Status of multi-turn tracking of protons from IR debris

Stefano Redaelli, BE-ABP

Acknowledgements: R. Bruce, T. Weiler
Outline

- Scope
- Multi-turn tracking
- Examples
- Loss maps
- Outlook
Scope

- We need tools to track the product of collisions around the ring
  - Multi-turn tracking
  - Precise treatment of large off-momentum errors
  - Model the interaction with the collimators

- Natural choice: SixTrack version for Collimation studies
  - For the moment, different simulation setup to study the interaction of primary protons on the collimators of IR7/3

- Need to setup tracking using external input distributions from IP1/2/5
  - Done in the past (T. Weiler, F. Roncarolo, et al.) within different scopes

- Today: only discuss proton simulations
Multi-turn tracking from IP1

Example:

**start tracking in IP1, 3.5 TeV (2011 config)**

Initial distributions generated off-line

Crossing and separation:
- computed by SixTrack

Then, standard tracking with collimators

**Input distributions in IP1**

- \( x \) and \( x' \)
- \( y \) and \( y' \)
- \((x,x')\) and \((y,y')\)

**Nominal bunch, on-momentum, 640 trajectories**

**Shown:** Vertical (crossing) plane

**Layout elements**

**Nominal aperture**
Developed tools to check distributions at various elements around the ring → will use them for particle distributions at the cryo-collimator locations.
Tracking of off-momentum particles

Case study: flat distribution of $\delta p/p$, zero initial betatron amplitude at IP1

$\delta p/p = -5\%$

$\delta p/p = 0$
Acceptance for $A_\beta=0$
Analytical models

\[
\left( \frac{\delta p}{p} \right)_{\text{cut}} = \frac{A(s)/2 - \Delta CO(s)}{D_x(s)}
\]

Approximated linear model
Following the particles around the ring...
More realistic IP distributions

Real betatron distributions for different $\delta p/p$!
Color coding:
- $0.4\%$
- $0.6\%$
- $0.7\%$
- $1.0\%$
- $1.2\%$

Momentum acceptance can be re-computed with the betatronic transverse distributions

S. Redaelli, 3rd ColUSM, 23-02-2012
Tracking of off-momentum bunches

Interactions with primary collimators of IP3
Example of loss maps from IR1

Example: zero $A_\beta$ with $\delta p/p$ cut at 5%

Measurements in physics (fill 2242)

IP2: Ion operation

MB10

MQX's
A look at other IPs

δp/p = -5%

IR2 tracking

δp/p = 0
Outlook

☑ Presented the status of tracking tools for single- and multi-turn losses of IR products
  
  - *SixTrack* with collimation routines were prepared to study what leaks out of the IPS

☑ Tools are ready to start detailed simulations!
  
  - Tracking under control.
  - Can produce loss maps for present machine layout!
  - Still to improve and fully debug preliminary setup to start in different IPs
  - Comparison with analytical models to check dynamics of off-momentum particles

☑ Need realistic particle distributions from the p-p collisions!
  
  - See previous talk by Francesco

☑ What comes next:
  
  - Simulations with real distributions from FLUKA
  - Comparison with 2011 data at 3.5 TeV
  - Study dependence on beam and machine configurations (Xing) to define a solid layout for DS collimators