Light ion collimation in the LHC: exploratory study

..with a caveat: the aperture model needs to be corrected!

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Case study: $^{18}Ar_{40}$

- Not yet LHC official 'baseline' – exercise to identify potential showstoppers
- Light candidate:

Ar40 (Z=18, A=40)

Ar40 beam parameters	
Ion collision energy [GeV]	126000
Energy/nucleon [GeV]	3150
Relativistic gamma	3384
# ions per bunch	$2 \cdot 10^{9}$
# bunches	592
Transverse norm emittance [m·rad]	$1.7 \cdot 10^{-6}$
Peak luminosity [$cm^{-2} \cdot sec^{-1}$]	10^{31}

Z →

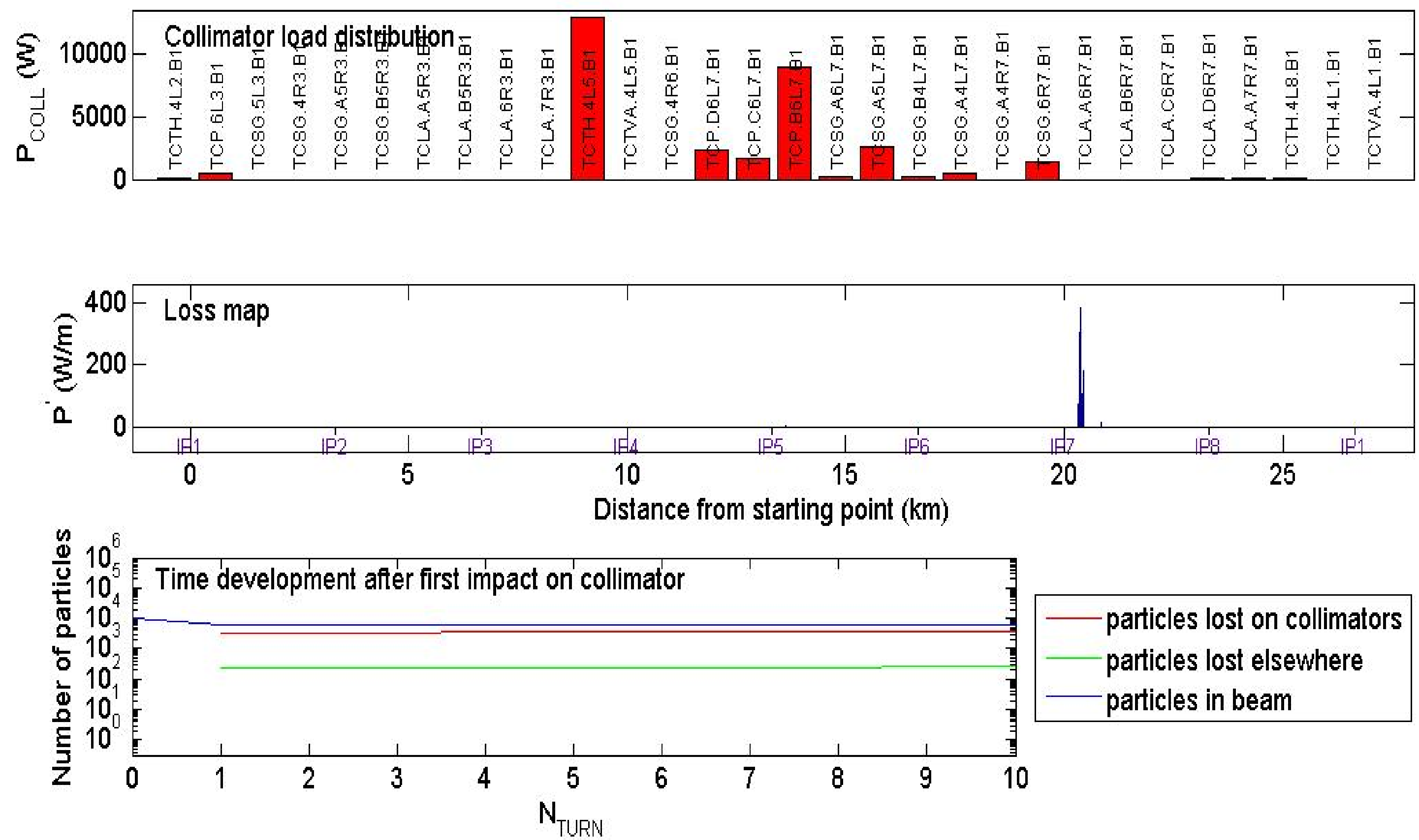
A ↓

Ar40 – 0.0%	Cl39 – 3.2%	S36 – 1.25%	P34 – 2%
Ar39 – 2.6%	Cl37 – 2.05%	S35 – 1.6%	P33 – 1%

