

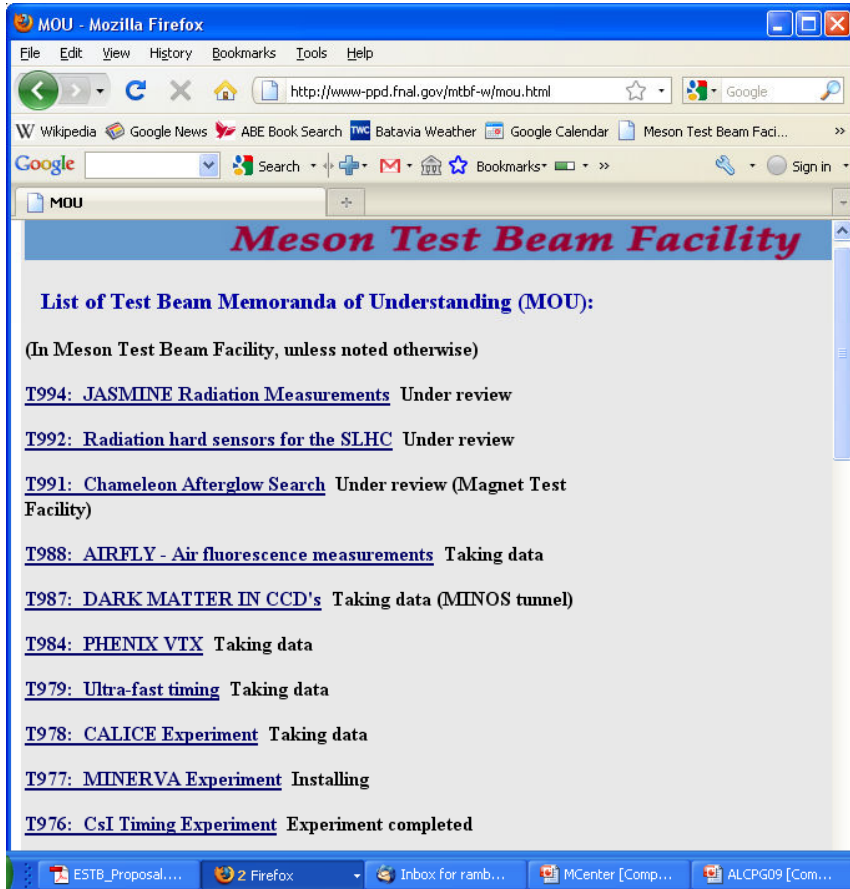
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# The Status of Fermilab's Test Beam Facility

