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Suggestion for PIP-II MPS FRS

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December 14, 2015

Reasoning for writing PIP-II MPS FRS now

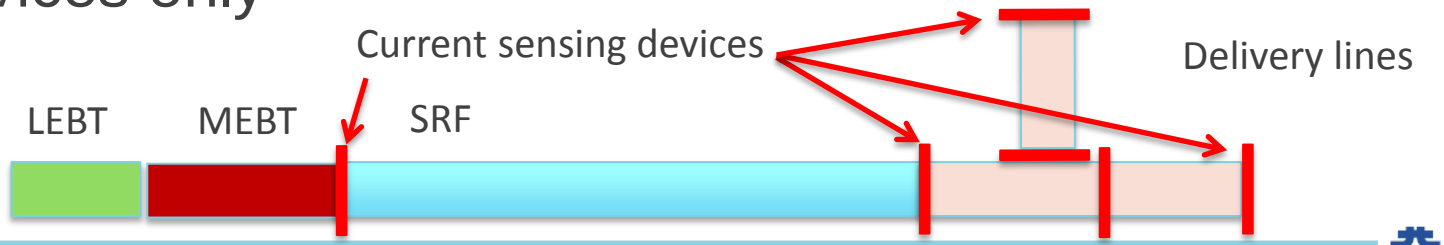
- Needed for defining the PIP-II machine
  - Unlikely to be quickly followed by TRS
    - Too many details that need to be specified (see G. Vogel report at the last meeting) and that certainly will change before PIP-II construction
  - May stay in a draft form until firming up is required
- To agree on possible MPS logic and try it at PXIE
  - The main goal of PXIE MPS is to protect the PXIE
  - Still, implementing elements of a structure applicable to PIP-II would be highly desirable

Summary of suggestions

- Two-tier MPS: primary and secondary devices
- Scales for loss levels and response time
- Two-tier response to events

Primary MPS devices

- Specified in TRS with testing procedures; modification require approval by the MPS coordinator; can't be masked
- Sensing
  - Signal from Fermilab Complex MPS
  - Comparing currents downstream of MEBT
    - difference = beam loss
- Beam shutting – down
  - LEBT chopper, LEBT dipole, Ion Source modulator, Ion Source bias power supply
- Up to the end of MEBT, sensing is provided by secondary devices only



Secondary MPS devices

- PIP-II MPS TRS should describe them broadly and specify the general protocol of interaction with MPS. Some devices can be masked.
- The list of secondary sensing devices includes
  - Status signals from subsystems
    - A malfunctioning subsystem (e.g. RF amplifier) should drop the beam permit
  - Vacuum gauges
  - Positions of insertion devices
  - Indicators of beam losses (e.g. radiation monitors, scrapers)
- Possible secondary beam-shutting devices
  - MEBT chopper, switching magnets, separators
  - RFQ/LEBT timing (for pulse operation)

Scales

- The primary beam current comparing system should identify the beam loss as a difference between readings in specified locations and drop the beam permit if it detects a beam loss of
  - >500 μA while averaged over 1 μs
  - > 20 μA averaged over 1 ms

- The primary system should drop the permit if it detects a large deviation of the measured beam pattern from the expected one.
  - current averaged over 30 μs sliding time window exceeds the expected value by more than 20% of the beam current or 20 μA, whichever is larger.

Response to events

- The beam can be shut off in one or two steps.
  - Step 1: The beam is shut off by the LEBT chopper within 10 μs after a system drops the beam permit. This time is measured as difference between moments of the permit drop in the location of the failure and disappearance of the beam at the entrance of the RFQ.
  - Step 2: If the average beam current measured by designated primary system devices doesn't drop below measureable level after 10 μs, the Ion Source modulator, LEBT dipole and the Ion Source bias power supply are turned off.
- MPS should be capable of
  - initiating both steps at once in potentially sever cases
  - assigning different latching scenarios to different events
    - Automatic restoring vs operator acknowledgement