ILC Activity in the Fermilab Test Beam

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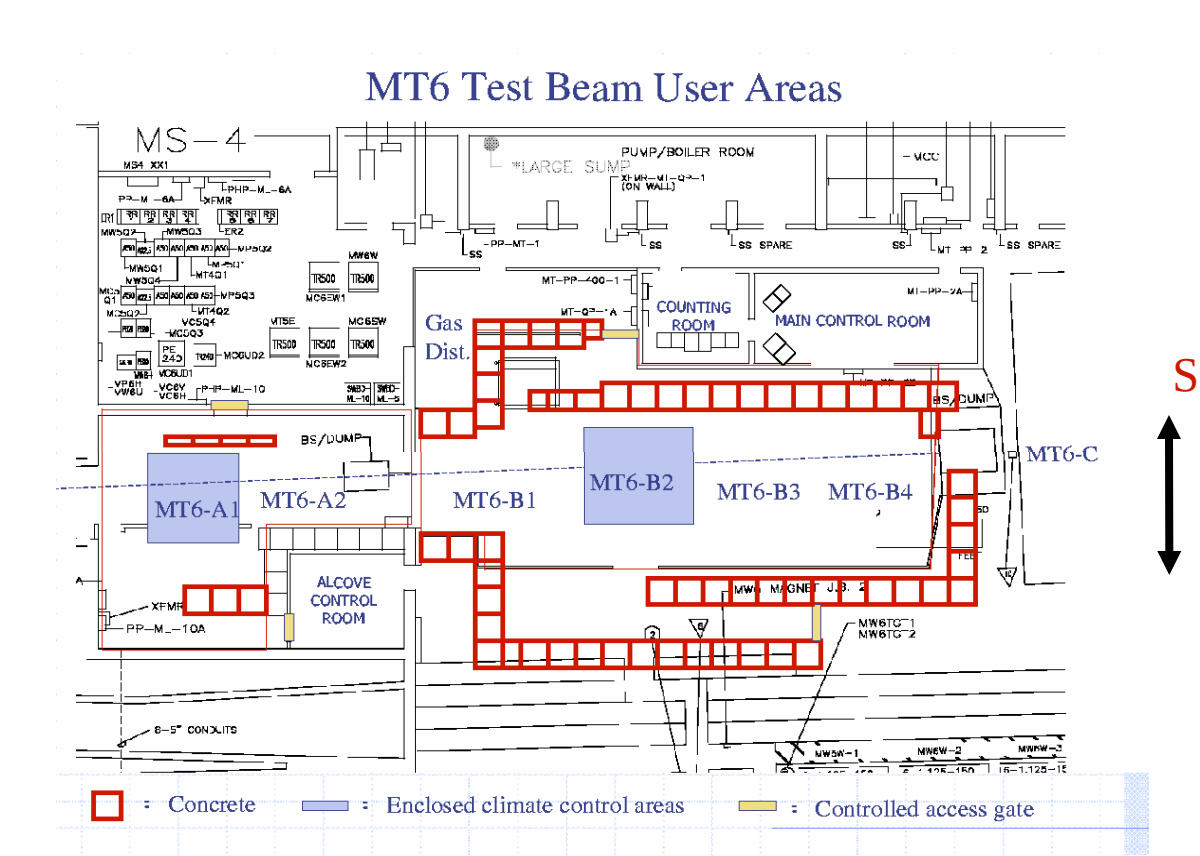
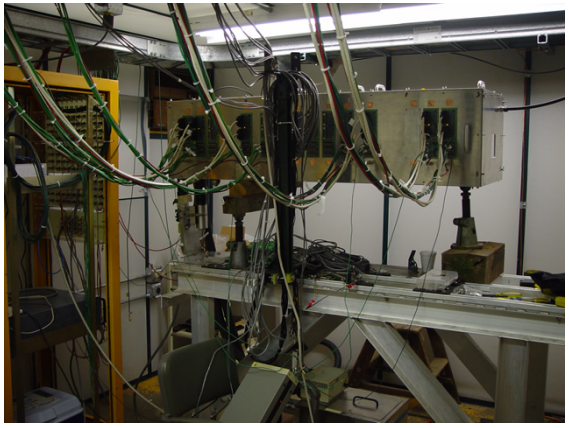
- Quick overview of facility
- ILC experiments that have taken beam so far this year
- New spill structure options
- Upgraded MTest beamline for ILC calorimetry proposal
- Potential for MCenter as a test facility

The Facility



- 2 beam enclosures, but cannot be operated independently.
- 6 user stations, with a 7th downstream of the beam dump. An experiment can take up more than one station.
- 2 climate stabilized huts with air conditioning.
- 2 separate control rooms.
- Outside gas shed + inside gas delivery system brings 2 generic gas lines, 1 nitrogen line and 2 exhaust lines to each of the user areas
- Lockable work area with 3 offices for small scale staging or repairs, plus 2 open work areas.



Measured rates in the MTBF beamline

Tune (GeV)	Rate in MT6/spill*	e^- fraction	Resolution in ECAL
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 %

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

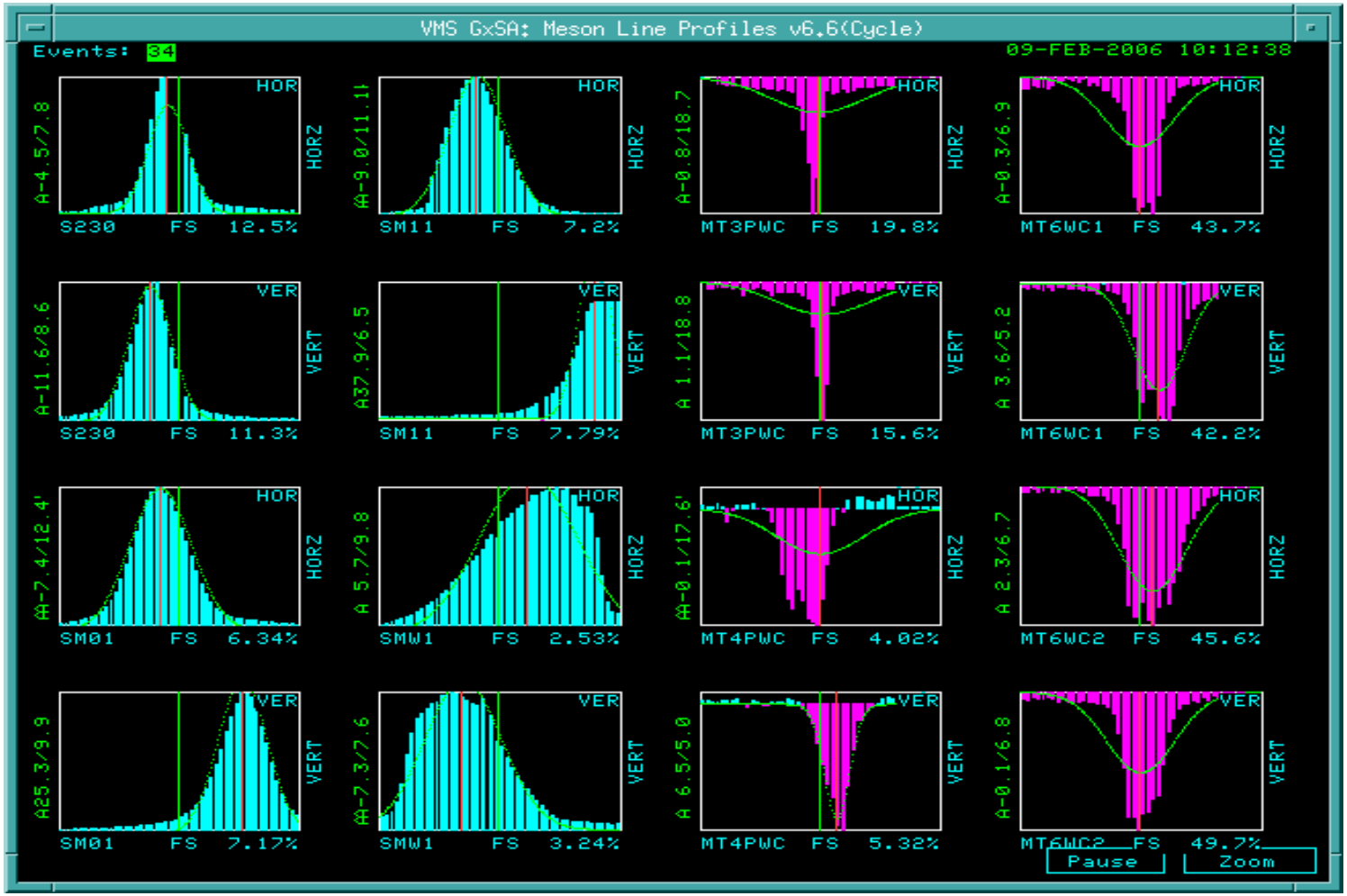
Shielding limits in various sections of MTEST are:

2E12 protons/2.9sec from M02 to M03 pinhole collimator

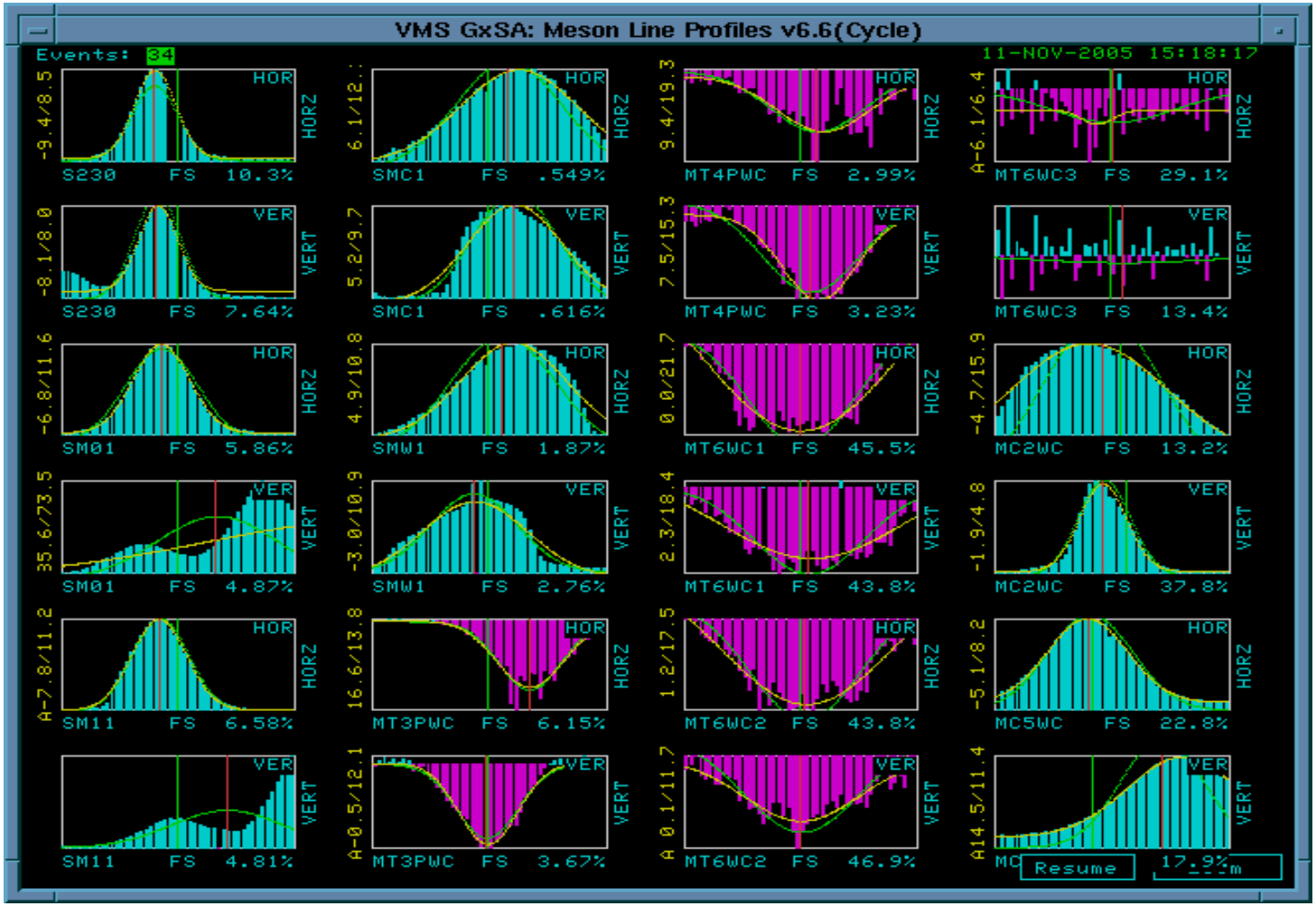
2E7 particles/2.9sec from M03 pinhole collimator and downstream

7E5 particles/2.9sec in the MT6 experimental area.

