

FERMILAB TEST BEAM FACILITY

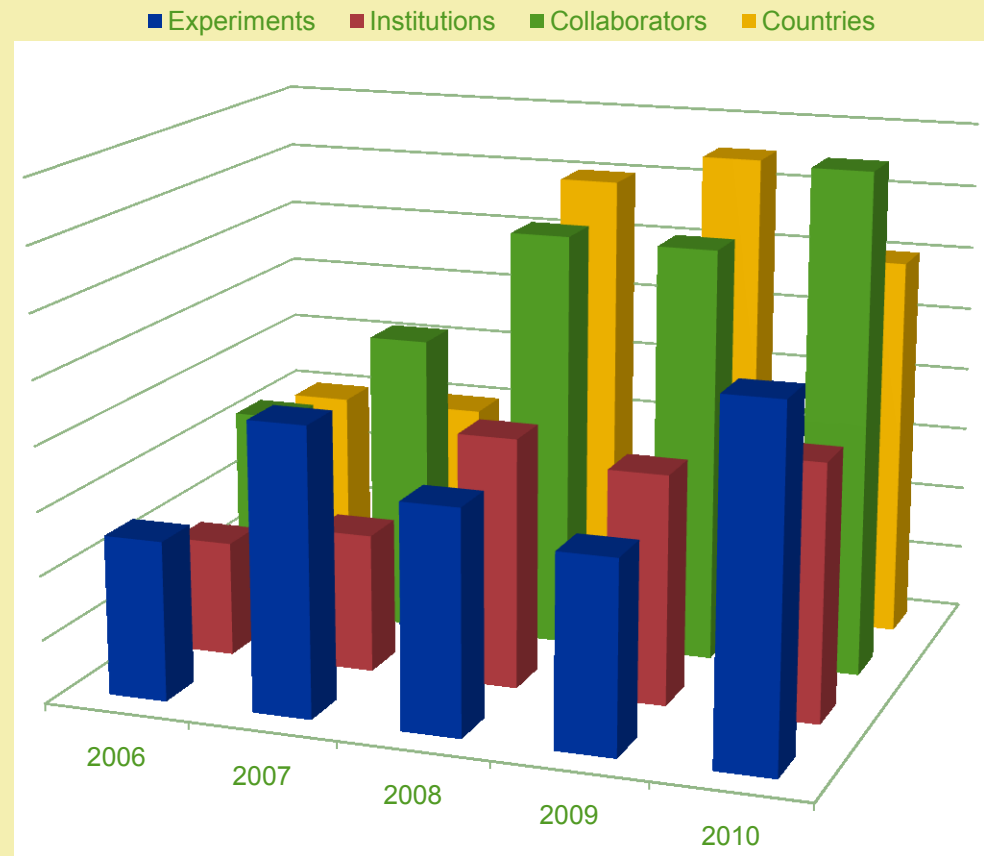
Aria Soha

June 11, 2011

TIPP 2011

The Fermilab Test Beam Facility

- World Class Facility
- The only operating U.S. HEP Test Beam
- Detector R&D focus
- Since 2005:
 - 32 experiments
 - 464 collaborators
 - 108 institutions
 - 24 countries



