

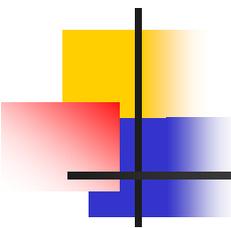
NuMI Beam Commissioning Working Group

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Fermilab

The MINOS Collaboration Meeting

at Caltech

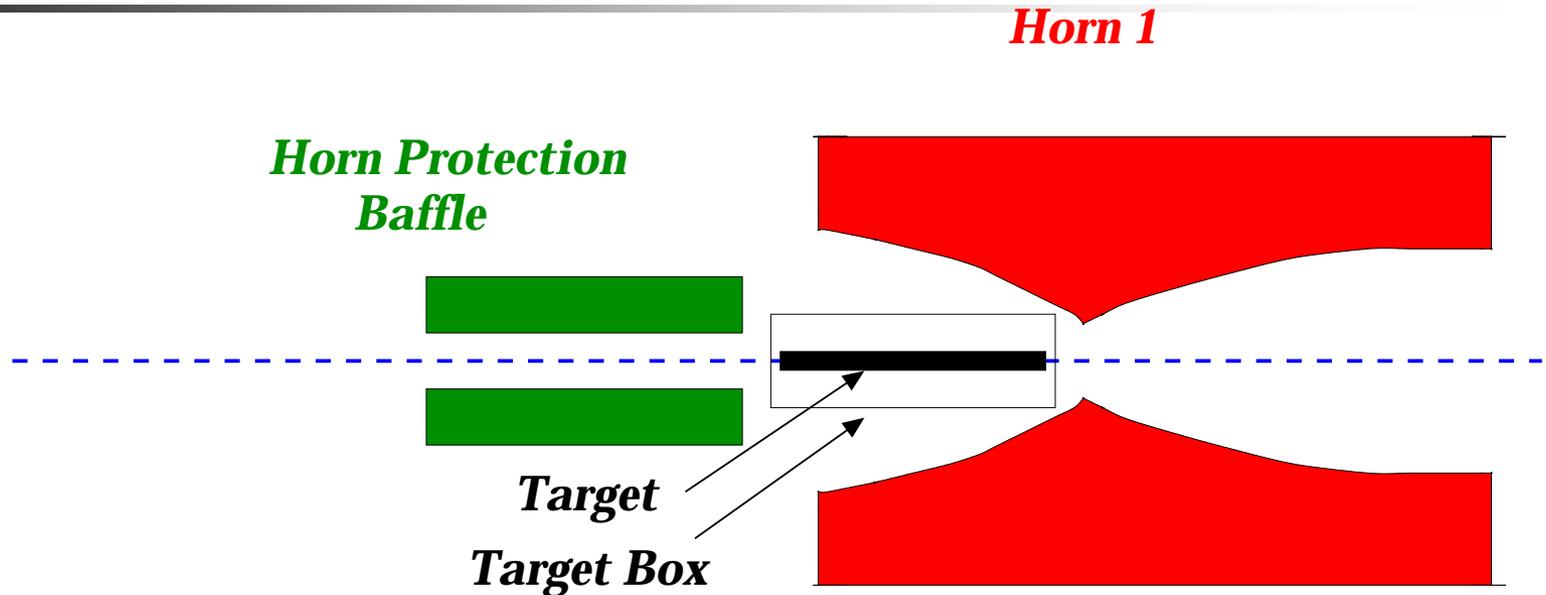
January 3-6, 2002



Neutrino Beam Commissioning

- Three related subjects:
 - Beam commissioning
 - Diagnostics in case of beam malfunctioning
 - Neutrino beam re-commissioning after a replacement of beam elements
- Objective:
 - Certify that the beam elements are positioned/function within prescribed tolerances
 - Identify possible misplacements/malfunctioning
 - Collect auxiliary data (if any, to be defined) to validate our understanding of the neutrino beam

