

Beam behaviour at VELO during powering failures of warm dipoles and quadrupoles

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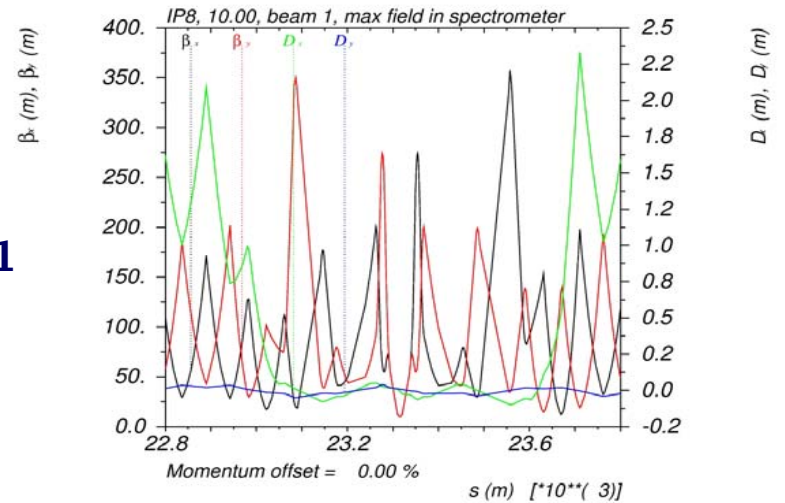
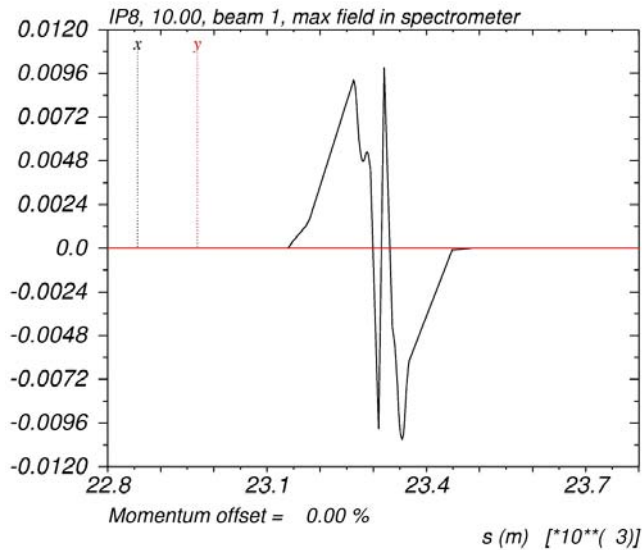
- *Introduction*
- *Simulations*
- *Beam profiles and losses at VELO*
- *Conclusions*

- The calibration of VELO at 450 GeV raises two relevant issues
 - *Can the LHCb spectrometer be operated at maximum field?*
 - *Can the VELO be closed to its minimum aperture (5 mm, 18σ)*
- Both actions are possible in nominal 450 GeV collision optics, but raise protection issues in case of magnet failures (Y. Papaphilippou)
- Study of some failure scenarios at the location of VELO (around IP8)

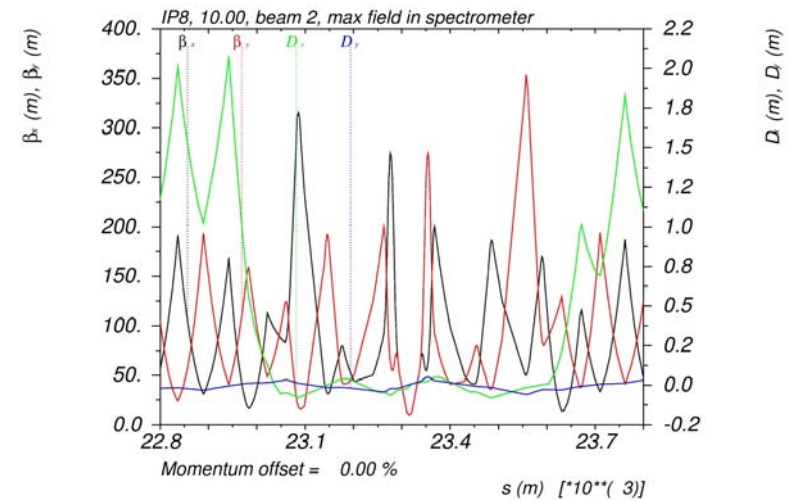
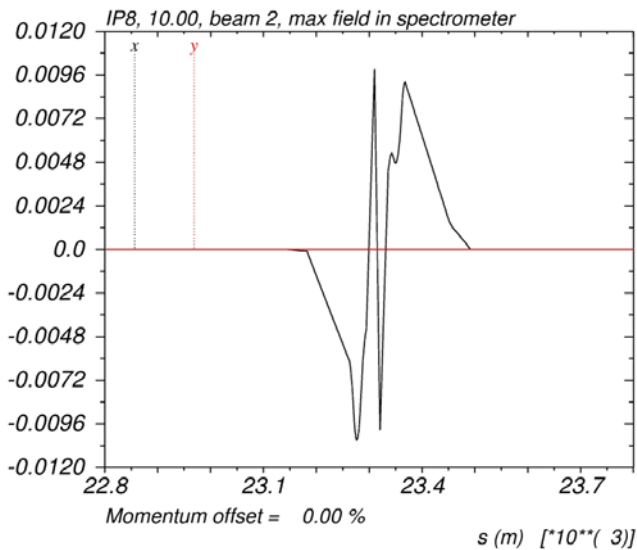
- Done with the 450 GeV collision and injection optics
- Powering failures leading to the fastest effects in the beam (warm magnets in IR3 and IR7 affected)
- Failures with slower effects, including the LHCb main dipole and its compensator, are supposed to be handled redundantly by the Protection Systems