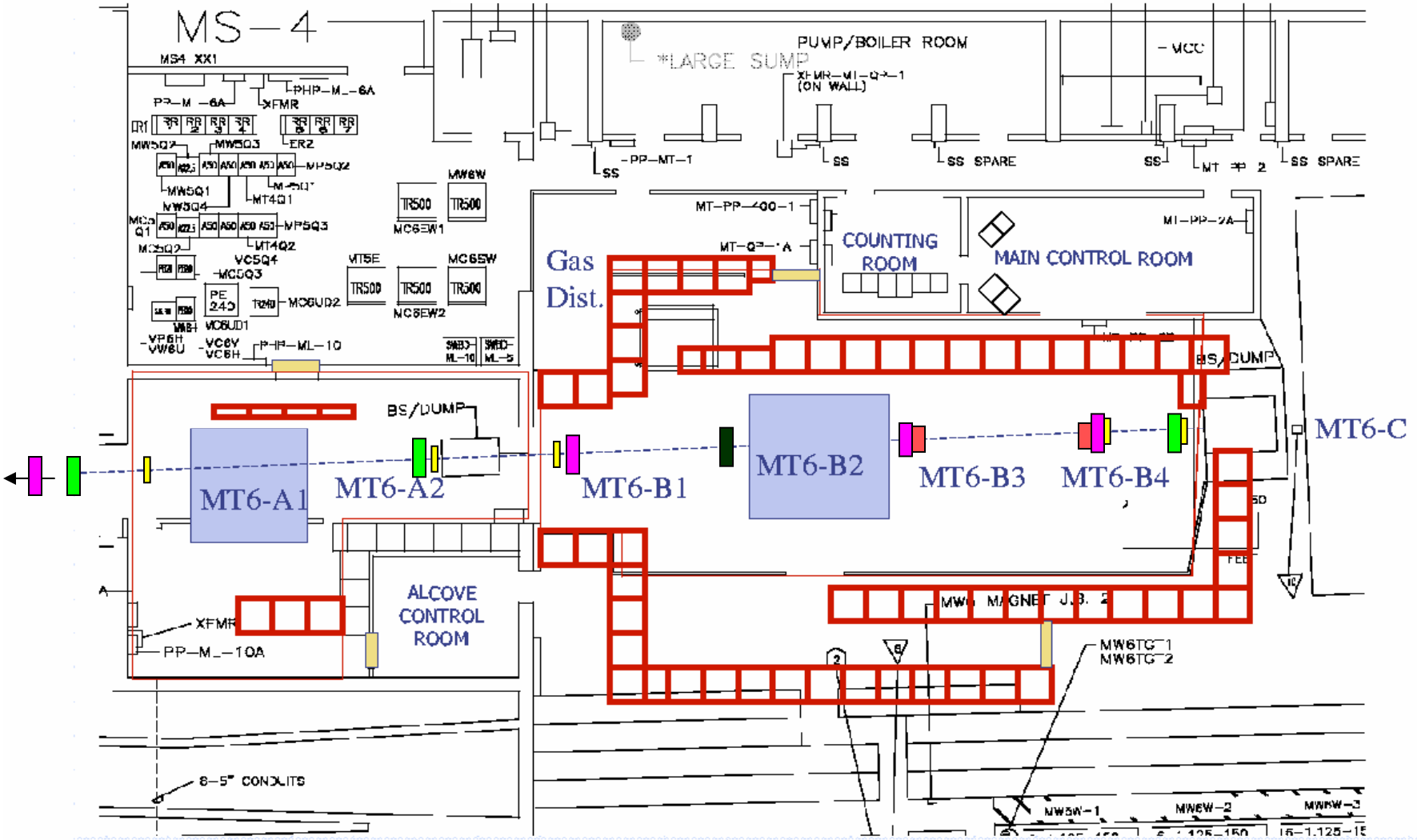
MTest Profiles 120 GeV proton mode



MTest Profiles 16 GeV pion mode



Test Beam Facility Detectors



: Concrete : Enclosed climate control areas : Controlled access gate

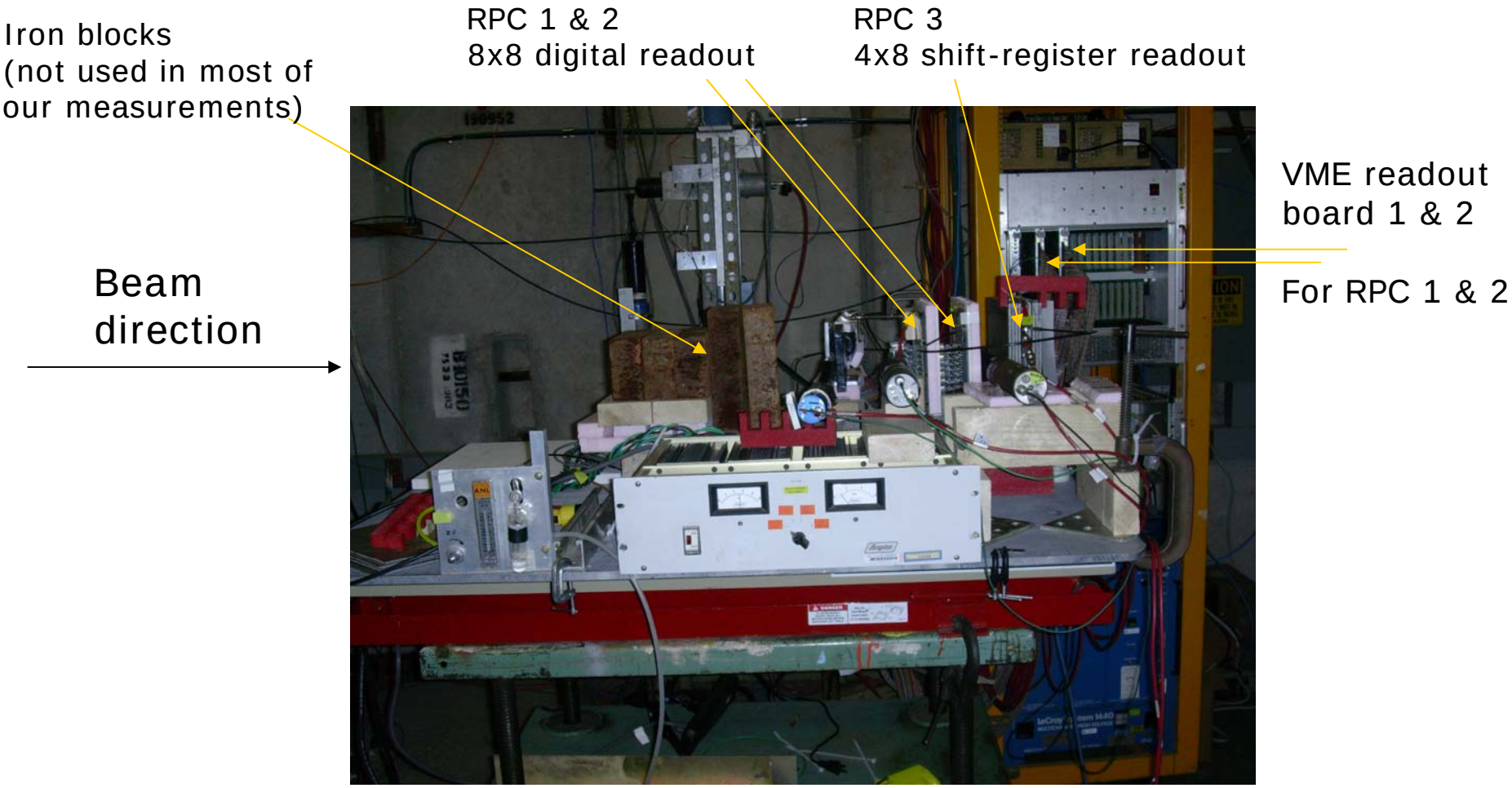
Scint. PWC Finger counters Swic SSD

ILC Test Beam Experiments at Fermilab

List of MTBF Memoranda of Understanding (MOU):