Neutrino beam elements



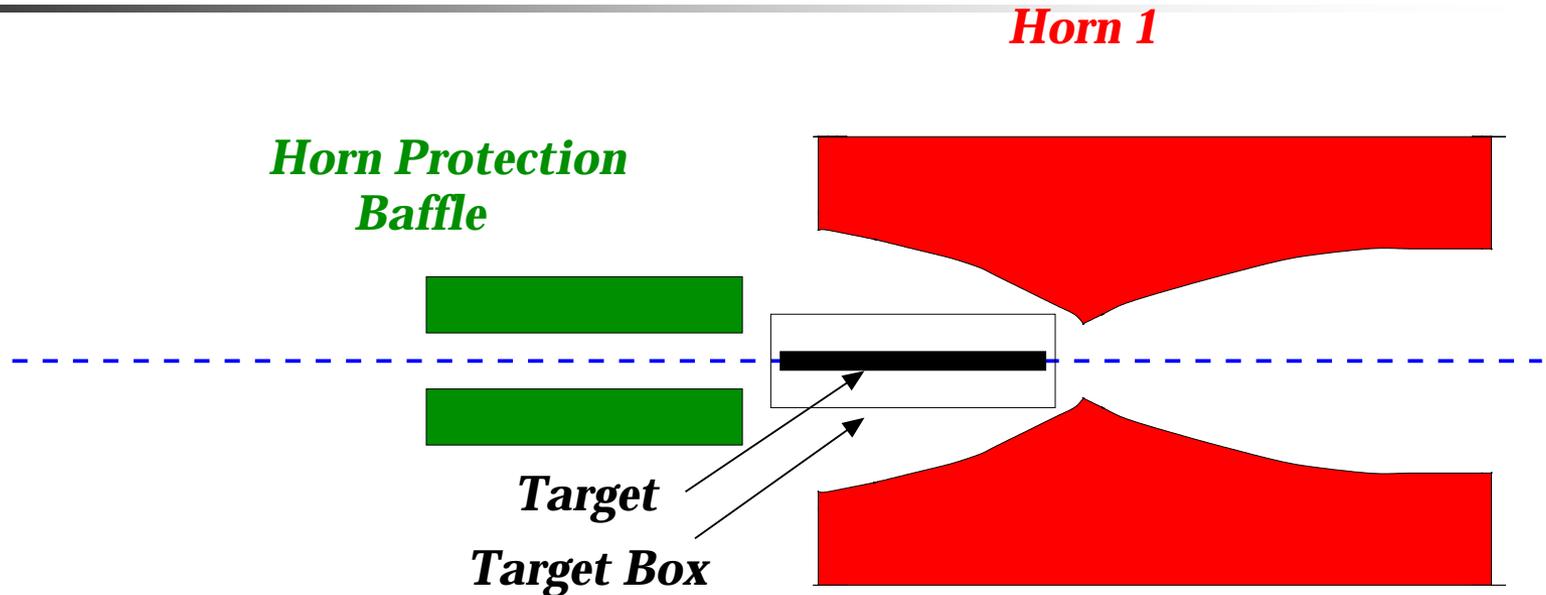
Also:

- Horn 2 (to be commissioned)
- Decay pipe (not much can be done)

Why discuss now?

- make sure that the beam line is adequately instrumented/monitored
- Need to finalize design (baffle/target) and to design the support structures:
 - Movement capabilities/ranges

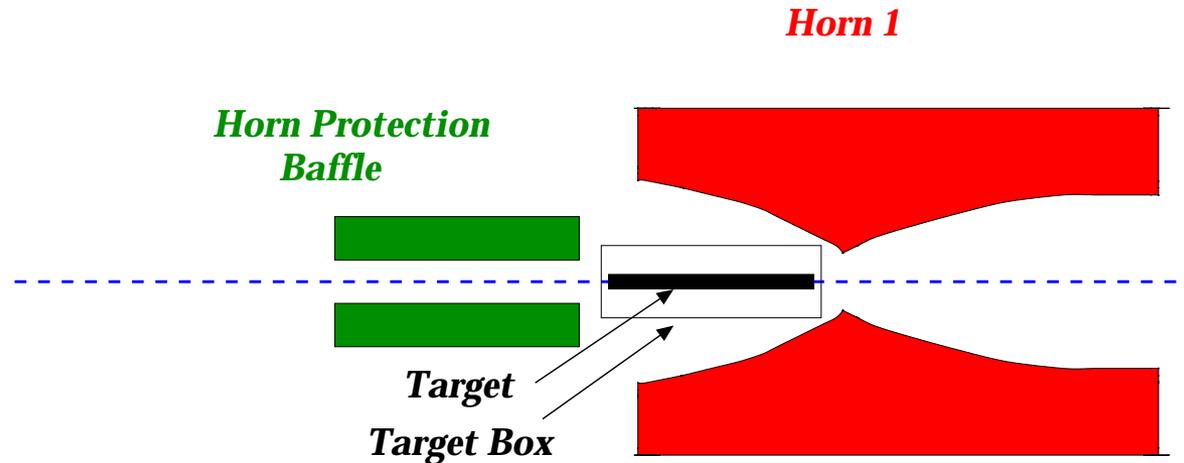
Neutrino beam elements: functions/sensitivity I