	<i>Injection</i>	<i>450 GeV collision</i>
<i>on_sep1</i>	1	0
<i>on_sep2</i>	1	0
<i>on_sep5</i>	1	0
<i>on_sep8</i>	1	0
<i>on_x1</i>	0	0
<i>on_x2</i>	1	1
<i>on_x5</i>	0	0
<i>on_x8</i>	1	1
<i>on_alice</i>	1	1
<i>on_lhcb</i>	7000/450	7000/450
β^*_1	17 m	11 m
β^*_2	10 m	10 m
β^*_5	17 m	11 m
β^*_8	10 m	10 m

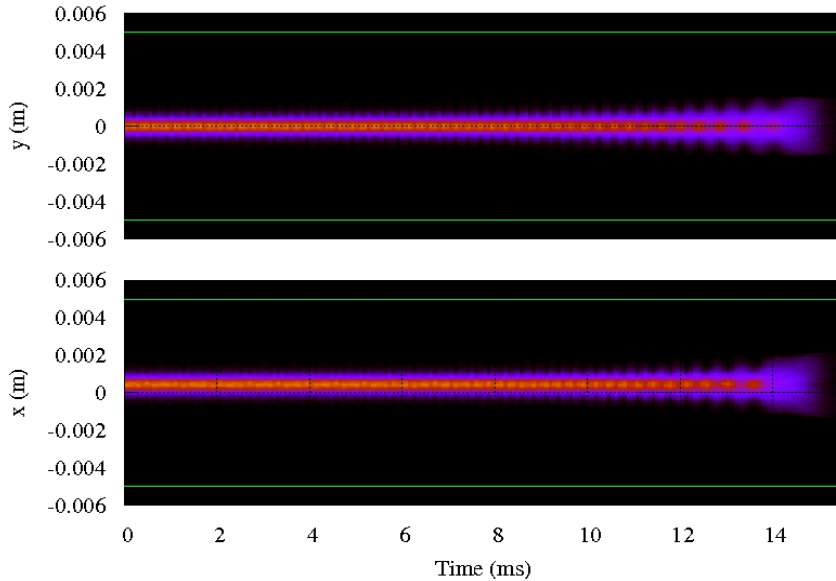
Beam 1



Beam 2

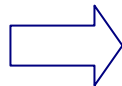


