
Experimental program and layout proposal

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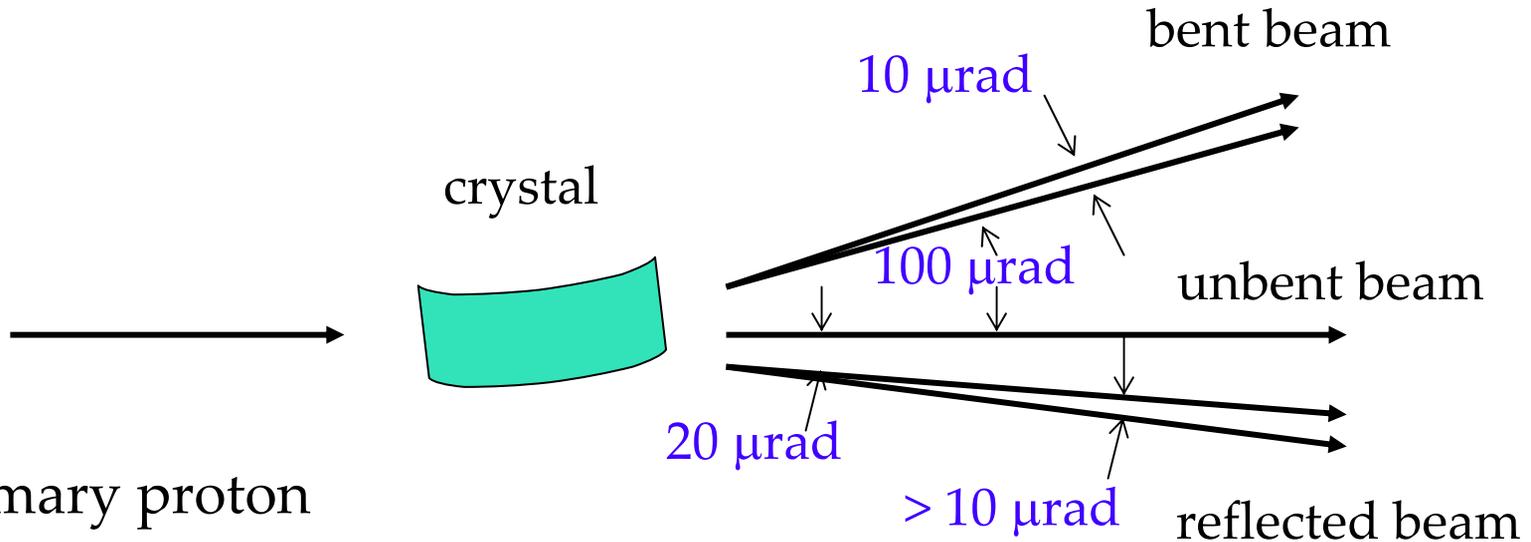
University of Ferrara – INFN Ferrara

Crystal Channeling Workshop - CERN
9 - 10 March 2006

INTAS PROPOSAL

- INTAS Proposal “Experimental study of crystal channeling at CERN SPS for use at the LHC in diffractive physics and halo cleaning”, Ref. Nr 05-103-7525
- “a facility at CERN SPS for tests and characterization of crystals to be used for particle channeling studies in the SPS”
- 2 crystal stations (equipped with goniometers, crystal holders and particle detectors): deflection at large (some mrad) and low (200 μ rad) angles