Horn(s):

- Focus the pion beam, define the neutrino beam direction →
 - Position with respect to the proton beam/angle (need studies for the low energy beam case)
 - Position with respect to the horn (~ 0.5 mm)

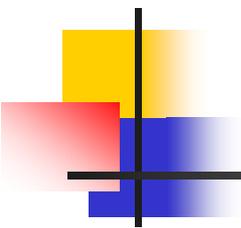
Neutrino beam elements: functions/sensitivity II



Baffle:

- Protect the inner conductor of the horn, cooling lines of the target (decay pipe window ??) →
 - Position with respect to the horn (~ 0.5 mm)

Neutrino beam elements: functions/sensitivity III



Proton beam/target:

- Produce pions to be focused by the horns →
 - Target size (6.2x15 mm) \gg proton beam size (1 mm)
 - Average production point (defined by the proton beam position) needs to be aligned with the center of the horn(s) (~ 0.5 mm ??)
 - Target position/angle not very critical, as long as protons do not miss it (~ 1 mm?)

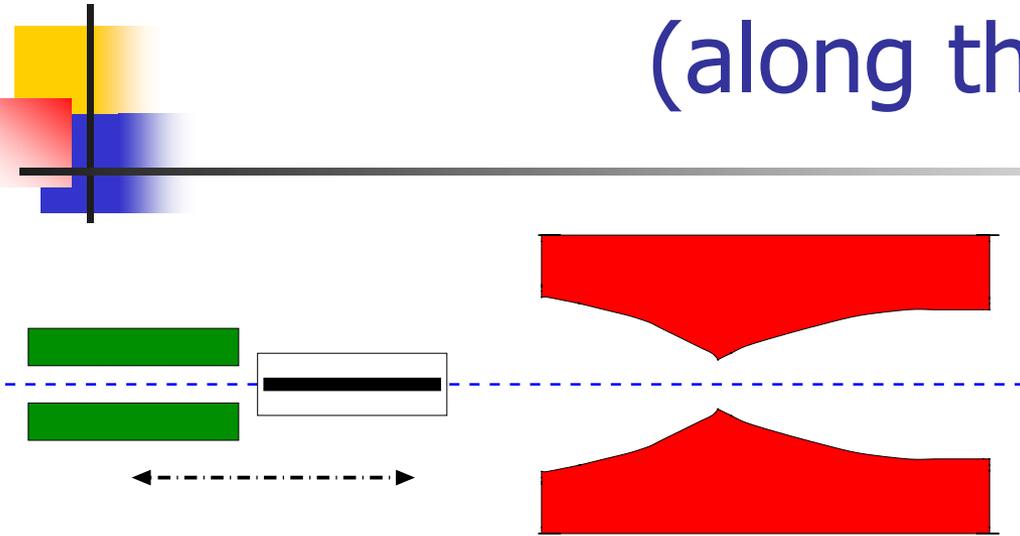
Proton beam direction

How well do we have to measure absolute proton beam direction?

- Beam Position Monitors/Multiwire chambers spaced by 12 meters, precision < 0.5 mm (in absolute reference frame) → precision better than 50 microradians
- Confirm/verify with some other system/element

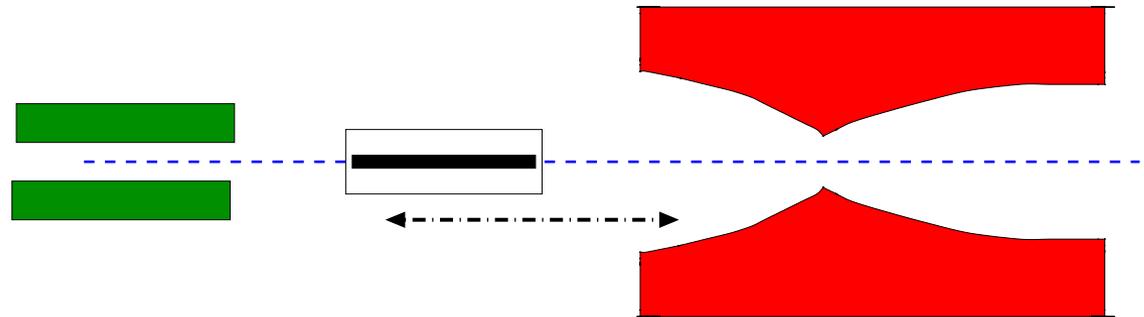
Commissioning: verify that the horns and the target are centered on the actual proton beam direction.