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*Fermilab*

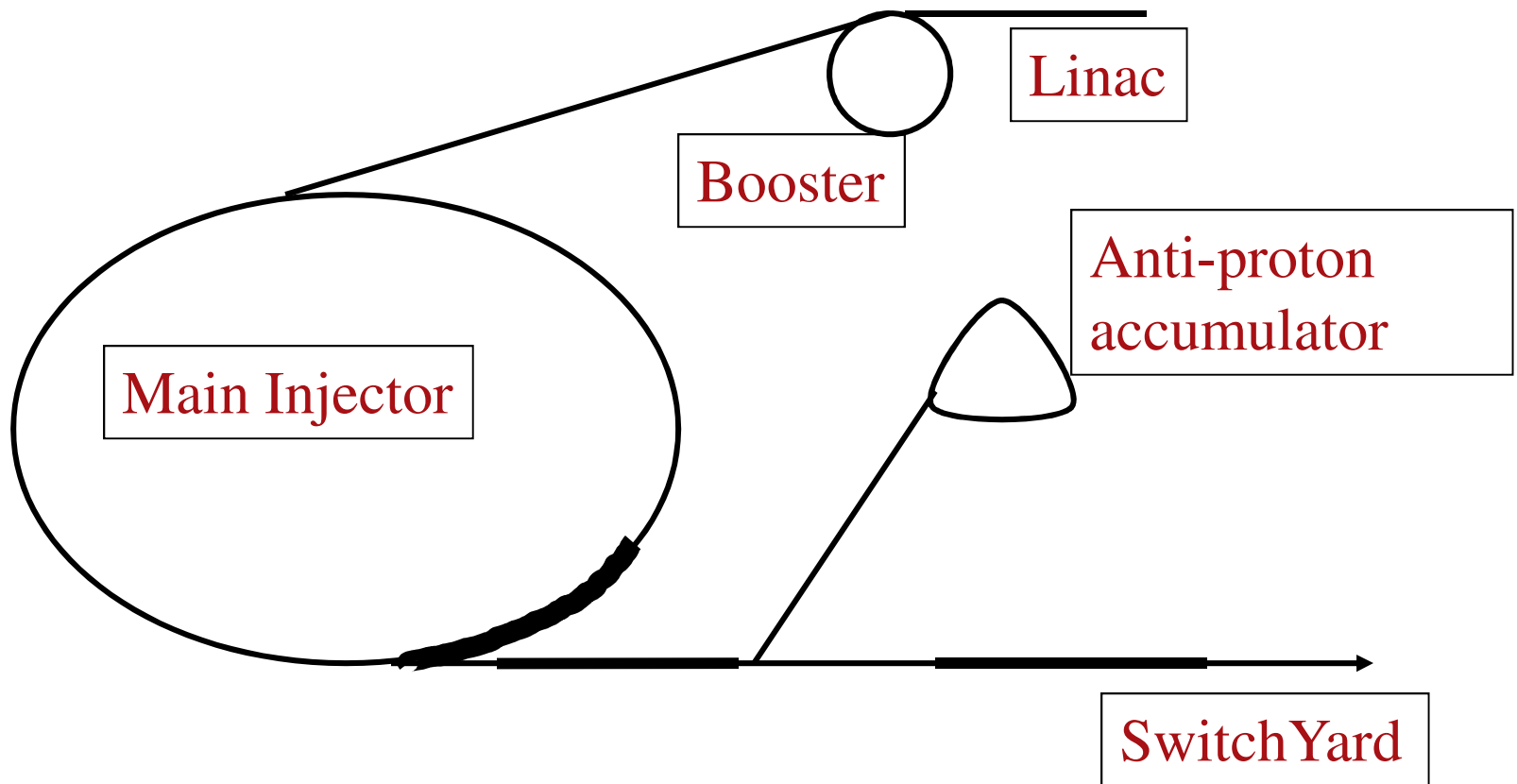
# A World-Class Program



Affiliations of Test Beam Users,  
According to their MOU

Year	Experiments	Institutions	People	Countries
2009	7	49	147	14
2008	5	42	112	13
2007	10	28	102	8
2006	5	18	65	6

