UA9 STATUS REPORT FOR 2011

W. Scandale
for the UA9 Collaboration

CERN - IHEP - Imperial College - INFN - JINR - LAL - PNPI - SLAC

SPSC, October 25, 2011
UA9 hardware in 2011

Collimation region

High dispersion area
UA9 basic layout

Collimation region

High dispersion area

Observables in the collimation area:
- Intensity, profile and angle of the deflected beam
- Local rate of inelastic interactions
- Channeling efficiency (with multi-turn effect)

Observables in the high-D area:
- Off-momentum halo population escaping from collimation (with multi-turn effect)
- Off-momentum beam tails
Residual imperfections:

- Residual torsion ≈ 1 μrad/mm
- Amorphous layer size ≤ 1 μm
- Miscut ≈ 100 μrad

- Torsion is no longer an issue
  - torsion over the beam size < critical angle
  - full mitigation of the detrimental effects

- Schematic view of the residual miscut angle

Different paths for different vertical hit points

Different paths at small impact parameter
Goniometer

The critical angle governs the acceptance for crystal channeling

- 120 GeV $\Rightarrow \theta_c = 20 \mu\text{rad}$
- 270 GeV $\Rightarrow \theta_c = 13.3 \mu\text{rad}$

\[
\theta_c = \sqrt{\frac{2U_0}{E}}
\]

Transfer function

residual inaccuracy $|\delta\theta| \leq 10 \mu\text{rad}$

in a full angular scan the drive position changes by 300 $\mu\text{m}$ around the initial value in the plotted range
Channeling efficiency by coll. scans

Proton beam at 120 GeV

Efficiency 70-85%

channeling kick

Equivalent crystal kick[μrad]

~ 67m / Δμ=90°
~ 45m / Δμ=60°

Crystal 3

Pb-ion beam at 120 GeV

Efficiency 50-74%

channeling efficiency

channeling width

channeling angle
Loss rate reduction at the crystal

~ 67m / Δμ=90°

Loss rate reduction factor:
- for protons 5÷8
- for lead ions ≈ 3
- σ_{tot}(lead ions)=σ_{h}+σ_{ed}=5.5 b=10×σ_{tot}(p)

BLM count (r.un.)

Angle (μrad)

protons

simulation

data

x5-8 reduction

Lead ions

BLM count (r.un.)

Angle (μrad)

simulation

data

x3 reduction
Loss rate reduction at the crystal

\[ \sim 67m / \Delta \mu = 90° \]

Discrepancy between data and simulation:
- crystal surface imperfections
- miscut angle

First hit
Second hit

Protons
Lead ions
Off-momentum halo population

1. Linear scan made by the TAL2 (or Medipix) with the crystal in fixed orientation

2. Angular scan of the crystal with the TAL2 (or the Roman pot) in fixed position in the shadow of the absorber
off-momentum halo: linear scans

proton beams

Crystal 4

- Crystal at 4.9 \( \sigma \)
- TAL at 7.7 \( \sigma \)

scans with the Roman pot of the internal side (momentum loss side)
off-momentum halo: beam tails

Loss rate as a function of the medipix position at the high-dispersion location

- Crystal at 5.4 σ
- TAL at 7.2 σ

- More populated tails on the internal side than on the external side
- Particles that have lost momentum are continuously produced by the interactions with the crystal and the absorber edges

proton beams

Crystal 3

beams
off-momentum halo: linear scan

Crystal 4
Pb-ion beams

$\sigma \approx 1.2 \text{ mm}$

decreasing distance from the beam centre
off-momentum halo: angular scans

Crystal 4
proton beams

Loss rate as a function of the crystal orientation

- Crystal at 5.6 σ
- TAL at 7.6 σ
- TAL2 at 9.3σ

reduction factor in the dispersive area

- Decreases due to off-momentum particles produced in the absorber
- Increases when the TAL2 is more and more retracted
off-momentum halo: angular scans

proton beams

Loss rate along the SPS

Crystal 4
- Crystal at 5.6 σ
- TAL at 7.6 σ
- TAL2 at 9.3σ

Sextant 5

amorphous

channeling
Perspective for 2012

- The extension of UA9 to LHC is seen favorably by LHCC and by the accelerator directorate (to be announced soon)
  - Time allocation in LHC to be shared in between the machine and the experiments (however very limited)
  - Dedicated run time to avoid conflicts with the high-luminosity operation.

- UA9 in the North Area and in the SPS
  - The main goal will be to validate scenarios, detectors and hardware for LHC
  - Upgrade of the SPS experimental setup required

- Crystal collimation scheme for the high-intensity SPS operation.
  - Preliminary investigations based on UA9 experimental setup
  - Later an ad-hoc setup is required.
  - The collimation is requested at high-energy in pulsed mode
    - Very demanding constraints on crystal acceptance and on goniometer stability

UA9 request to the SPSC

- 5 days in the SPS (4 with protons and 1 with Pb-ions)
- 5 weeks in H8 (3 with protons and 2 with Pb-ions)
New hardware and priorities for 2012

SPS – 5 full days
1) High intensity, high flux operation for loss maps along the SPS
2) Operation with Pb-ions
3) Hardware test for LHC (crystals and goniometer)
4) Collimation efficiency of multi-strip crystals

H8 – 5 weeks
1) Test of new crystals for LHC
2) Test of instrumentation for LHC
3) Deflection efficiency with Pb-ions
4) X-ray spectra PXR as a tool to detect the crystal integrity
Publications


5. W. Scandale et al., Observation of Multiple Volume Reflection by Different Planes in One Silicon Crystal for High-Energy Negative Particles. EPL 93 (2011) 56002.


Acknowledgments

- The EN/STI group was of an extraordinary support to UA9
- BE/OP-BI-RF groups carefully prepared the SPS for our needs
- Special thanks to our funding agencies, reference Committees and Referees