Alternative for the IR2 Nb3Sn magnet and cryo-collimator scheme

Ions at 7 TeV (post LS2)

Tom Mertens

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http://indico.cern.ch/event/333525/

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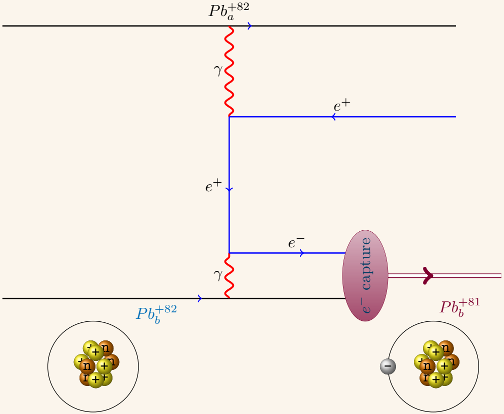
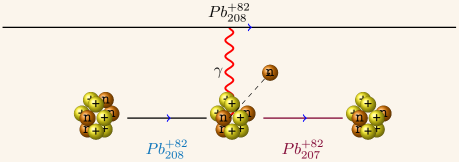
BFPP and EMD

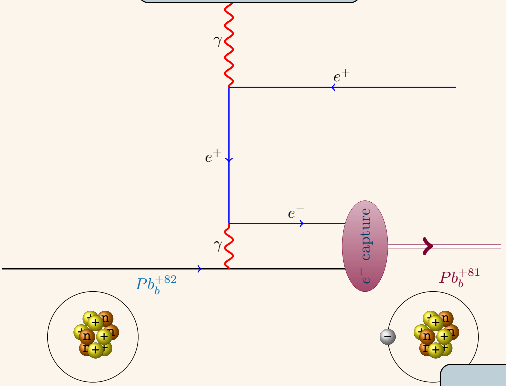


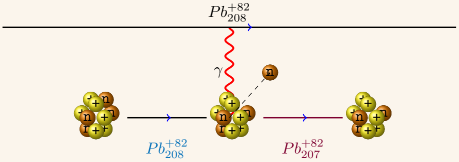


[Klein(2001), Jowett et al.(2004)Jowett, Braun, Gresham, Mahner, Nicholson, Shaposhnikova, and Pshenichnov, Meier et al.(2001)Meier, Halabuka, Hencken, Trautmann, and Baur, Oppedisano and the ALICE Collaboration(2011), Pshenichnov(2011), Bruce et al.(2009)Bruce, Bocian, Gilardoni, and Jowett]

BFPP and EMD

$$\sigma_{BFPP} = 281b$$
$$\delta = 0.01235$$





$$\delta = \frac{1-\frac{\Delta m}{m}}{1-\frac{\Delta Q}{Q}} - 1$$

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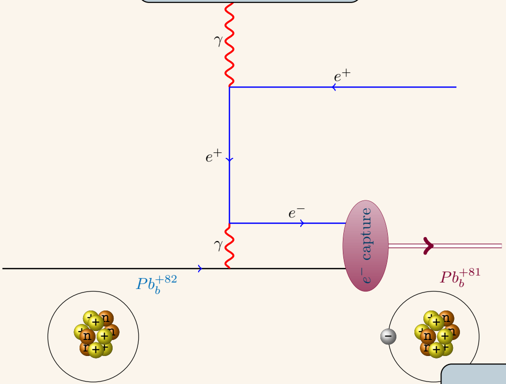

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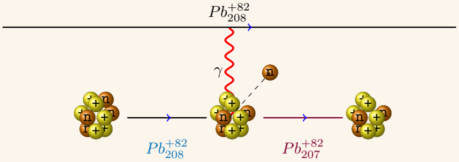

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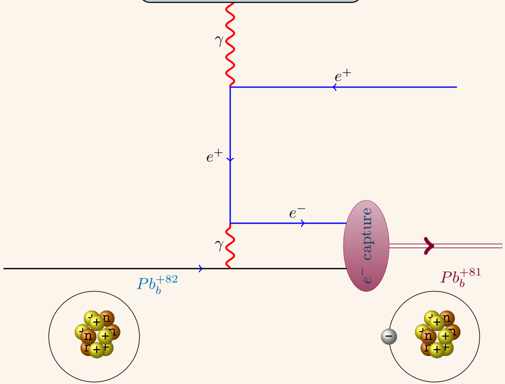

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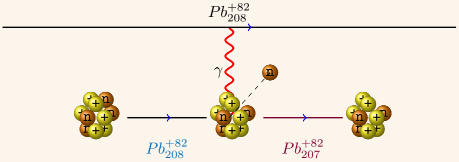

$\sigma_{Phys} = 8b$

BFPP and EMD

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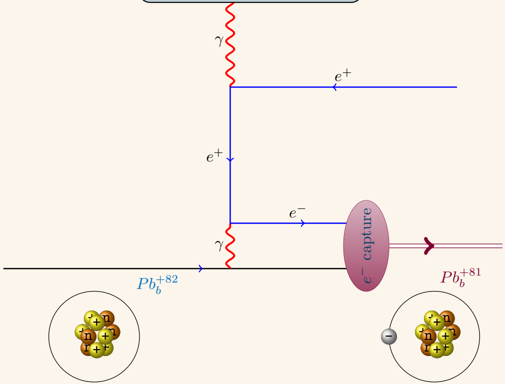