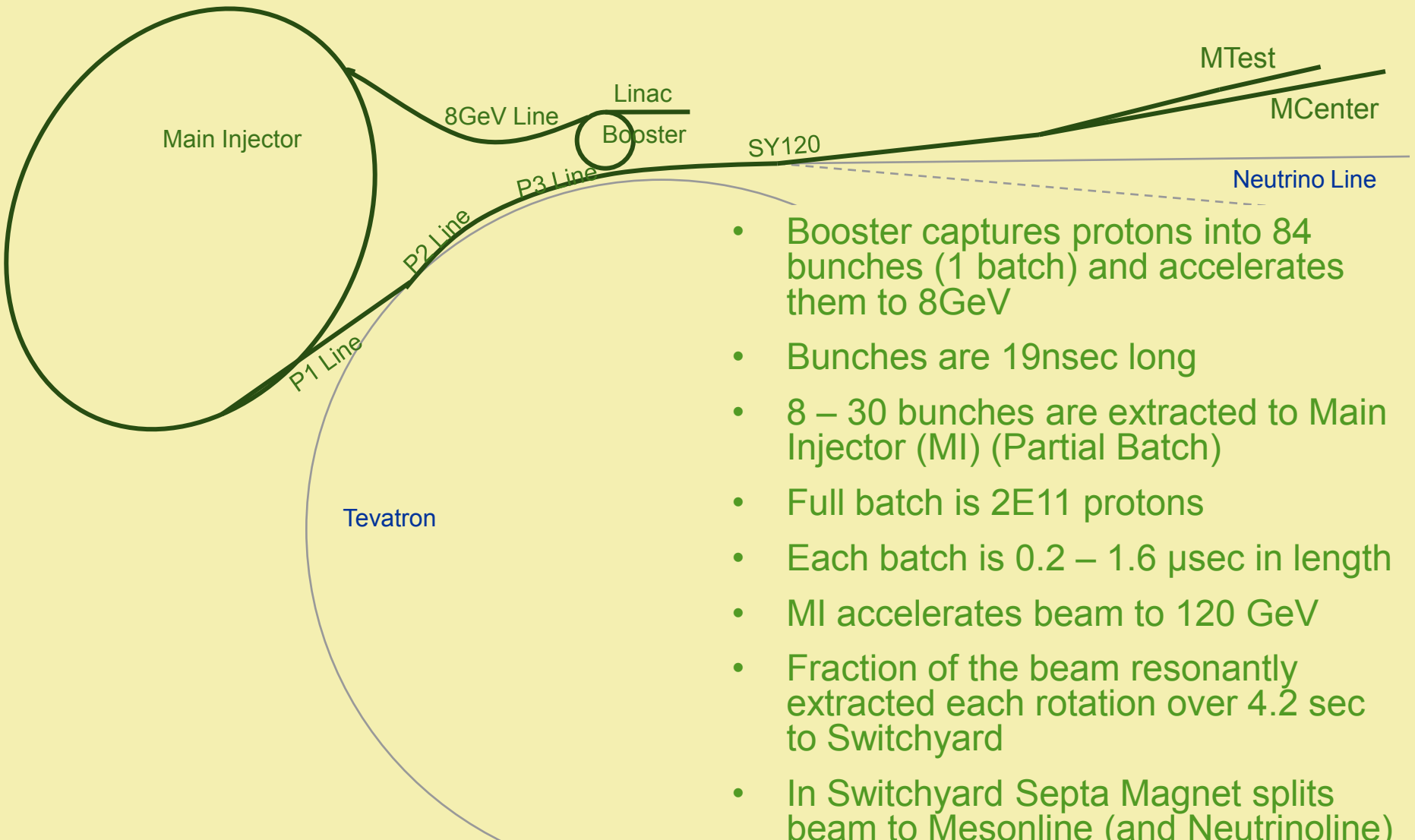
Location

Fermi National Accelerator Laboratory

Meson Detector Building – West



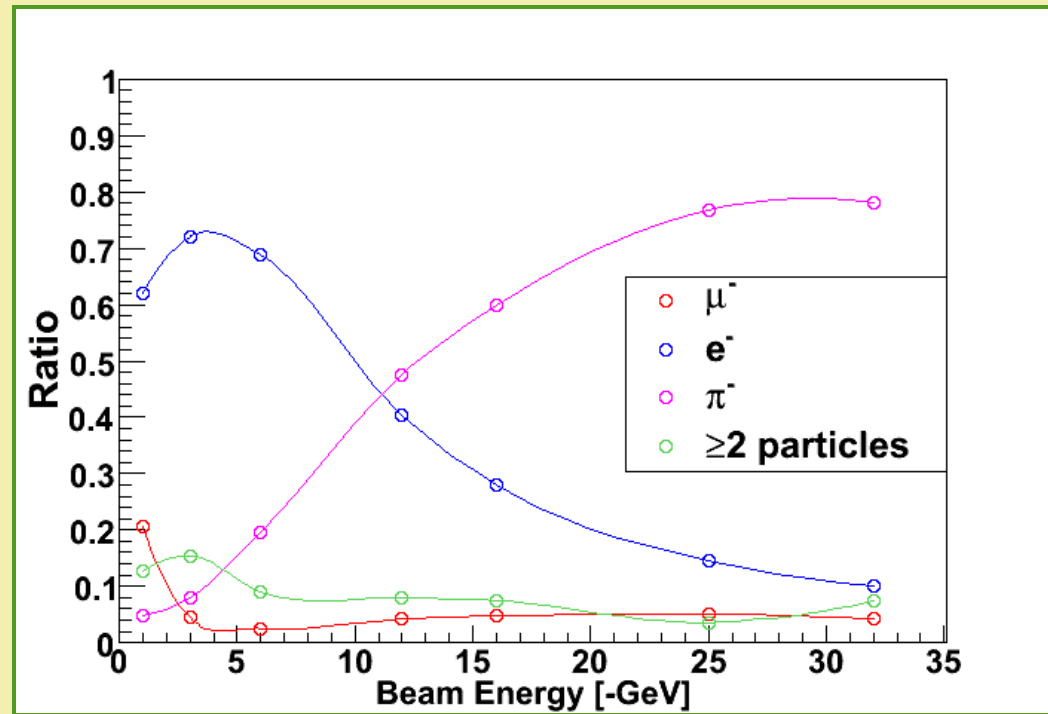
Beam Delivery



- Booster captures protons into 84 bunches (1 batch) and accelerates them to 8GeV
- Bunches are 19nsec long
- 8 – 30 bunches are extracted to Main Injector (MI) (Partial Batch)
- Full batch is $2E11$ protons
- Each batch is 0.2 – 1.6 μ sec in length
- MI accelerates beam to 120 GeV
- Fraction of the beam resonantly extracted each rotation over 4.2 sec to Switchyard
- In Switchyard Septa Magnet splits beam to Mesonline (and Neutrino line)

Particle Composition of Beam

- 120 GeV Protons
- 2 - 66 GeV Pions
- 0.5 – 32 GeV Electrons
- Broadband Muons



- If beam were smoothly extracted, 100 kHz or less would imply 1 particle per MI rotation would occur.
- Beam extraction is not smooth resulting in up to 35% double occupancy per MI rotation

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%

Operating

- Test Beam makes up 5% of Fermilab's HEP program
- 6 sec event (4.2 sec spill) every 60 seconds for 12 hours a day
- Normal Operating Hours: 0400 – 1800
 - Stop for Tevatron Fill (2 hrs)
- Control room manned during beam hours