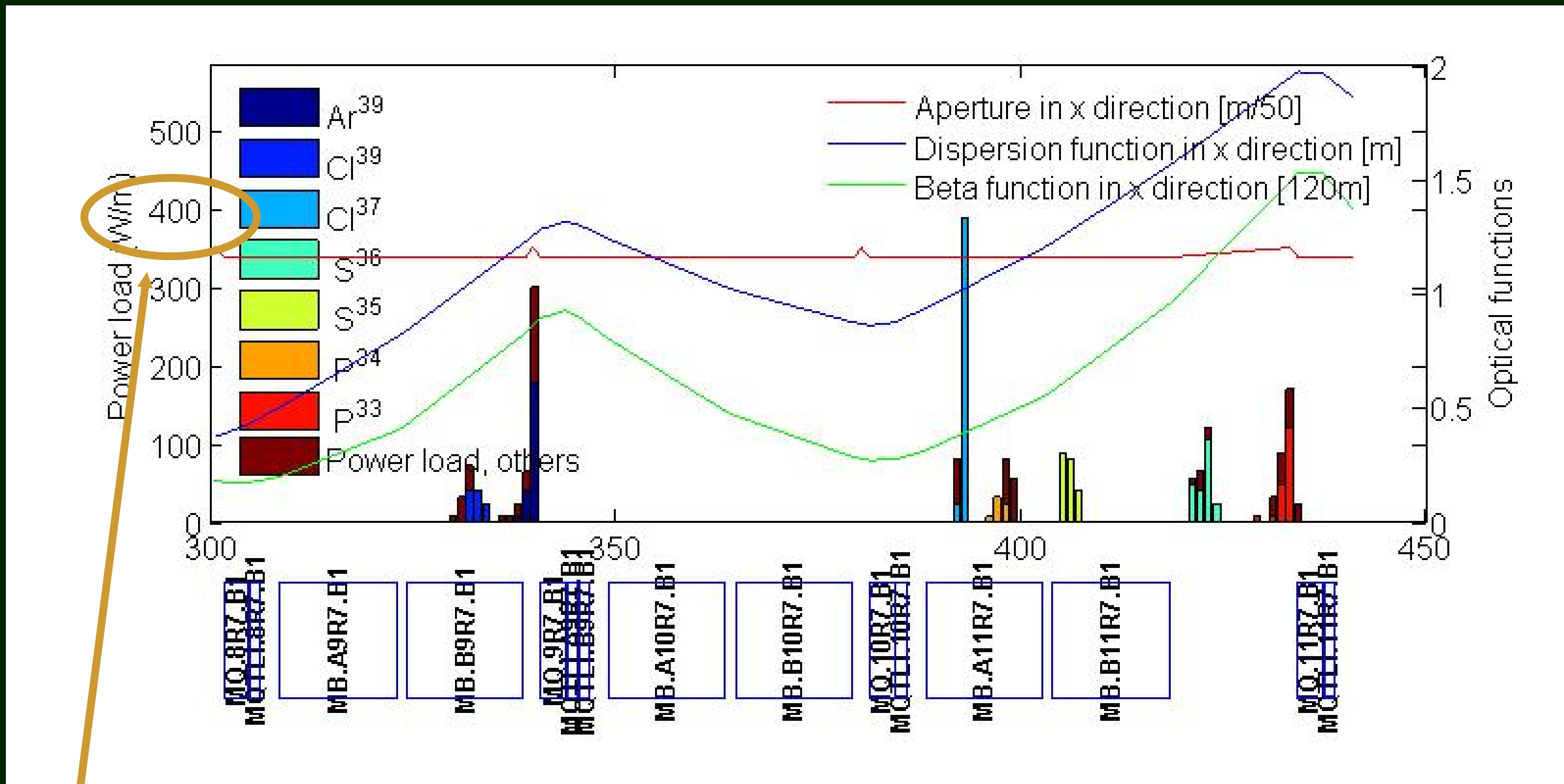
Main daughters and their effective momentum error, FLUKA calculated x-sections

Phase I with nominal collimator settings (purely academic..)