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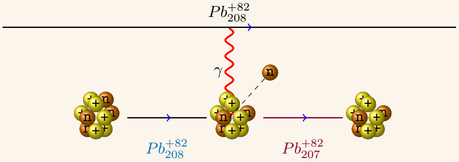
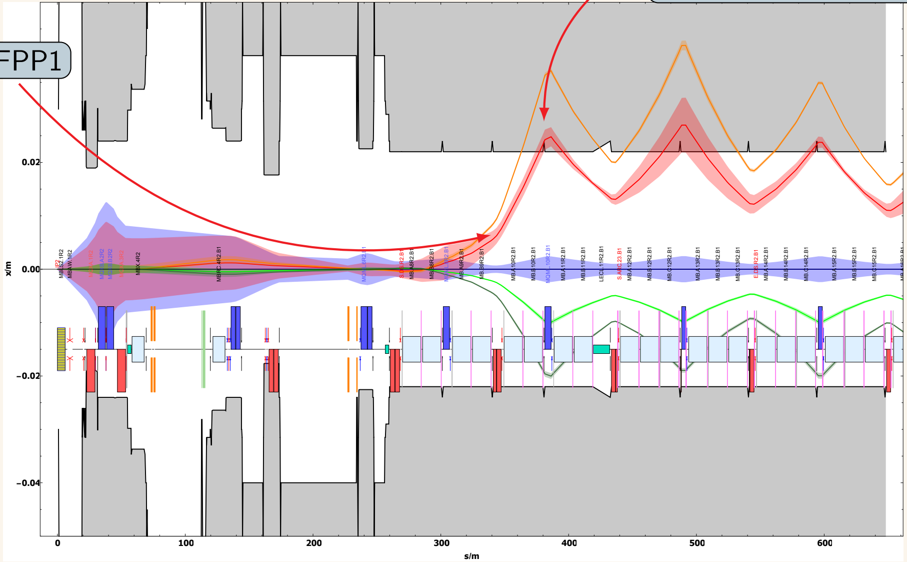


Both processes give rise to secondary beams in the LHC.

BFPP and EMD

BFPP impacts dipole magnet possible magnet quench

BFPP1



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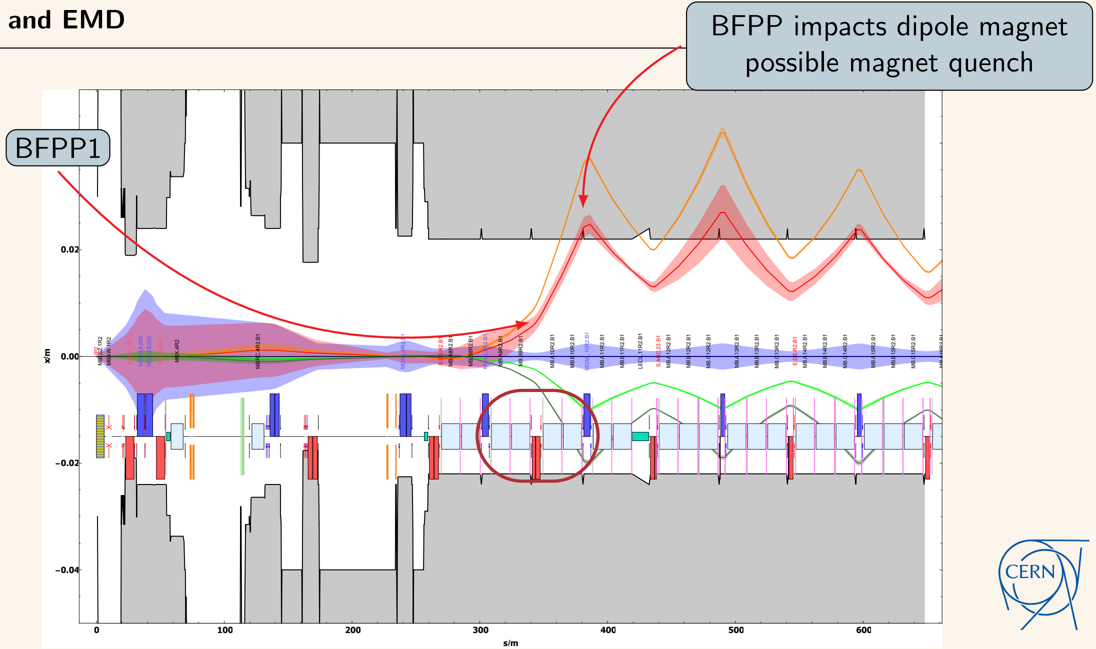
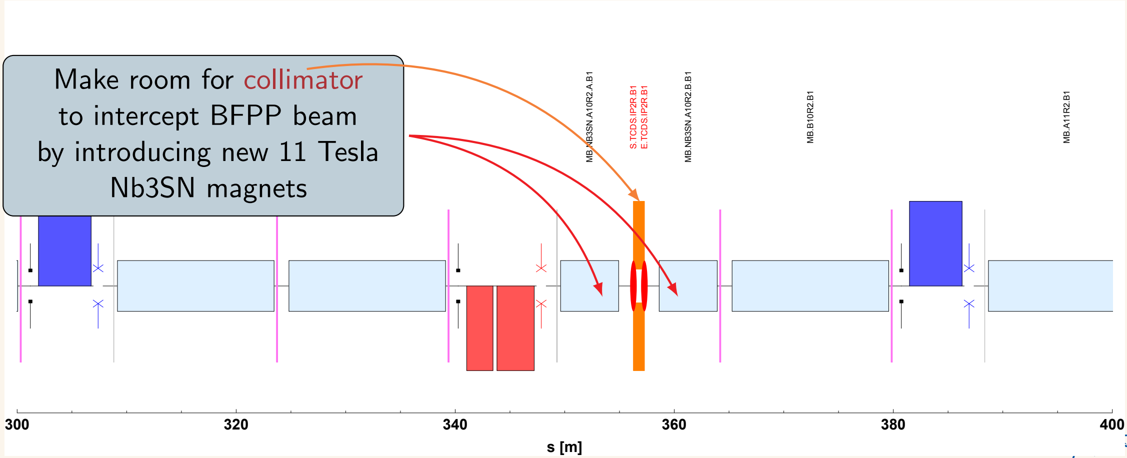
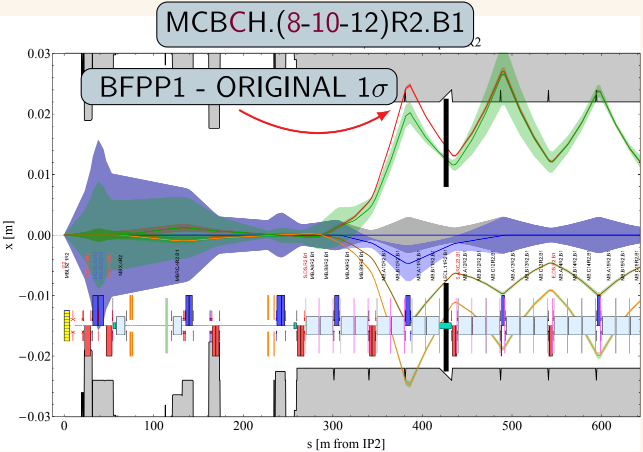