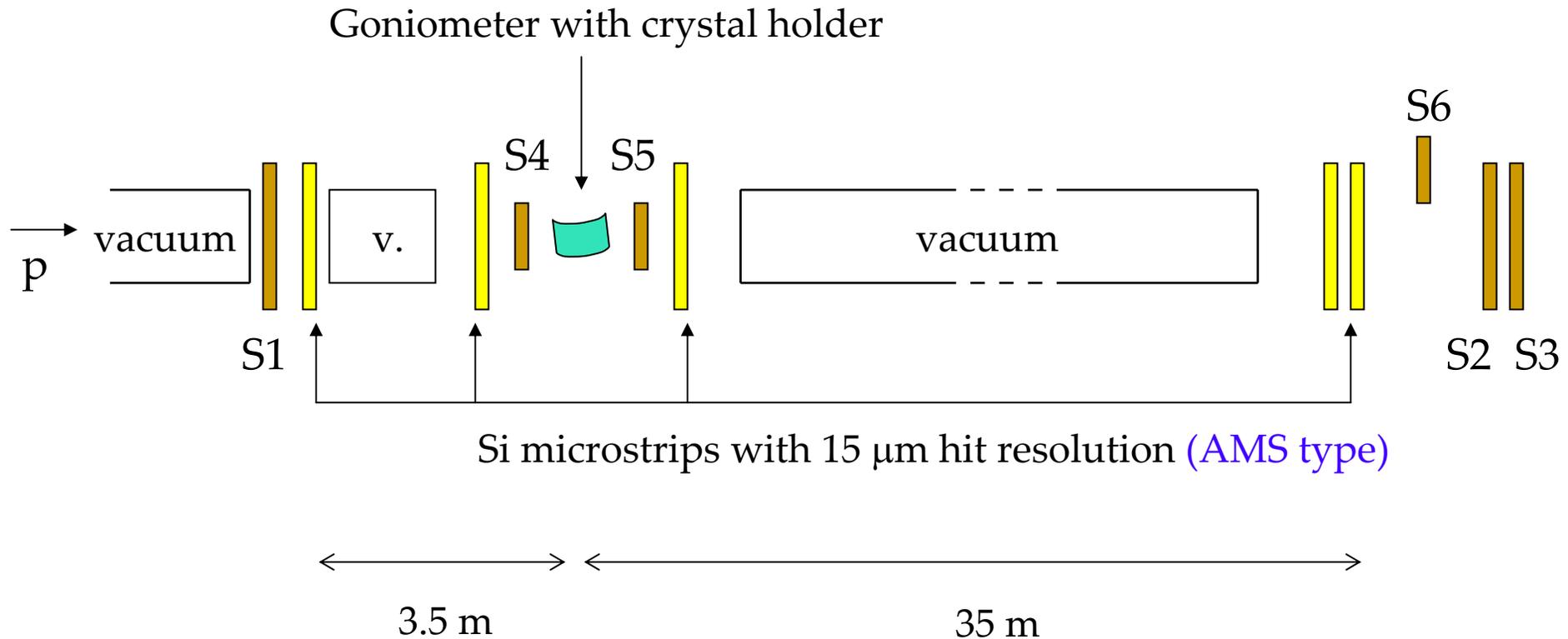
H8 extracted beam experiment



- primary proton beam
 - $400\ \text{GeV}/c$
 - $10^5\ \text{ppp}$
 - 2 mm in diameter
 - $3\ \mu\text{rad}$ divergence

The idea is to track the trajectories of the particles and to determine the cross sections for each branch

Proposed layout



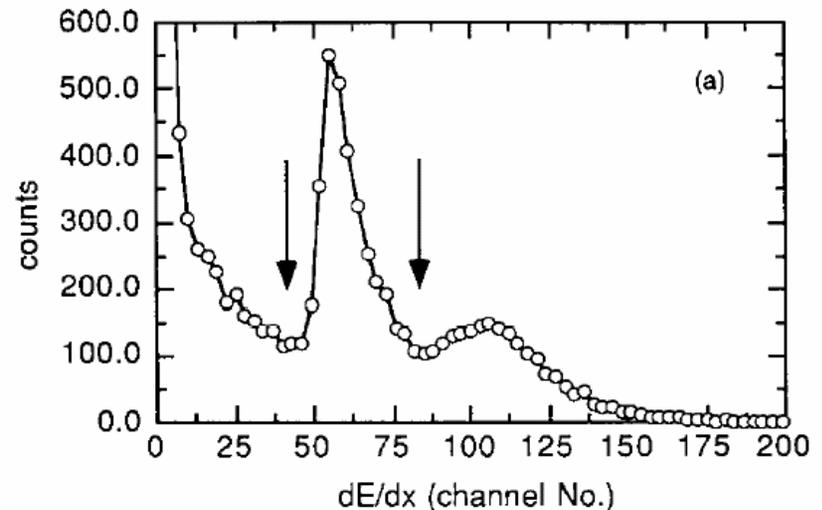
- 300 μm thick silicon ($\sim 0.3\% X_0$) \rightarrow 2.0 μrad
- 1 mm scintillator ($\sim 0.2\% X_0$) \rightarrow 1.7 μrad
- 200 μm mylar windows ($\sim 0.07\% X_0$) \rightarrow 0.9 μrad