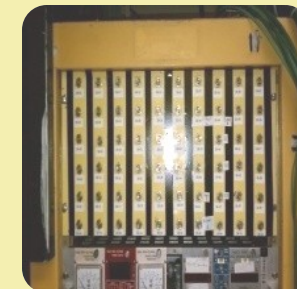
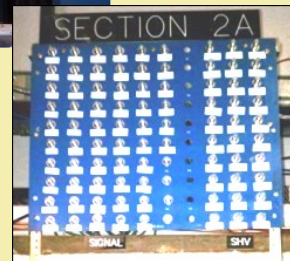
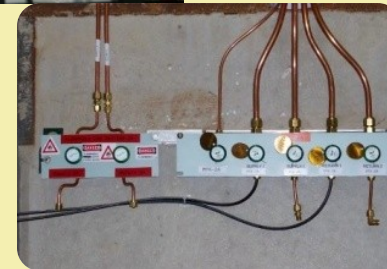
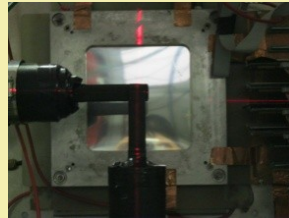
Facility Details

- Multiple Control Rooms
- Conference Room
- Climate-controlled areas for experiments
- Machine Shop
- Several Work Rooms
- Storage Rooms and Cabinets



Facility Details

- Remotely controlled Motion Tables
- Laser Alignment
- State-of-the-Art, web-based Cameras
- Helium Tubes
- Gas Delivery
- Signal and High Voltage cable patch panels



Facility Instrumentation

- 2 Cerenkov Detectors



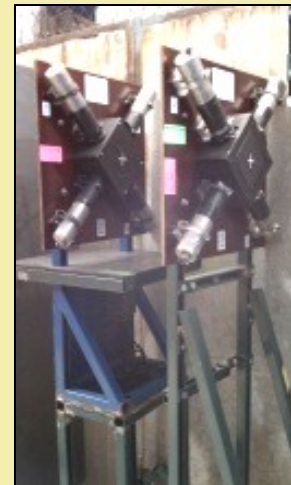
- 2 Pixel Telescopes



- 4 MWPC Tracking System



- Time of Flight System



- Lead Glass Calorimeters

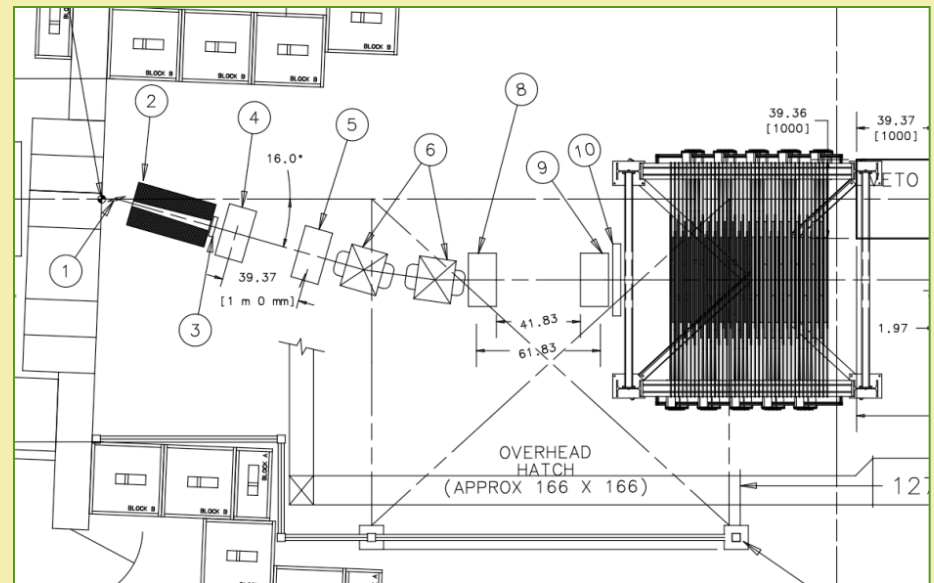


- Assorted Trigger scintillators



Accommodating Users

- In 2008, T-977 MINERvA experiment requested
 - ~200 – 1000 pions/spill,
 - with momentum as low as 200 MeV/c
- They requested Fermilab build another beamline...