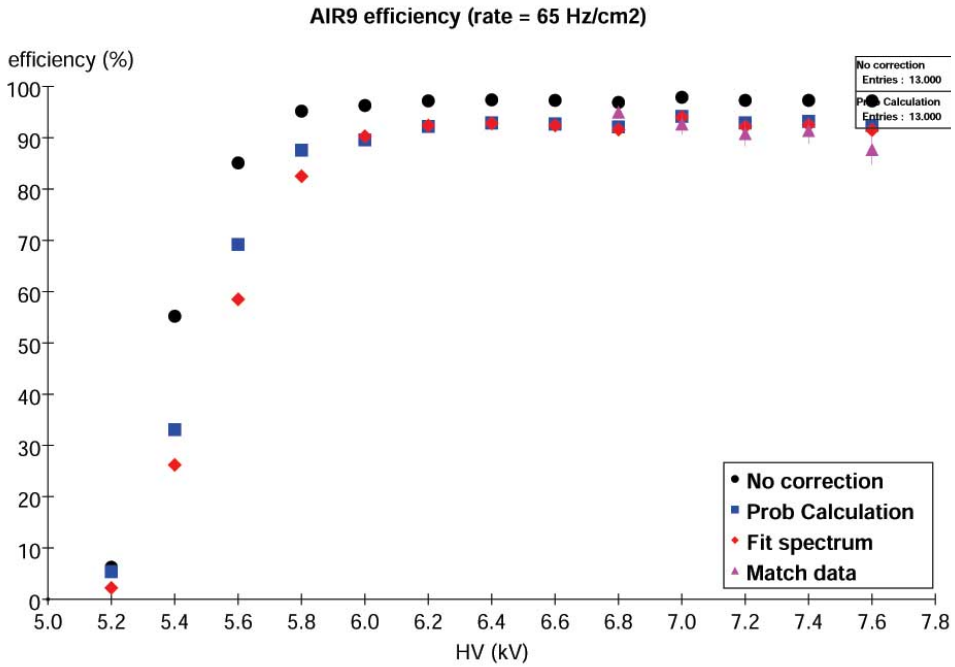
T926: RICE Experiment completed
T927: BTeV Pixel Experiment completed
T930: BTeV Straw Experiment completed
T931: BTeV Muon Experiment completed
T932: Diamond Detector Signed
T933: BTeV ECAL Experiment completed
T935: BTeV RICH Experiment completed
T936: US/CMS Forward Pixel Taking data
T941: UIowa PPAC Test Experiment completed
T943: U. Hawaii Monolithic Active Pixel Detector Experiment completed
T950: Kaon Vacuum Straw Tracker Analyzing data
T951: ALICE EMCAL Prototype Test Analyzing data
T953: U. Iowa Cerenkov Light Tests Analyzing data
T955: RPC Detector Tests (Argonne) Taking data
T956: ILC Muon Detector Tests (Indiana) Taking data
T957: ILC Tail Catcher (NIU) Taking data
T958: FP420 Fast Timing Test Signed
T959: Microparticle Shielding Assessment In review

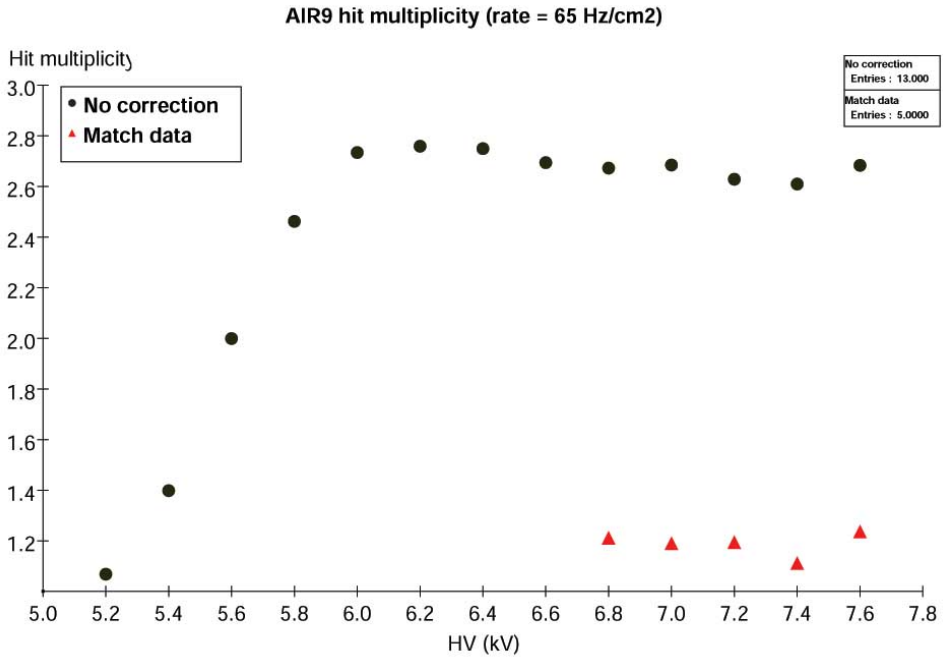
T955 – ILC RPC Tests in MT6 (Argonne)



- Taken data with 120 GeV proton and 16 GeV pion, at beam intensity 60 – 5k Hz/cm^2
- Tested 3 RPCs, this talk will cover the results from the first 2 chambers

AIR9: efficiency and hit multiplicity





- Efficiency measurement
  - ~92%, consistent with cosmic ray tests
  - All method agrees for HV>6kV
  - Prob. Calculation over estimate at low HV (as expected from method)
- Hit multiplicity m~1.2
  - Should be treated as an upper limit
  - Consistent with cosmic ray tests m~1.1

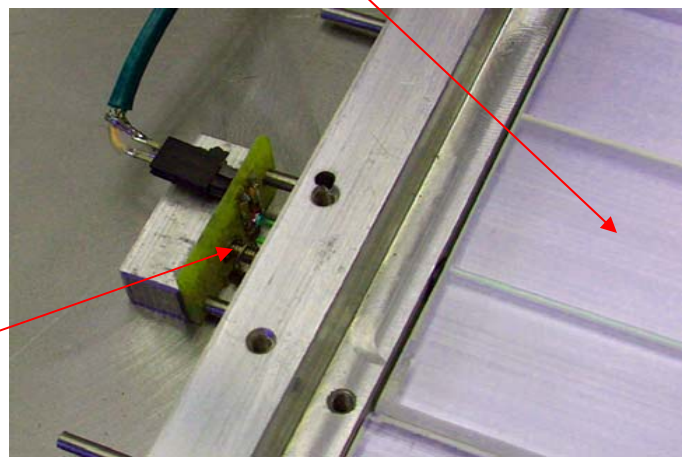
T956: ILC Muon Detector Test (Indiana/FNAL)