BFPP impacts dipole magnet
possible magnet quench
BFPP1
x/m
s/m
0.02
0.00
-0.02
-0.04
0
100
200
300
400
500
600

Nb3SN optics

Make room for collimator to intercept BFPP beam by introducing new 11 Tesla Nb3SN magnets

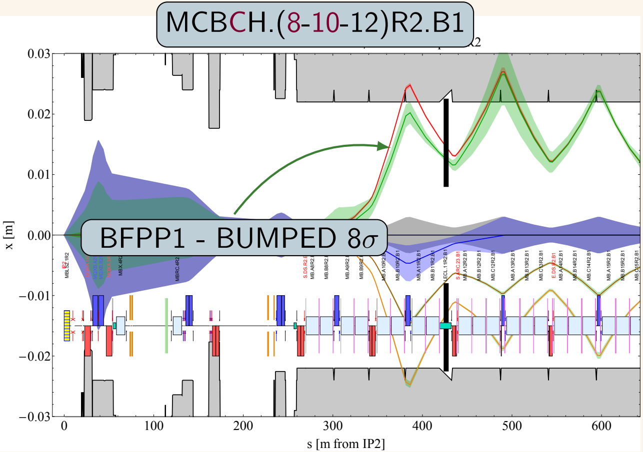


3 corrector bumps



Plots of the other bumps can be found in the backup slides.

3 corrector bumps



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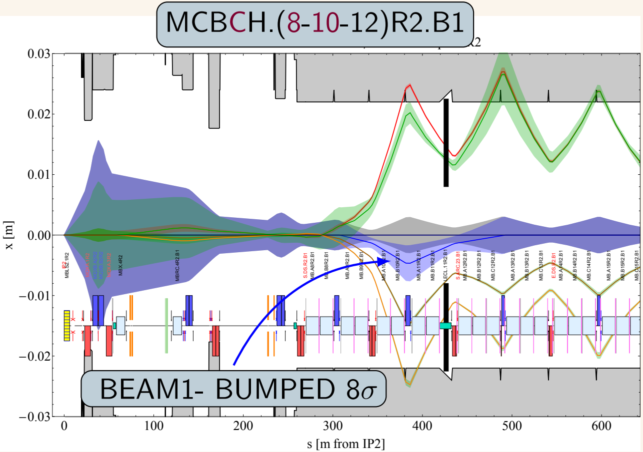