Beam profile at VELO
Worst powering failure at RQ5.LR3 at collision 450 GeV

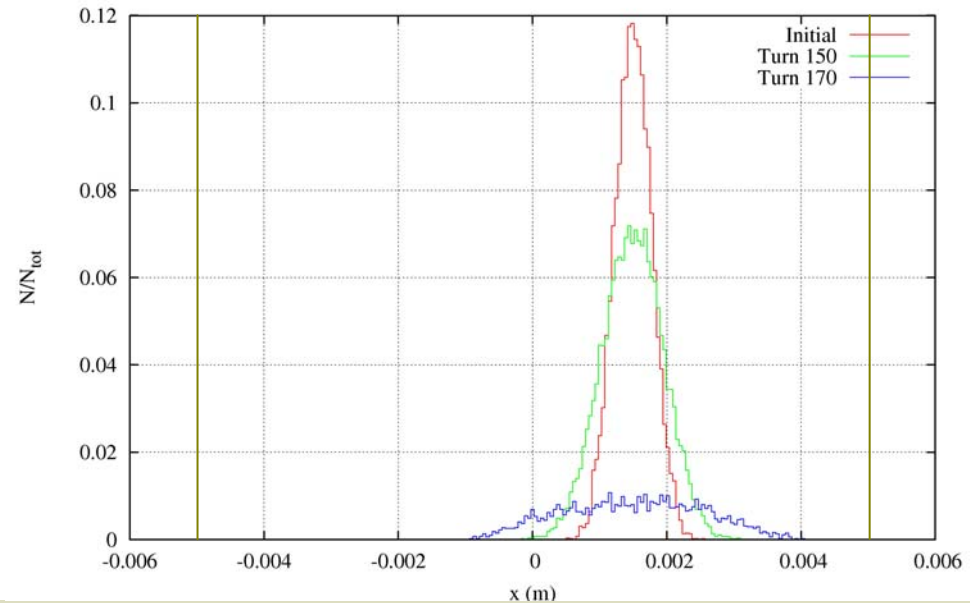


← Evolution with time in both planes, measured at every turn

Beam profile at different turns

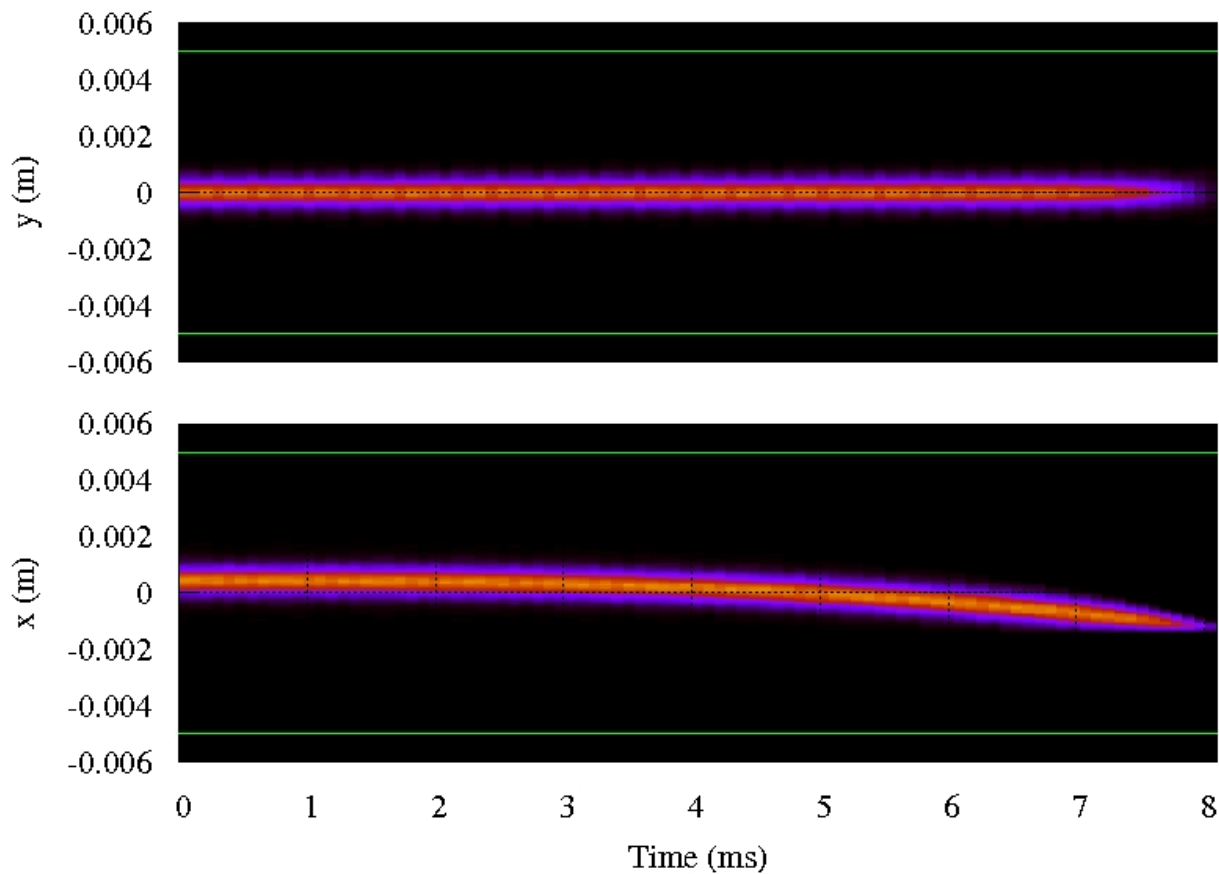


Beam profile at several moments (x-plane)
Worst powering failure at RQ5.LR7 at collision 450 GeV, beam 2



