BLM maps for LHC ion collimation – an update

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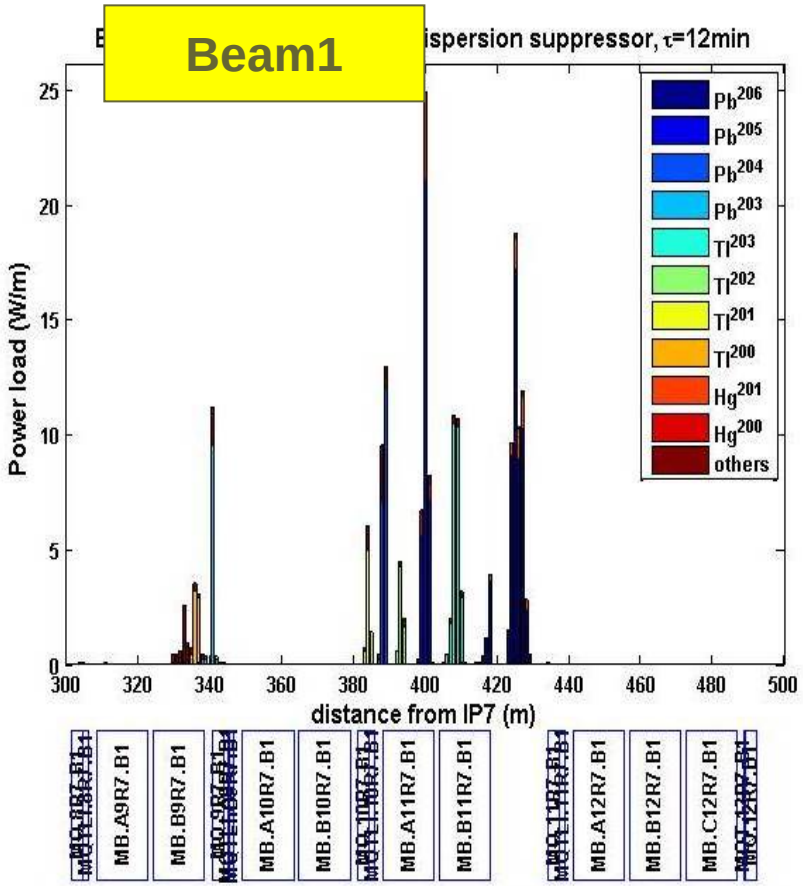
- IR7:
  - Brief recap of simulation results
  - Proposed maps for BLM installation
- IR3:
  - Code setup for momentum collimation studies
  - IR3 vs IR7
  - Proposal for BLM installation

IR7 @ collision energy

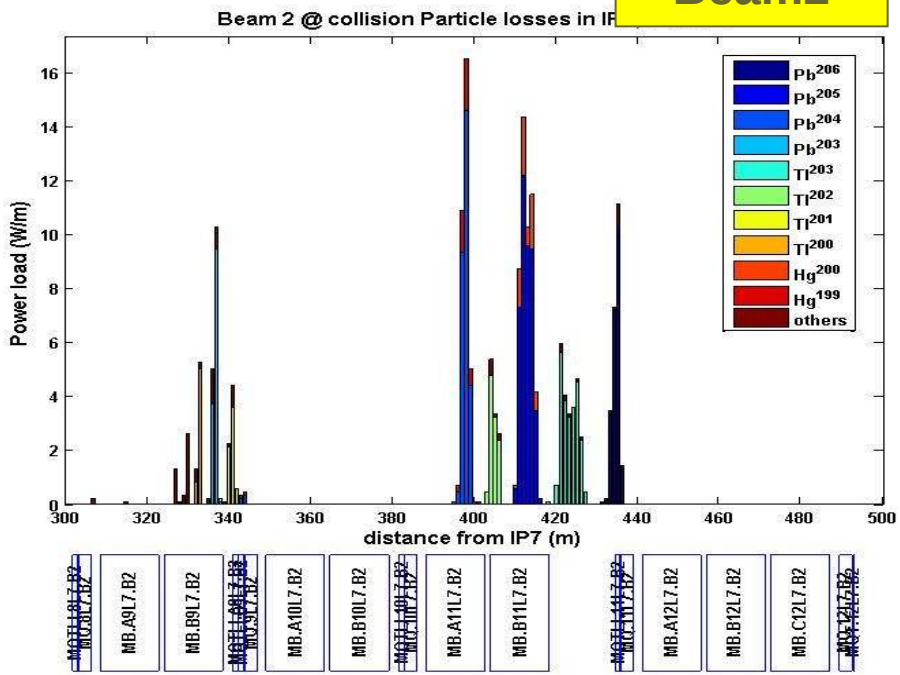
Beam1

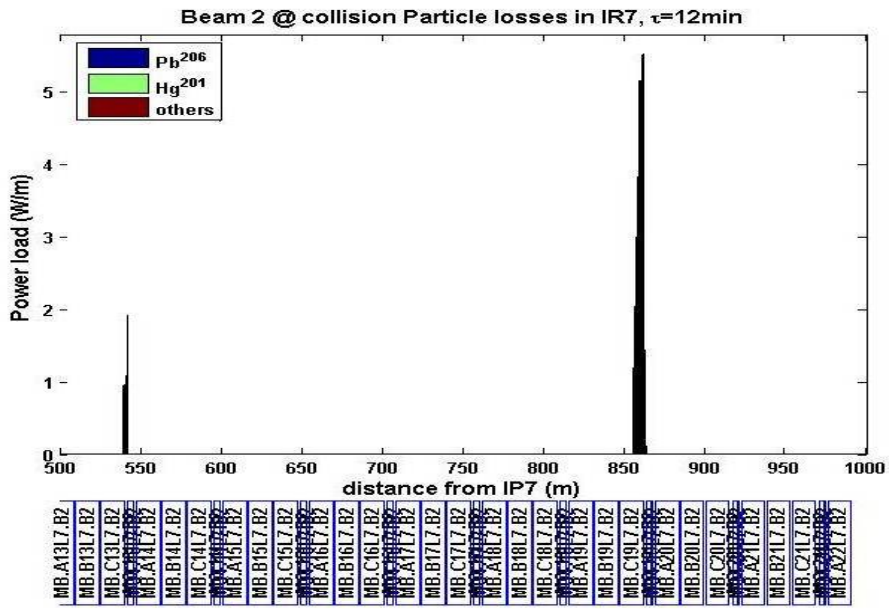


Losses confined to IR7 dispersion suppressor, cells 9 & 11

Two peaks downstream in the arc for Beam2

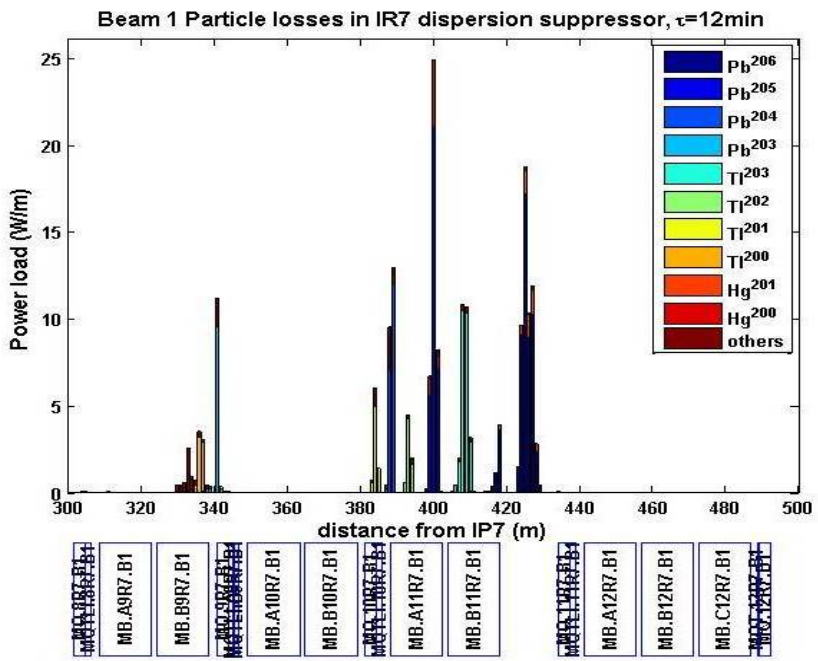
Beam2



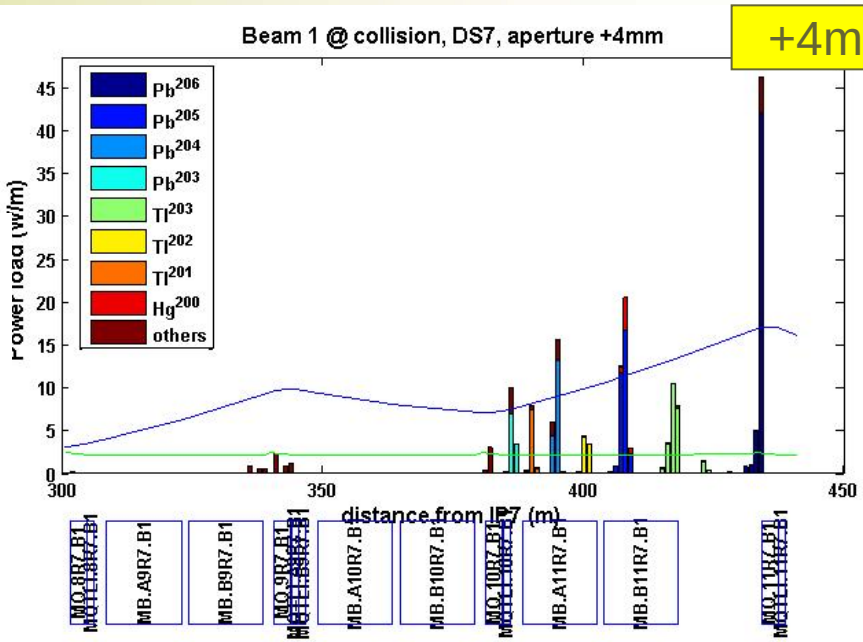


Aperture sensitivity (Beam1):

