

# ProtoDUNE-SP Beam Line Instrumentation Updates

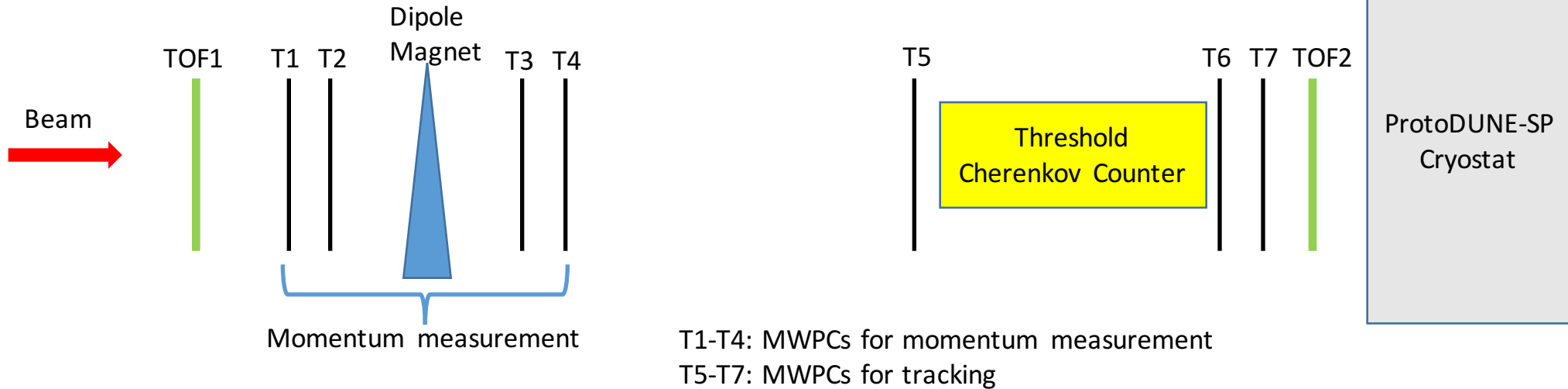
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# ProtoDUNE-SP Beam Line Instrumentations:

- Considering various options:
  - TOF and Threshold Cherenkov for particle ID
  - MWPCs to improve momentum measurement
  - MWPCs near the cryostat for tracking reconstruction

