - 2-5% muons
  - 45-50% pions
  - 30% protons
- At 8 GeV -
  - 30% positrons
  - 10-15% muons
  - 15-20% pions
  - 30-40% protons

TOF measurements at low E

- 4 PMT's on each counter. Upstream is 4 mm thick, while downstream is 20 mm thick.
- Made measurements at 1,2 and 4 GeV with 440 psec resolution.
- Have improved resolution to 280 psec since this data was taken
- Definite proton content of low energy beam has been observed, but pion content is too low at 1 and 2 GeV to measure in this data. (Prediction for 1 GeV pion content is about 1% of electron rate seen.)





2 GeV proton at 9 nsec

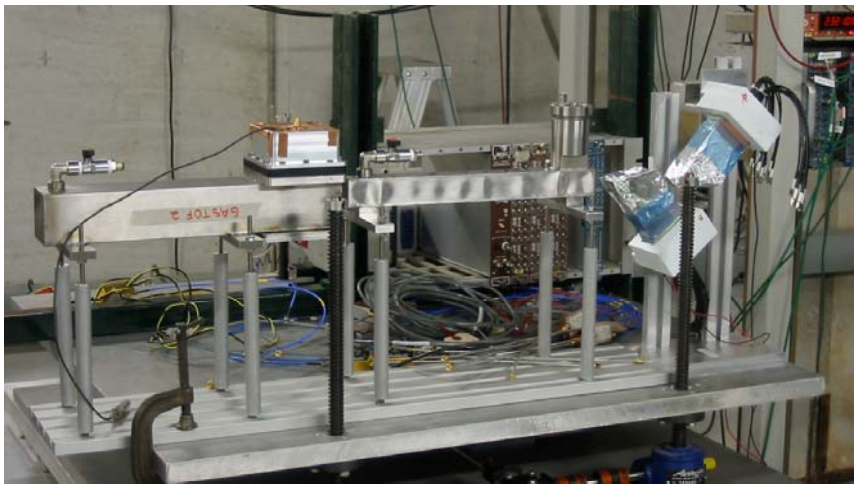
1 GeV proton at 32 nsec

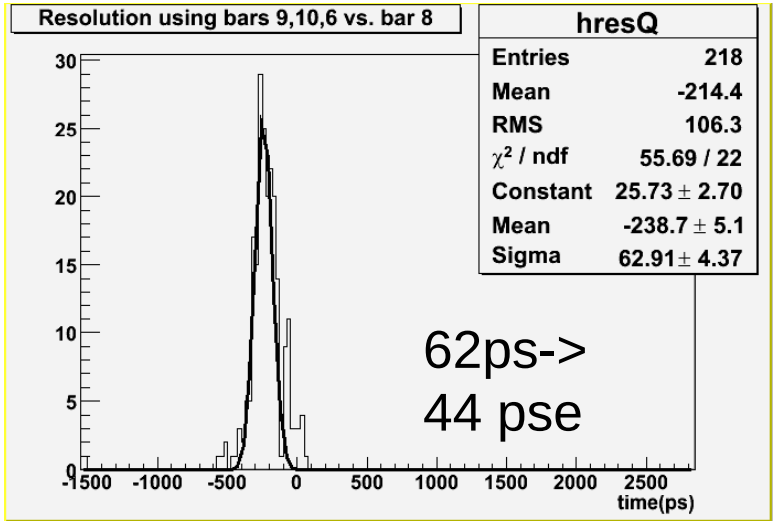
Using T958 TOF counters for Facility

The FP420 collaboration tested two types of TOF counters in T958:

- QUARTIC - quartz bars + microchannel plate pixel PMT
- GASTOF - gas cerenkov + microchannel plate

The latter promises to be a very good low density system for use in the future test beam facility.