Beam1, E=3.15TeV, 10k ions, Dp/p=0, I= $2 \cdot 10^9$ ppb, TCTs at 8.3σ



Losses in IR7 dispersion suppressor



I = $2\cdot10^{9}$ ppb (Pb-Pb ‘equivalent’ luminosity..)

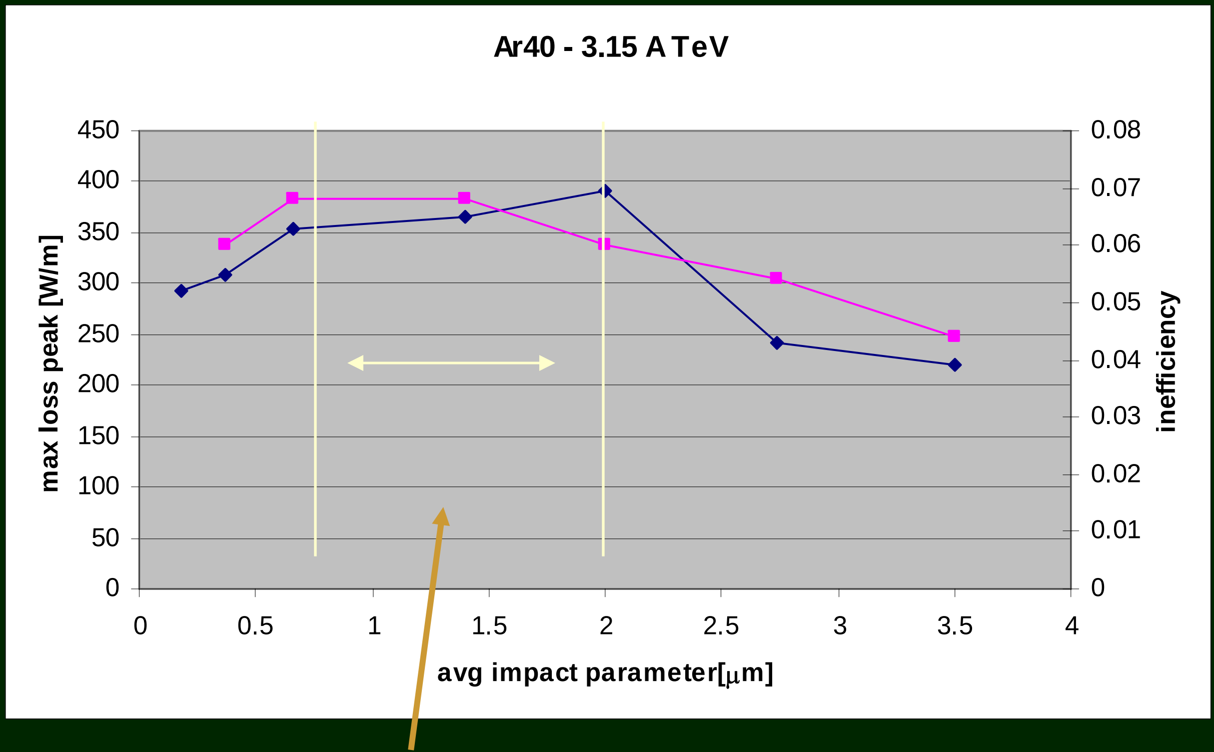
Alternative scenarios:

i) constant # of nucleons per bunch : I=$0.364\cdot10^{9}$ ppb

ii) constant energy per bunch : I = $0.32\cdot10^{9}$ ppb

Impact parameter study

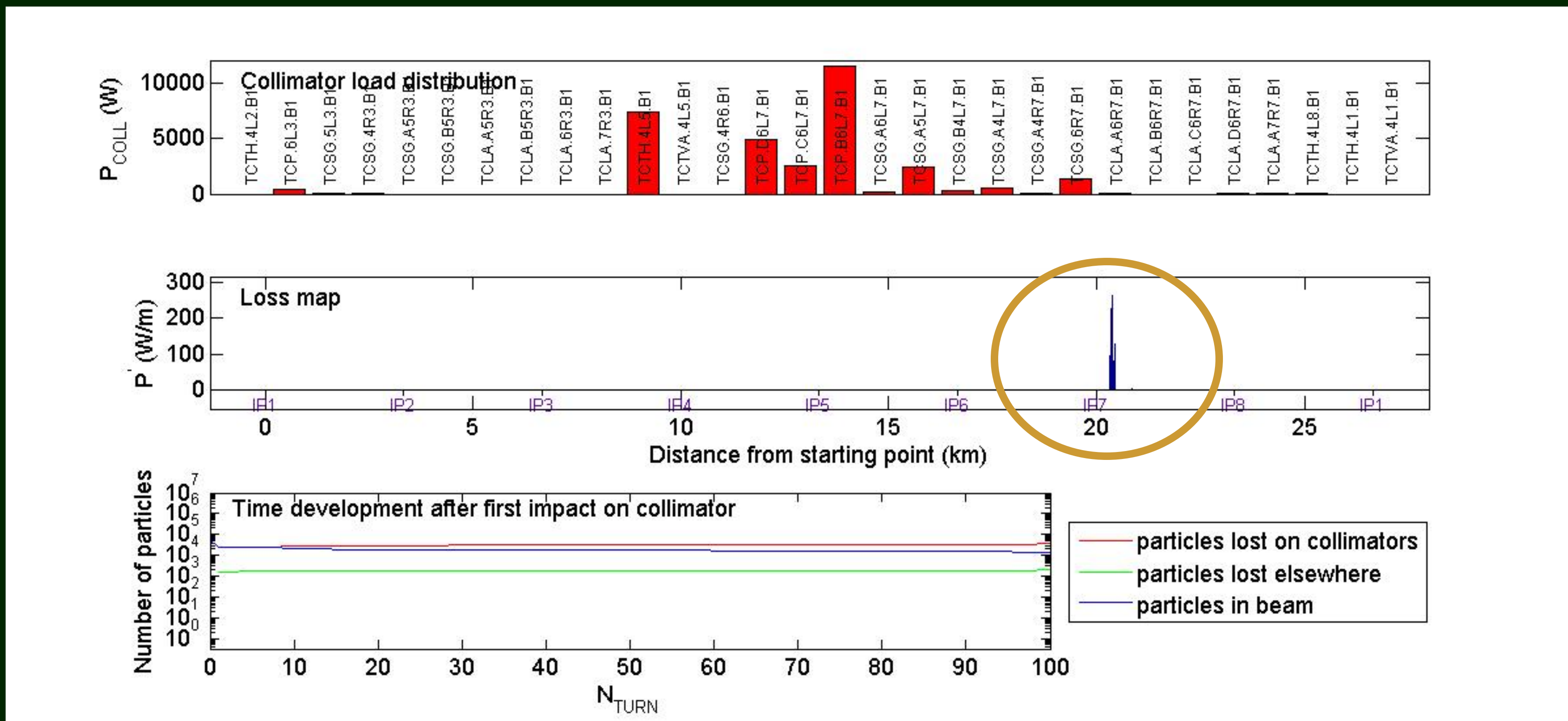
E=3.15TeV, 10k ions, Dp/p=0, I= 2·109 ppb



