Proton Beam for K2K

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Beam Line Layout
Primary Beam Characteristics

- MR Intensity
- Time
- 2.2 sec repetition
- Injection (9 bunches)
- Acceleration (0.5GeV to 12 GeV)
- 1-turn Extraction

Diagram:
- MR Intensity axis
- Time axis
- 2.2 sec repetition

Diagram Elements:
- Injection (9 bunches)
- Acceleration (0.5GeV to 12 GeV)
- 1-turn Extraction

Diagram Labels:
- Primary Beam Characteristics
Primary Beam Characteristics
- Time Structure

• 12-GeV Proton Fast Extracted Beam

\[ f_{RF} = 7.9 \, MHz \]
\[ I_{beam} = 5.6E12 \, ppp \]
Primary Beam Characteristics
- Emittance

- $\varepsilon$: Measured Emittance (FW1/e²M) in mm mrad by Parabola Fitting Method at q11-in (31m from Extraction)

\[ \varepsilon_H = 13\pi \]
\[ \varepsilon_V = 8\pi \]
Beam Line Optics
- Beam Envelope
Beam Line Optics
- Acceptance & Beam Profile @ q11-in

TURTLE
Proton Beam Monitors

- EP1-in
- q01-in
- q01-out
- Col.-out
- q11-in
- b12-out
- q12-in
- K5-TGT
- BS3-in
- q16-in
- K6-TGT
- bs6-in
- q31-in
- vd1-in
- inbtrn q37—q38
- h32-in
- q45-out
- q49-in
- to 1st Beam Dump
- q53-in (out)
- q57-in (out)
- q59-in (out)
- q61-in (out)
- q65-in (out)
- b48-out
- q68-in
- h37-in
- v39-out
- TGT
- DV-in

Distances:
- 0m
- 70m
- 208m
- 350m
- 400m
Proton Beam Monitors
- SPIC/LS/CT

- **Profile Monitors**
  SPIC: Segmented parallel Plate Ionization Chamber
  LS: Luminescence Screen (Cr-doped Almina Ceramic Plate)

- **Intensity Monitor**
  CT: Current Transformer
  SEC: Secondary Emission Chamber (for Supp lment)
Beam Monitors
- SPIC/LS/CT

Monitors in the Beam Pipe
Beam Monitors
-at the Production Target

Monitors on the Slide Table
Operations

- Transmission

• at Extraction
  □ Vacuum Window (300µm Ti foil)
  □ 5 m Air in Septa
  □ Fixed Beam Monitors (SEC/SPIC/LS/SUS foils)
  cause
  6-8% Beam Loss & □ 3-4 Emittance Growth

• Transmission
  TGT/Ep1-in = 0.85   w/ full of Monitors in the BL
  ~5% improved when ½ of LSs (~2.5g/cm²) out
Operations

- Beam Tuning

Tuning Routine

- Steer the Beam Orbit to the Beam-Line Center
  1\textsuperscript{st} Beam Dump Mode
  \textarrow{Arc Transfer Mode}

- Targeting
  Direct $\nu$-Beam to Super-K
  Muon Profile is Sensitive to the Primary beam
  (work as a proton-beam monitor)
Operations

-Proton Beam Profile

SPIC at the Target

LS at the Target

Horn  SPIC
Elevation View of T-Station & μ-pit
Muon Monitors in the $\mu$-pit
Operations
-
\(\nu_\mu\) (Muon) Response (Cont.)

- Muon Profile at the Muon Pit
Operations

$\nu_\mu$ (Muon) Response

- Horn Lens System (Point to Parallel Optics)
Operations

$\nu_\mu$ (Muon) Response (Cont.)
Operations

-Tuning Request in 2001

- Tuning Request
  - Scheduled
    - at the beginning of every run (~4 weeks),
    - after the MR study/Tuning,
    - at the Ion Source Maintenance
  - Accidental (User Claimed)
    2 times in 2001 (10th Jan ~ 12th Jul, 5 runs),
    1…Beam Shift/Drift
    1…Transmission Down
    were found to be caused by
    failures of the current-readout in Mag.-PS
( 7 times in 2000, due to beam shift/drift)
Muon Centroid Drift in 1 day

Horizontal
-1 mrad
+1 mrad

Vertical
Beam Shift/Drift in 2000

Beam shifted
Recovered after 33 hours

µ-X Profile

- before shift
- shifted
- recovered

2m
Summary

- Fast Extracted Proton Beam
  \[ I_{beam} > 6 \times 10^{12}\text{ppp}@\text{Extraction}, \ 5.6 \times 10^{12}\text{ppp}@\text{T-station} \]
  \[ \varepsilon_{H/V} \sim 13\pi/8\pi \text{ mm m}\ (\text{FW1/e}^2\text{M}) \]

- Proton Beam Monitors
  30 SPICs/LSs…Beam tuning/monitoring
  16 CTs…Intensity(Transmission) & Time Structure

- Operations
  Tuning Routine…Steer Beam & Targeting
  Only 2 accidental tuning requests in 2001
  Very Stable! ★★★
  Muon monitor is a high-precision proton-beam monitor.