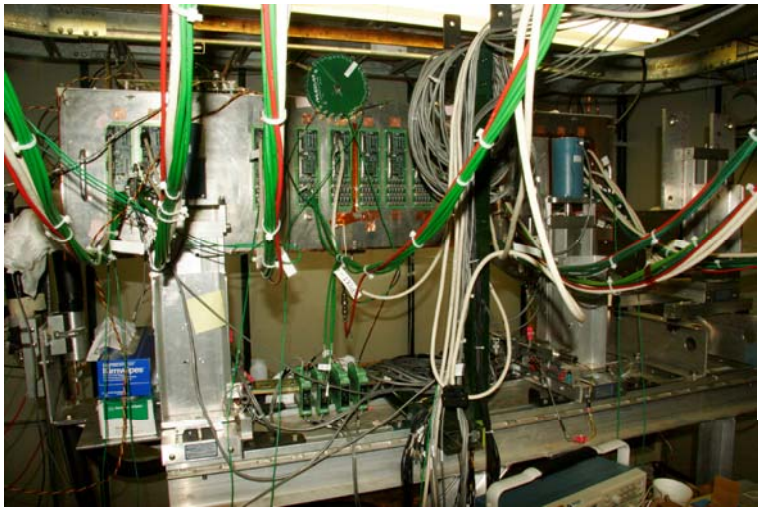


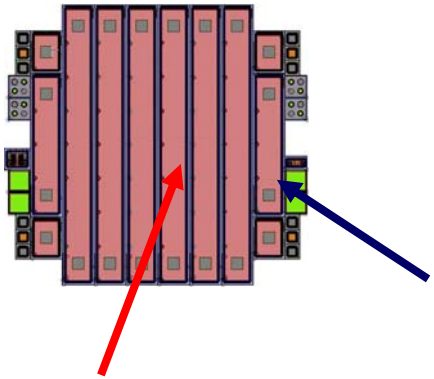
QBD,E,Gvs.QBC. 62ps.
(0.4*QBD+0.4*QBE+0.2*QBG)-QBC

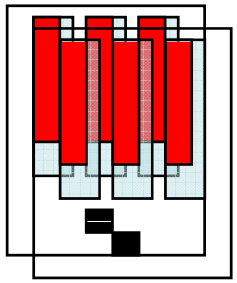
Using information from 4 bars lowers effective resolution from 75 psec to 44 psec.

A pixel telescope for the test beam facility

- Telescope of 6 BTeV pixel detectors used to test CMS forward pixels
- Physical infrastructure (stepping motors, power distribution, etc.) still remains and will be used by the facility
- Fermilab plans on upgrading this setup to provide accurate tracking for ILC pixel research
- “1x4” PHENIX sensors, with FPIX3 readout will be used to develop new 5-10 micron tracking system







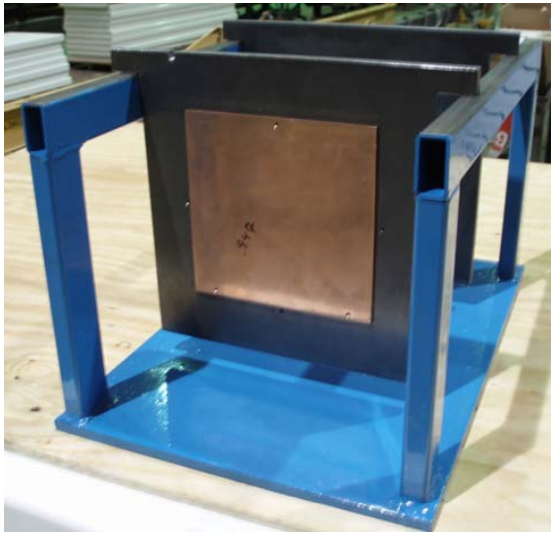
2 stations upstream of DUT & 2 downstream (precision x & precision y)