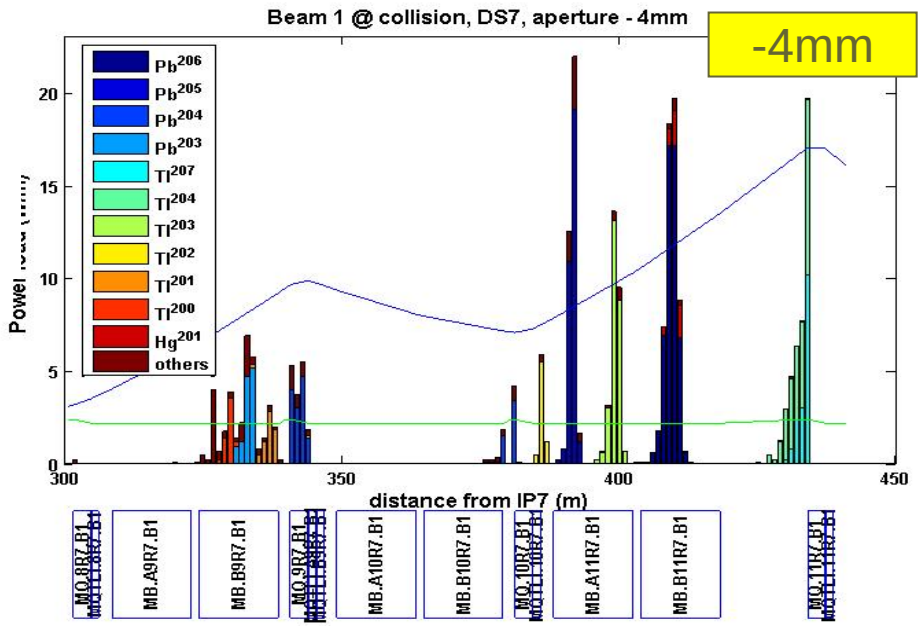
nominal



+4mm



-4mm



Effective momentum error: $\frac{\Delta P}{P} = \frac{Z_1 A_2}{Z_2 A_1} - 1$

$^{207}Tl \rightarrow +0.75\%$

$^{204}Tl \rightarrow -0.71\%$

BLMs coverage:

Philosophy :

Adding 1mm to aperture (all elements) causes a shift in the beam loss peaks by up to 2m

BLMs coverage of IR7:
3 patches available in cells 8,9,11 (dipoles) X 8 channels (max) X 2 BLMs

2 channels available on quad patches (regions 8,9,10,11,13)

Need tight coverage of cells 9-11

Numbers:

BLM active length = 40 cm

Dipole length = 14.3 m (x2)

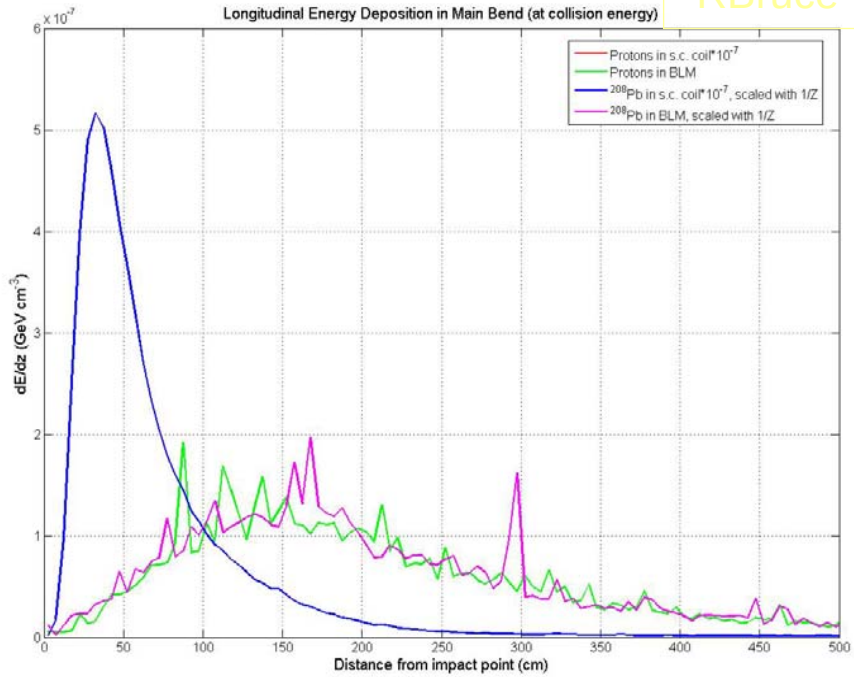
Long. spread of energy deposition=

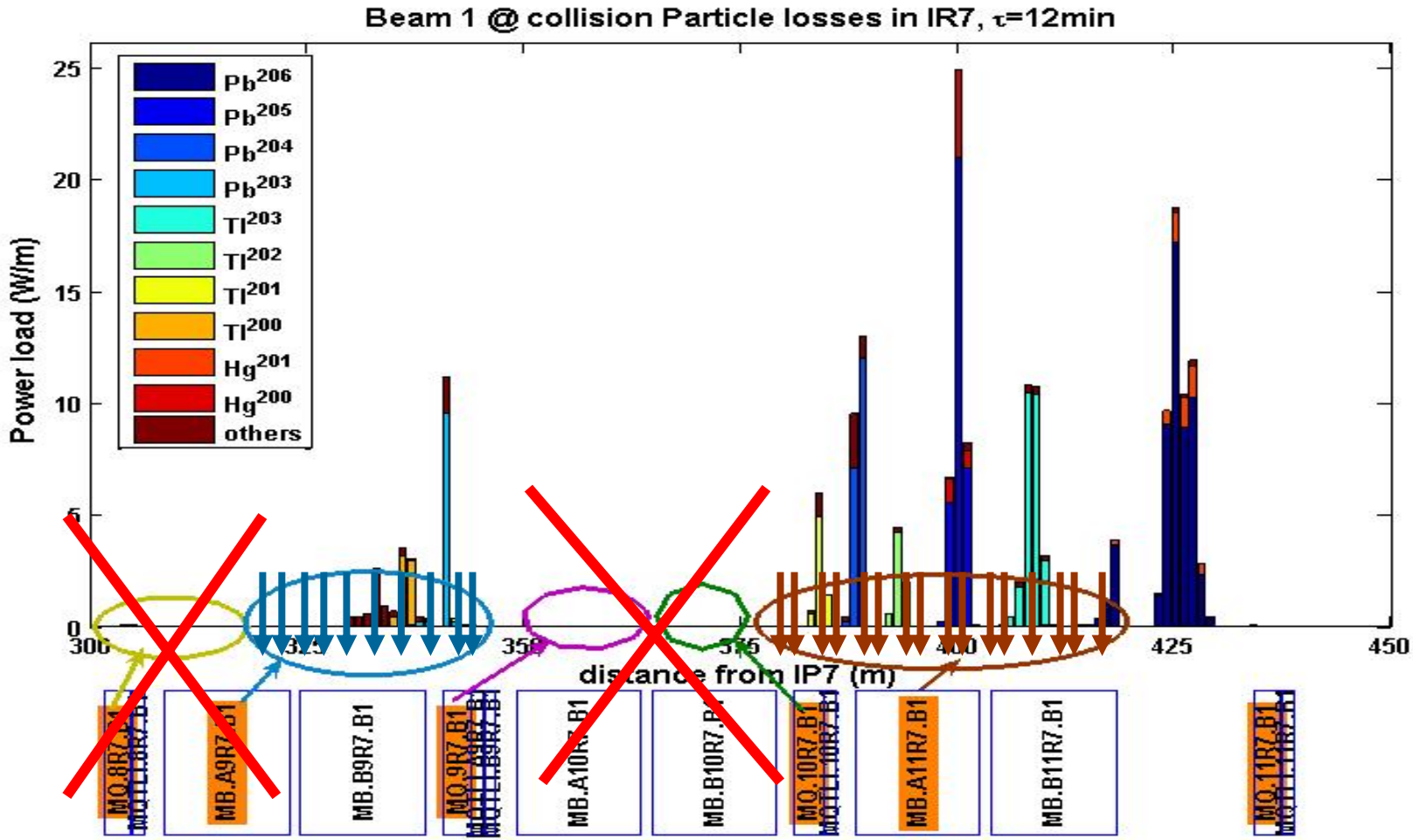
2.5 m FWHM

peak @ 1.5 m from impact

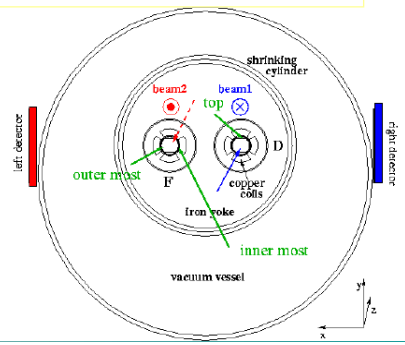
For coil deposition peak @ 30cm from impact point