Tertiary Beamline



Target/
Collimator

TOF 1

WC 1

WC 2

Spectrometer
Magnets

WC 3

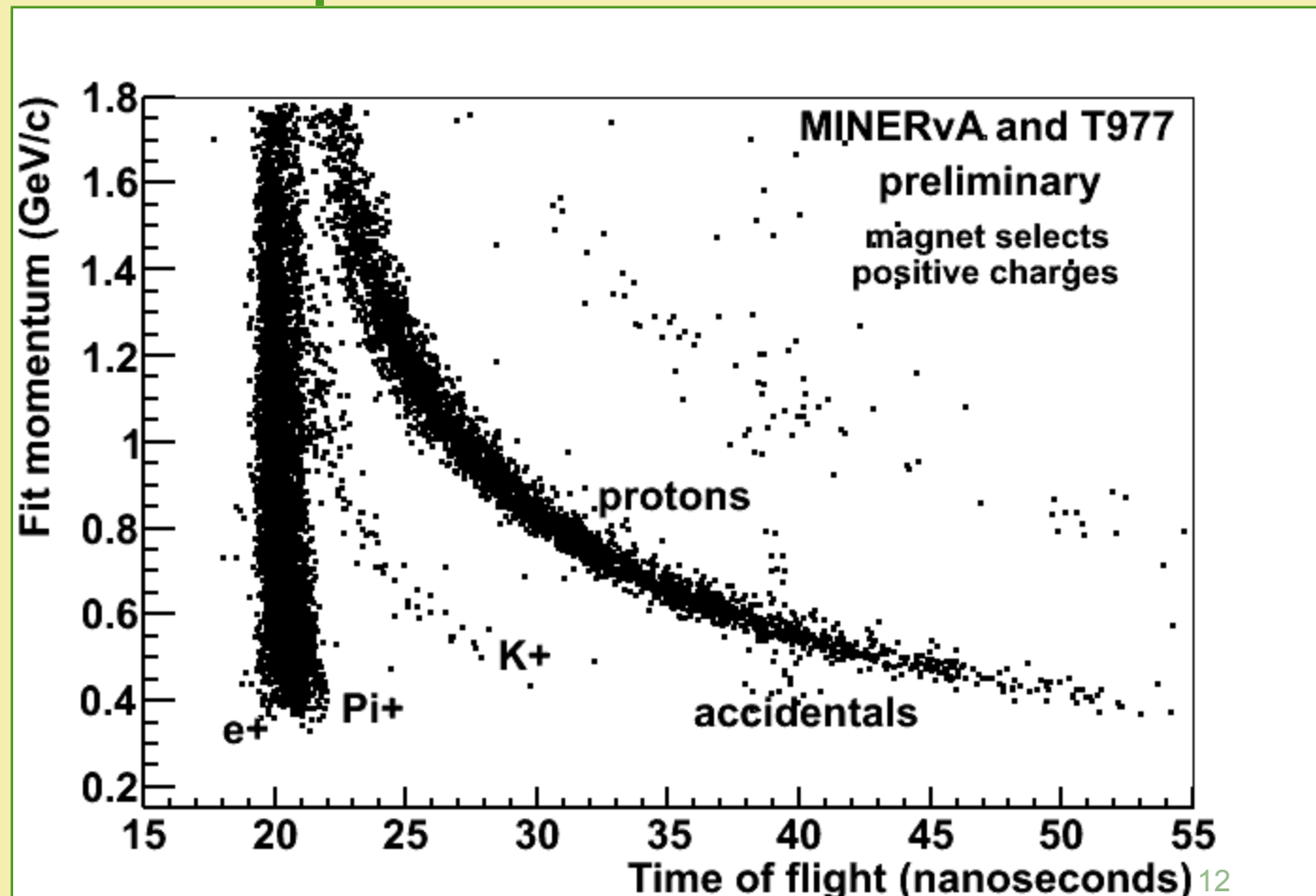
WC 4

TOF 2

Tertiary Beam Details

Plot of Fit Momentum vs. TOF;
Shows: Separation of Species and Available Momenta

- 60% pions,
- 40% protons,
- very few electrons, kaons, and deuterons.



Tertiary Beam Details

- **Rates:** about 200 particles / 4 sec spill (~50 Hz)
- **Momentum Resolution:** $dp = 3\%$
 - multiple scattering limited for this momentum range
- **Bias:**
 - MINERvA design goal for bias is $< 2\%$.
 - So far only 5% demonstrated
- WC4 can be moved to achieve lower or higher momentum
 - design momentum is 200MeV minimum

Schedule

<http://www-ppd.fnal.gov/FTBF/schedule.html>

2010					
Dates	Experiment	Description	User	Area	Contact
1. Oct 1 - Oct 5	T978	CALICE Installation	Primary	2-CD	Repond
2. Oct 6 - Oct 14	T978	CALICE Installation	Primary	2-CD	Repond
Oct 7 - Oct 9	Facility in Open Access: Workshop on Detector R&D				
3. Oct 15 - Oct 19	★ T978	CALICE	Primary	2-CD	Repond

2011					
15. Jan 5 - Jan 11	★ T978	CALICE	Primary	2-CD	Repond

42. Jul 13 - Jul 19	T1008	Super B Prototype Installation	Primary	2-BC	Posocco
43. Jul 20 - Jul 26	★ T1008	Super B Prototype	Primary	2-BC	Posocco
44. Jul 27 - Aug 2	T1008	Super B Prototype	Primary	2-BC	Posocco
45. Aug 3 - Aug 9	★ T1010	GEM Chamber Characteristics Test	Primary	2-C	Yu
46. Aug 10 - Aug 16	T1010	GEM Chamber Characteristics Test	Primary	2-C	Yu
47. Aug 17 - Aug 23					
48. Aug 24 - Aug 30					
49. Aug 31 - Sep 6					
50. Sep 7 - Sep 13					
51. Sep 14 - Sep 20					
52. Sep 21 - Sep 27					