1x4 will be used for test beam

1x8 will be used by PHENIX

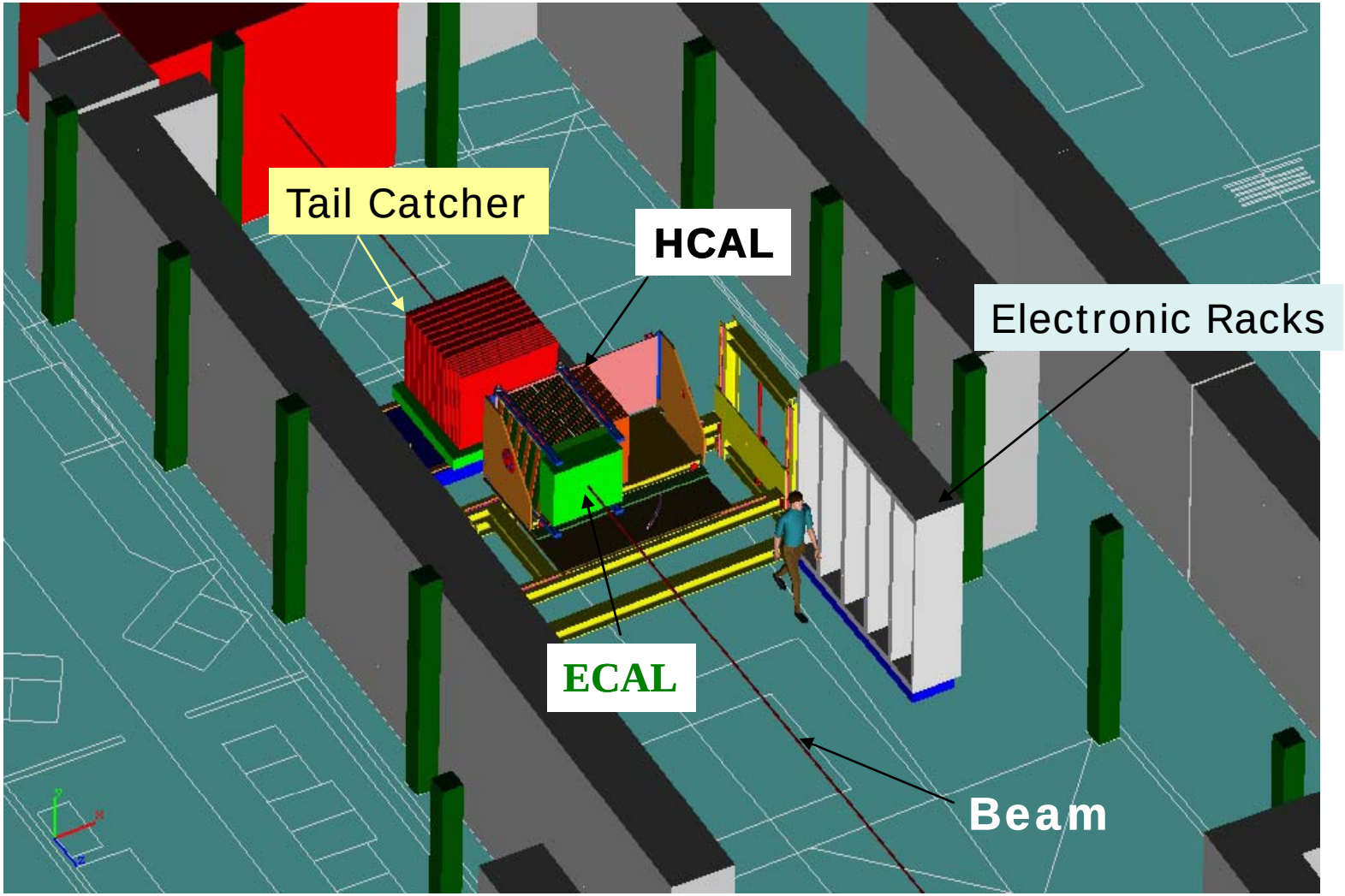
Future experiments

- T966, under direction of Marco Batagglia of LBL, will be bringing CMOS pixel sensors to the test beam in July.
- CALICE has stated a goal of bringing their large scale motion table to the Test Beam Facility this year.
- MINERVA would like to test their large scale prototype in the test beam during Spring, 2008.
- COUPP bubble chamber plans a scattering experiment



