Loss maps along the ThomX transfer line and the ring first turn

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Introduction

ThomX [1] is a 50-MeV-electron accelerator using Compton backscattering to generate a high X-ray flux.
Here we present loss studies in the transfer line (TL) and the ring first turn.

Simulations

Tracking

The simulation involve :
- the particle tracking in the ThomX transfer line (TL) and the ring first turn (defined as linear section),
- the localisation of particle loss (such particles are not futher tracked),

Random Selection of Particles

Particle selection :
- Uniform random selection within transverse beam parameters
- Used emittance $= k^2 \times \epsilon$
  $\Rightarrow$ Used beam size $= k \times \sigma$
- 12 σ beam $\Rightarrow$ beam size = pipe size
- $>$ 12 σ beam : additional square cut in x-y plan of 35 mm

(in order to avoid the selection of too many particles outside the pipe)

Random Selection for Losses Along ThomX

- Number of particles : 4×100
- Beam size : 1 σ, 5 σ, 12 σ and 20 σ

Random Selection for Projected Loss Map

- Number of particles : 10000
- Beam size : 20 σ

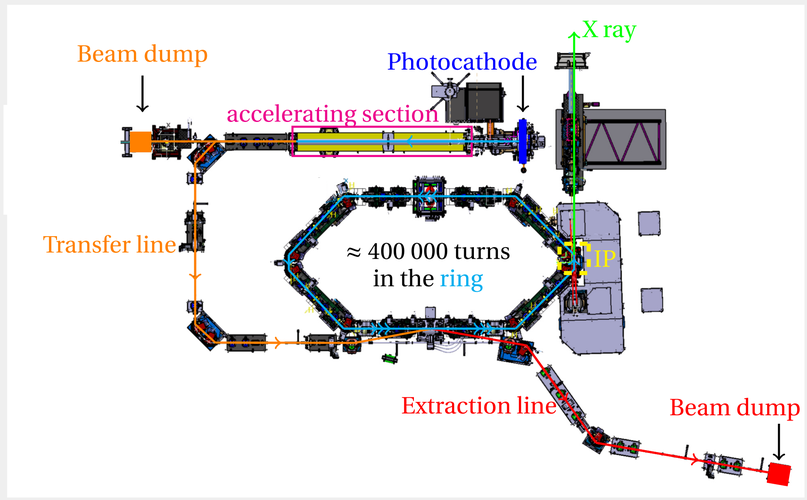
See also

— Monday's posters :
- MOPAB305
- MOPAB306
- MOPAB307
- MOPAB308
- MOPAB309

— Today's (Wednesday) posters :
- WEPAB117
- WEPAB053
- WEPAB054

— Thursday's posters :
- THPAB222

ThomX



Aperture definition

Aperture in the :
- TL : circle of radius 17.5 mm
- Ring : Ellipse 40 mm wide, 24 mm high

Beam parameters (begin of TL)

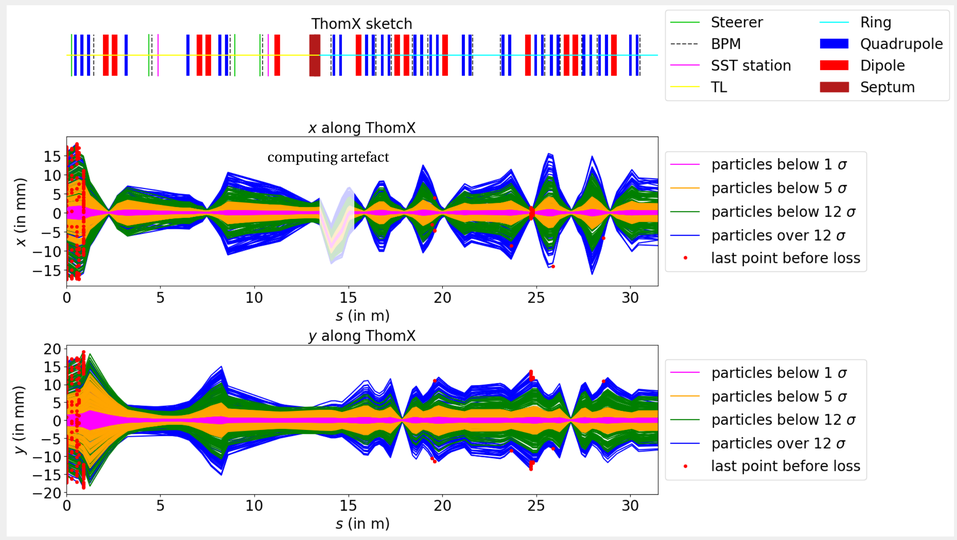
- $\beta_x = \beta_y = 43.2$ m
- $\alpha_x = \alpha_y = 11.0$