Measurement

- preparation:
 - alignment of silicon tracker with straight tracks
 - crystal positioning inside the beam
 - angular scan for crystal alignment
 - efficiency defined as fraction of bent particles to unbent particles (considering only particles that cross the crystal entrance surface)
 - offline selection of tracks as a function of the impact position on crystal entrance face (to avoid edge effects)
 - background measurement (need of additional detector for veto?)
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Proposed options (1)

- if 10^5 ppp, need to downscale the trigger
- perform measurements as a function of bending angle
- measurements in axial channeling conditions
- need of a SciFi hodoscope for triggering? for crystal alignment? for online information?
- instrument Si crystal with surface barrier detector to measure energy loss? (for alignment, ...)
- measurement with lower momentum secondary beam (200 GeV/c)



Proposed options (2)

- “normal” beam ($2 \times 2 \text{ mm}^2$)
 - tails cover reflected beam
 - subtraction of non channeled component from beam profile

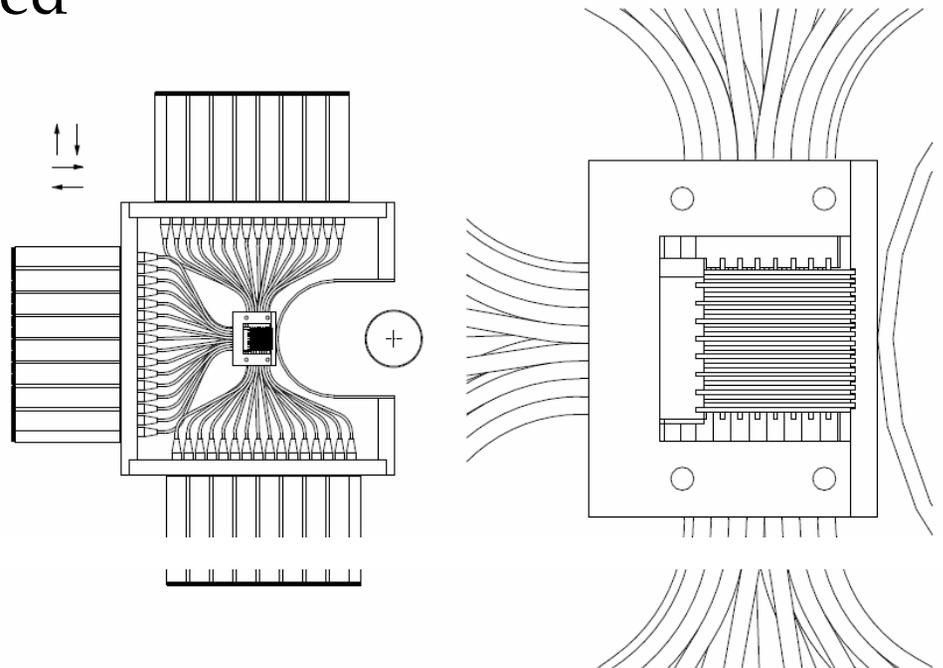
 - “micro beam” ($10 \times 10 \text{ }\mu\text{m}^2$)
 - clear conditions for separating channeled and reflected component from non channeled
 - too high instantaneous rate in single detector strip?
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Scintillating Hodoscopes