RBruce





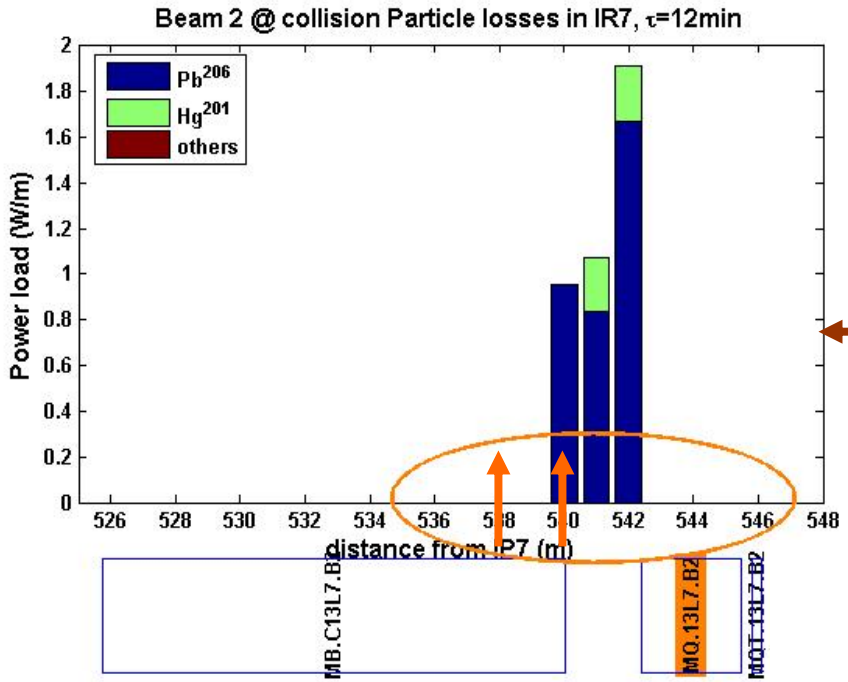
B. Dehning's team



- 2.5 m spacing in cells 9 (downstream dipole) & 11, no coverage in cell 10

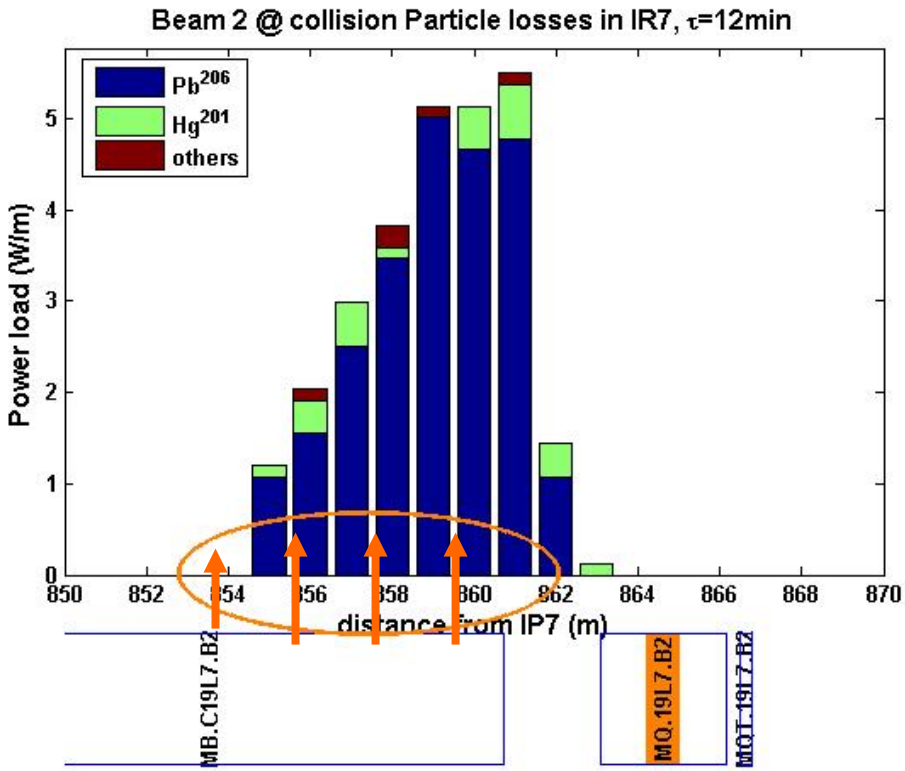
-Transverse position: inside (left) for beam2, outside (right) for beam1

Beam2, arc region



cell 13

cell 19



Beam 1

BEAM	IP	SLOT	s(m) from IP7	Transv pos	MAD-X name	cold mass type
1	7	BJBAP.A9R7		Outside	MB.A9R7.B1	MBA.9R7
			317			
			320			
			322.5			
			325			
			327.5			
			330			
			332.5			
			335			
			337.5			
			340			
1	7	BJBAP.B9R7		Outside	MQ.9R.B1	MQ.9R7
			345			
1	7	BJBAP.A10R7		Outside	MQ.10R7.B1	MQ.10R7
			376.5			
1	7	BJBAP.A11R7		Outside	MB.A11R7.B1	MBA.11R7
			379.5			
			386			
			388.5			
			391			
			393.5			
			396			
			398.5			
			401			
			403.5			
			406			
			408.5			
			411			
			413.5			
			416			
			418.5			

4 patches, 27 BLMs

Beam 2

BEAM	IP	SLOT	s(m) from IP7	Transv pos	MAD-X name	cold mass type
2	7	BJBAP.A9L7		Inside	MB.A9L7.B2	MBB.9L7
			320			
			322.5			
			325			
			327.5			
			330			
			332.5			
			335			
			337.5			
			340			
			342.5			
2	7	BJBAP.A11L7		Inside	MB.B11L7.B2	MBA.11L7
			388.5			
			391			
			393.5			
			396			
			398.5			
			401			
			403.5			
			406			
			408.5			
			411			
			413.5			
			416			
			418.5			
2	7	BJBAP.B11L7		Inside	MQ.11L7.B2	MQ.11L7
			433			
2	7	BYPLM.A13L7		Inside	MQ.13L7.B2	MQ.13L7
			538.5			
			541			
2	7	BYPLM.A19L7		Inside	MQ.19L7.B2	MQ.19L7
			854			
			856.5			
			859			
			861.5			

5 patches, 30 BLMs

IR3 momentum collimation studies: ICOSIM setup

Initial Gaussian beam distribution in x, x', y, y' with

$$\varepsilon_x = \varepsilon_y = 1.5/(\beta\gamma)\ \textit{mm mrad}$$

$\Delta p/p$ follows random distribution with parabolic shape in the interval $\pm[dpp1, dpp2]$ where:

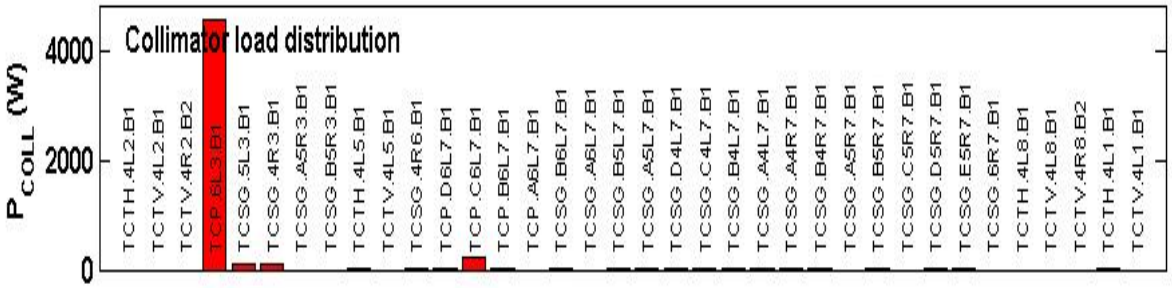
dpp2= $\Delta p/p\_{TCP}$ (corresponding to primary collimator gap height)