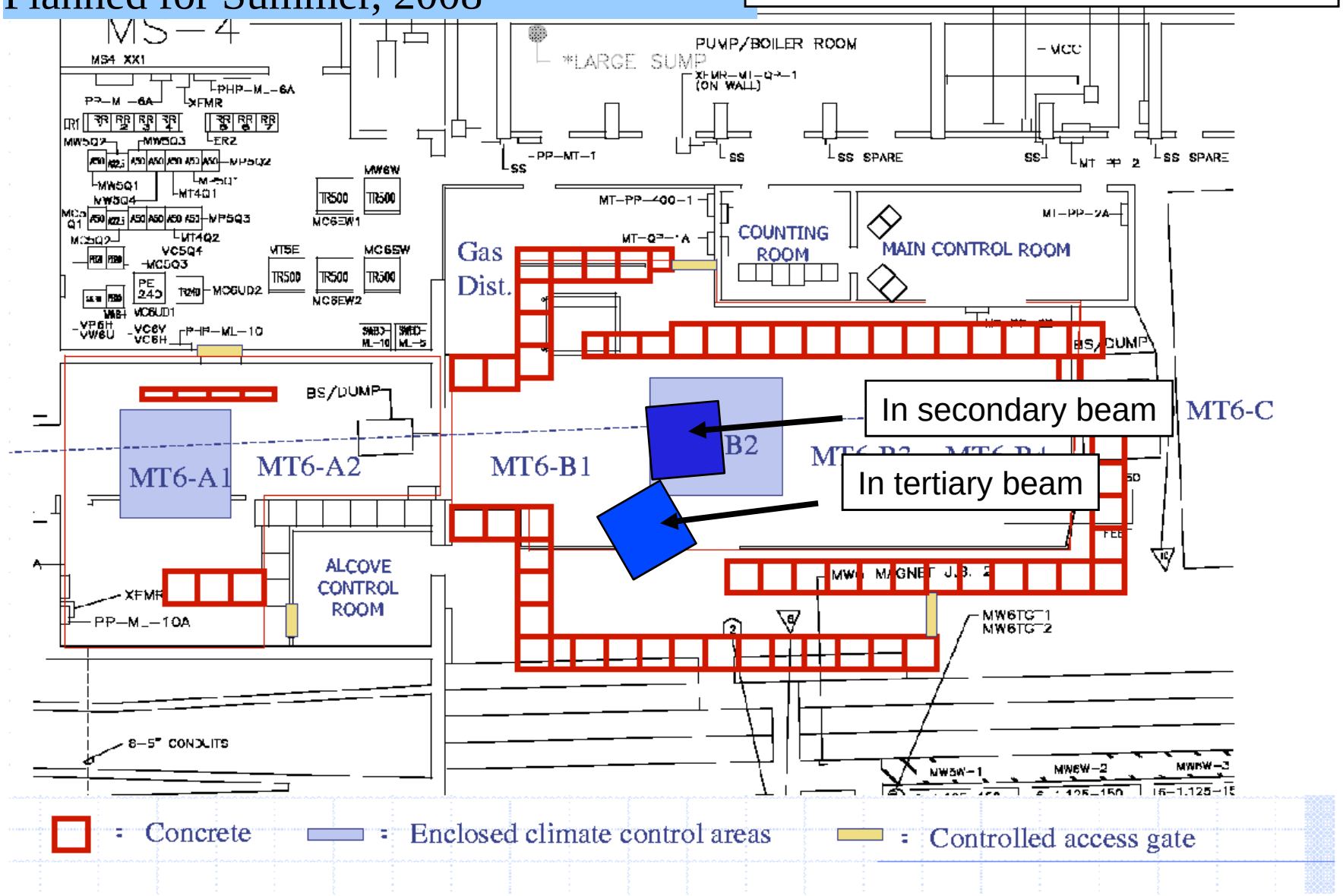
- Portions of the DHCAL part of CALICE, including the Argonne RPC's and the UTA GEMS, are planning a 'slice test' at Fermilab this summer