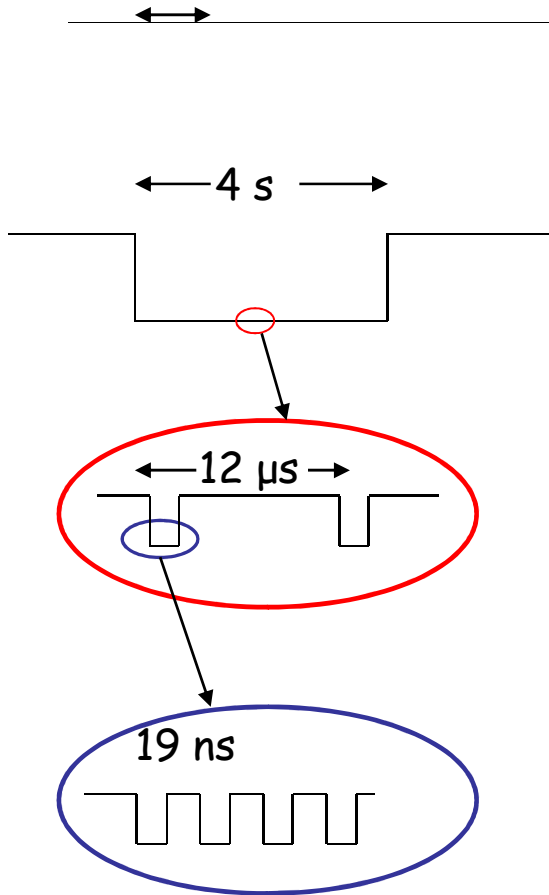
# Main Injector Extraction



## Extraction of beam from Main Injector:

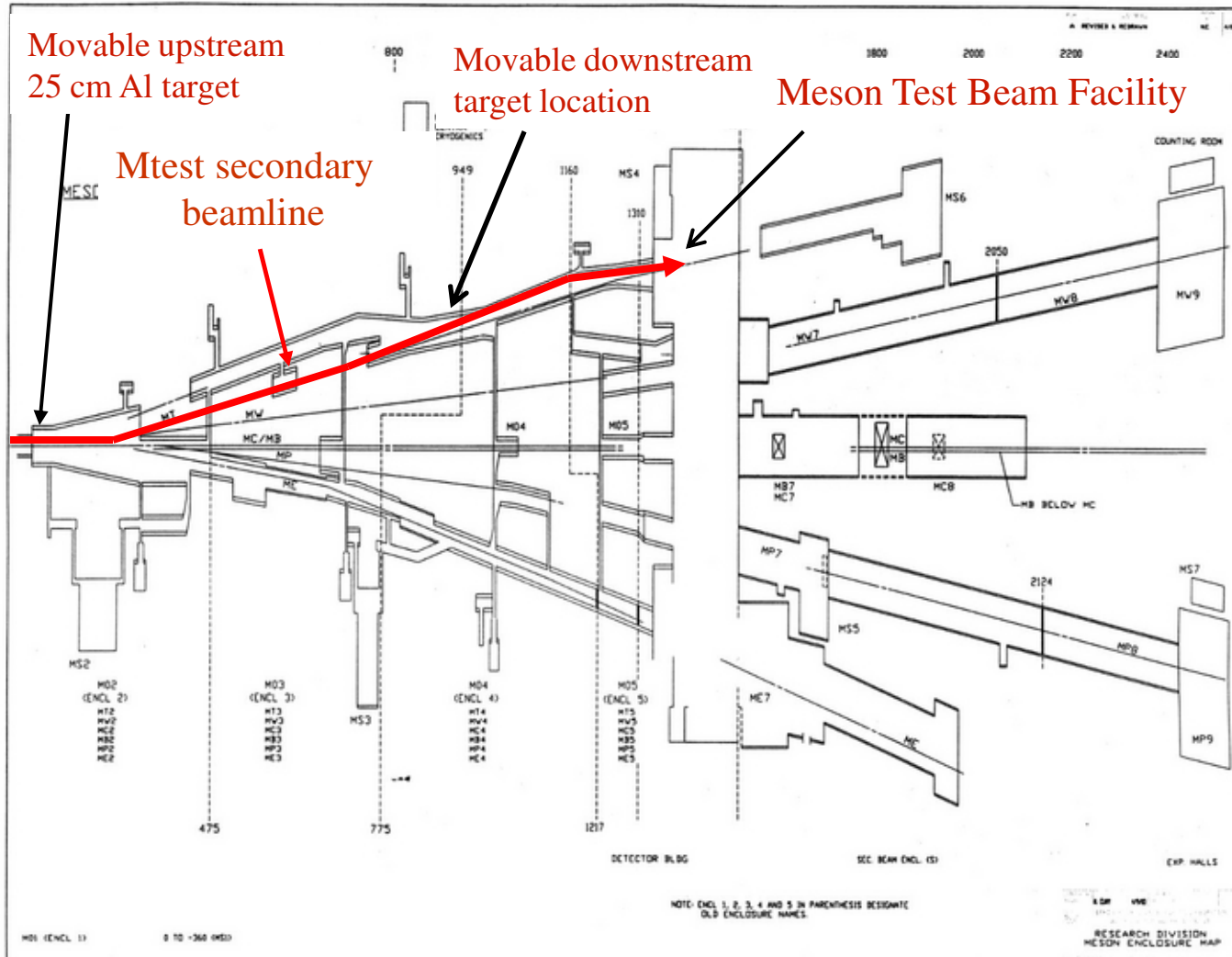
- Load 1 batch from Booster to the Main Injector
- The batch length ranges from 0.2 to 1.6  $\mu\text{sec}$  in length – Full batch equals  $2E11$  protons
- A fraction of the beam is resonantly extracted in a slow spill for each Main Injector rotation

# Spill options available at MTest



- Daily hours: 04:00 to 18:00
- Spills per min: One 4 second spill/minute, or Two 1 second spills/minute
- # Pulse trains: ~80,000 'batch rotations'/second ( 1 microsecond train, followed by 11 microsecond void )
- # Pulses: from 5-60 'bunches' per 'batch' (each bunch is 19 nsec long)

# Beam Delivery to MTest User Facility



**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 downstream target

# Beam Rates and Electron Content

## Measured rates\* without lead scatterer

Beam Energy (GeV)	Rate at Entrance to Facility (per spill)	Rate at Exit of Facility (per spill)	%Pions, Muons**	% Electrons**
16	132,000	95,000	87%	13%
8	89,000	65,000	55%	45%
4	56,000	31,000	31%	67%
2	68,000	28,000	<30%	>70%
1	69,000	21,000	<30%	>70%