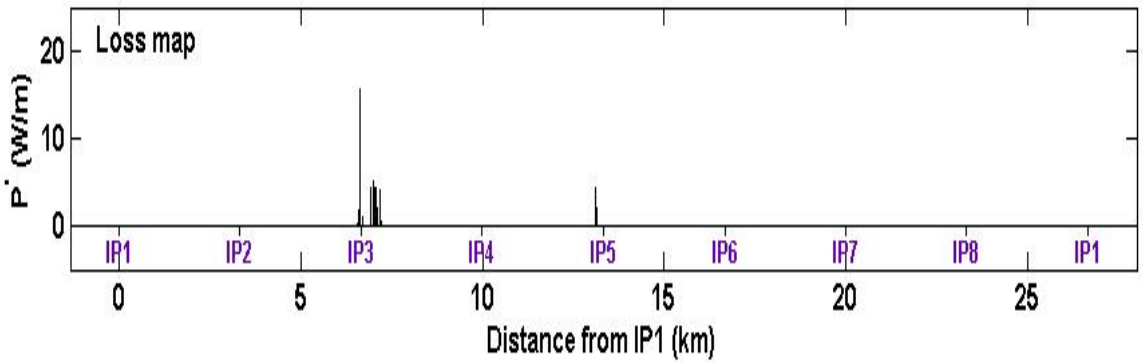
dpp1= *dpp2* -4×$\Delta p/p\_{\sigma x}$ (corresponding to σ_x of the beam)

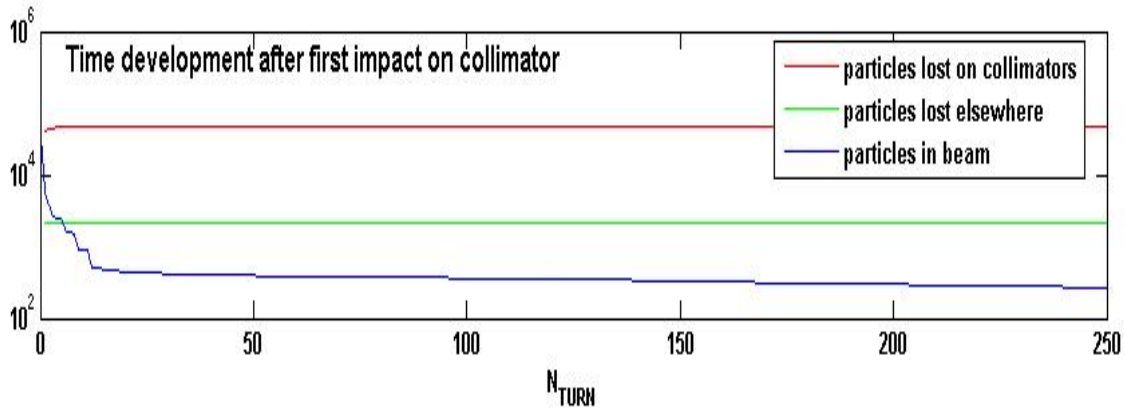
Linear tracking from TCP to TCP with blow-up in $\Delta p/p$ every 100 turns