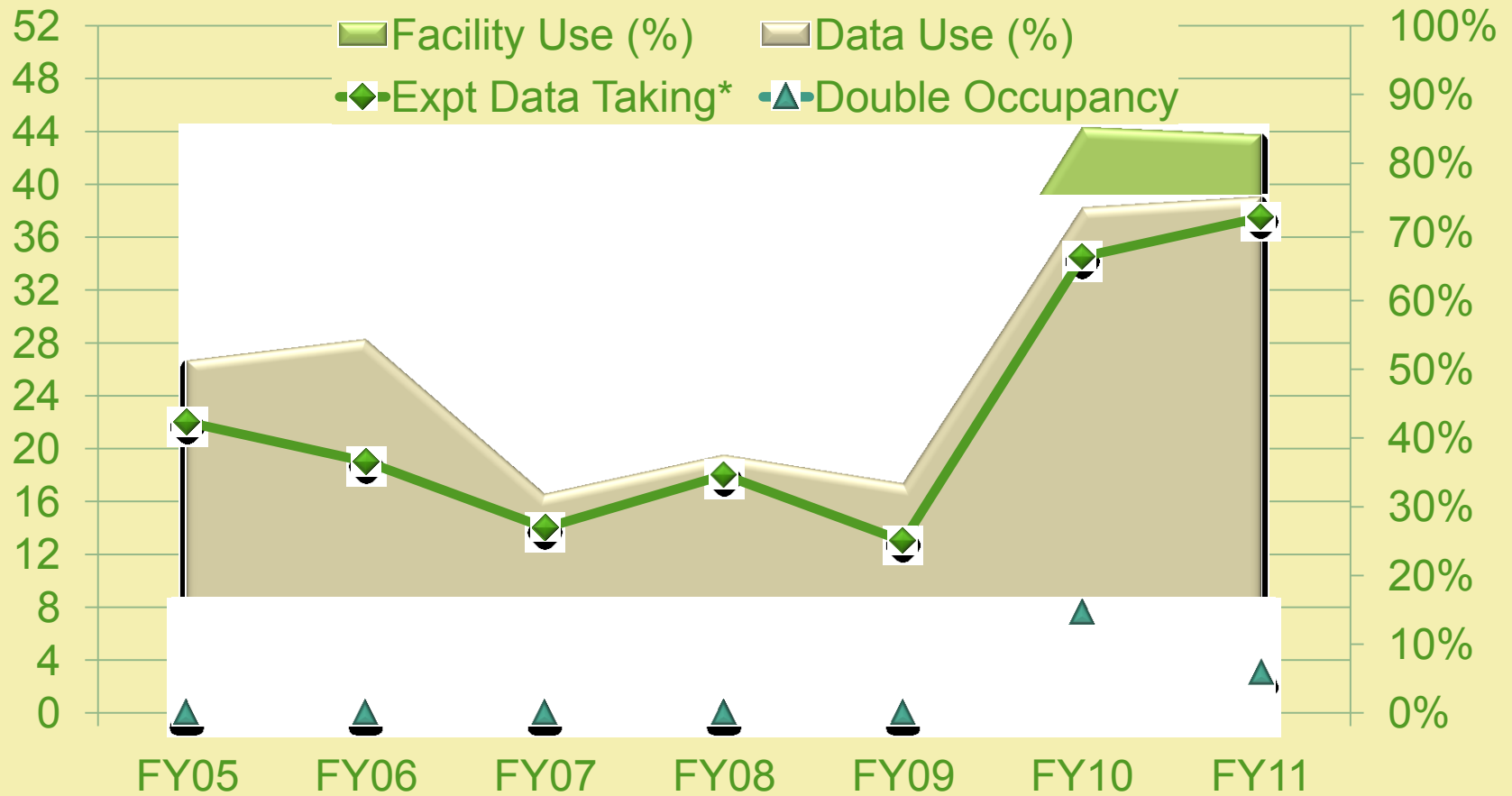
2011					
Dates	Experiment	Description	User	Area	Contact
1. Sep 28 - Oct 4					
2. Oct 5 - Oct 11 11	★ T992	Radiation-hard Sensors for the SLHC	Primary	1-B	Kwan
3. Oct 12 - Oct 18 18	T992	Radiation-hard Sensors for the SLHC	Primary	1-B	Kwan
4. Oct 19 - Oct 25	★ T978	Fast Timing Counters for PSEC	Primary	2-B	Albrow
5. Oct 26 - Nov 1	★ T1015	Dual Readout Calorimetry	Primary	2-B	
6. Nov 2 - Nov 8	★ T978	CALICE	Primary	2-CD	Repond

11. Dec 7 - Dec 13	★ T1015	Dual Readout Calorimetry	Primary	2-B	
12. Dec 14 - Dec 20					
13. Dec 21 - Dec 27					
14. Dec 28 - Jan 3					

2012					
15. Jan 4 - Jan 10					
16. Jan 11 - Jan 17					
17. Jan 18 - Jan 24					
18. Jan 25 - Jan 31					
19. Feb 1 - Feb 7					
20. Feb 8 - Feb 14		Facility In Use: ECIT 2012			
		Facility In Use: ECIT 2012			
		Facility In Use: ECIT 2012			
		No Beam Available: Accelerator Shutdown			

