Commissioning Scenarios and Availability of Loss Data

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Outlines

- Recall of simulated commissioning scenarios for
  - different collimator settings
  - energies
  - imperfections

- Available FLUKA inputs for scenarios of interest

- Preliminary planning for future studies

Commissioning Scenarios

Simulations have been performed for:

1. Different complements of collimators (according to production and installation schedule with respect to foressen beam commissioning schedule)

2. Different settings of collimators

3. Different energies from injection up to collision

4. Impact of imperfections has been taken into account

Commissioning Scenarios

Simulations have been performed for:

1. Different complements of collimators (according to production and installation schedule with respect to estimated beam commissioning schedule)

The full phase 1 system is installed

↓

We assume that we have time to set up the full system: simulations with 44 ring collimators per beam (15 hours for setup).
Operation with a limited number of collimators is not excluded during commissioning.

Collimator settings during ramp

Three possible settings have been analyzed:

1. **Constant**: collimator apertures (in mm) are kept unchanged as at injection.

2. **Intermediate/Tolerance optimized**: primary collimators are closed at 6σ, remaining collimators are closed by keeping the retraction (in mm) with respect to the TCP unchanged ==> Tolerance budget constant*

3. **Nominal**: all collimator gaps are scaled with $\sqrt{\gamma}$ (TCP at 6σ)