Issues: Moving the target/baffle (along the beam)



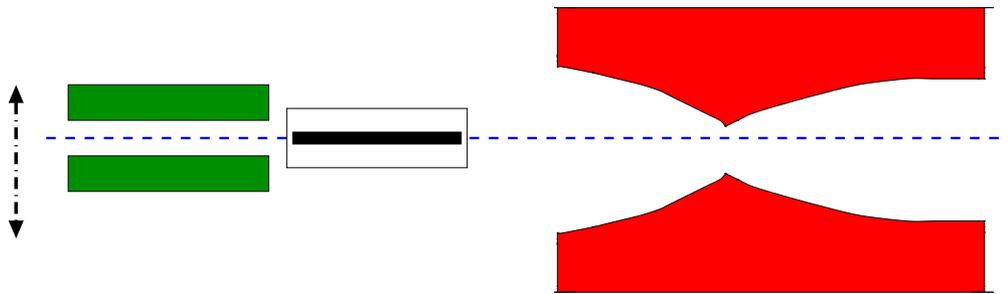
What is the desired range of target movement?

Couple?decouple?
motion of the
target and the
baffle?



Issues: Moving the target (transverse to the beam)

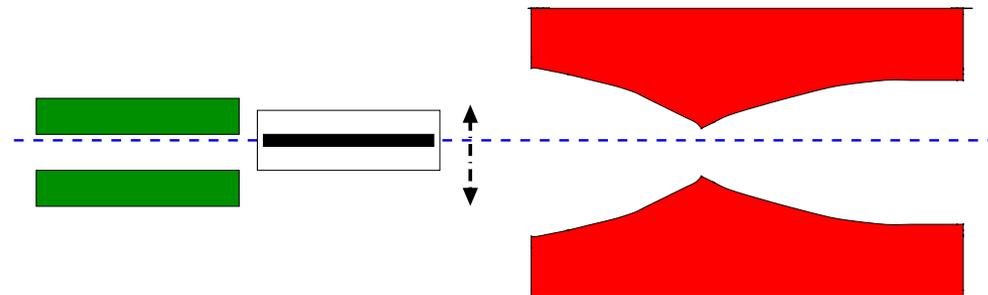
Why? To debug the focusing system.. Production spectra.. Any useful information to be had? Studies in progress.. (Mark Messier, need more people, more work)



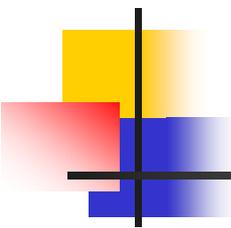
Baffle/target coupled:
• horn in danger at high intensities

Baffle/target mounted separately:

•Maximal flexibility



Alignment of the neutrino beam devices

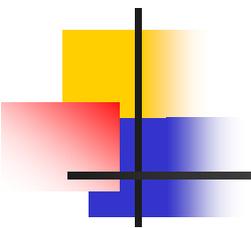


- Beam position monitors/multiwires
- Baffle
- Target
- Horn 1 and 2

Will be positioned/surveyed with the accuracy ~ 0.5 mm (in absolute reference system). This is more than adequate for the oscillation experiment, especially with the low energy beam.

The purpose of the 'commissioning' is to verify the survey information with the help of the beam-related data.

Best done without movement of the elements in question.

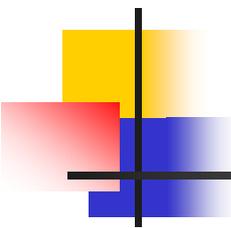


Neutrino beam pre-commissioning

Assume:

- Proton beam extracted from the Main Injector, transported to the Target cave
- Beam Position Detectors functional, BPM's calibrated against multiwire chambers
- Near detector functional and calibrated, reconstruction program debugged and understood
- Muon detectors commissioned and calibrated
- Horns installed and surveyed
- Baffle and target installed, surveyed, remote motion mechanism calibrated
- Horns functional, pulsed, magnetic field measured

Warning: 'beyond the baseline' assumptions



- Near Detector fully functional, debugged and calibrated. Reconstruction and analysis software running. **Including high(er) energy beam configurations.**
- Beam monitoring chambers fully operational. **Detectors cross-calibrated to a few % level.**
- **Fiducial cross-wires on the horns + associated Beam Loss Monitors installed**
- **Target remotely moveable along the z direction**
- **Target moveable to the 'out of beam' position**