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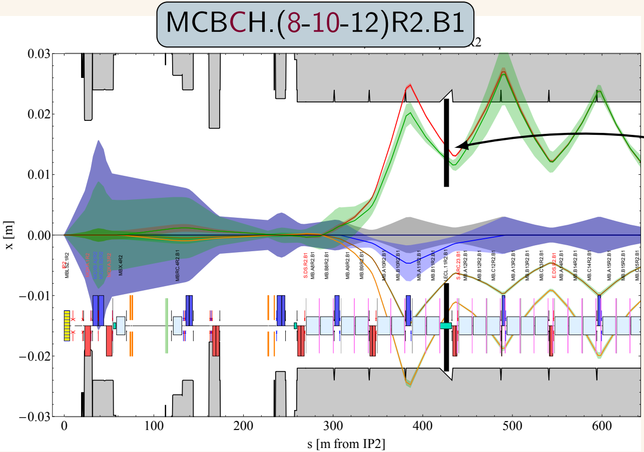
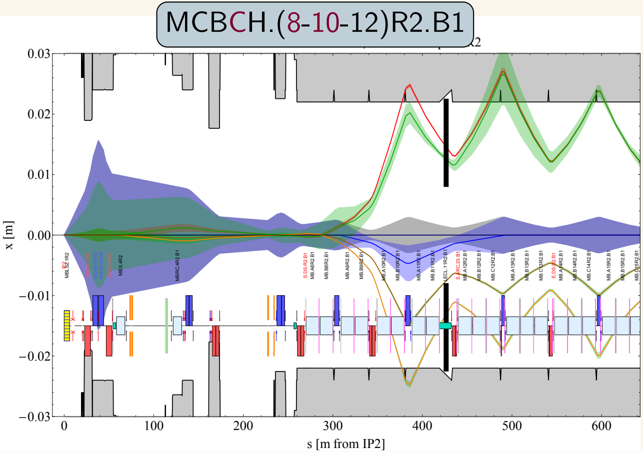


An alternative approach is to create an orbit bump to move the first peak of the BFPP beam down such that we can intercept it with a **collimator** to be installed in the empty cryostat.

Plots of the other bumps can be found in the backup slides.

3 corrector bumps



We can consider using different horizontal correctors to construct the bump. The table below contains three examples, where we show the correctors and their used strength in percentages of their maximum strength that were used to create the bumps.

MCB(C)H.XR2.B1	6	8	10	12	14
Bump 1	26	57		46	
Bump 2		30	11	32	
Bump 3		30		31	17

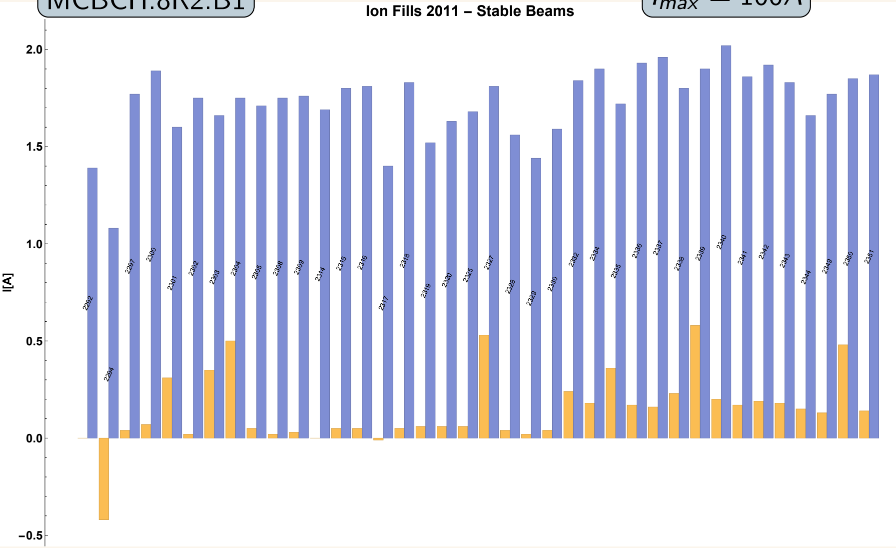
Strengths used during ion runs 2011 (in stable beams) : roughly 7 percent! (Double it for 7 TeV runs.)

See also next slides.