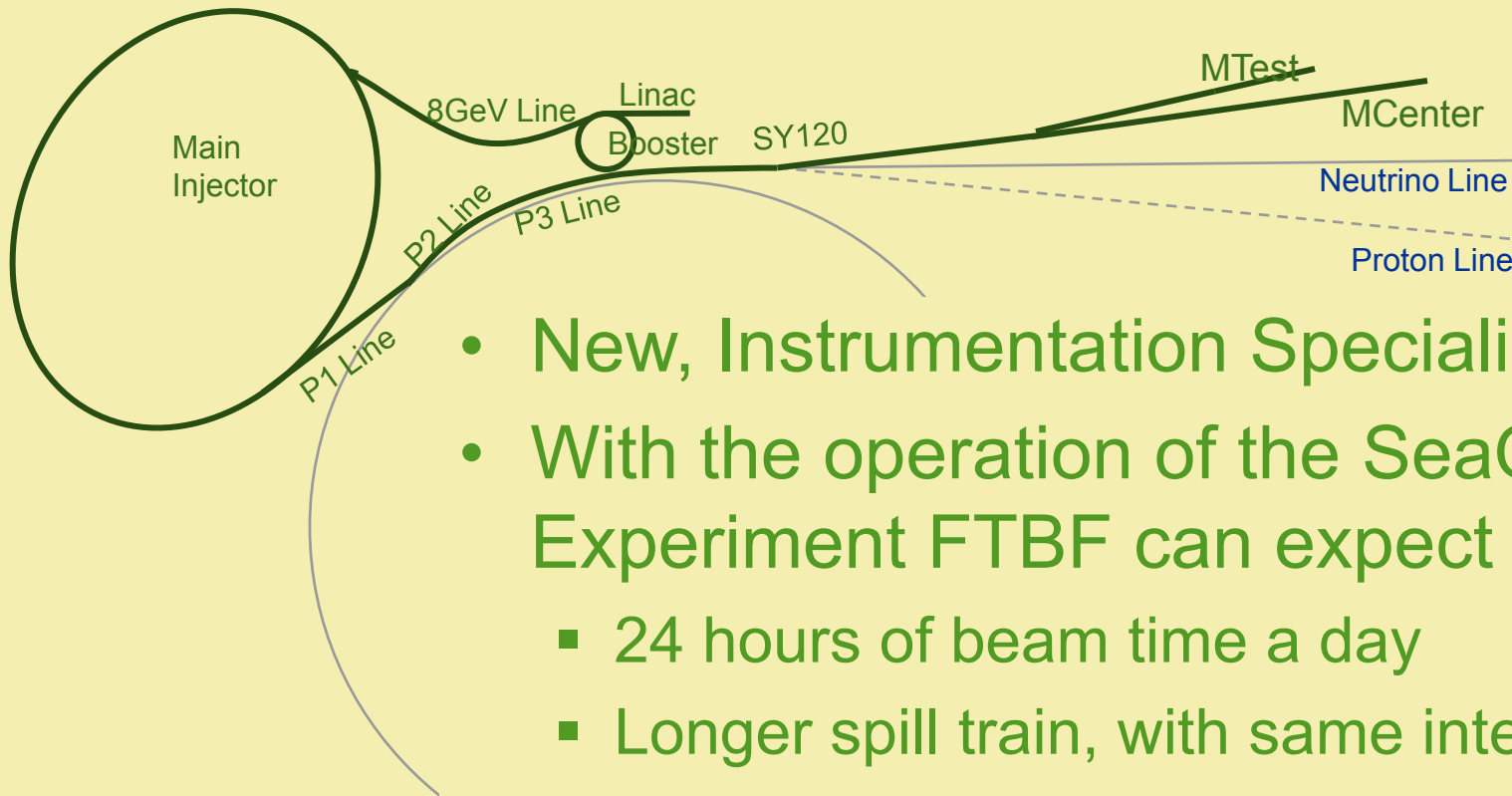
- Time still available for Aug/Sept 2011
- Fermilab Accelerator shutdown scheduled for March 2012 through February 2013 (11 months)

Weekly Usage



- *Experiment Data Taking Includes Double Occupancy
- Facility Use includes Experiment Installation, Facility Tests, & Data Use, and is normalized to Beam Availability

Facility Expansion



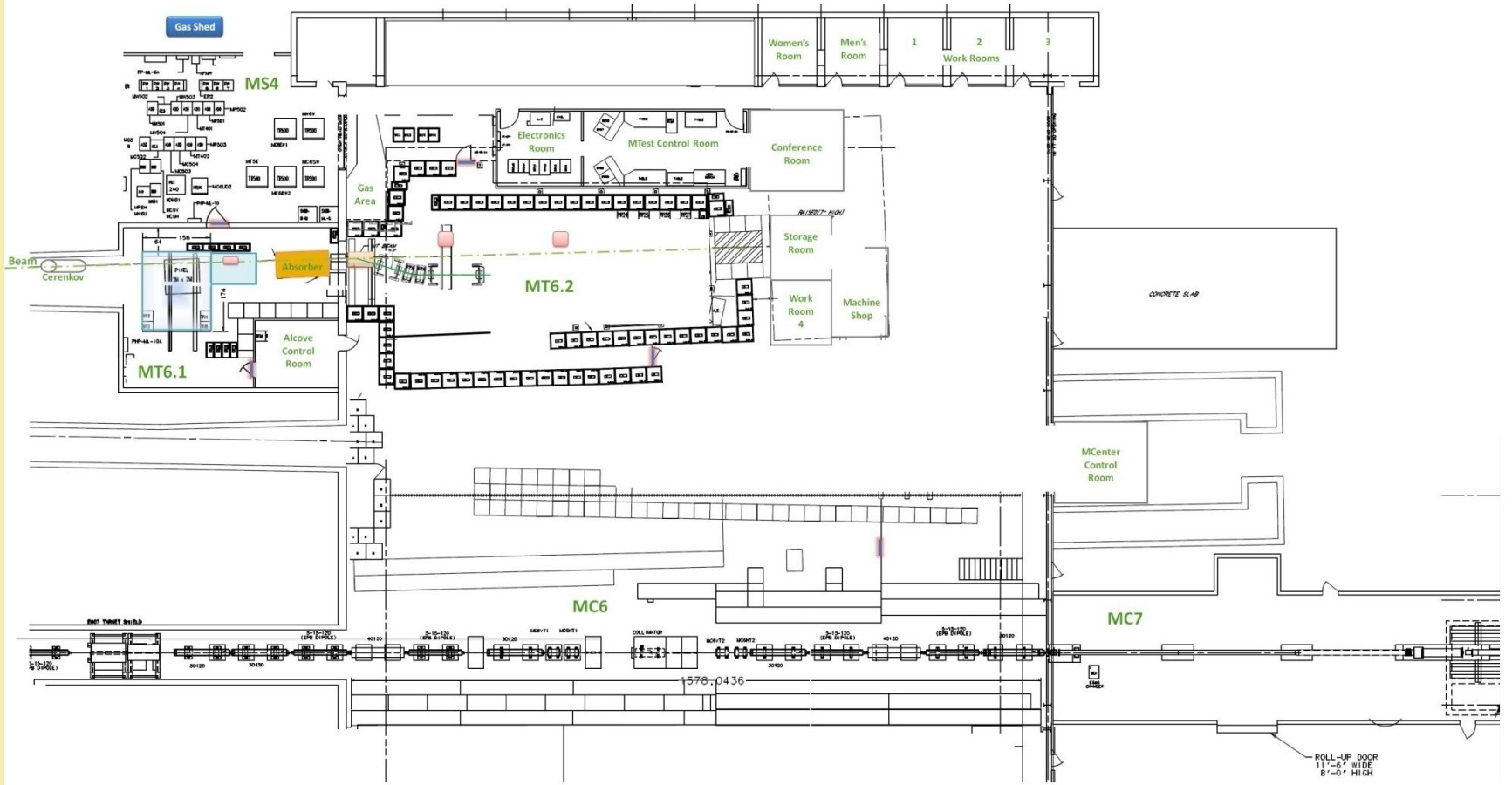
- New, Instrumentation Specialist
- With the operation of the SeaQuest Experiment FTBF can expect
 - 24 hours of beam time a day
 - Longer spill train, with same intensities
- MCenter line start-up
 - Doubles the capacity of our facility for small users