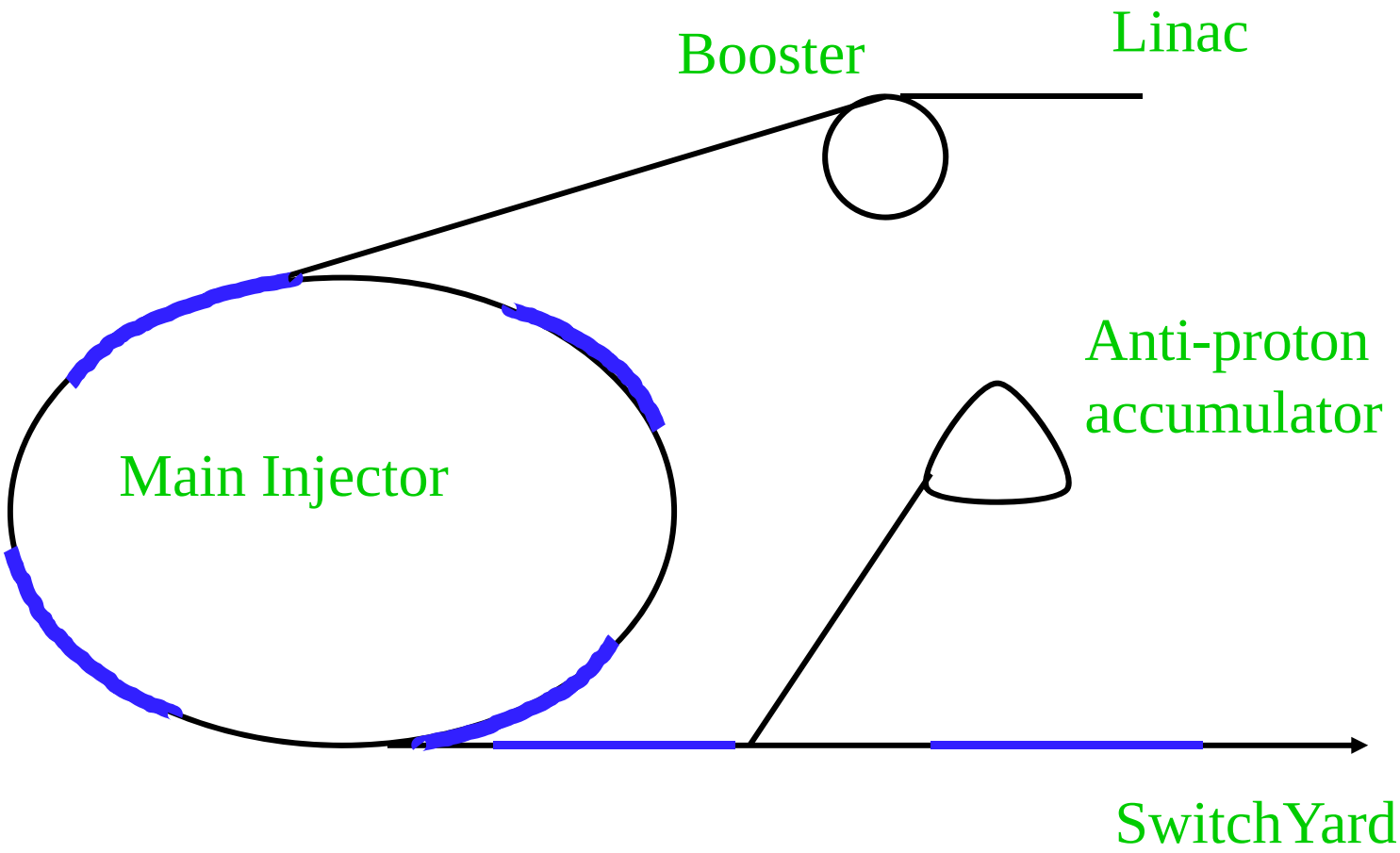
Example of CALICE Setup at MTBF



2.5 x 2.5 meter MINERvA test detector Planned for Summer, 2008

Requests 300 MeV beam!