Strenght used for ions 2011: overview

MCBCH.8R2.B1

$I_{max} = 100A$



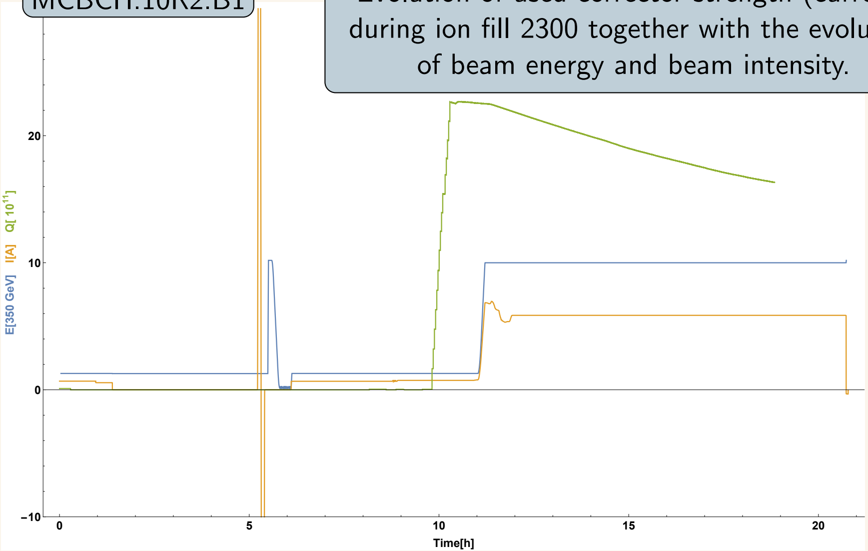
Maximum
Minimum

Strength used for ions 2011: Fill 2300

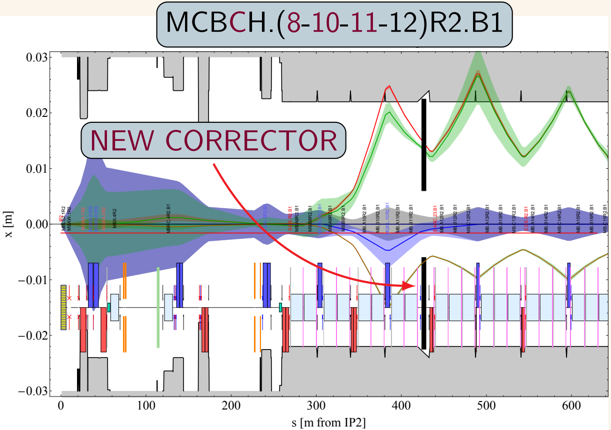
MCBCH.10R2.B1

Evolution of used corrector strength (current) during ion fill 2300 together with the evolution of beam energy and beam intensity.

$E[350 GeV]$ $I[A]$ $Q[10^{11}]$



3 correctors + a new corrector

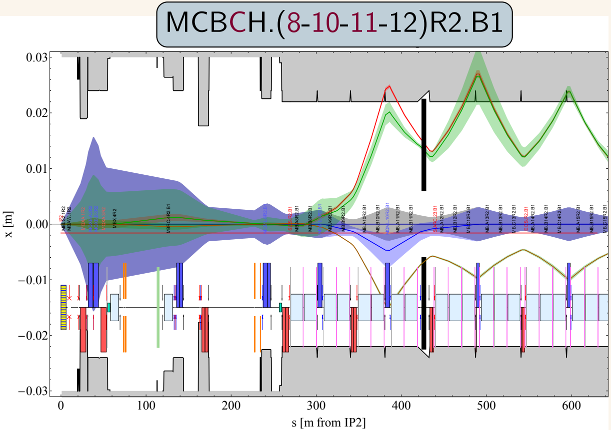


We also considered installing a new (existing type - MCBCH) corrector next to the, *to be installed*, collimator in the empty cryostat with the aim of reducing the strengths used by the existing correctors that were used to create the bumps. This also adds some flexibility to shape the bump and to have some control over the collimator impact angle of the BFPP beam.

Plots of the other bumps can be found in the backup slides.

Actual kick values can be found in tables in the backup slides

3 correctors + a new corrector



The tables below show the used corrector strengths for both cases, without and with the additional corrector (named MCBCH.11R2 below). Again the used strength values are shown in percentage.

MCB(C)H.XR2.B1	6	8	10	11	12	14
Bump 1	26	57			46	
Bump 2		30	11		32	
Bump 3		30			31	17

MCB(C)H.XR2.B1	6	8	10	11	12	14
Bump 1	04	31		16	25	
Bump 2		30	10	43	20	
Bump 3		30		23	26	00

Plots of the other bumps can be found in the backup slides.

Actual kick values can be found in tables in the backup slides

CERN

Summary

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- YES
- Do we need an extra corrector?
- Not necessarily,
- but can be useful to reduce load on magnets and
- adds extra flexibility in bump shape.
- Residual corrector strength available with bump without extra corrector : 40-50 percent
- Residual corrector strength available with bump with extra corrector : 60-70 percent