- RD22 Scintillating Hodoscope
 - FNAL E835 SciFi Tracker
 - DIRAC Scintillating Hodoscope
 - ATLAS Luminosity SciFi
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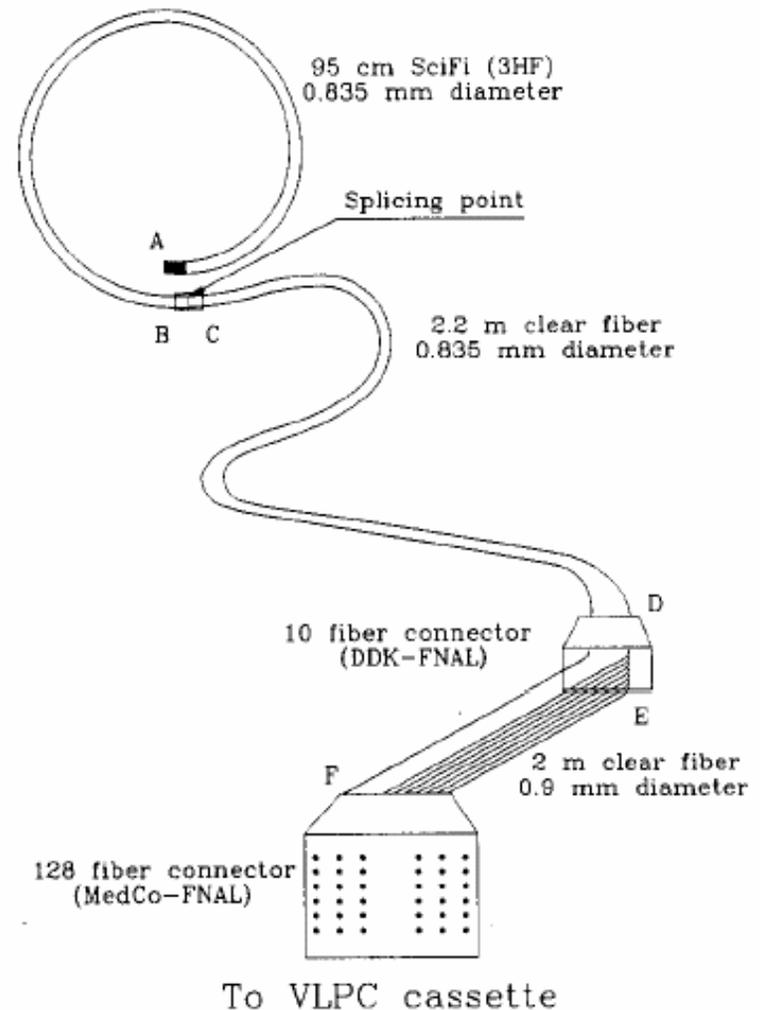
RD22 Scintillating Hodoscope

- installed close to the SPS vacuum tube to measure the profiles of the extracted proton beam
- 32 horizontal + 32 vertical scintillator strips
- $32 \times 32 \text{ mm}^2$ active area: each strip $1 \times 4 \times 32 \text{ mm}^3$
- 64 PMTs (1 inch Philips 1910): to be replaced and electronics to be refurbished
- 98% hodoscope efficiency
- maximum rate per strip:
~ 10 MHz



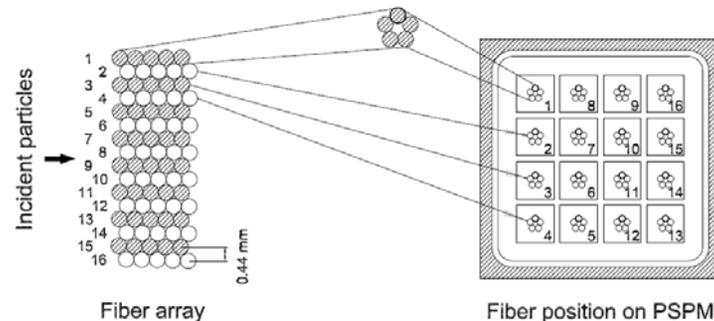
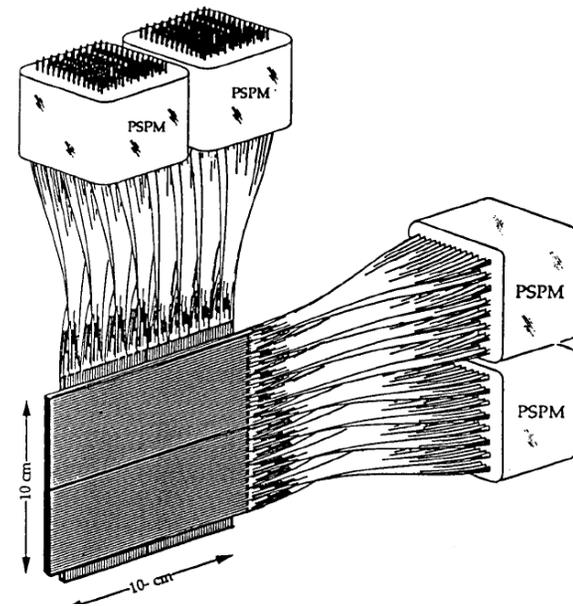
FNAL E835 SciFi Tracker