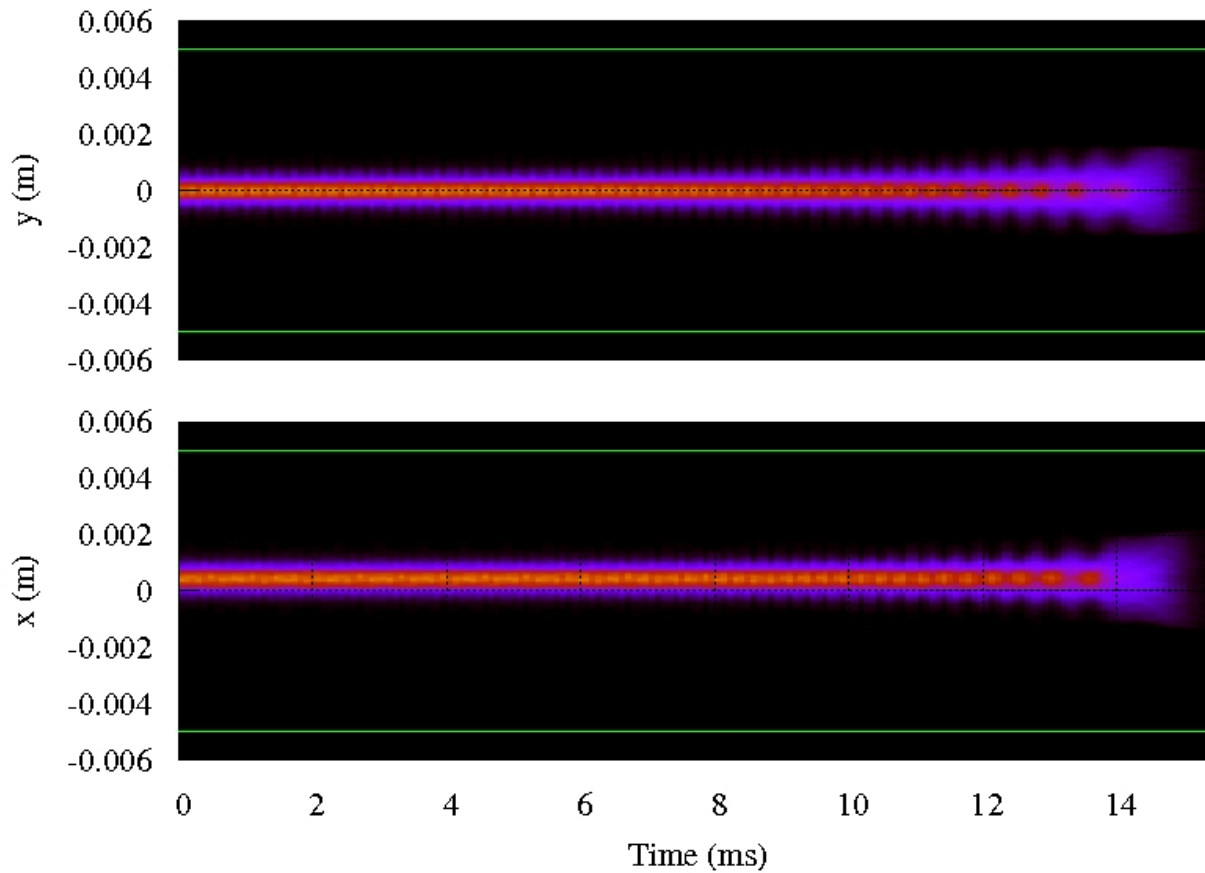
Beam profile at VELO
Worst powering failure at RD1.LR1 at collision 450 GeV