*see CWG talk 23/04/2007

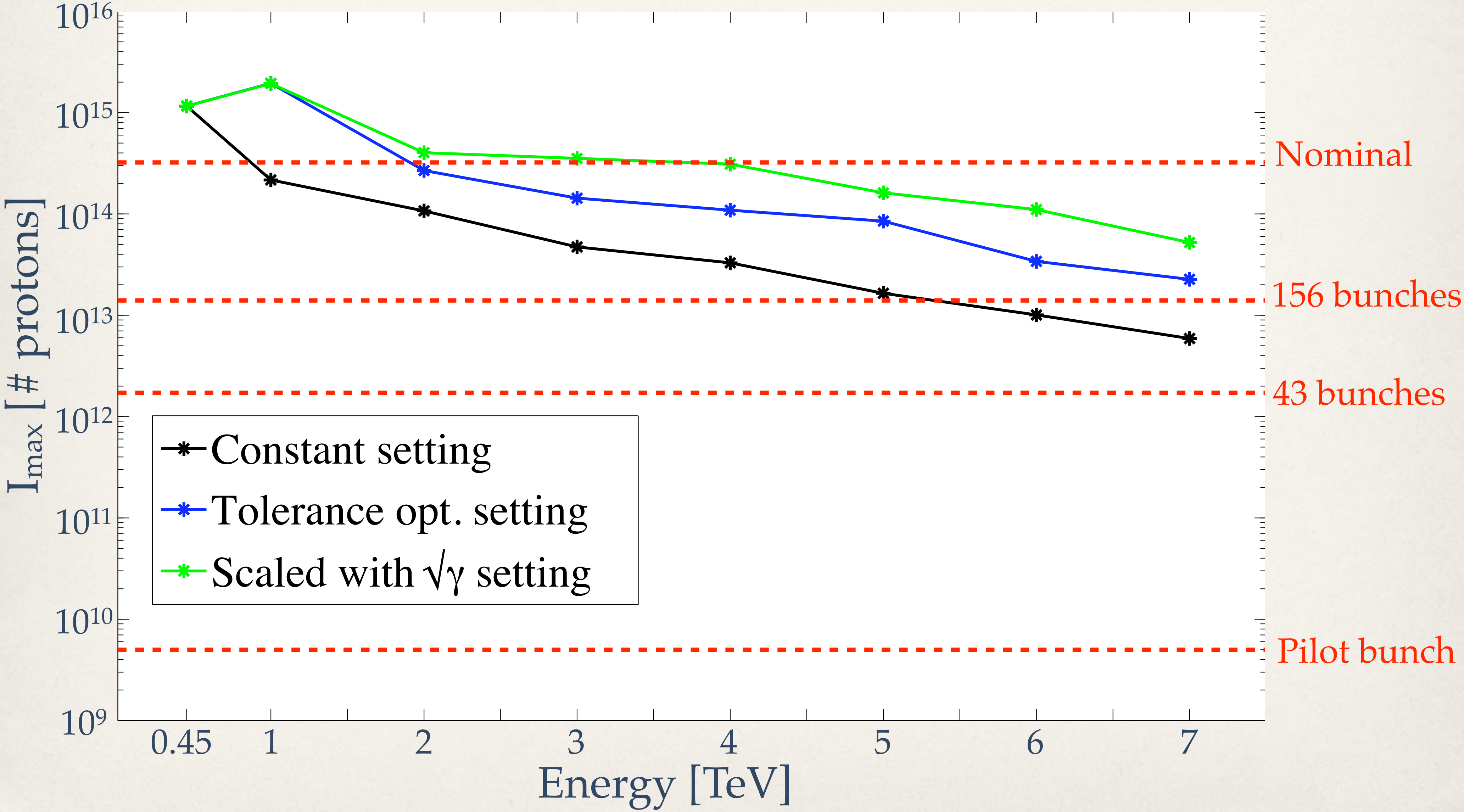
Collimator settings during ramp

Intermediate case is the commissioning scenario approved by the LMC.

Energy [TeV]	Half gaps [σ]							
	IR3			IR6		IR7		
	TCP	TCSG	TCLA	TCSG	TCDQ	TCP	TCSG	TCLA
0.45	8.3	9.6	10.3	7.3	8.3	6	7	10.3
1	9.5	11.4	12.5	8	9.5	6	7.5	12.5
2	10.6	13.2	14.6	8.6	10.6	6	8	14.6
3	12	15.4	17.2	9.4	12	6	8.6	17.2
4	13	16.8	19	10	13	6	9	19
5	13.6	18	20.2	10.3	13.6	6	9.3	20.2
6	14.4	19.2	21.7	10.8	14.4	6	9.7	21.7
7	15.2	20.4	23.2	11.1	15.2	6	10	23.2