MCenter User Area



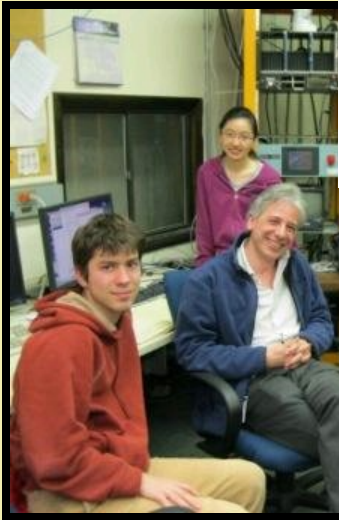
This section of beam pipe has been modified to have flanges and a bellows, so as to make it easily removable.

Facility Overview



Outreach

- opportunities for students to explore physics with **hands on experience**
- graduate and undergraduate students
- perform real beam tests with real equipment and detectors



FTBF Summary

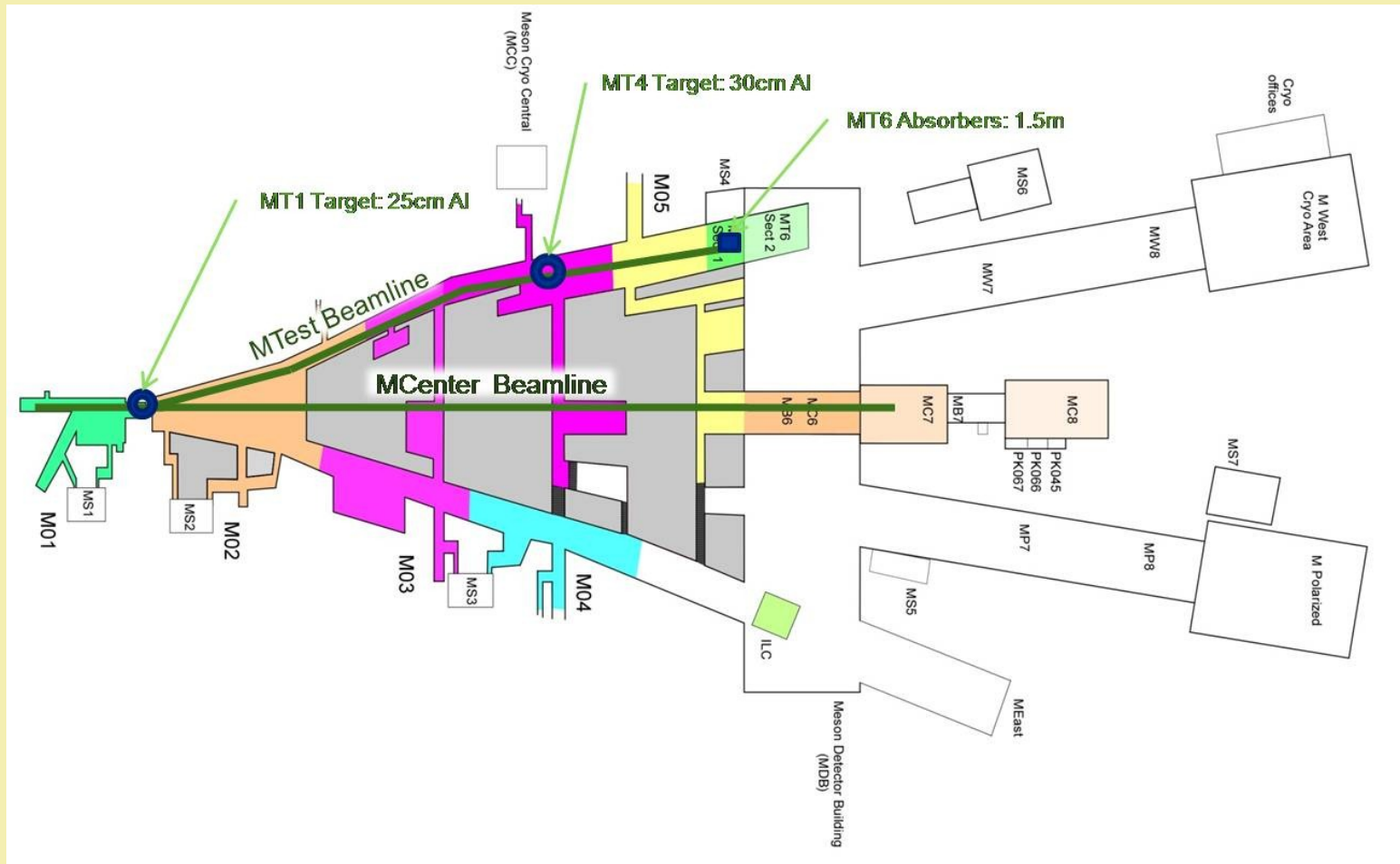
- Fermilab Test Beam Facility is an HEP Beam facility for world-wide Detector R&D
- Flexible beam delivery
 - Protons, pions, muons, electrons, kaons
 - 200 MeV – 120 GeV
 - 1 – 300 kHz intensities
- Extensive facility infrastructure & instrumentation