$\beta^* = 10$ m
on_x8 = 1
on_sep8 = 0
on_lhcb = 7000/450



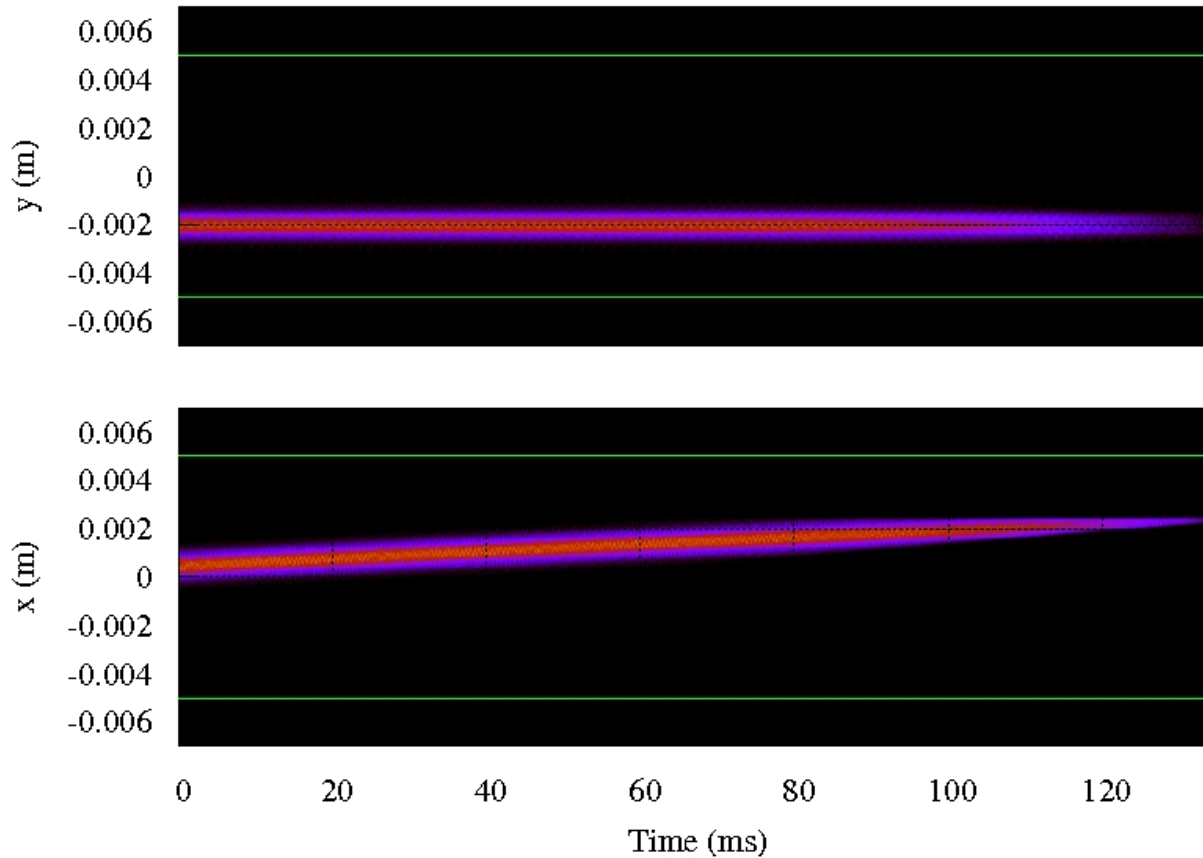
Beam profile at VELO
Worst powering failure at RQ5.LR3 at collision 450 GeV

$\beta^* = 10$ m
on_x8 = 1
on_sep8 = 0
on_lhcb = 7000/450



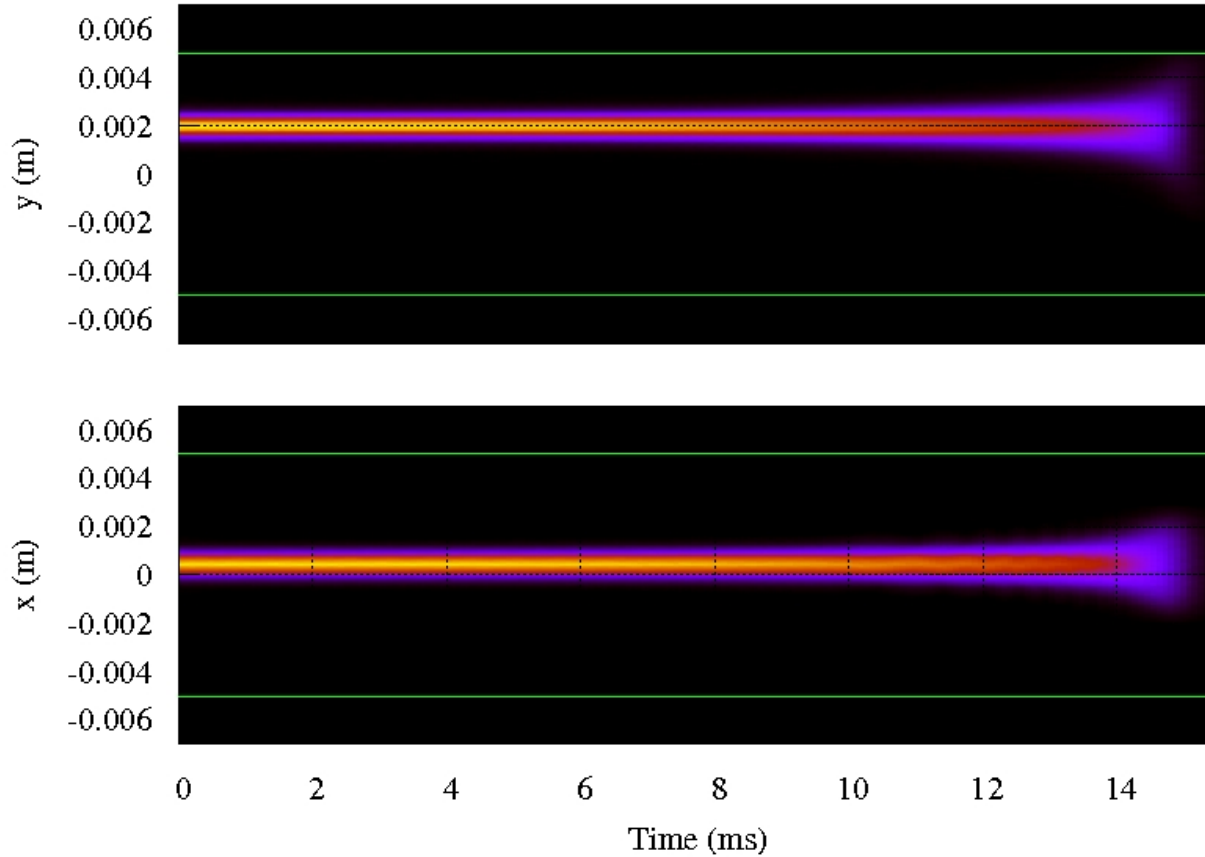
Beam profile at VELO
Worst powering failure at RBXWSHR8 at injection, beam 1