Installed in MTEST

Stack designed and being assembled at Fermi

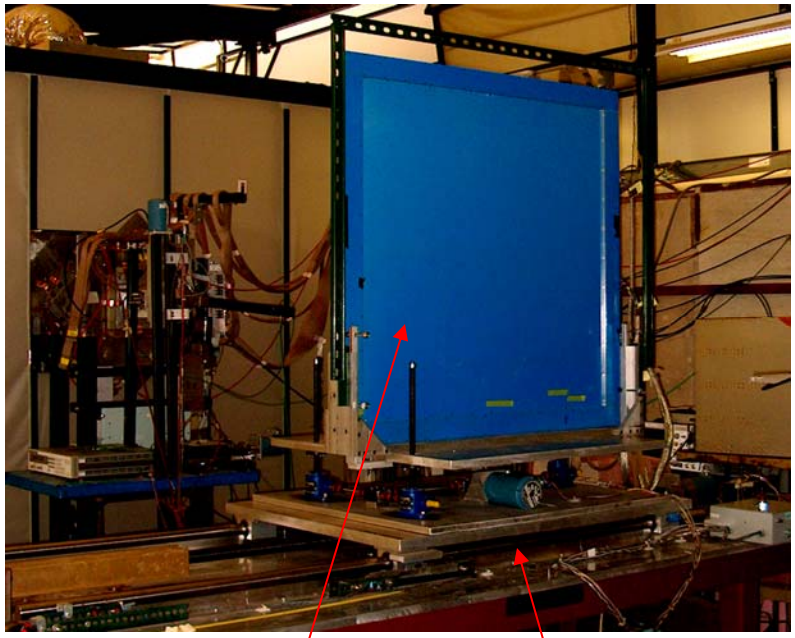
Diagram of Full Detector

Extruded Scintillator



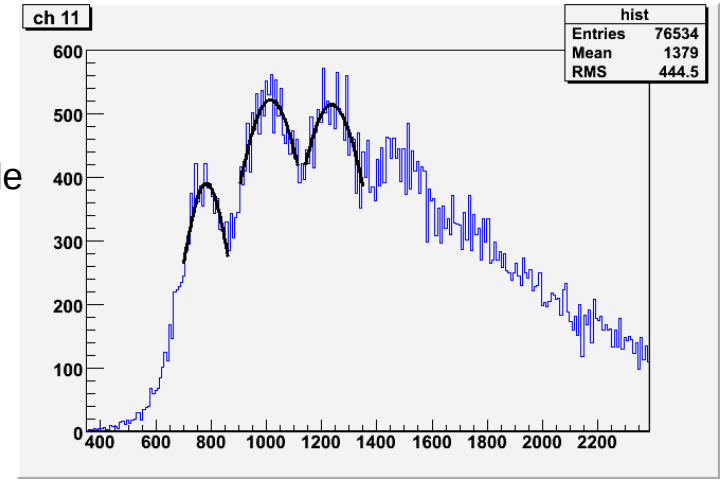
Silicon
Photomultiplier

- Moved into the facility 3rd week of Feb.
- Took beam in the last week ~ 5 days
- Took 120 GeV/c protons, 16 GeV/c (mostly pions) and some beam dump muon runs
- ~ 1M events collected
- Calice DAQ Electronics chain reproduced and tested
- Results will be compared with 3 GeV/c e- data from DESY
- Will attempt to run at CERN in July, if SiPM chips are available.
- Likely future running at MTest with multiple layers.



TCMT cassette at MTBF

Motion table



Calibration data showing single Photoelectron separation

New Spill Structure

- Accelerator Division spent several weeks in June coming back up from the spring shutdown and developing a new Main Injector extraction ramp structure for SwitchYard 120 beam.
- The intention was to understand what it takes to reduce the flattop spill time so that more extraction cycles can be fit into one minute, thus potentially improving the duty cycle.
- They successfully implemented a 0.9 second flattop spill and then spent several shifts restoring to the 3.6 second flattop spill that has been standard for the last year.
- The AD is working to automate the switchover from one type of spill to the other, which is difficult due to its effect on anti-proton production.
- Heating of the Main Injector dipole magnets physically limits us to one 3.6 second spill per minute, but allows for approximately 16 0.9 second spills per minute.
- The actual number of spills allowed for SwitchYard 120 extraction is determined by Program Planning, since it affects the rest of the Fermilab program. We are limited to a 5% impact on the Tevatron or Neutrino program.
- Currently the default scheme is one 3.6 second spill/minute (or two 0.9 second spills/minute), for 12 hours a day.

Planned Upgrades

Upgrading the Test Beam

- The proposal to test ILC calorimetry at Fermilab (TM-2291) indicates a need for low energy pions (1 GeV) and high energy electrons (25 GeV).

- Both of these beam types are difficult in the current test beam due to the length of the beamline and sheer number of windows, scintillators, etc.

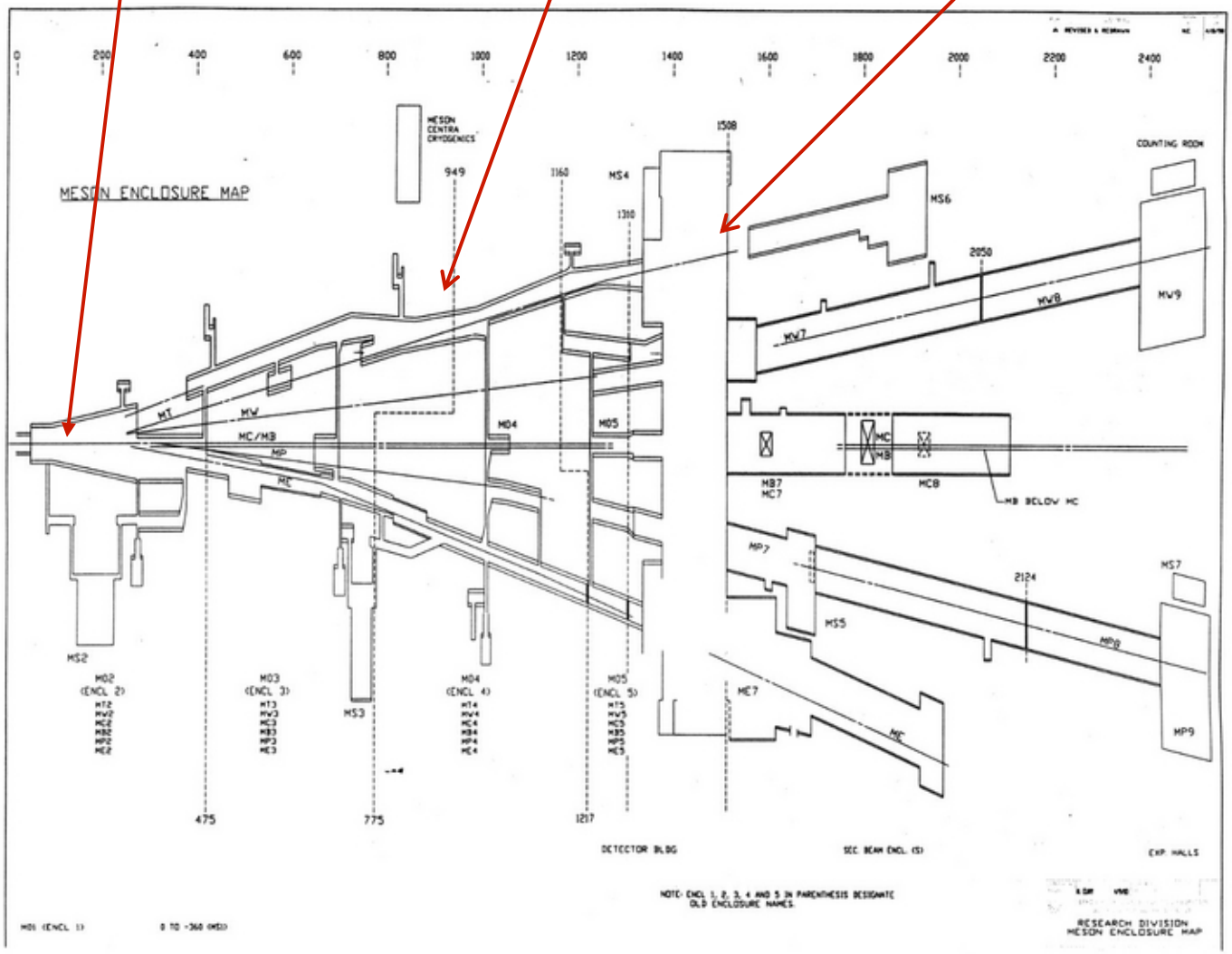
- The External Beams Group has completed a design to install a movable target in the M03 enclosure and redesign the downstream part of the beamline. Low current power supplies and Hall probes will be installed on many of the current beamline elements. Many new quadrupoles will be installed.