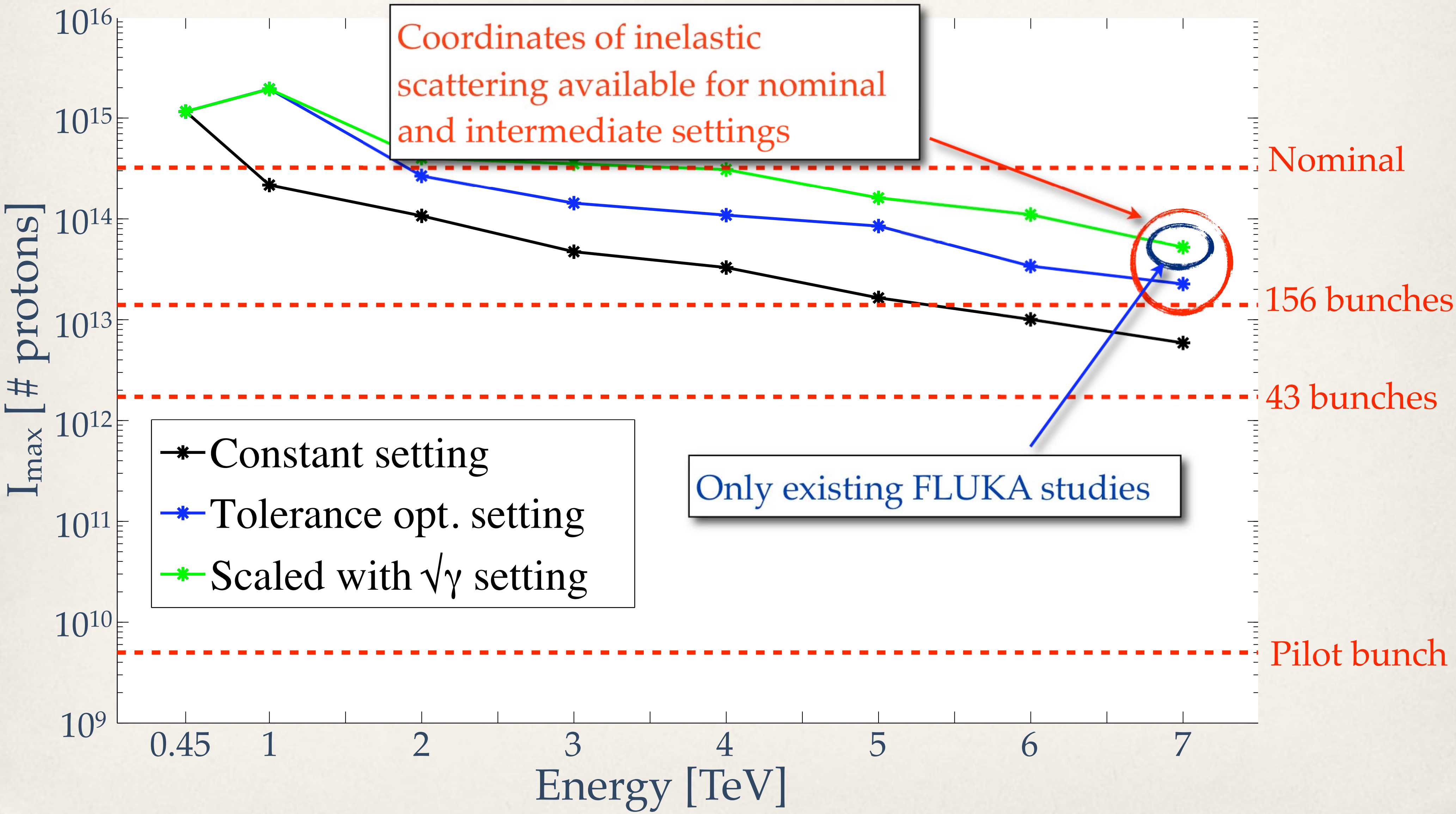
Intensity Reach During Energy Ramp

Ideal Machine ! (~1 order of magnitude lower I_{max} for real machine)