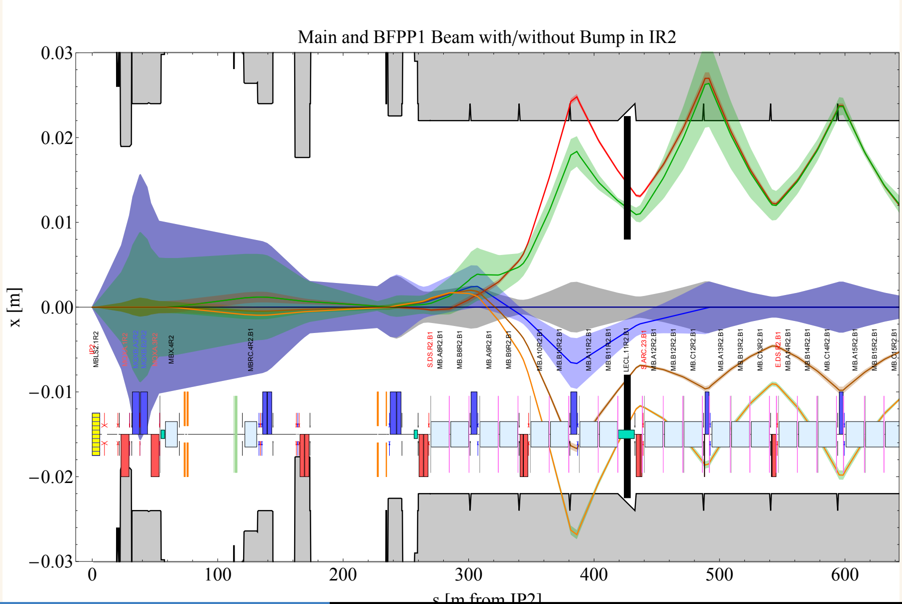
BACKUP SLIDES

Angle Kicks

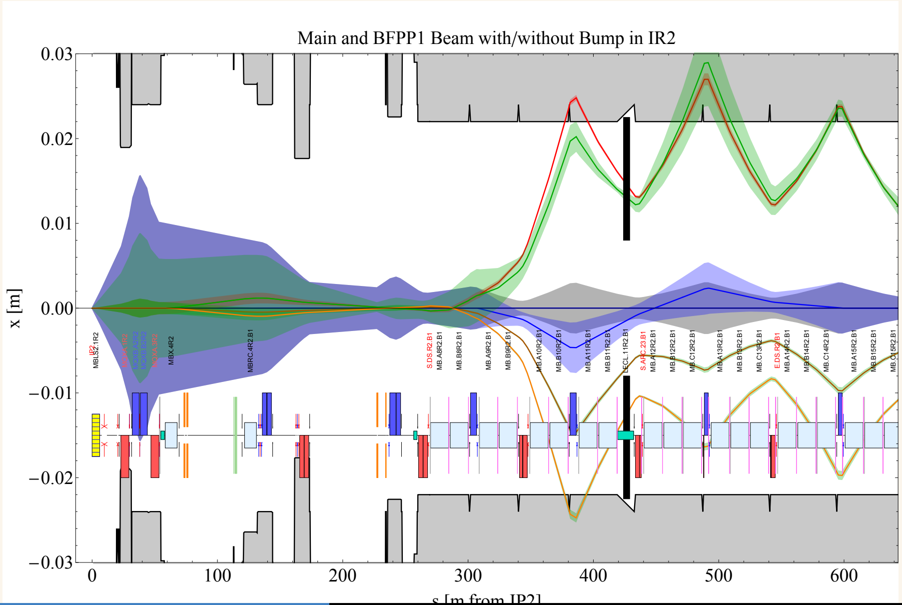
MCB(C)H.XR2.B1	6	8	10	12	14
Bump 1	2.38242e-5	-6.82452e-5		-3.76679e-5	
Bump 2		-3.63689e-5	-1.33984e-5	-2.63415e-5	
Bump 3		-3.63689e-5		-2.52651e-5	1.34225e-5

MCB(C)H.XR2.B1	6	8	10	11	12	14
Bump 1	3.99235e-6	-3.63689e-5		-1.90735e-5	-2.07889	
Bump 2		-3.63689e-5	1.17765e-5	-5.1742e-5	-1.61124e-5	
Bump 3		-3.63689e-5		-2.76846e-5	-2.10093e-5	-8.5219e-11