Full tracking and physics same as per betatron collimation

Beam1 at collision





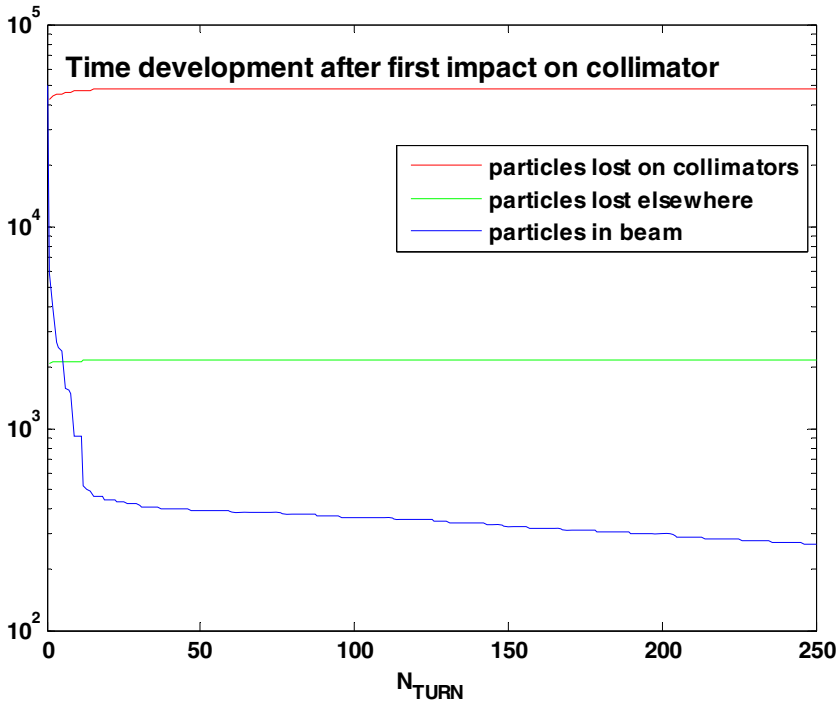


50k particles

Collimator load concentrated onto one primary collimator

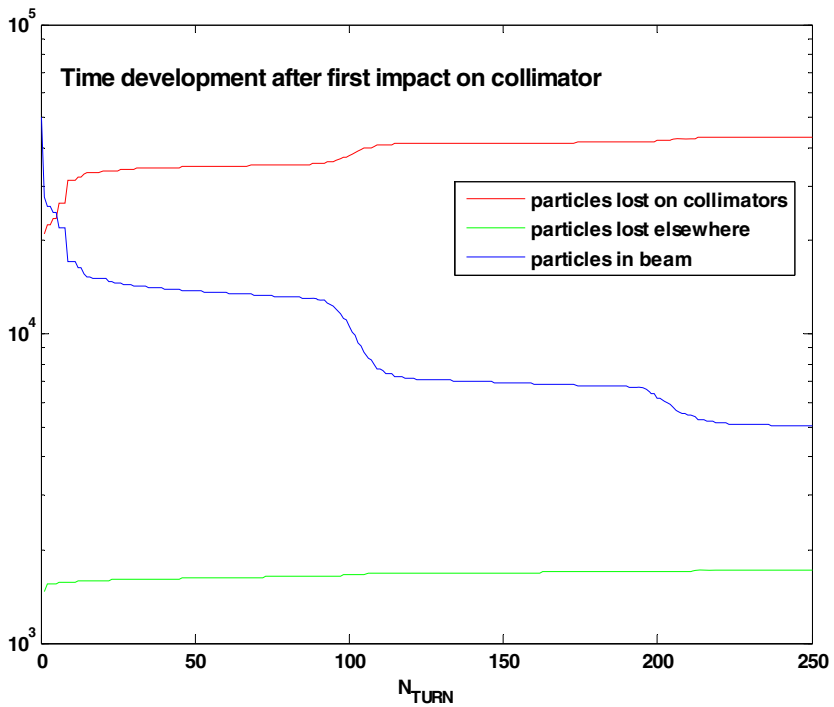
Most particles lost on first few turns

IR3



η=0.046

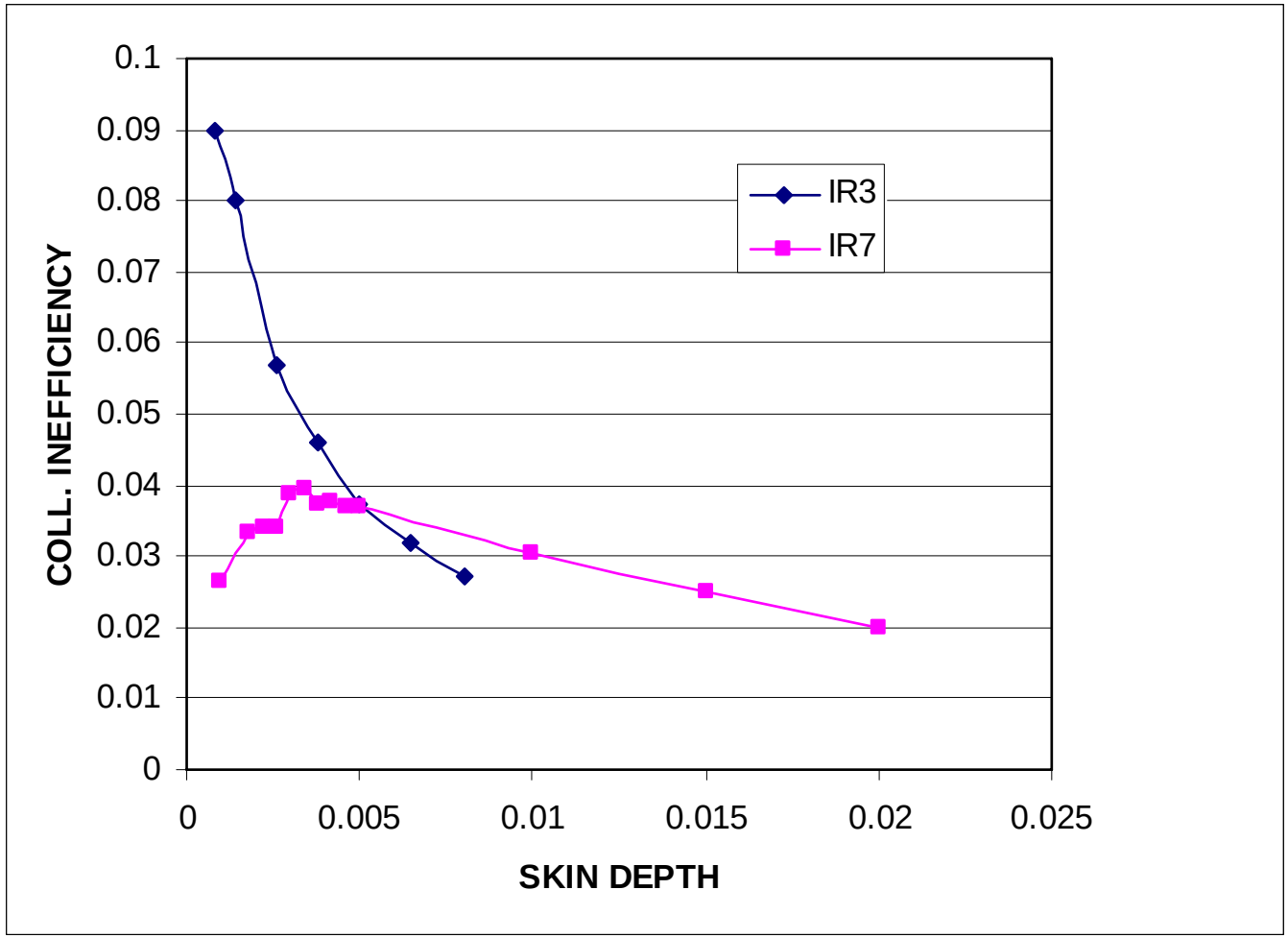
IR7



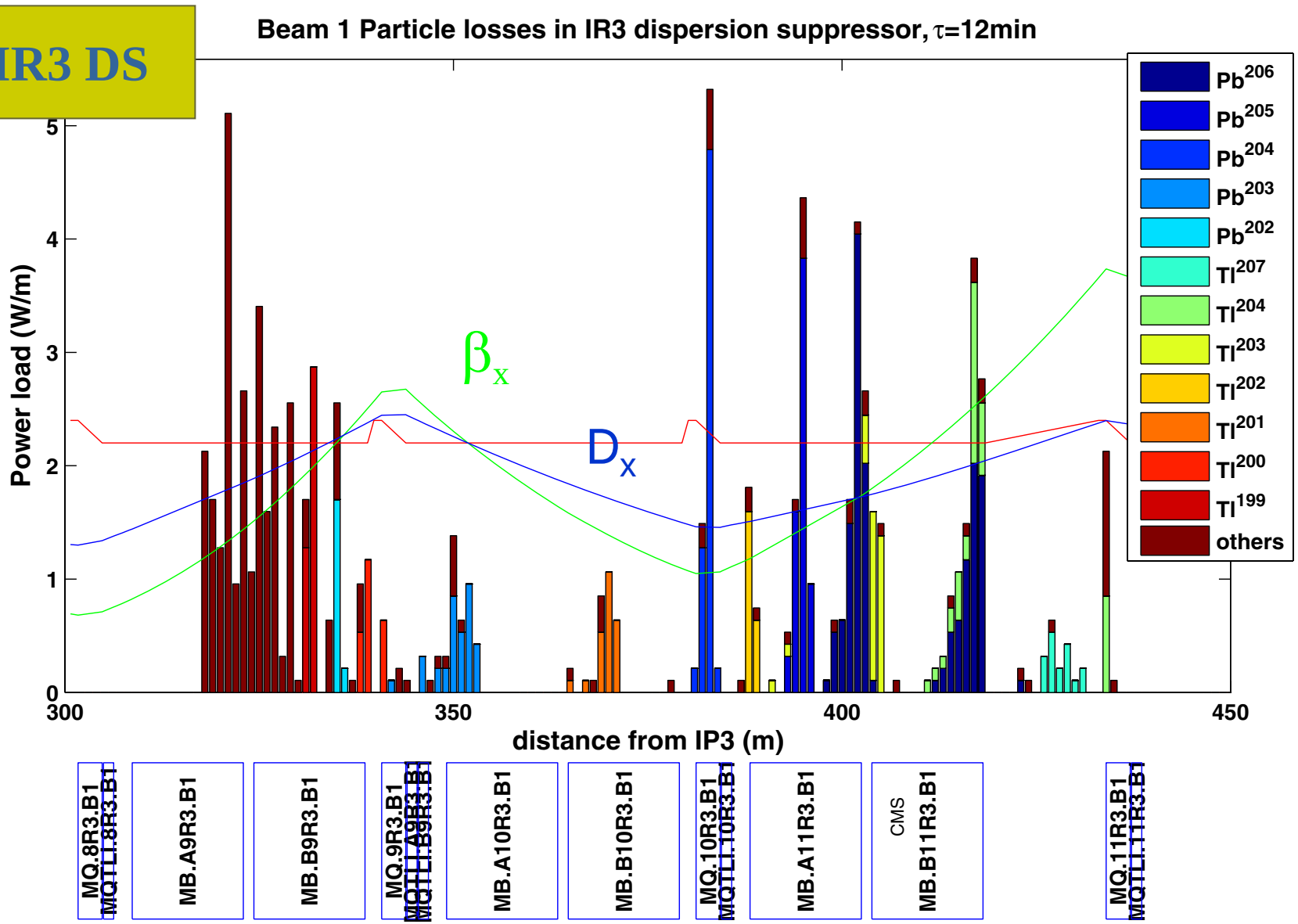
η=0.040

Qualitative difference ….

