Organization of the UA9 Simulations WG

R. Noble, W. Scandale, Andrei Seryi, M. Silari
(on behalf of the WG)

UA9 Collaboration Meeting
14 May 2009

This WG is the follow-up of the SLAC CRYSTAL working group started in March 2008

Preliminary structure and organization

- a small committee to call the meetings, prepare the agenda, write minutes
  - R. Noble, W. Scandale, Andrei Seryi, M. Silari
- 3 WG reflecting the ground interest, each with a coordinator reporting progress
- The Simulations WG is an inter-laboratory scientific collaboration

Simulations needed for UA9 runs in 2009

(prepared by W. Scandale)

Proposed work plan for approval

Four observables:

- ❑ Impact parameter in the crystal entry face and extracted beam profile
- ❑ Loss distribution
- ❑ Machine parameters
- ❑ Collimation efficiency

Simulations needed for UA9 runs in 2009

Observable: Impact parameter in the crystal entry face and extracted beam profile

Parametric dependence of the beam halo diffusive regime on the damper and octupole excitation

- ❑ Parametric simulation as a function of the damper voltage and octupole strength
- ❑ Impact parameter versus impact angle
- ❑ Impact parameter versus crystal position (6σ position is an appropriate choice?)
- ❑ Beam lifetime (+ crystal position dependence)
- ❑ Diffusion speed (+ crystal position dependence)
- ❑ Effect of synchrotron motion

Impact parameter/angle and beam profiles along the extraction channel

- ❑ Impact parameter distribution at the crystal (w/wo the close-by Cerenkov detector)
- ❑ Impact parameter distribution at the RP1 (inner and outer pots) (w/wo crystal)
- ❑ Impact parameter distribution at the TAL (is the Cerenkov of any use ?)
- ❑ Impact angle through betatron phase relations. Check if the information on the profile at the RP1/TAL can be used to deduce the impact angle at the crystal and vice-versa.
- ❑ Extracted beam footprint at the wire scanner

Simulations needed for UA9 runs in 2009

Observable: Loss distribution

Crystal primary versus amorphous primary

- ❑ Baseline loss maps for crystal and amorphous primary
- ❑ Differences in loss map
- ❑ Optimal locations in the SPS ring where the loss difference is maximal
- ❑ Optimal detectors and optimal sensitivity (are the UA9 detectors of any use ?)
- ❑ Are we able to detect inelastic or diffractive interactions?
- ❑ Expected cross-section of the proton-crystal interactions with energy loss
- ❑ Expected cross-section of the proton-tungsten interaction with energy loss
- ❑ Loss map of these off-momentum particles, which had inelastic interactions
- ❑ Beam loss map in presence of synchrotron motion
- ❑ Can we detect some off-momentum loss with the scintillators close to Q521 ?
- ❑ Is there a better location to observe off-momentum loss, are there better instruments ? which sensitivity we need ?

Simulations needed for UA9 runs in 2009

Observable: Machine parameters

Stability of the CO

- ❑ Any prescription in case we have closed orbit fluctuations ? (up to 200 μm)
- ❑ Optimal Tune and chromaticity
- ❑ Sensitivity to tune and chromaticity values in diffusive mode
- ❑ Expected beam lifetime
- ❑ Effect of residual gas (is it fully negligible in diffusive mode ?)

Align the UA9 movable devices with beam loss:

- ❑ Simulate the optimal procedure and find the possible pitfalls
- ❑ Align the crystal to the beam
- ❑ Expected loss map and expected signals in the UA9 detectors
- ❑ Suggest the optimal procedure (taking into account the non-reproducibility of the goniometer orientation)

Simulations needed for UA9 runs in 2009

Observable: collimation efficiency

- Collimation efficiency using beam lifetime or counting the particles incoming into the crystal
- Check if all the lost particle hit the crystal
- Check how the particles touch the TAL (how many crystal traversal before touching the TAL). Impact parameter. Impact angle. Beam interception by the TAL
- Check if the two cerenkovs will give a correct estimate of the collimation efficiency (sensitivity to the alignment + multipass)
- Effect of synchrotron motion

The present working groups are:

1. Particle Tracking: Cavoto (lead), Robert-Demolaize, Drees, Peggs, Laface, Scandale, Gilardoni, Hasan

2. Loss Evaluations: ? Need to define participants

3. Crystal-Particle Interactions: Noble (lead), Spencer, Seryi, Stupakov, Taratin, Smirnov, Silari, collaborators Ellison (UNM), Yazynin (IHEP)

Particle Tracking WG

Cavoto (lead), Robert-Demolaize, Drees, Peggs, Laface, Scandale, Gilardoni, Hasan, Bolognini

What we have done:

1. Tracking code for SPS based on linear machine (6x6 matrices) plus nonlinear thin elements for sextupoles and octupoles.
2. Crystal emulator based on evaluation of probability.
3. Roman pot multiple scattering.
4. Dumper for emittance grow-up (setting up).
5. Data analysis software are currently under development. Common output format for the electronics of the roman pots has been defined.

With these elements, single and multi turn simulations were performed and the first results are collected into E. Laface et al. "Simulation results for crystal collimation experiment in SPS UA9", Proceedings of PAC 09, Vancouver, Canada, 2009.

What's been keeping us busy…

1. Characterization (comparison between our model and previous experiments) of dumper and octupoles strength in order to control the flux of particles from the beam core to the crystal edge.
2. A new cycle of simulations with the dumper and octupoles in order to predict the multi turn effect of these devices.
3. Analysis of the multi-turn physics of the crystal using data readings from Roman Pots are also being performed. Study the limitations on mechanical parameters (e.g. TAL opening, effect of the dead zone of the silicon strips) for the study of single particle, multi-turn crystal physics: how to avoid repeating a single-pass experiment ?

Crystal-Particle Interactions WG

R. Noble, J. Spencer, A. Seryi, G. Stupakov, A. Taratin, G. Smirnov, M. Silari, UNM collaborator Jim Ellison, IHEP collaborator Igor Yazynin (others are welcome to join us!)

Noble and Spencer with Yazynin : Extend EM and Nuclear interactions in Igor's fast channeling code, but maintain speed

1. Multiple Coulomb scattering, plural, single scattering for different thicknesses; energy loss, both dE/dx and large momentum transfer to atomic electrons.
2. Nuclear elastic scattering on nucleons and nucleus.
3. Single diffractive excitation of target (angle change and energy loss by p).
4. Excitation of incident p (larger energy change).
5. Bremsstrahlung and direct pair production as scattering and energy loss mechanisms for high energy p.

→ Make these improved algorithms available as developed to "Crystal Emulator" of Particle Tracking WG.

Taratin with Scandale: Simulations for SPS beam collimation experiment

1. Analysis of multi-reflections in single crystal, beam halo generation.
2. SPS beam collimation for single crystal in channeling mode (Report CERN/AT 2008-21) and for different sequences of crystals in VR mode.

The minutes and slides of the SLAC CRYSTAL working group meetings are on the LARP Crystal Collimation site:

http://indico.fnal.gov/categoryDisplay.py?categId=106

It has been agreed to set-up an Indico site at CERN where to store minutes and documents of the UA9 Simulations WG meetings. Those of the first two meetings are at:

Meeting of 29 April 2009
http://indico.cern.ch/conferenceDisplay.py?confId=58731

Meeting of 13 May 2009
http://indico.cern.ch/conferenceDisplay.py?confId=58731

The two will be merged together and linked to the UA9 web site which is in preparation