## One Possible Configuration



## Particle ID:

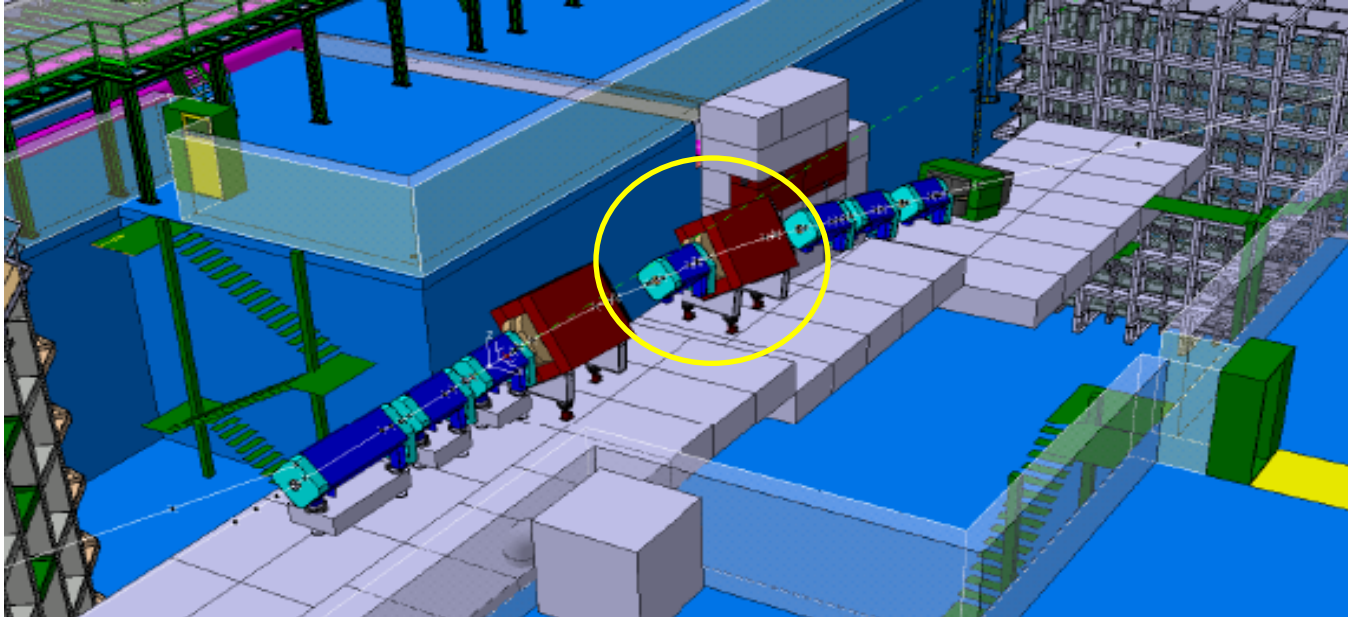
- TOF system with  $\sim 50$ ps timing resolution
- Fermilab (per Flavio C.) may be able to provide the TOF detectors
- Assuming  $\sim 10$ m between TOF1 and TOF2 detectors:
  - $3\sigma$  K- $\pi$  separation up to 4 GeV/c
  - Proton ID over all momentum range
- Threshold Cherenkov counter (provided by CERN) can cover PID at higher momentum. E.g. CO<sub>2</sub>@3bar can discriminate K- $\pi$  from 3 to about 7 GeV/c
- **Essential to have a TOF system with good timing resolution and at least one Threshold Cherenkov Counter for ProtoDUNE-SP**
- Particle ID info will be needed for the DAQ trigger to reduce data rate and volume → need a group to work with the DAQ experts to make it happen

## Momentum Measurement:

- Nominal aperture of the beam optics yield beam momentum spread of about 5% ( $\Delta P/P$ )
- If we want to do better, we will need to add tracking before and after the momentum defining dipole magnet
- B·L of the dipole magnet is  $\sim 3.8$  T·m. To achieve momentum resolution on the order of 1 - 2%, need MWPCs with  $\sim 1$ mm pitch positioned at about 1m from the dipole magnet
- However, requires hard work to get to a few % level:
  - Careful survey of the detectors
  - calibrate with tracks (halo muon?)
  - Need good field map for the dipole magnet
  - + ...

## Comment from Lau Gautignon concerning installing MWPCs around the dipole magnet:

*“Also there is very little free space left in the beam line and integration of additional equipment will each time require a redesign of the line (almost all space is taken by equipment and vacuum connections).”*



CERN plans to install three fiber tracker stations (still and R&D project) to monitor beam profile. At this point, still not clear (at least to me) if those can be used for momentum measurements

## Particle Tracking:

- Adding MWPCs near the cryostat beam window is more straightforward; more space to work with
- However, still need to obtain the chambers or build them and install/commission the detectors in beam
- Flavio has identified some sources at Fermilab. May need help (postdocs or grad students) at Fermilab this summer to get the chambers working
- Need to check total material budget. Adding 4+3 MWPCs, TOF, and Cherenkov Counter may have impact on low momentum electrons
- A good area for university groups to get involved

## Summary:

- TOF with good timing resolution and at least one Threshold Cherekov Counter is a must for ProtoDUNE-SP
- Need to discuss with DAQ group on how to integrate the PID info into the trigger system. This is an important issue → we do not want to prescale our important data away and DAQ/Offline groups want to minimize the data volume
- Need to come up with crisp physics arguments why we need to add detectors to improve momentum measurement and tracking:
  - What ProtoDUNE physics is compromised if  $\Delta P/P \sim 5\%$ ?
  - What ProtoDUNE physics is compromised if we do not have good tracking?
- Looking for groups to take "ownership" of beam line instrumentations