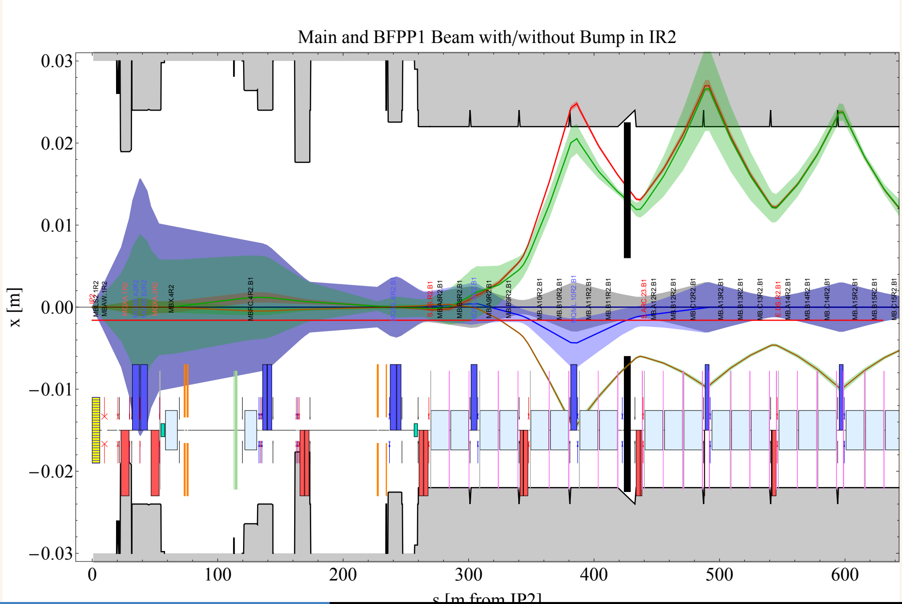
Bump R6R8R12



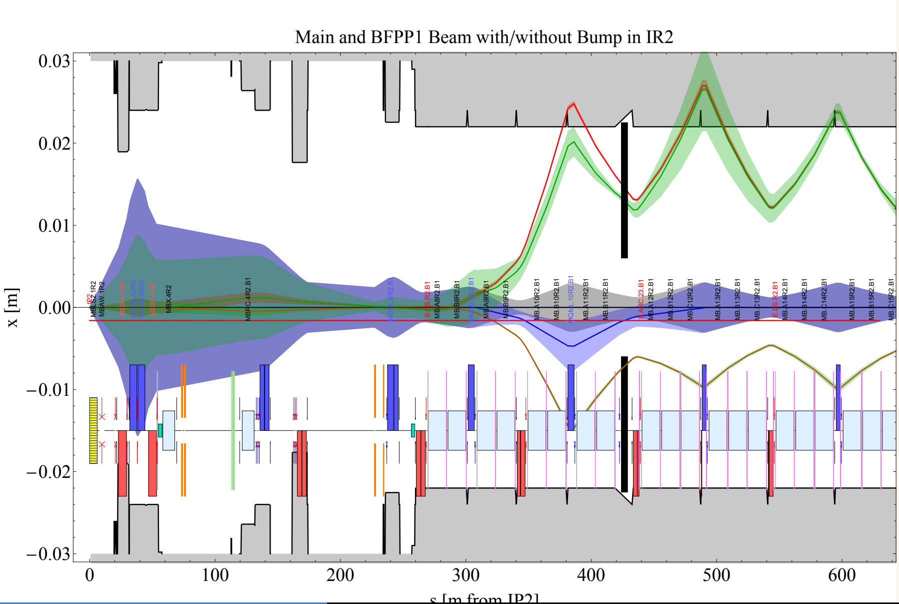
Bump R8R12R14



Bump R6R8R11R12



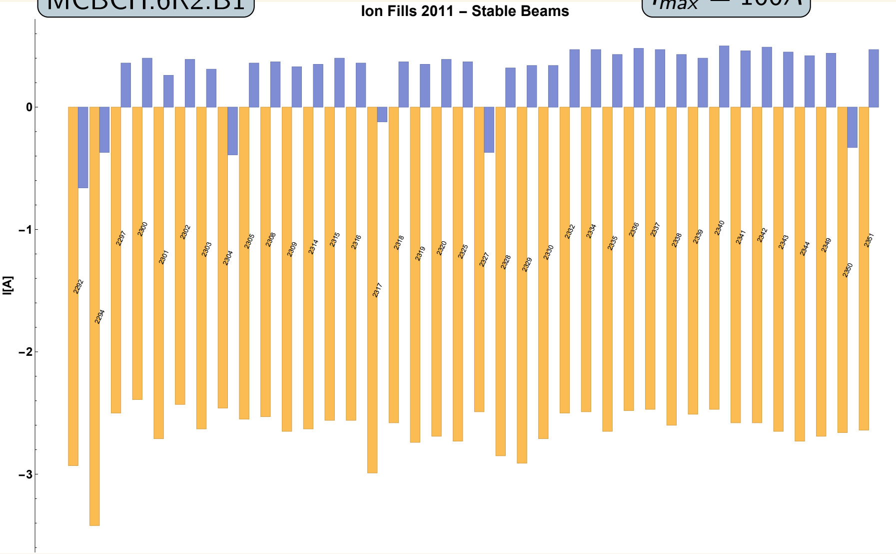
Bump R8R11R12R14



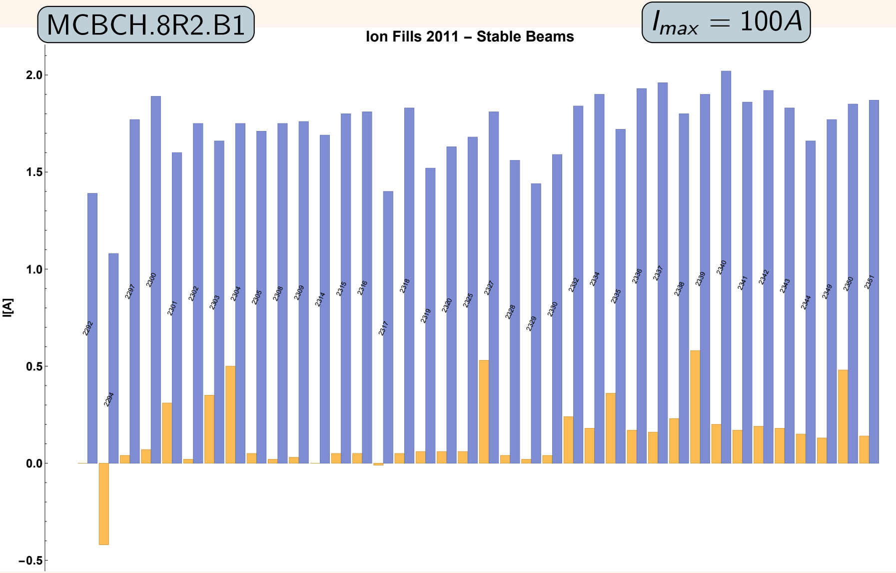
Strenghth used for ions 2011: R6

MCBCH.6R2.B1

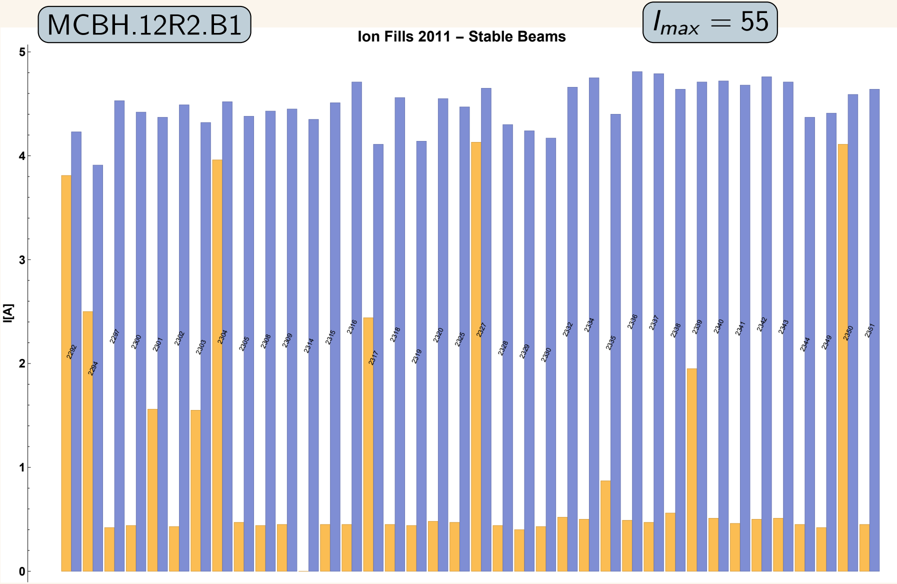
$I_{max} = 100A$



Strength used for ions 2011: R8



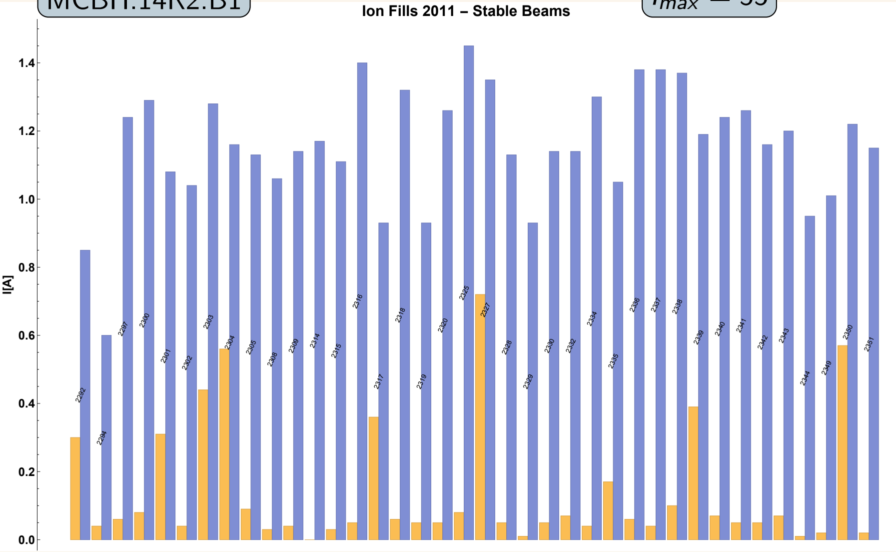
Strength used for ions 2011: R12



Strength used for ions 2011: R14

MCBH.14R2.B1

$I_{max} = 55$



Bibliography

R. Bruce, D. Bocian, S. Gilardoni, and J. M. Jowett.
Beam losses from ultraperipheral nuclear collisions between $^{208}\mathrm{Pb}^{82+}$ ions in the large hadron collider and their alleviation.
Phys. Rev. ST Accel. Beams, 12:071002, Jul 2009.
doi: 10.1103/PhysRevSTAB.12.071002.
URL http://link.aps.org/doi/10.1103/PhysRevSTAB.12.071002.

John M Jowett, Hans Heinrich Braun, M I Gresham, E Mahner, A N Nicholson, Elena Shaposhnikova, and I A Pshenichnov.
Limits to the Performance of the LHC with Ion Beams.
(LHC-Project-Report-772. CERN-LHC-Project-Report-772):4 p, Aug 2004.