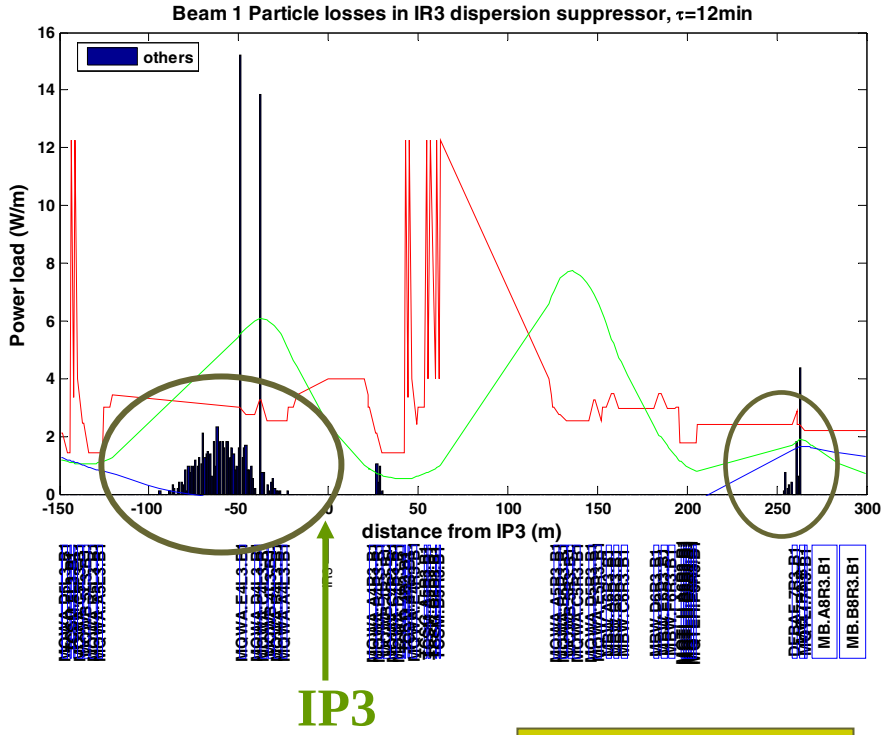
Collimation inefficiency



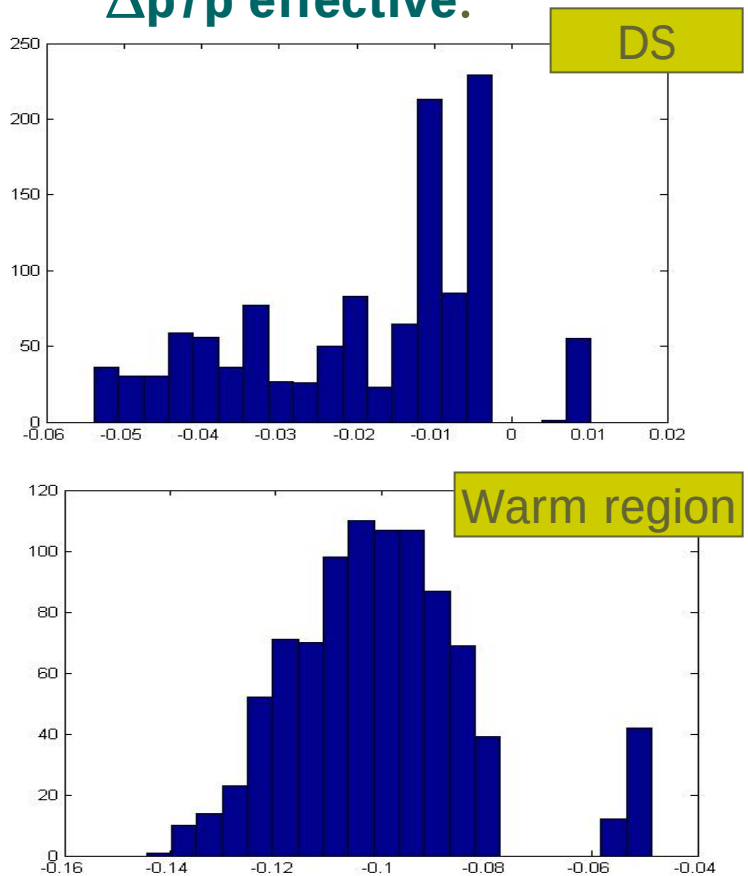
IR3 DS


Beam 1 Particle losses in IR3 dispersion suppressor, τ=12min
Power load (W/m)
distance from IP3 (m)
βx
Dx
Pb206
Pb205
Pb204
Pb203
Pb202
Tl207
Tl204
Tl203
Tl202
Tl201
Tl200
Tl199
others
MQ.8R3.B1
MQTLI.8R3.B1
MB.A9R3.B1
MB.B9R3.B1
MQ.9R3.B1
MQTLI.A9R3.B1
MQTLI.B9R3.B1
MB.A10R3.B1
MB.B10R3.B1
MQ.10R3.B1
MQTLI.10R3.B1
MB.A11R3.B1
CMS
MB.B11R3.B1
MQ.11R3.B1
MQTLI.11R3.B1

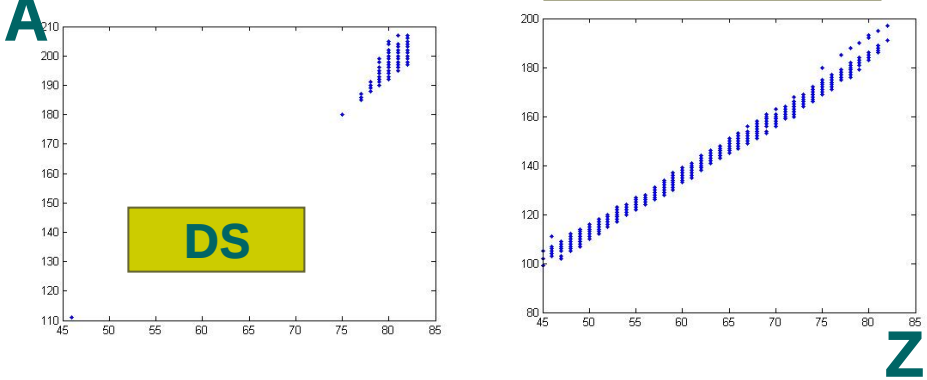
Outside DS: warm region



Δp/p effective.



Warm region



Particles with very different rigidity:

DS: $0<|\Delta p/p \text{ eff}|<0.05$

Warm region: $0.08<|\Delta p/p \text{ eff}|<0.14$

Outside DS:

losses in the arc

2 ion species

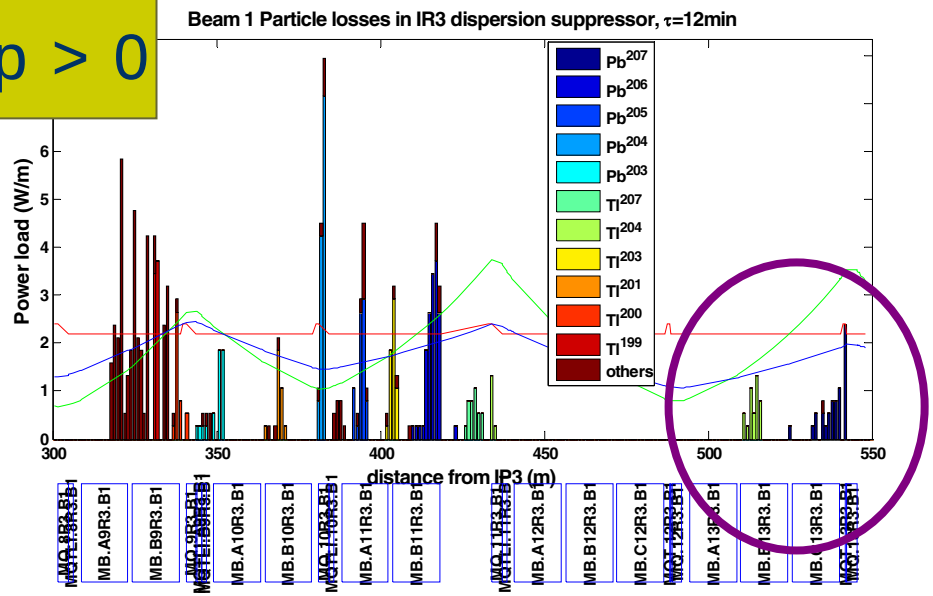
Effective momentum error:

Pb^{207} → -0.48%

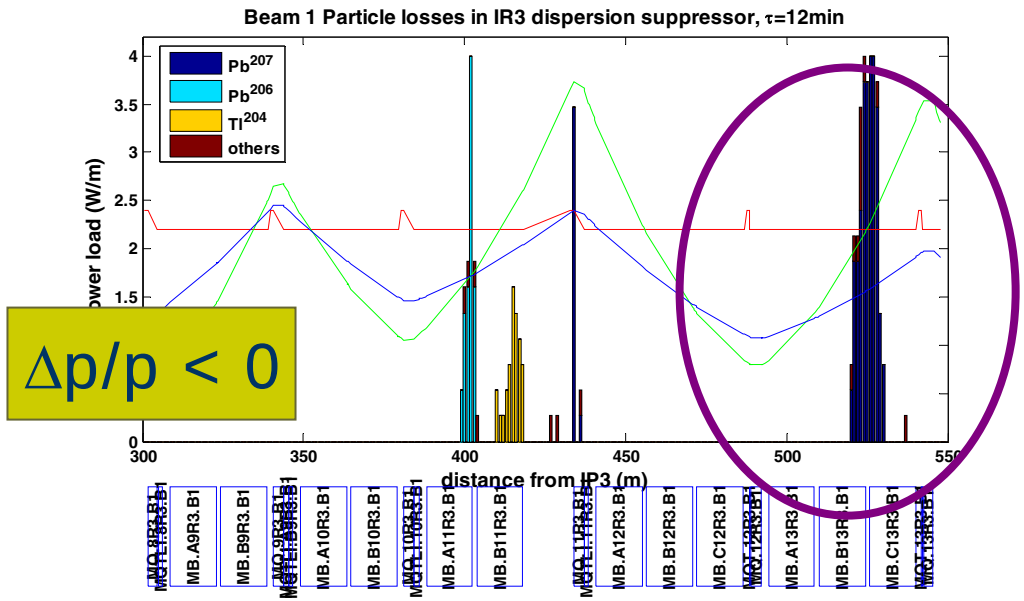
Tl^{204} → -0.71%

π phase advance from TCP

Δp/p > 0

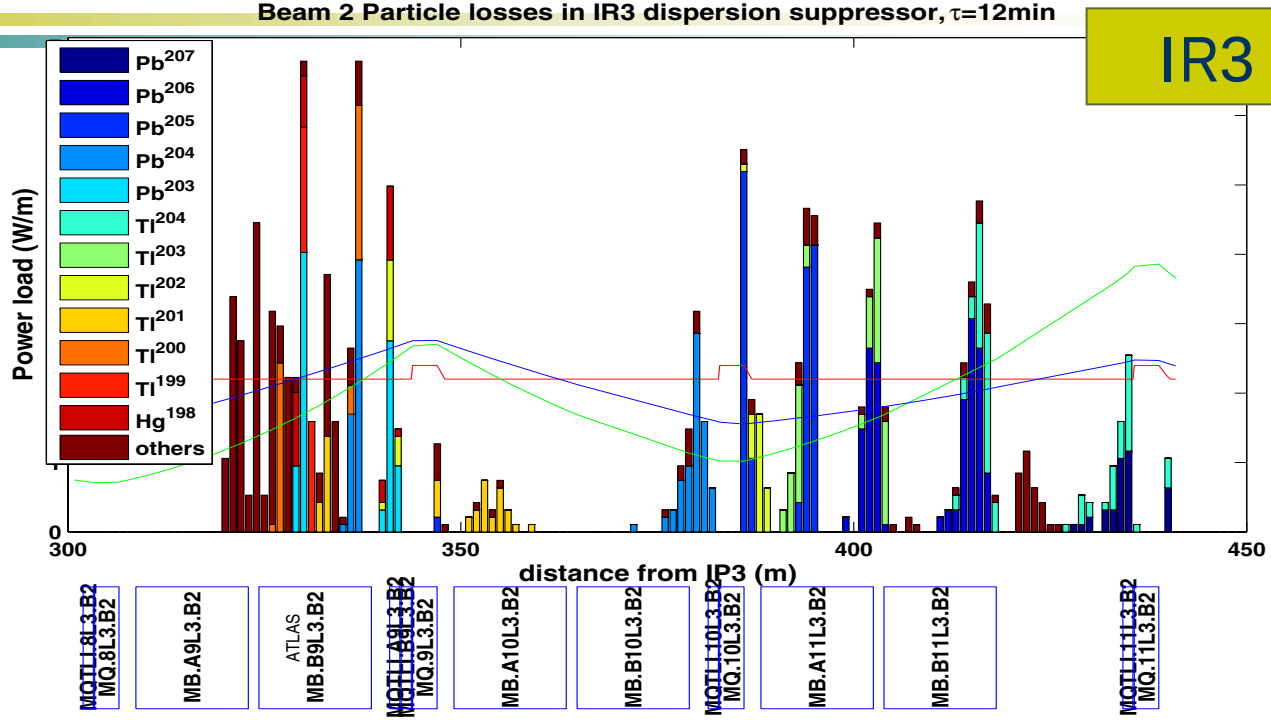


Δp/p < 0

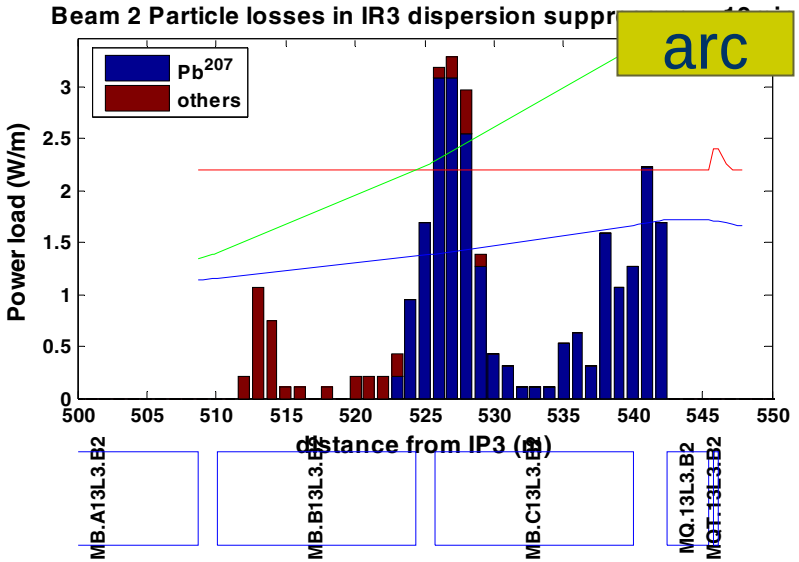


Beam2:

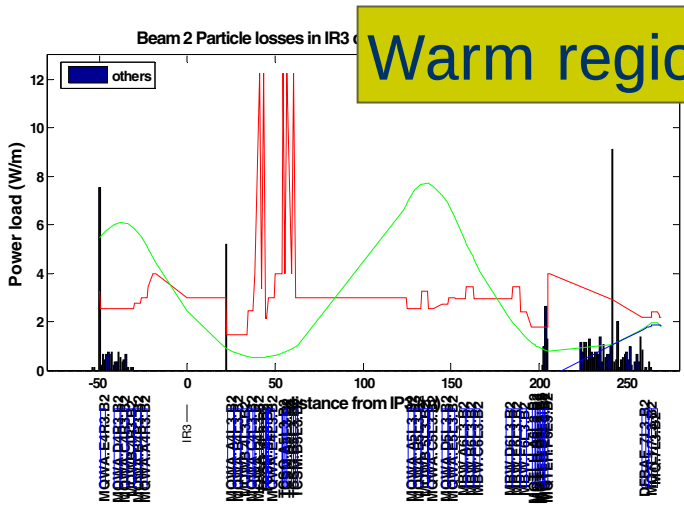
IR3 DS



arc

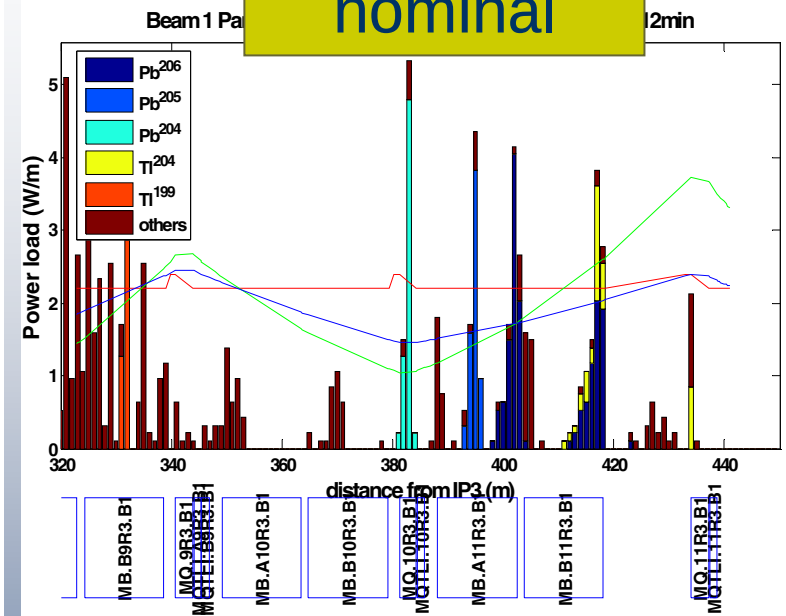


Warm region

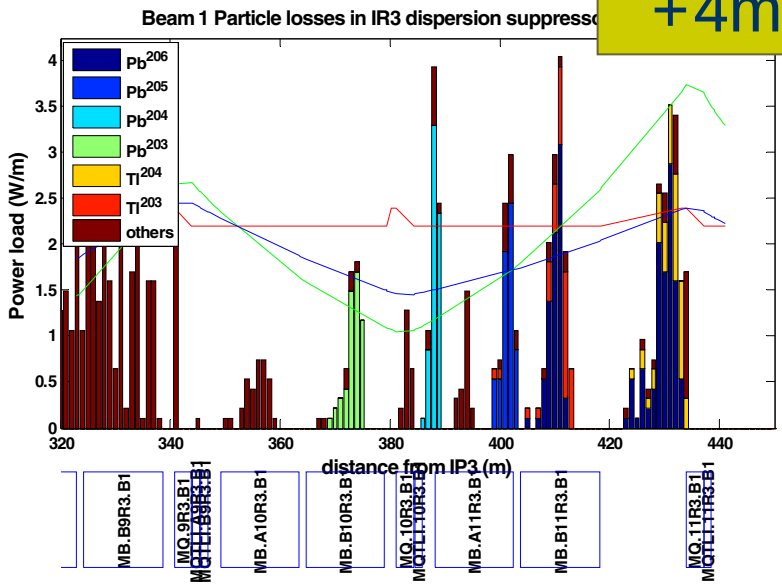


Aperture sensitivity (beam1):