- Beamline monitoring and particle I.d. will be optimized to reduce material in the beam. This will include a differential Cerenkov counter, beamline TOF and tracking with a pixel silicon station and SciFi detectors.

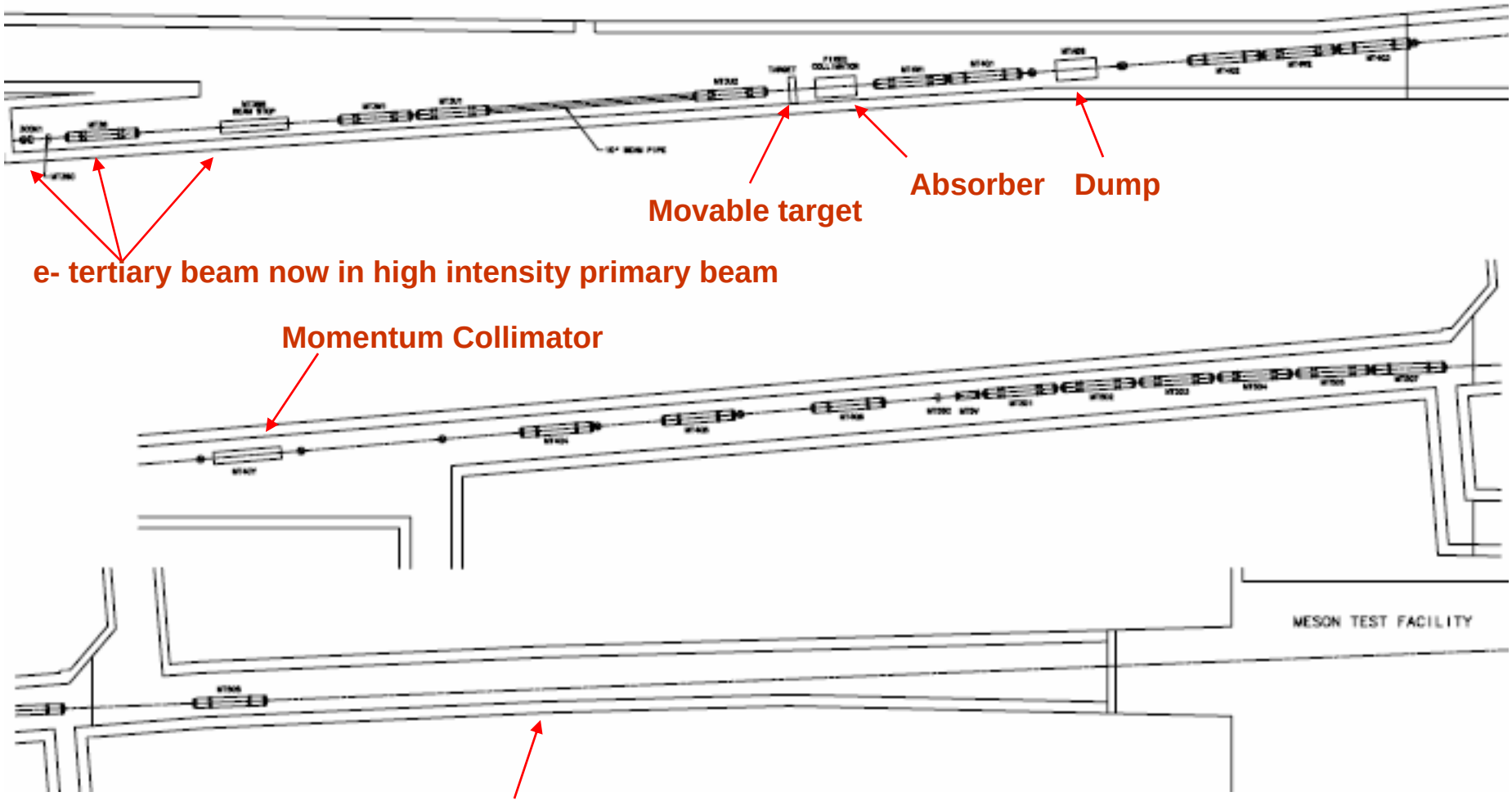
Meson Detector Building

Current 40 cm Al target

Proposed new target location



New Beamline Layout



Enhancement due to pion decay

Energy (GeV)	Enhancement due to Pion Decay factor
1	**90**
2	**9.2**
4	**3.0**
8	**1.8**
16	**1.3**

+

Enhancement due to material in beam

Energy (GeV)	Hadron Enhancement	Electron Enhancement
4	25	~90
8	6.4	14
16	2.5	6.3

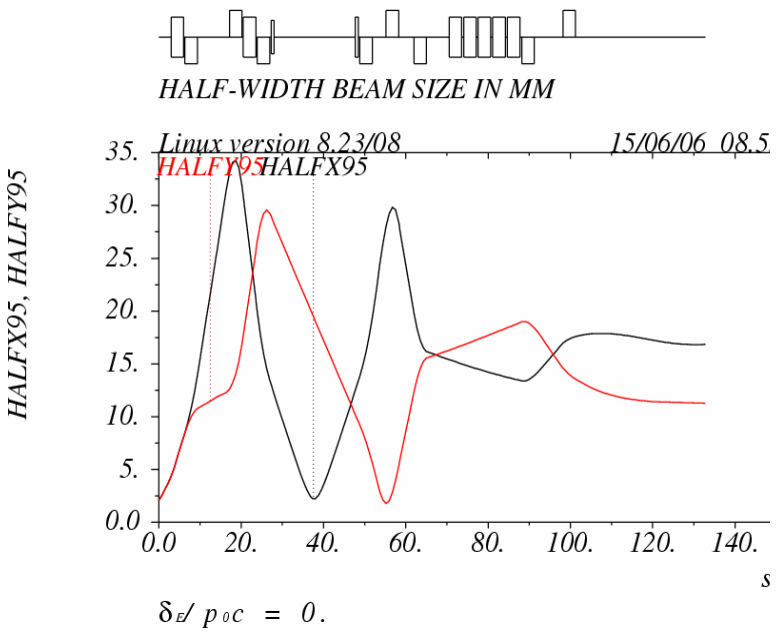
+ Enhancement due to increased momentum bite (from ¾% to 2%)