$\beta^* = 10$ m
on_x8 = 1
on_sep8 = 1
on_lhcb = 7000/450

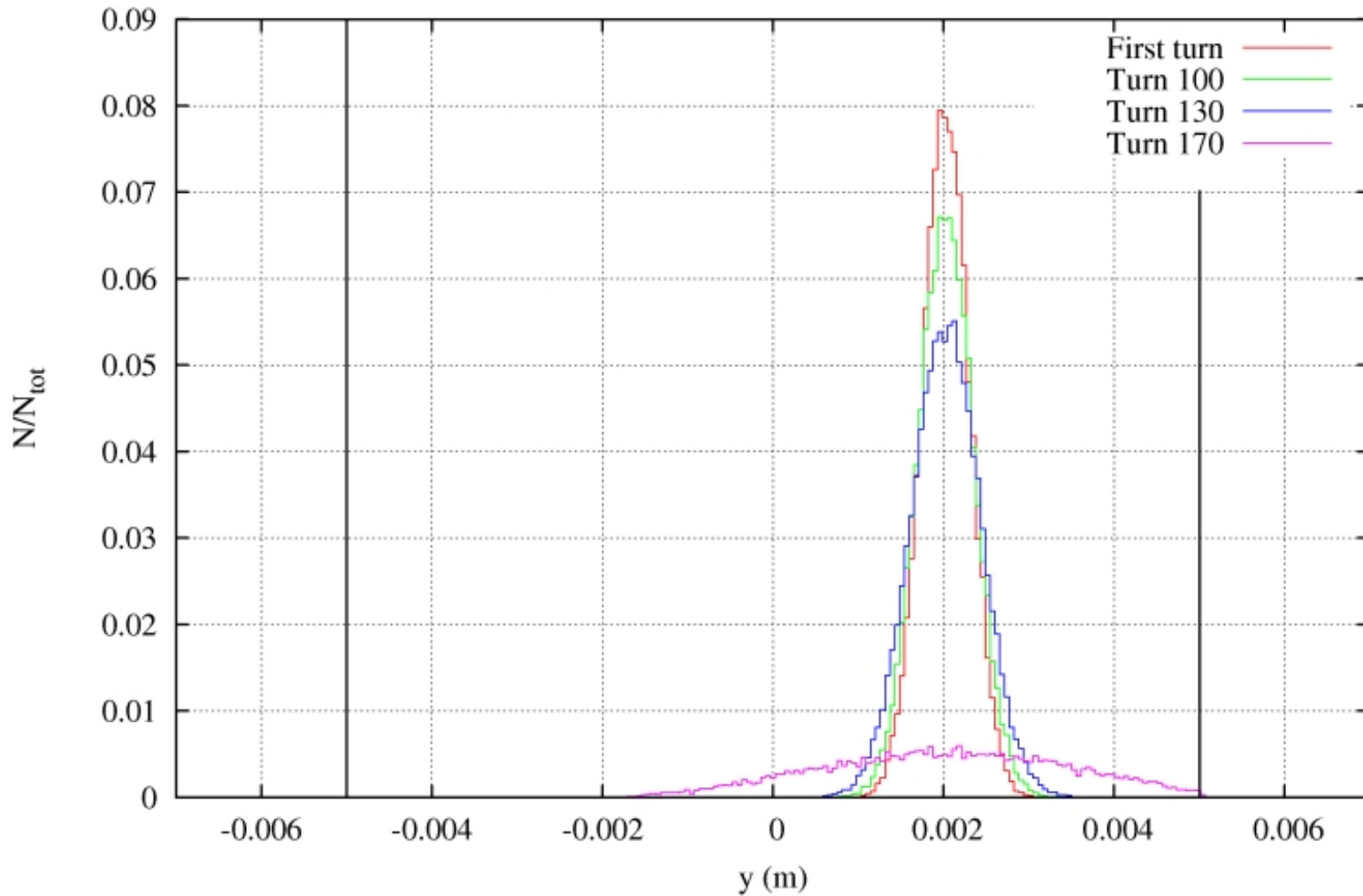


Beam profile at VELO