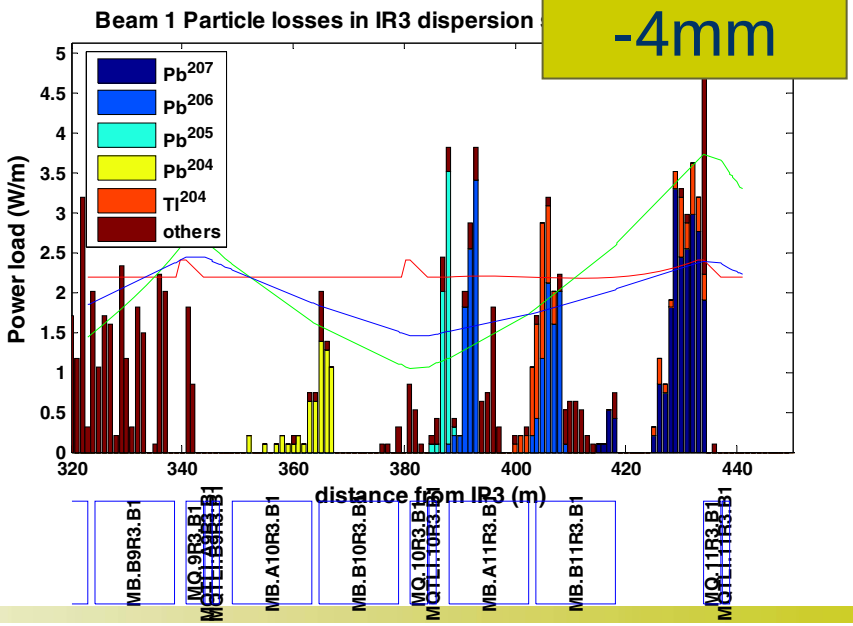
nominal



+4mm



-4mm



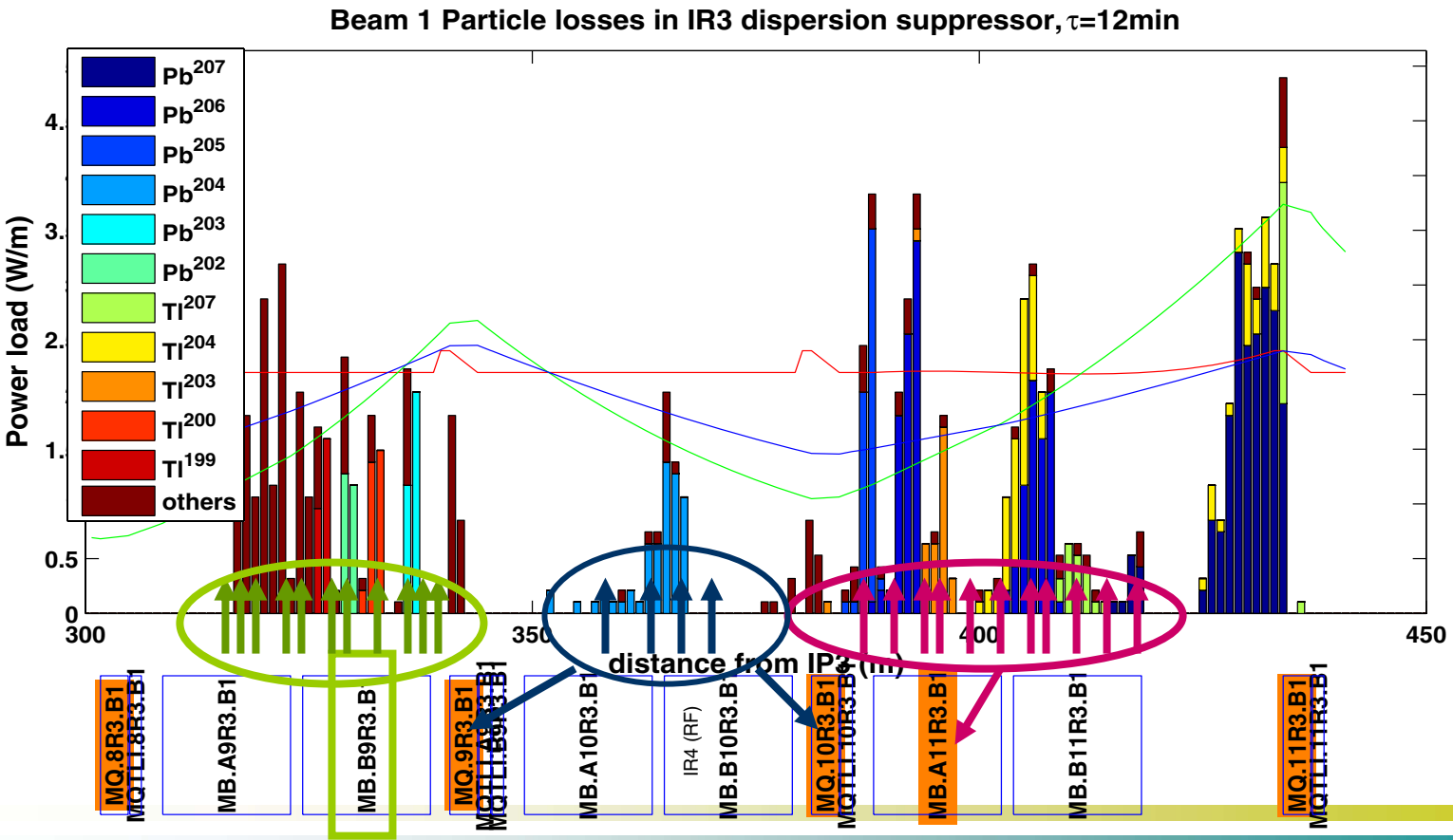
Within DS peaks are shifted by a few meters per mm change in aperture

IR3 BLMs coverage

•Only 2 dipole patches originally available (cells 8 and 11), one to be moved downstream to cell 9 upon request

•Tight coverage of cells 9 and 11 (2.5m spacing)

•Sparse(r) coverage of cell 10 (3.75m spacing)



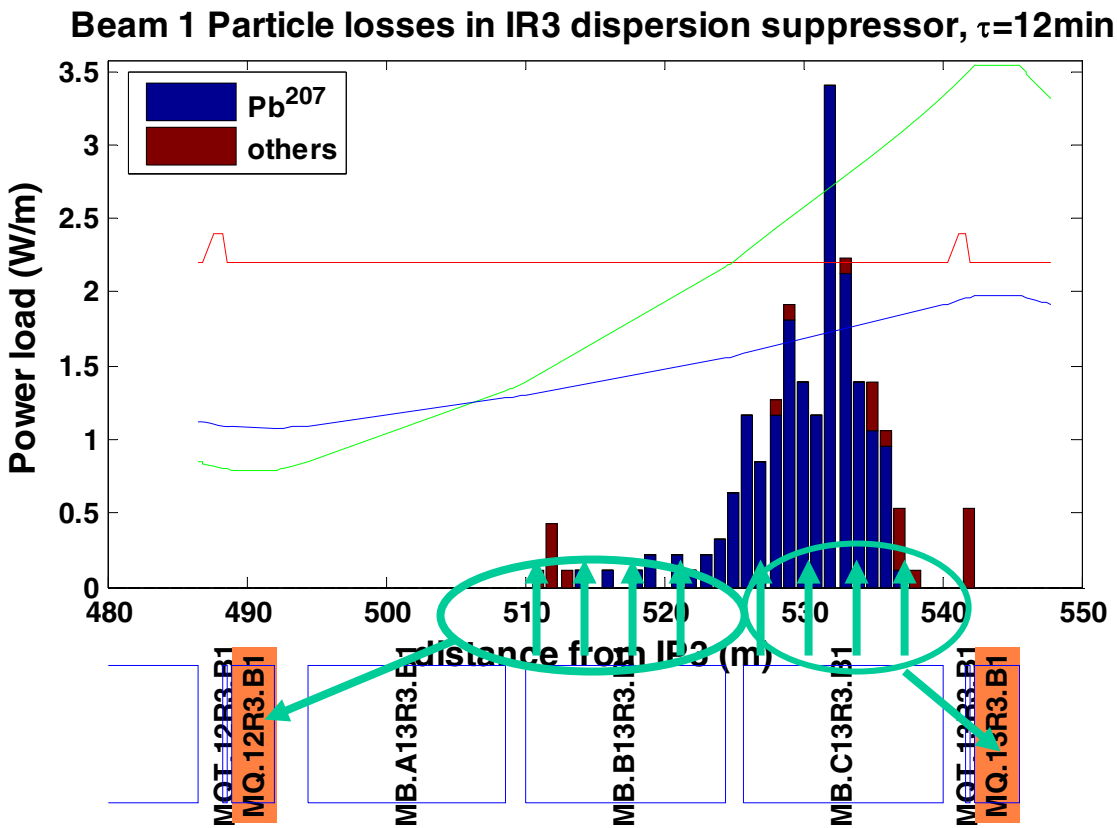
Arc region:

Proposal for installation of extra patch turned down → use quadrupole patches only

Losses due to a couple of ion species only and more spread out longitudinally than in DS

3.75 m chamber spacing should be sufficient (..best we can do..)

Up to 33m long cable connections (?)



beam 1

BEAM	IP	SLOT	s(m) from IP3	Transv pos	MAD-X name	col
1	3	BJBAP.B9R3	315.5 318 320.5 323 325.5 328 330.5 333 335.5 338	Inside	MB.B9R3.B1	
1	3	BJBAP.A9R3	350 353.75 357.5 361.25	Inside	MQ.9R3.B1	
1	3	BJBAP.A10R3	365 368.75 372.5 376.25	Inside	MQ.10R3.B1	
1	3	BJBAP.A11R3	388 390.5 393 395.5 398 400.5 403 405.5 408 410.5 413 415.5 418	Inside	MB.A11R3.B1	
1	3	BYPLM.A12R3	512 515.75 519.5 523.25	Inside	MQ.12R3.B1	
1	3	BYPLM.A13R3	527 530.75 534.5 538.25	Inside	MQ.13R3.B1	

Total Beam1 = 39

6 patches, 39 BLMs

beam2

BEAM	IP	SLOT	s(m) from IP3	Transv pos	MAD-X name	cold mass type
2	3	BJBAP.B9L3	315.5 318 320.5 323 325.5 328 330.5 333 335.5 338	Outside	MB.B9L3.B2	MBA.9L3
2	3	BJBAP.A9L3	350 353.75 357.5 361.25	Outside	MQ.9L3.B2	MQ.9L3
2	3	BJBAP.A10L3	365 368.75 372.5 376.25	Outside	MQ.10L3.B2	MQ.10L3
2	3	BJBAP.A11L3	388 390.5 393 395.5 398 400.5 403 405.5 408 410.5 413 415.5 418	Outside	MB.B11L3.B2	MBA.11L3
2	3	BYPLM.A12L3	512 515.75 519.5 523.25	Outside	MQ.12L3.B2	MQ.12L3
2	3	BYPLM.A13L3	527 530.75 534.5 538.25	Outside	MQ.13L3.B2	MQ.13L3

Total Beam2 = 39

6 patches, 39 BLMs