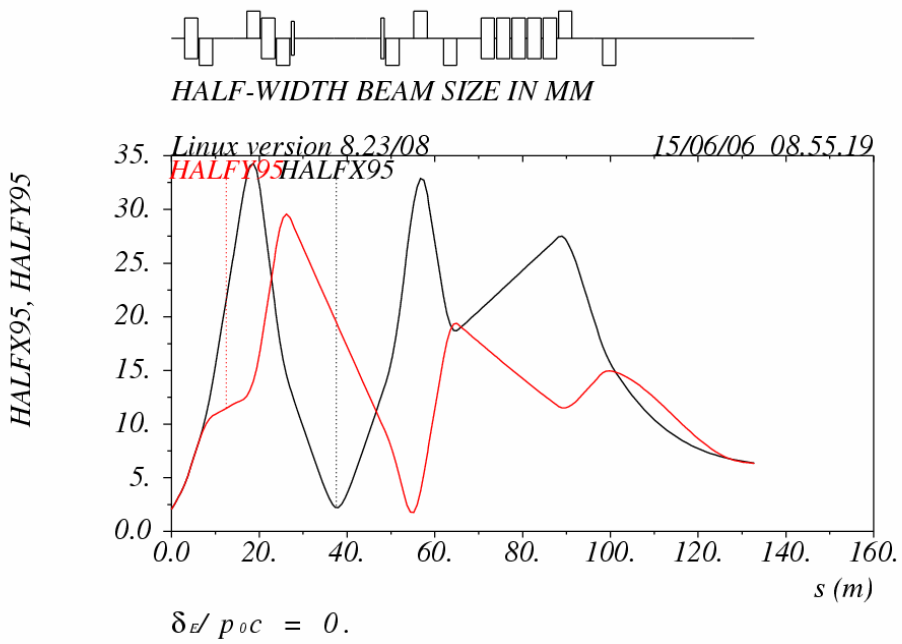
+ Enhancement due to increased aperture

=

Energy (GeV)	Present Hadron Rate MT6SC2 per 1E12 Protons	Estimated Rate in New Design (dp/p 2%)
1	**---**	**~1500**
2	**---**	**~50K**
4	**~700**	**~200K**
8	**~5K**	**~1.5M**
16	**~20K**	**~4M**

Triplet Beam Optics – two operational tunes





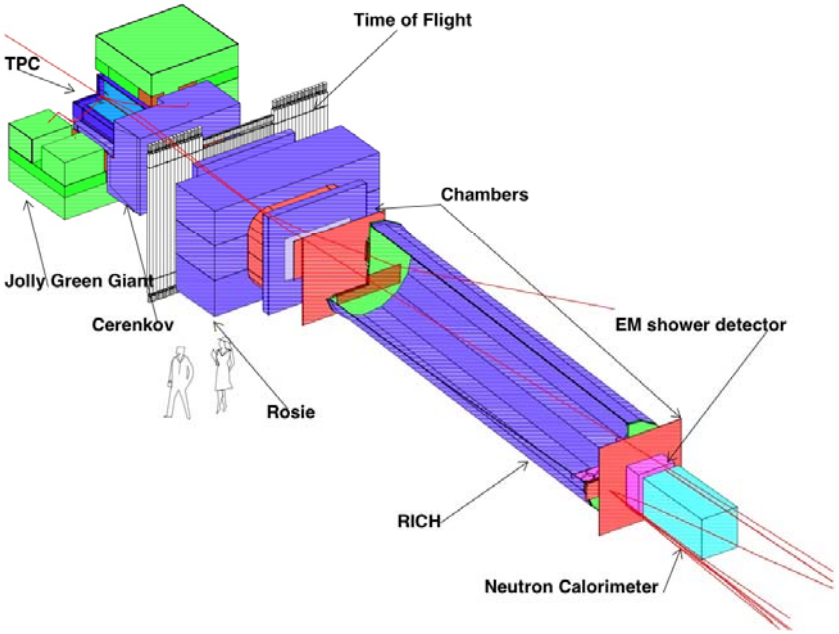
Low dispersion

Small beam size

MCenter Beamline

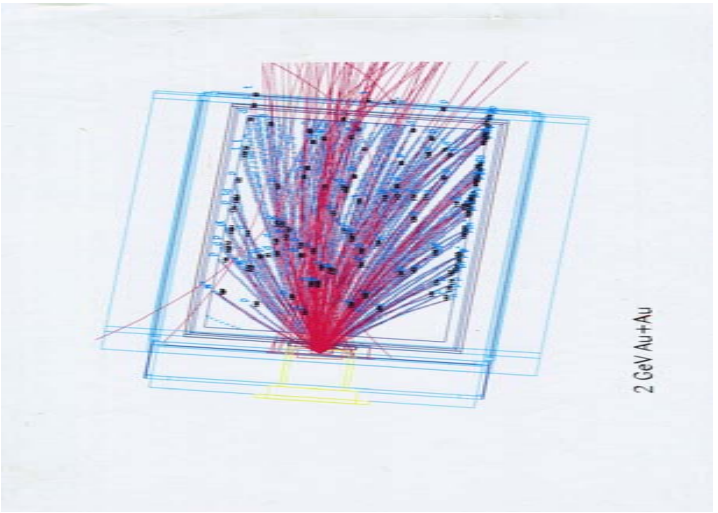
MIPP

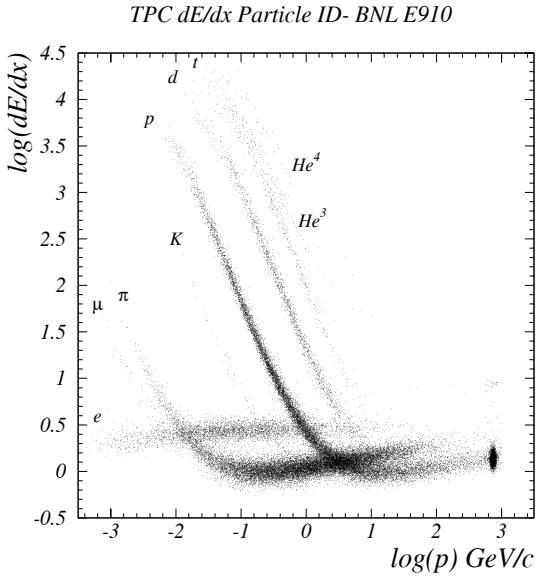
Main Injector Particle Production Experiment (FNAL-E907)



- Currently, MCenter beamline terminates in MIPP - a multi-beam, multi-energy, multi-target particle production experiment.
- They have been invited to submit to the Fermilab PAC a proposal for an upgrade and new run of this detector.
- The ‘Jolly Green Giant’ spectrometer magnet needs coil replacement and the DAQ needs enhancement for this upgrade.
- This beamline and detector is a powerful generic spectrometer whose results can be beneficial for ILC detector R&D.
- As an example, the spokesman for the experiment, Rajendran Raja, has shown how the experiment could be used as a tagged neutron spectrometer.
- This facility could be used in the future in a test beam capacity, especially as a test bed for TPC and calorimetery work.