- 0.835 mm diameter KURARAY scintillating fibers coupled to clear fibers
- read-out by Visible Light Photon Counters (Rockwell)
 - ~70% quantum efficiency and high gain
 - ~14 p.e. for a MIP
 - to keep low thermal noise need to be operated at 6.5 K within ± 4 mK
- efficiency higher than 93%
- 5 ns time resolution



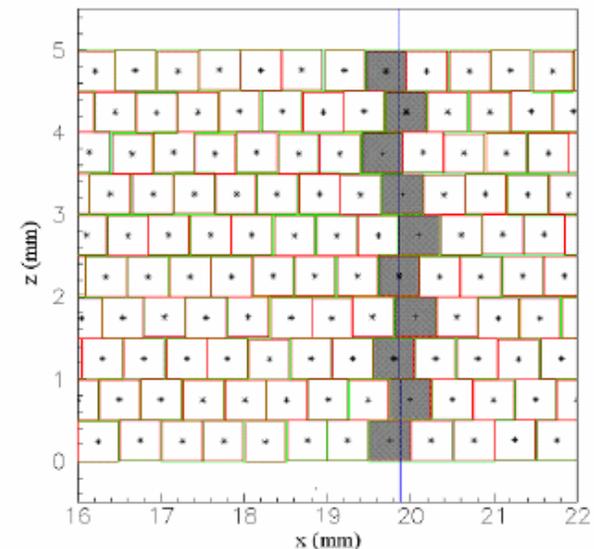
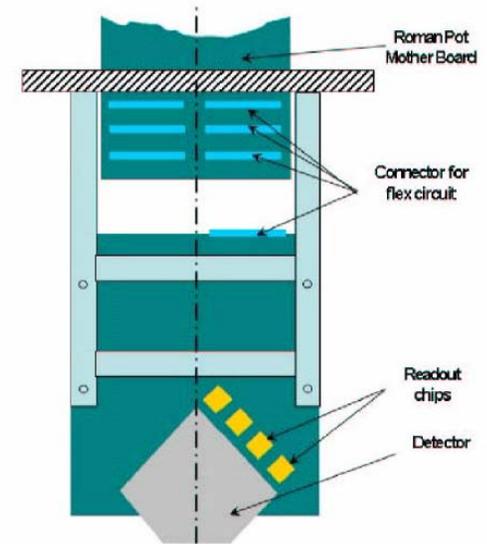
DIRAC Scintillating Hodoscope

- $10 \times 10 \text{ cm}^2$
- column pitch 0.44 mm
- 0.5 mm Φ fibers (0.28 mm prototype)
- 16 channels PSPM
- 5 fibers per pixel
- for 2 planes 480 channels (30 PMTs)
- spatial resolution: $127 \mu\text{m}$
- time resolution: 650 ps
- at flux $2 \times 10^7 \text{ s}^{-1}$



ATLAS Luminosity SciFi

- Roman Pot equipped with scintillating-fiber detector
 - stepping motors 5 μm resolution
- Scintillating fiber detector
 - 3 \times 3 cm², 0.5 mm square fibers, 10 fibers along track path
 - 10 layers of one plane staggered in multiples of 50 μm (spatial resolution of 20-30 μm)
 - 2 planes (X,Y) and a scintillator plate



SPARES

RD22 experiment

- 120 GeV/c SPS proton coasting beam, 5×10^{11} p
- 8.5 mrad bending angle
- extracted protons measured in external telescope:
 - scintillators for counting and triggering, FISC for monitoring
 - scintillating hodoscope to measure beam profile:
 - 3.2×3.2 cm²
 - 32 H + 32 V 1 mm strips (64 PMTs)
 - maximum rate per strip 10^7 s⁻¹
 - detection efficiency 98%