revised version submitted on 2004-10-21 11:24:16.

Spencer R Klein.
Localized beampipe heating due to e- capture and nuclear excitation in heavy ion colliders.
Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 459(1):51–57, 2001.

Helmar Meier, Zlatko Halabuka, Kai Hencken, Dirk Trautmann, and Gerhard Baur.
Bound-free electron-positron pair production in relativistic heavy-ion collisions.
Phys. Rev. A, 63:032713, Feb 2001.
doi: 10.1103/PhysRevA.63.032713.
URL http://link.aps.org/doi/10.1103/PhysRevA.63.032713.

C Oppedisano and the ALICE Collaboration.
Measurement of the electromagnetic dissociation cross section of pb nuclei at $\sqrt{s_{\mathrm{NN}}} = 2.76\,TeV$.
Journal of Physics G: Nuclear and Particle Physics, 38(12):124174, 2011.
URL http://stacks.iop.org/0954-3899/38/i=12/a=124174.

Bibliography II

I.A. Pshenichnov.
Electromagnetic excitation and fragmentation of ultrarelativistic nuclei.
Physics of Particles and Nuclei, 42(2):215–250, 2011.
ISSN 1063-7796.
doi: 10.1134/S1063779611020067.
URL http://dx.doi.org/10.1134/S1063779611020067.