More pessimistic range

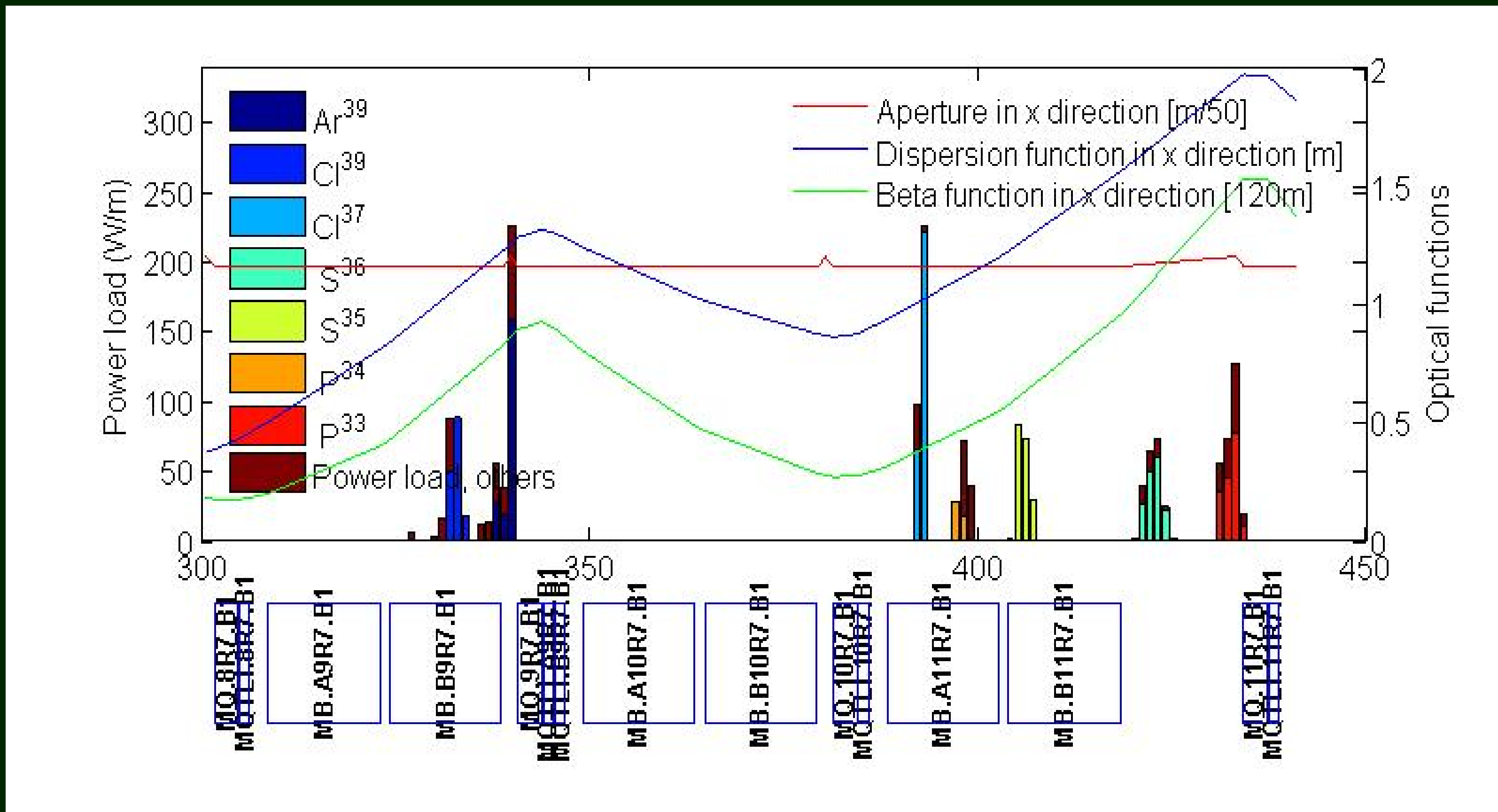
Conservative scenario

Beam1, E=3.15TeV, 50k ions, Dp/p=0,I= 2·109 ppb,
TCTs at 8.3σ, <μ>=1.5μm



Losses confined to IR7 dispersion suppressor, η=0.055

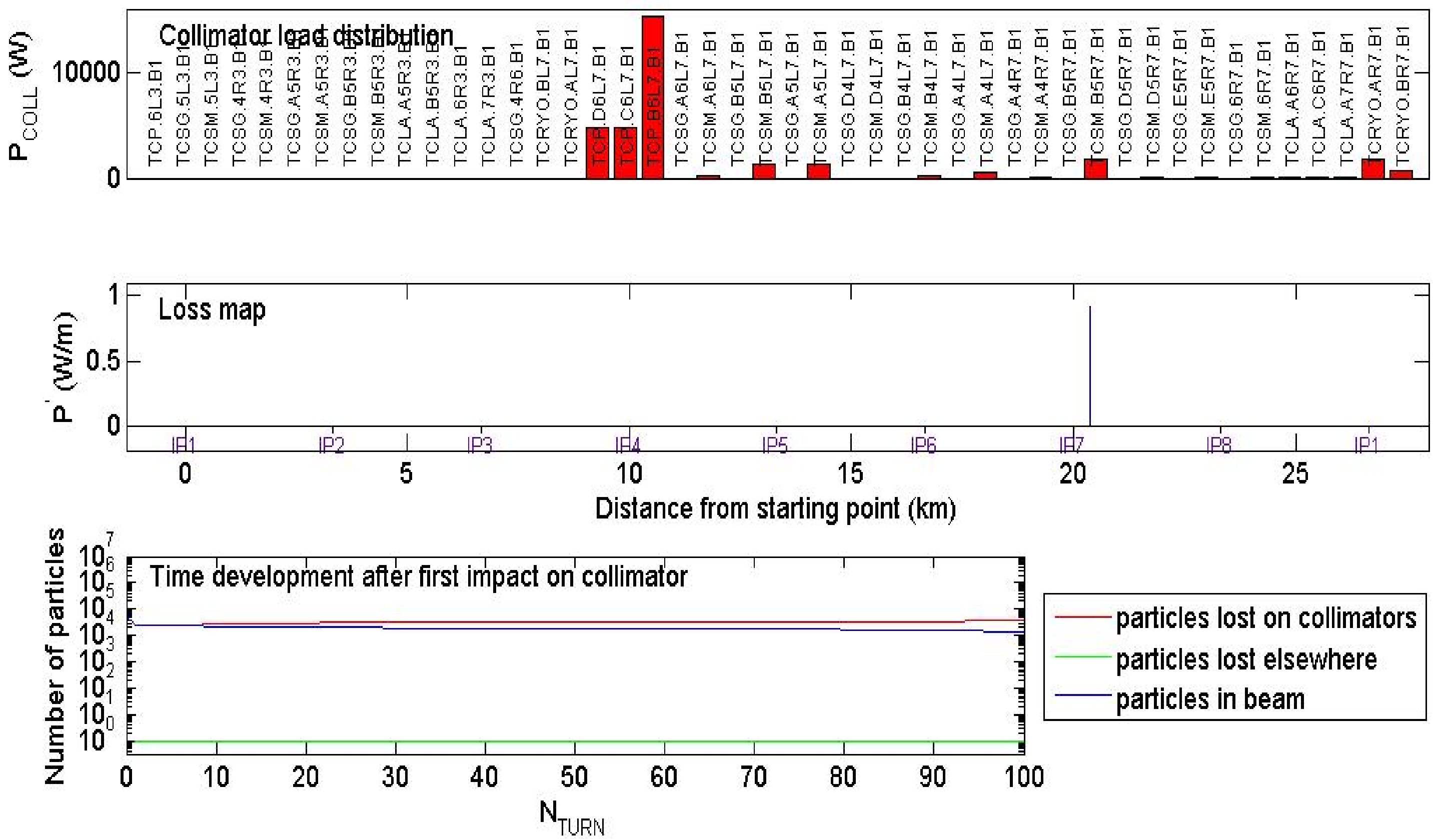
IR7 losses



Reduce by factor of ~6 for alternative 2 luminosity scenarios

Phase 2

$I=2\cdot10^9$, $\langle\mu\rangle=2\mu m$, TCRYOs at 15σ



Heat load on cryogenic collimators

	Gap (σ)	TCRYO.AR7.B1	TCRYO.BR7.B1
Pb208 ($I=7\cdot10^7$)	15	186 W	180 W
	30	83 W	258 W
	45	21 W	190 W
Ar40 ($I=0.32\cdot10^9$)	15	350 W	128 W
	30	201 W	222 W
	45	68 W	250 W

Conclusions

- Collimation performance for light Ar40 ions is qualitatively similar to what seen for Pb ions:

  1) discrete losses confined to the IR7 dispersion suppressor (PhaseI betatron collimation, purely academic exercise..)

  2) machine losses absorbed by the installation of cryogenic collimators in IR7 dispersion suppressor

- Simulations need to be repeated with correct aperture model

- How does the heat load on TCRYOs compare to current estimates of the collimator damage level?