## Measured rates\* with 1/4" lead scatterer

Beam Energy (GeV)	Rate at Entrance to Facility (per spill)	Rate at Exit of Facility (per spill)	%Pions, Muons**	% Electrons**
16	86,000	59,000	100%	0%
8	31,000	18,000	98%	2%
4	5,400	1,300	74%	15%
2	4,100	250	<30%	>70%
1	4,900	120	<30%	>70%

\*Rates here are normalized to 1E11 at MW1SEM

# Beam Delivery for CALICE

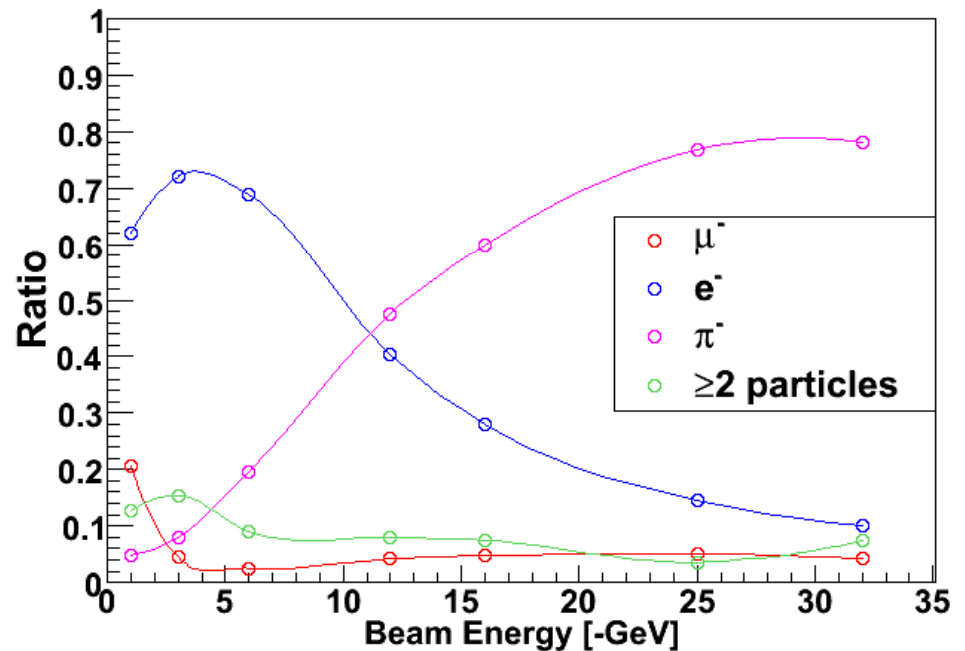
- The CALICE experiment (T978) has been the most comprehensive detector system to be installed at MTest and has summarized their results for beam composition.
- The Fermilab Accelerator Division has created beam tunes for CALICE as follows:

## Negative

1,2,3,4,6,8,10,12,15,20,30 GeV

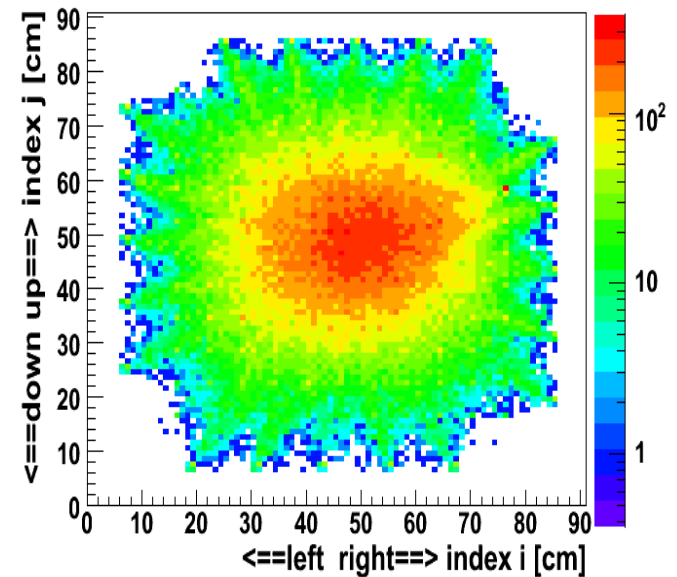
## Positive

32 GeV (high rate muon mode),  
120 GeV (proton mode)



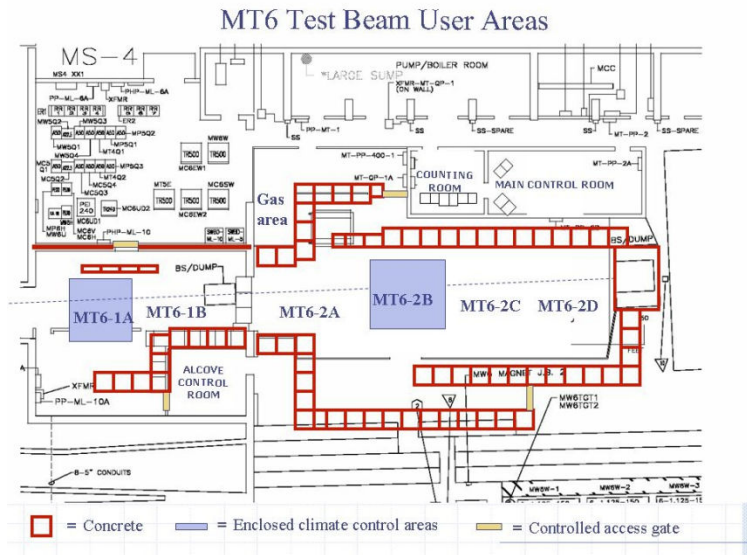
# Muon beam at MTest

- Can maximize muon flux by running high intensity at 32 GeV, and inserting 2.5 meter beamstop just before the user area.
- Broad-band muon flux can be delivered at 7 kHz over a square meter, as shown by CALICE

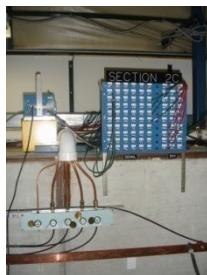




# User Facility



Spacious control room



Signal and HV cables



Gas delivery to 6 locations

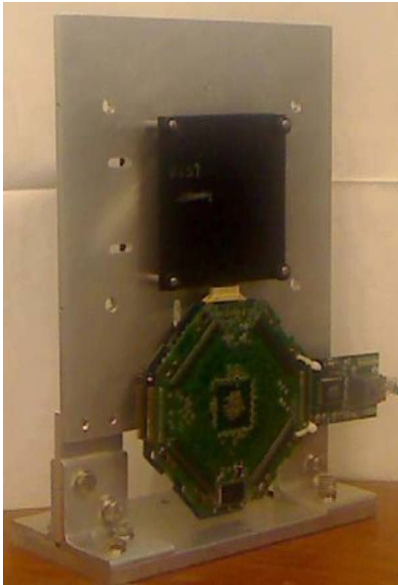


4 station MWPC spectrometer



Two motion tables

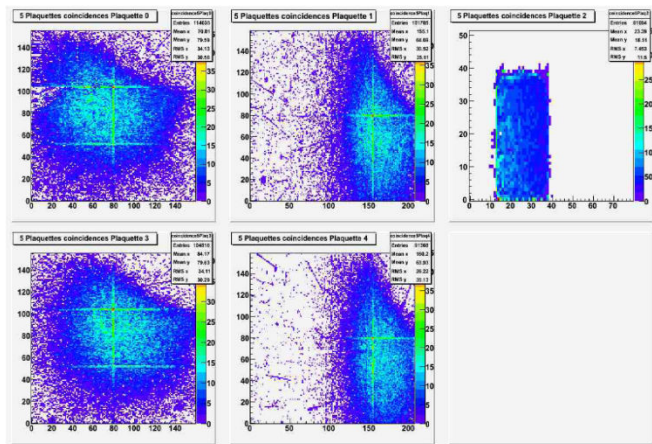
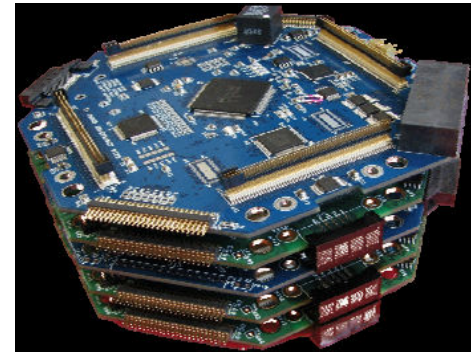
# New CMS Sensor Pixel Telescope



Sensors are B-grade, but functional at low intensity.