Emittance : $\epsilon = 5.0 \times 10^{-8}$ m rad.
$\Rightarrow$ Nominal beam size : $\sigma = \sqrt{\epsilon\beta} = 1.5$ mm

Losses Along ThomX

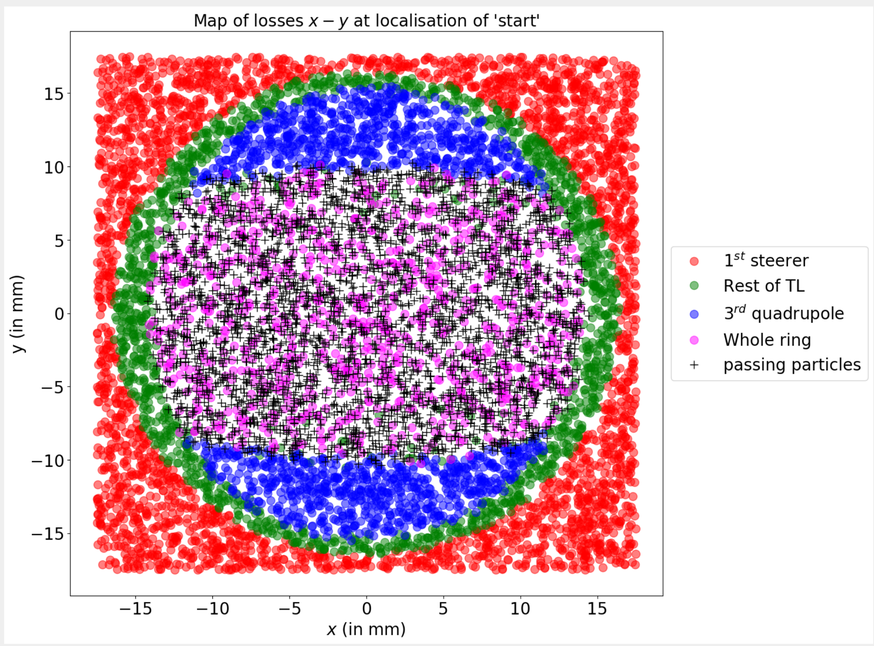
- $<$ 5 σ : no losses
- from 5 to 12 σ : some losses but only before the first dipole of the TL
- $>$ 12 σ : same + a few losses in the ring (particles with high transverse momentum at the beginning of the TL)

Remark : The "computing artefact" is a change of frame done to simulate the injection in the ring.



Projected Loss Map

The particles here are represented at their x-y position at the beginning of the TL and the marker colour represents the localisation of the particle loss.



- First element cut (red dots)
  $\Rightarrow$ Circular aperture
- Losses in the 3rd quadrupole mostly in upper and lower beam part
  $\Rightarrow$ Large vertical beam (also seen in the above loss map at s = 1.2 m)
- Central region = acceptance window

Loss = only particles beyond 12 σ
Other particles (black cross) pass the ring first turn

Acceptance window may be projected at the localisation of the screen stations to check that the beam is within the ring aperture before propagating it to the ring.

Conclusion

Maps of losses along an accelerator and projected maps of losses are efficient ways to predict localisation of losses and allow one to check the beam losses even before sending the beam in some critical part of the accelerator.
In ThomX the window of acceptance parameters will be calculated at the localisation of each SST station and a graphical representation of it will be added on TL beam images to check the risk of losses before injecting a beam in the ring.
Preliminary loss simulations show that beam losses are well controlled.

References

[1] A. Variola, J. Haissinski, A. Loulergue, F. Zomer, (eds). *ThomX Technical Design Report*. 2014, 164p. in2p3-00971281

[2] F. Christoph Iselin. *The MAD Program (Methodical Accelerator Design): Physical Methods Manual*. Version 8.13, 1994, `http://mad8.web.cern.ch/mad8/doc/phys_guide.pdf`