Worst powering failure at RQ5.LR7 at injection, beam 2

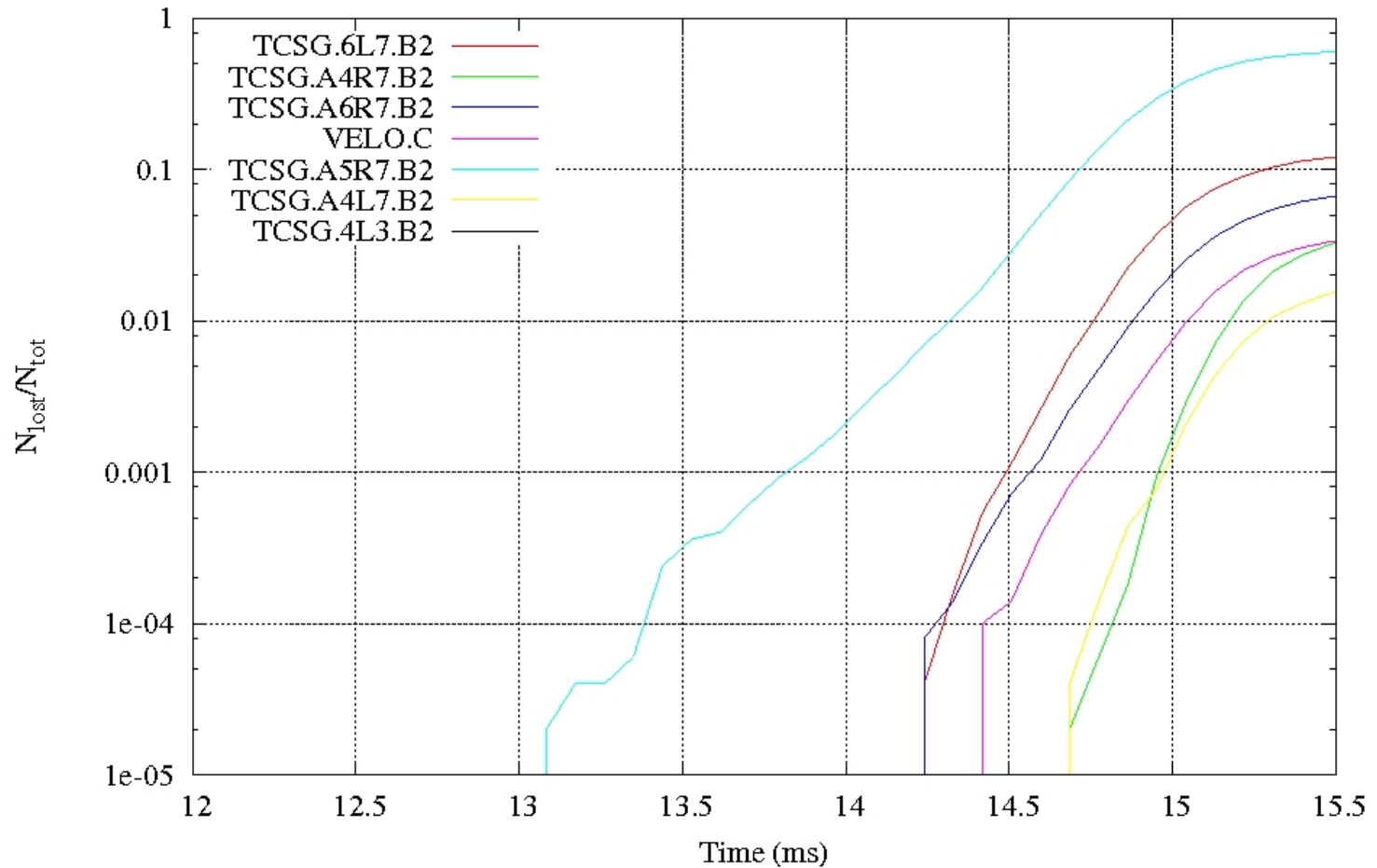
$\beta^* = 10$ m
on_x8 = 1
on_sep8 = 1
on_lhcb = 7000/450