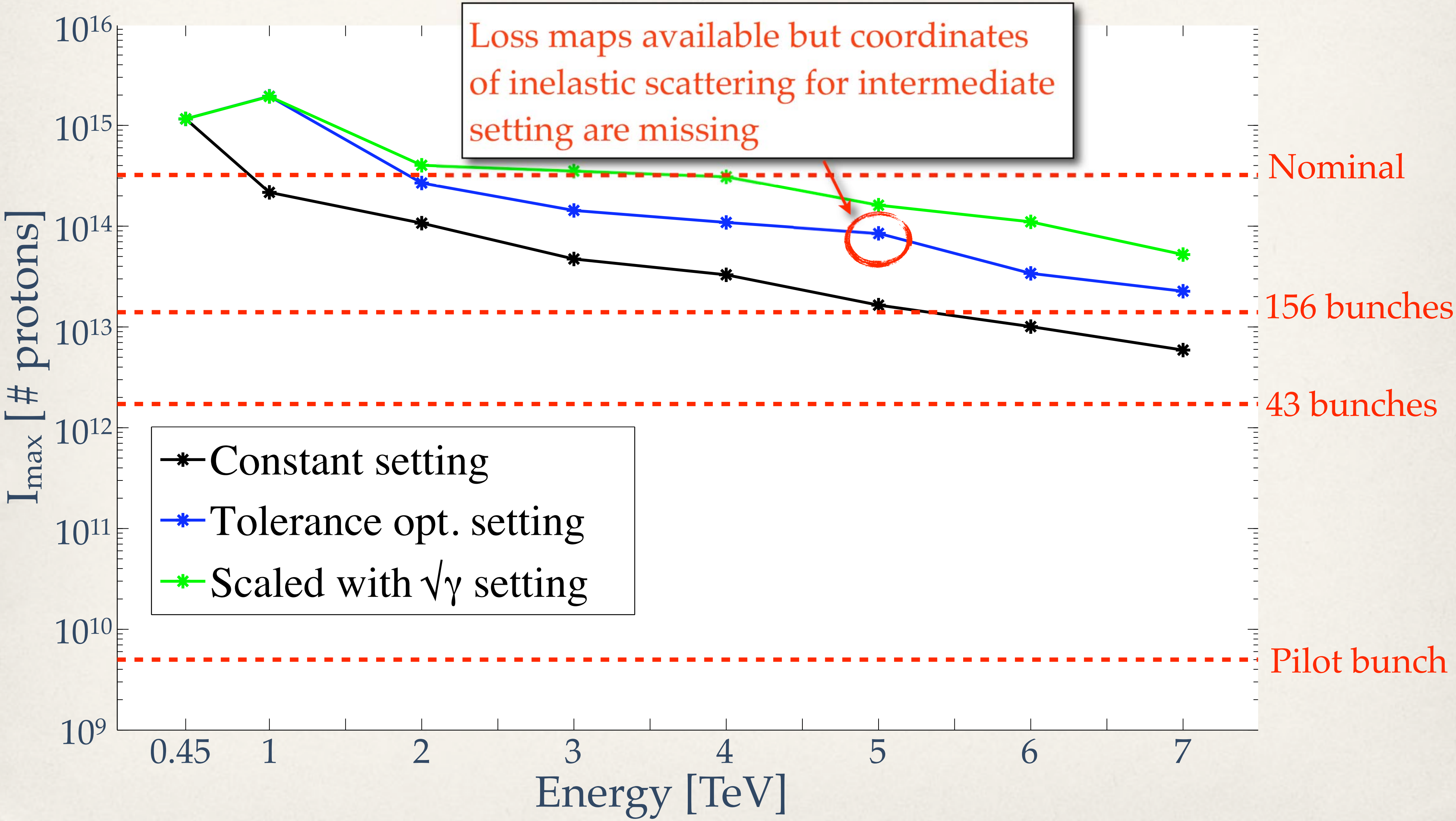
Intensity Reach During Energy Ramp

Ideal Machine ! (~1 order of magnitude lower I_{max} for real machine)



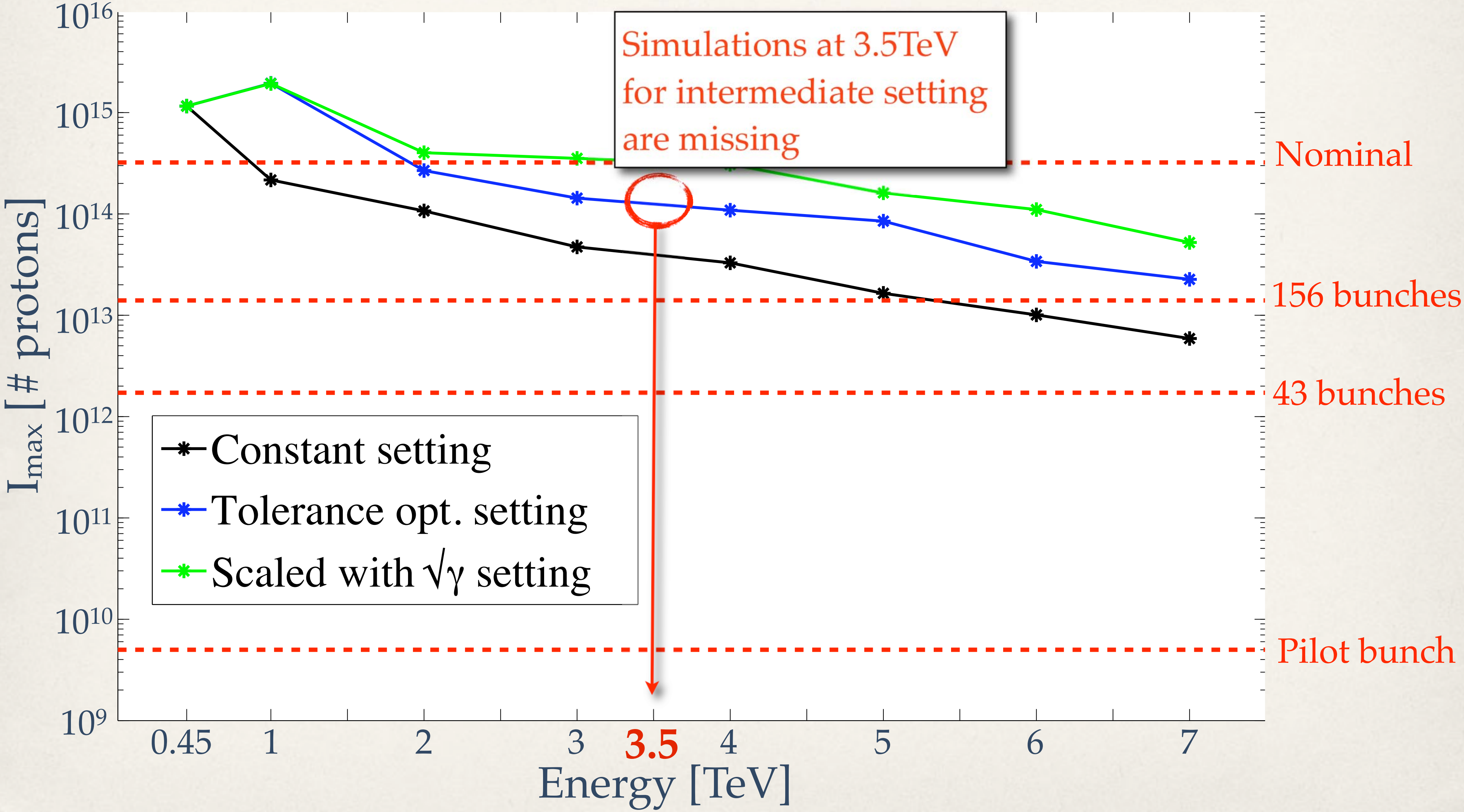
Intensity Reach During Energy Ramp

Ideal Machine ! (~1 order of magnitude lower I_{max} for real machine)