Overlap area is 2 cm x 2 cm

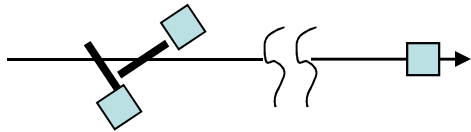
4 stations of  $100 \times 150 \mu\text{m}^2$  pixels gives 4  $\mu\text{m}$  resolution



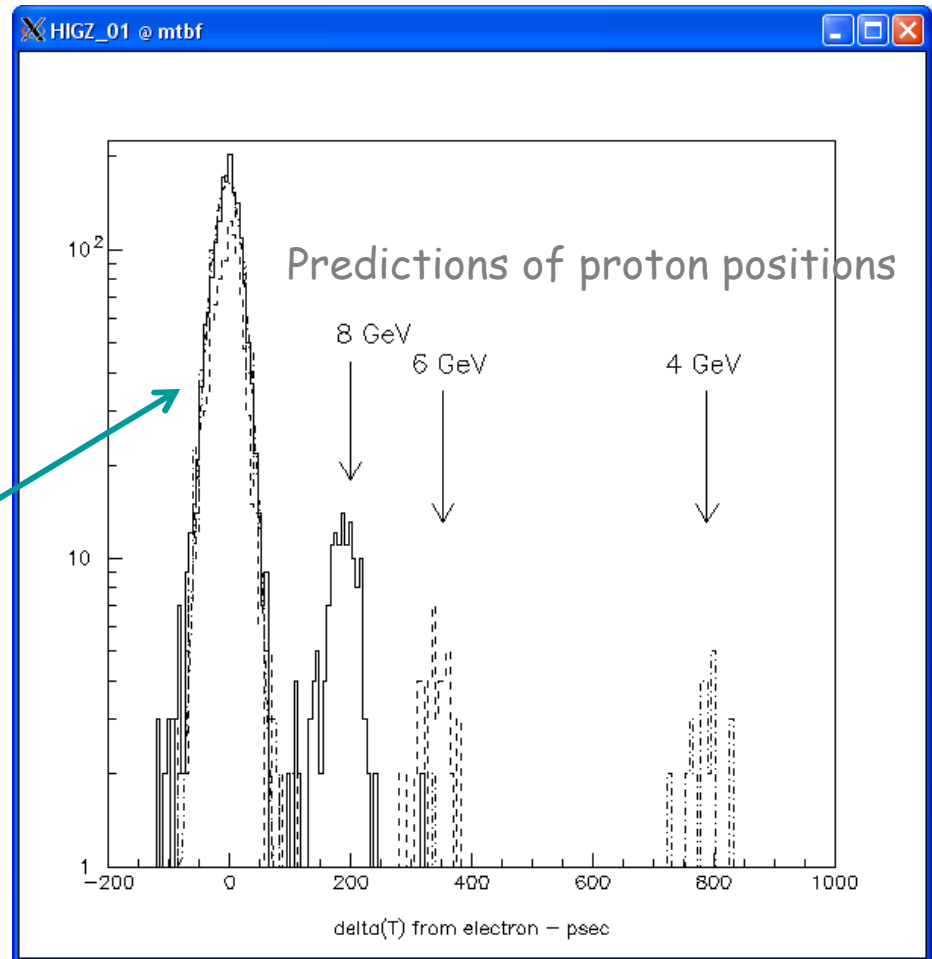
Clever vertically integrated DAQ, called “CAPTAN”, has node processing boards and data conversion boards. Horizontal connectivity for output. Multi-threaded application software running on Windows.

# Extreme Time-of-Flight System

Start = Double-Q-bar  
Stop = Photek 240  
Start-stop dist. = 8.7 m



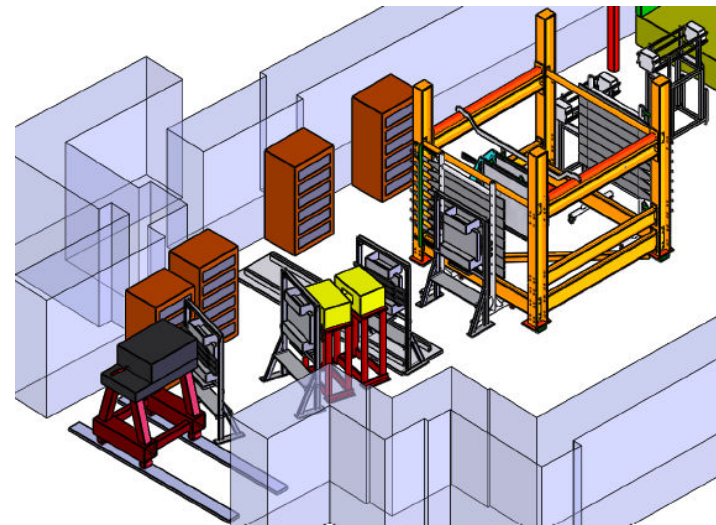
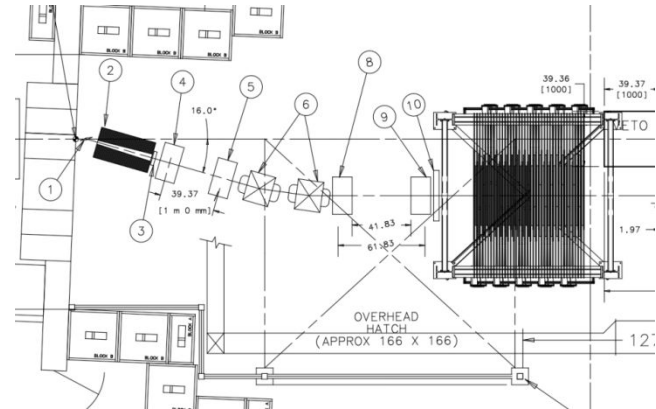
24 psec resolution  
positron peak, using  
average of A & B times