<http://www-ppd.fnal.gov/FTBF>

Additional Slides

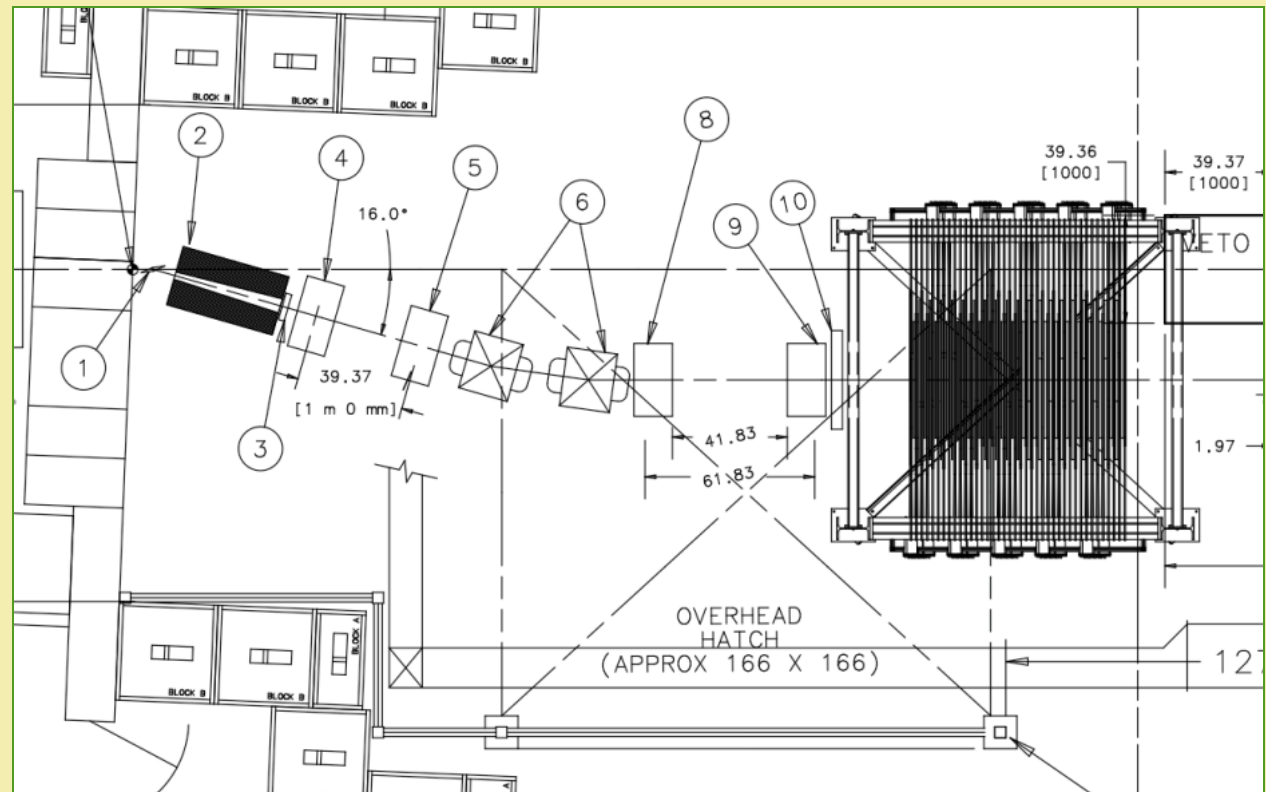
ADDITIONAL SLIDES

Meson Area Beamlines



Tertiary Beamline Proposal

1. 16 GeV pion beam hits a copper target and steel collimator at the entrance to MT6.2
2. Particles emerge at a 16° angle
3. TOF 1 (Scintillator)
4. Wire Chamber 1
5. Wire Chamber 2
6. Spectrometer magnets to straighten beam
- 7.
8. Wire Chamber 3
9. Wire Chamber 4
10. TOF 2 (Scintillator)
11. MINERvA detector



Beam Spot Size

Energy Resolution