The MIPP TPC

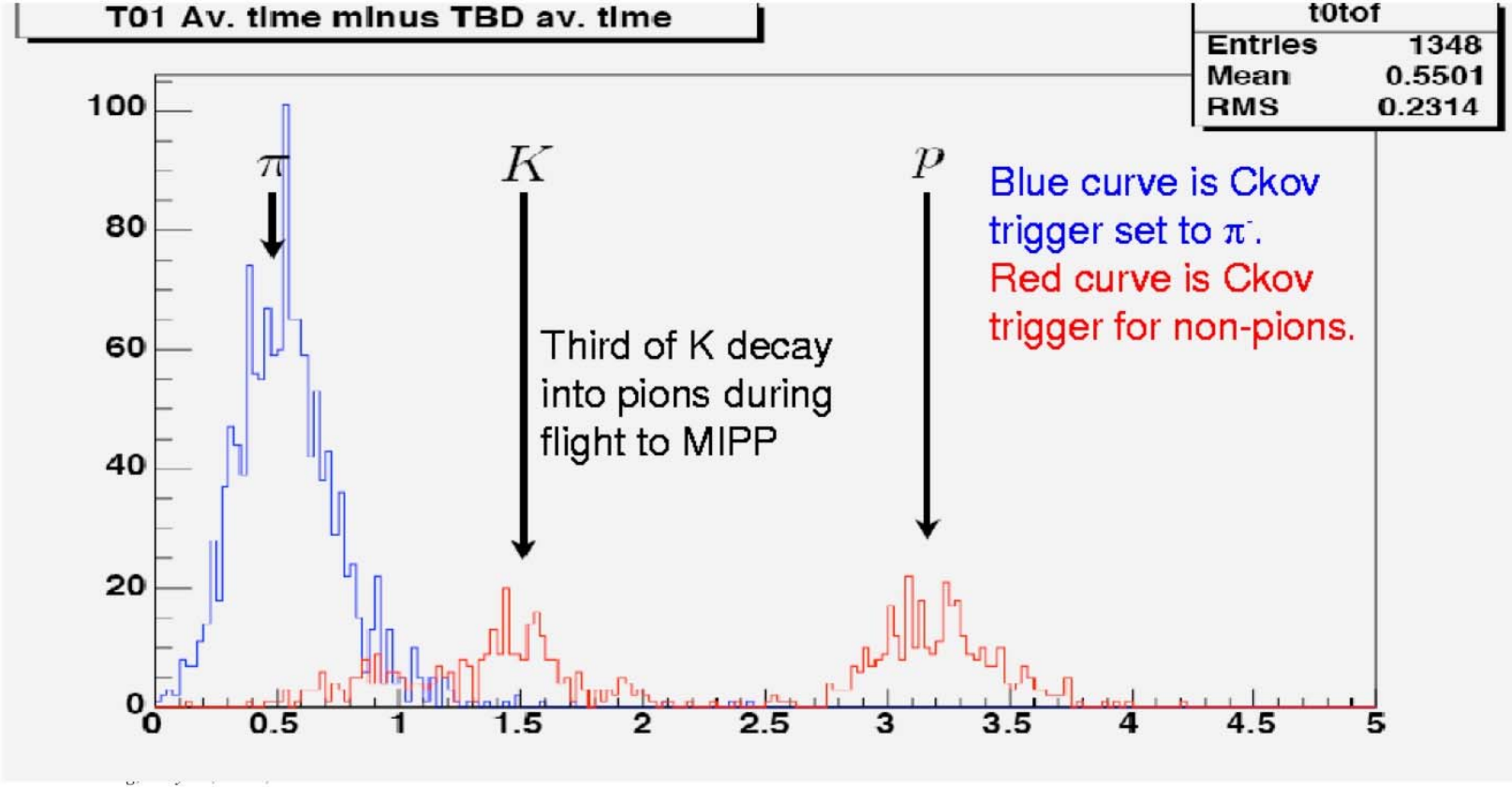

2 GeV Au+Au


TPC dE/dx Particle ID- BNL E910
log(dE/dx)
log(p) GeV/c
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-3
-2
-1
0
1
2
3
t
d
p
He4
He3
K
μ
π
e

Beam TOF PID

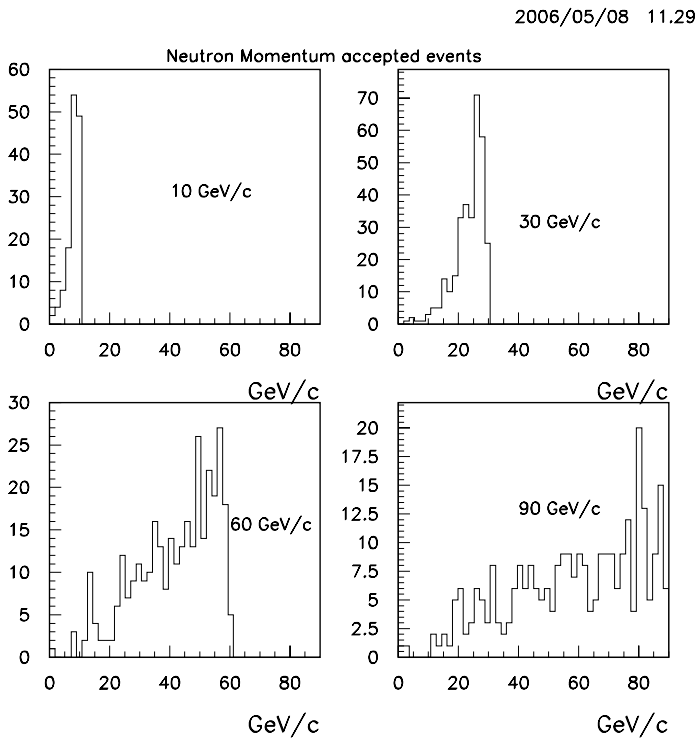
At low momentum the Beam Ckov will have to be evacuated and PID done by a beamline Time of Flight system.

MIPP using MCenter has experience with this:



- Tagged neutral beams possible with upgraded MIPP spectrometer and a hydrogen target- (R.Raja MIPP Note 130)

- Possible to acquire 50,000 tagged neutrons per day of running with the energy of each neutron known to ~2% event by event using an upgraded MIPP spectrometer. Also possible to get tagged K^0_L, anti-neutron and pizero beams.



Results from a diffraction production simulation with respect to proton momentum

Summary

- The Fermilab Meson Test Beam Facility is in full operation and has already supported several ILC users.
- The Fermilab Directorate has approved an upgrade to the MTest beamline, with the ILC in mind, which includes:
  - A new target closer to the user facility, which will allow low energy pion beams to be delivered.
  - High intensity proton beam delivered to the tertiary electron beam sweeper section, which will allow for higher energy, higher intensity electron beams.
  - Improved beam monitoring and identification.
- The Directorate has encouraged us to continue thinking of how to upgrade the test beam facilities at Fermilab to support multiple ILC detector tests in the future. The MCenter beamline and spectrometer may be a part of those future plans.