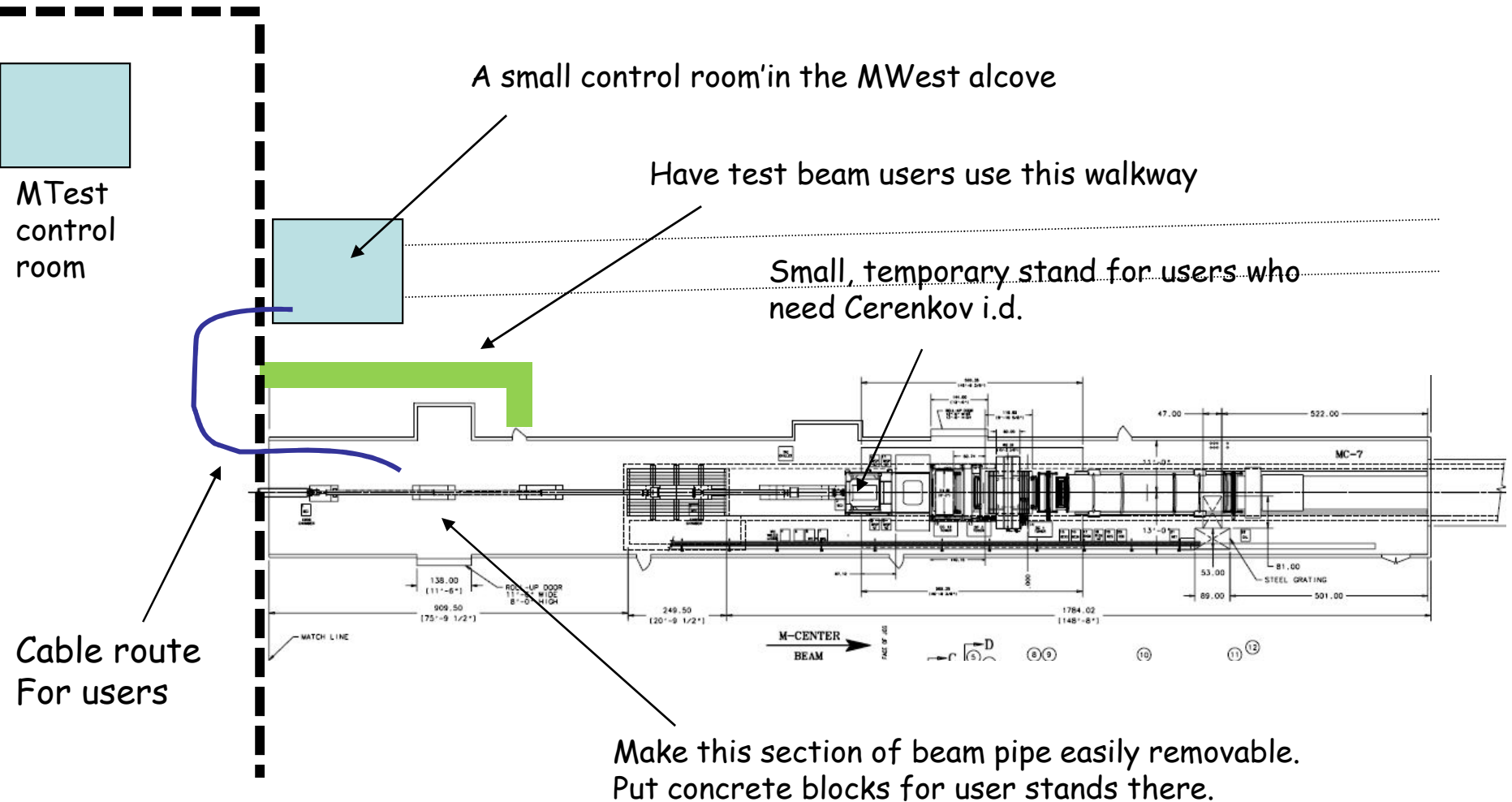
We can measure momentum of a high-energy proton using this system!