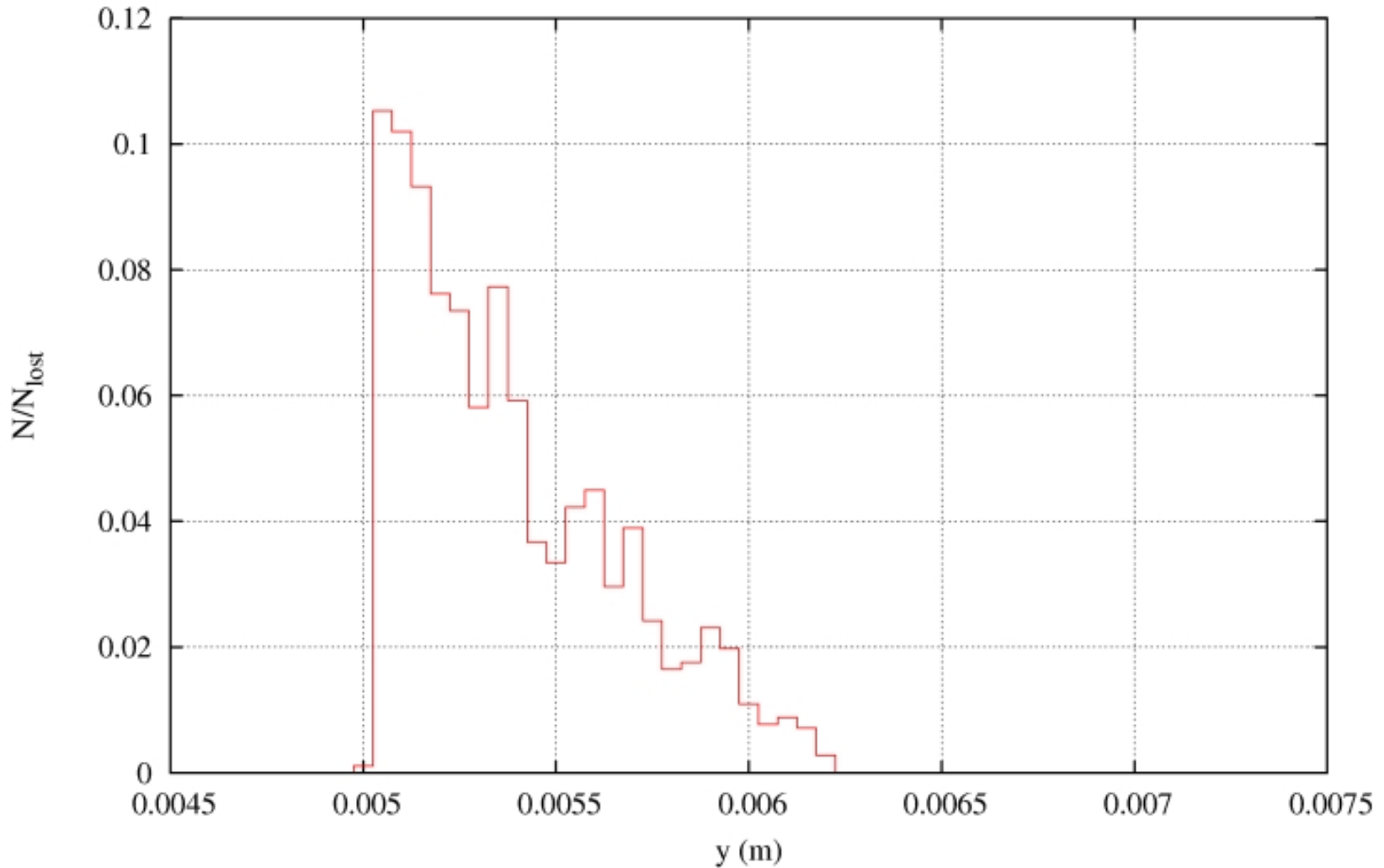
Beam profiles at different turns
Worst powering failure at RQ5.LR7 at injection, beam 2



Lost particles at collimators
Worst powering failure at RQ5.LR7 at injection, beam 2



Transversal distribution of losses at VELO
Worst powering failure at RQ5.LR7 at injection, beam 2



- After a fast failure the beam hits only the collimators in most cases.
 - *VELO would become an aperture limitation only if closed with injection optics (hypothetical case)*
 - *Still in this case, as expected, most of the primary losses would happen in the collimators*
- These simulations account only for the primary losses (collimators as black absorbers)
- Interest of code modification to record ALL the losses in case of a changing magnetic field (add K2 routines for tracking in MAD-X or implement changing parameters in sistrack)