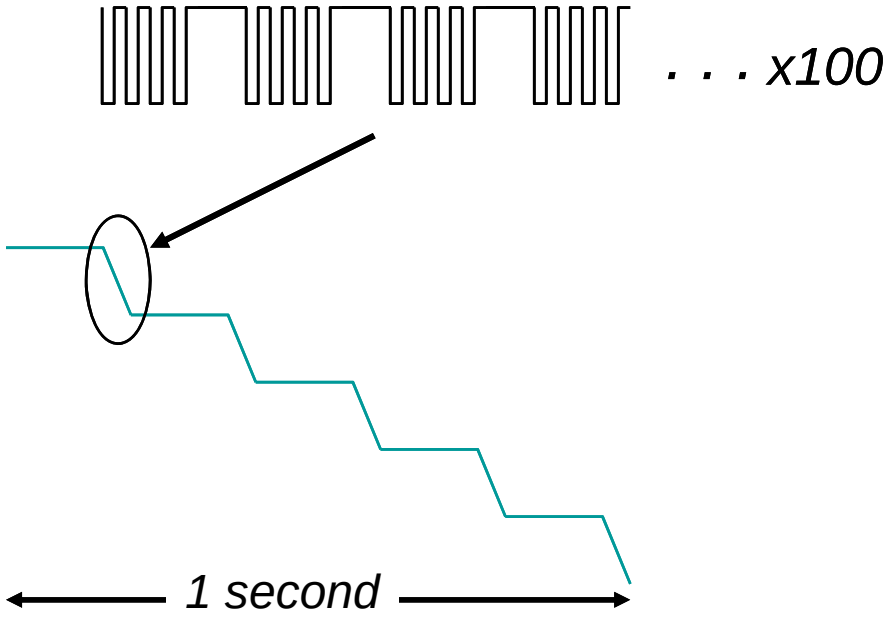


Current spill structure is one 4 sec spill/minute. To better match the CALICE DAQ capabilities, the Accelerator Division is working on a 1.0 second spill, with two spills/minute.

Can Fermilab Test Beam simulate ILC structure?

Possible path to ILC beam structure:

- Fill Main Injector with 4 Booster batches, with 19 nsec RF structure.
- Turn on already existing 2.5 MHz coalescing cavities. This results in a 400 nsec particle bunch spacing, with gap after 4 buckets.
- Implement a shorter - 1msec? - partial extraction cycle ('ping') using current quadrupole resonance magnet.
- Fit 5 of these pings in a 1 second spill



It is important for the ILC detector community to formulate the specific spill structure parameters they require for their tests. Stricter requirements make the job more difficult. If given a specific, realistic goal,then the Fermilab Accelerator Division has agreed to look into this possibility

Summary

- About 8 months ago, Fermilab initiated a significant investment in the Meson Test Beam Facility.
- As a consequence of this investment, both the beamline and user facilities were improved considerably over the last few years of running.
- In between servicing users (8 experiments) we have been trying to improve low energy delivery.
- Relatively easy to tune for hundreds of particles/spill down to 0.5 GeV - unthinkable last year.
- Tracking, Cerenkov and TOF systems have been commissioned.
- Future differential Cerenkov counter, fast GASTOF and pixel telescope will complete the significant monitoring of the beam.
- Potential creation of a tertiary beam for MINERVA tests, whose installation may conflict somewhat with CALICE
- Fermilab is starting to think about how to simulate the ILC beam structure in the Test Beam. To make progress on this potential we need ILC detector groups to specify their requirements for such a beam structure.