# Tertiary 300 MeV/c Beamline for MINERVA

- The MINERVA experiment requested space to create a new tertiary beamline that could deliver pions down to 300 MeV/c momentum.
- The Particle Physics Division and Accelerator Division have agreed to help and are proceeding on installation.
- Full tracking and TOF will allow for momentum measurement and particle i.d.
- Target station rolls away for other users.
- The full spectrometer will be tested in November, 2009

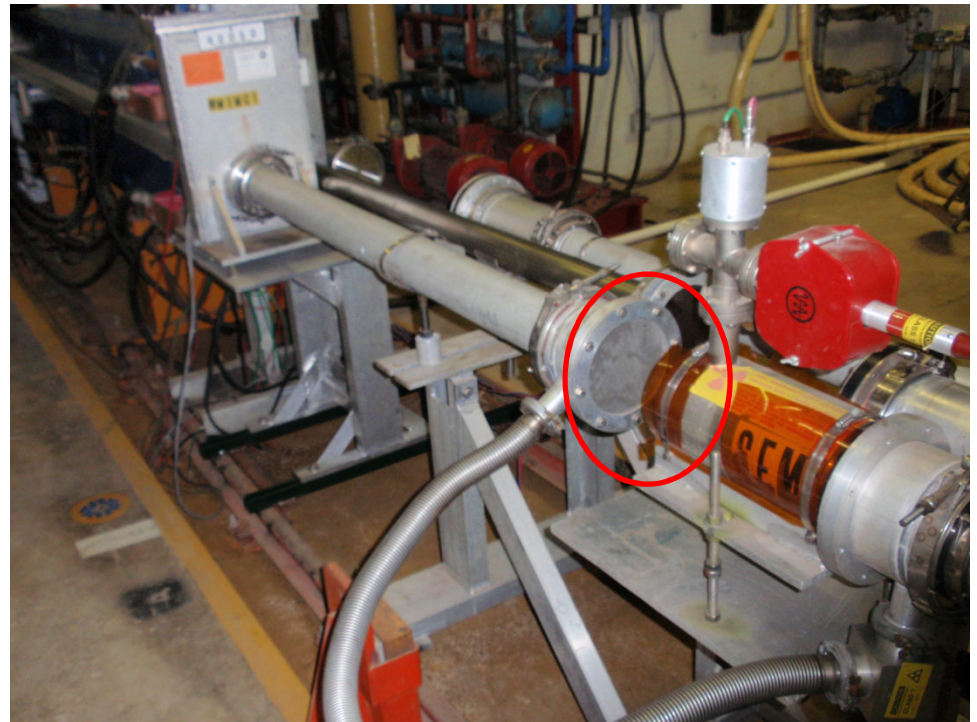


# Proposal for a Small Test Beam Area in MCenter



# An Irradiation Facility

- The JASMIN experiment (T993) plans on irradiating thin foils as part of their shielding and neutron production program.
- They will be using the M01 area, where the split between MCenter and MTest takes place.
- A small area, with SEM measurement of beam flux, can support future irradiation experiments as well.
- Full intensity is  $2 \times 10^{11}$  protons per minute, in about  $1 \text{ cm}^2$



# Summary

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- The MTest facility continues to support a large variety of advanced detector tests
- The beamline is quite versatile, delivering secondary beams from 1 to 64 GeV, and a primary beam of 120 GeV protons. Electrons are dominant at low energies. Muons can be selected for with a beam stop.
- A new tertiary beam is being developed, which should deliver tagged pions down to 300 MeV/c.
- Two new pixel telescope systems have been created for the facility, with resolutions of 5-10 microns.
- A new TOF system has been tested, with a resolution of 24 psec. Individual measurements on a 4 cm MCP/PMT show 6 psec resolution
- A proposal is being studied at Fermilab to support test beam activities in the MCenter beamline, perhaps in conjunction with the MIPP experiment.