Neutrino beam commissioning I

Strawman cenario

Low intensity proton beam ($\sim 10 \times 10^{11}$ ppp) target/baffle out of the beam

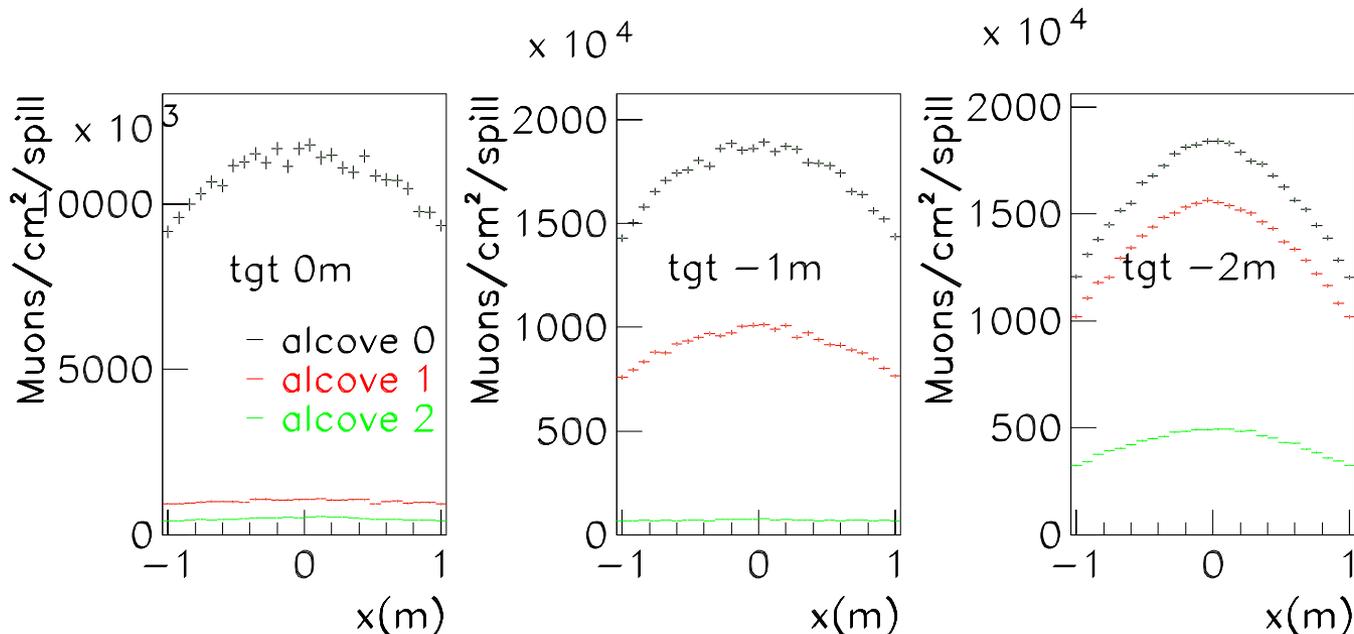
- Check horn pulse timing with respect to the beam
- Verify position of horn 1 using the fiducial cross-wires
- Verify position of horn 2 using the fiducial cross wires
 - This can be turned around into an independent verification of the proton beam direction, assuming the the horns are positioned correctly
 - Check the proton beam position at the entry to the decay pipe ?
 - Check the proton beam position behind the decay pipe?
- Install the target/baffle.
- Verify target position by moving the beam across and using the Budal monitor.
- Verify the baffle position using thermocouples

Switch to the nominal beam intensity.

Neutrino beam commissioning III

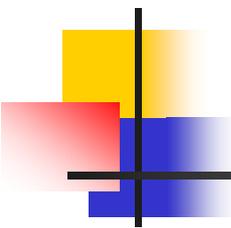
Strawman Scenario

- Move target (in steps of 50 cm) towards the nominal (low energy) position
 - Measure muon spatial distributions in alcoves 0,1 and 2 (\sim several minutes per position)
 - Repeat the scan several times to check reproducibility/stability



Neutrino beam commissioning IV

Strawman Scenario



- Collect any special conditions, auxiliary, data sets (if any shown to be useful) Need thought and work here, especially if non-standard conditions would be required (like pulsing one horn at the time).

Start taking data for oscillations