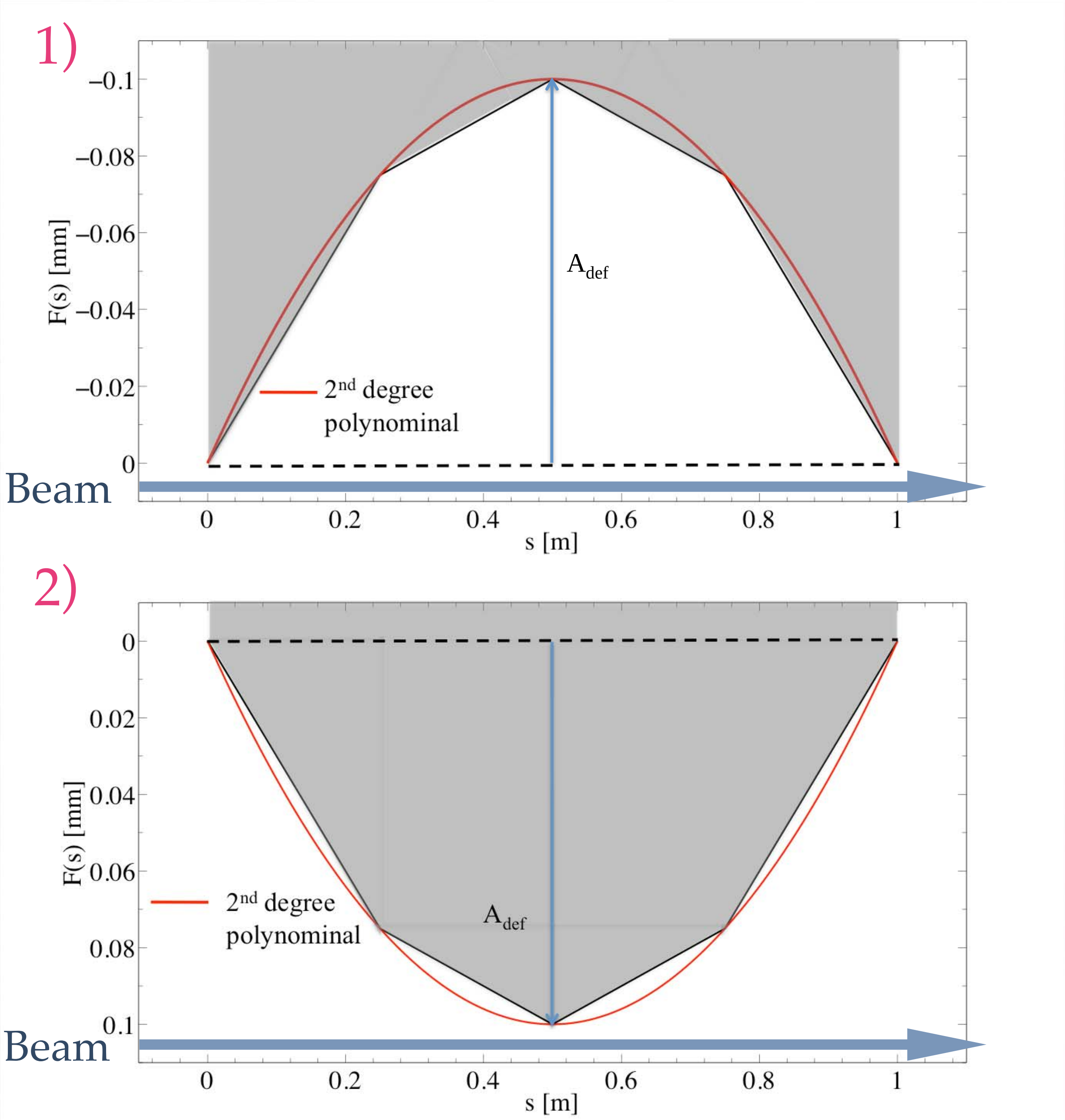


Intensity Reach During Energy Ramp

Ideal Machine ! (~1 order of magnitude lower I_{max} for real machine)



Jaw Imperfections



- Systematic jaw deformation:

1.Outwards with respect to the beam

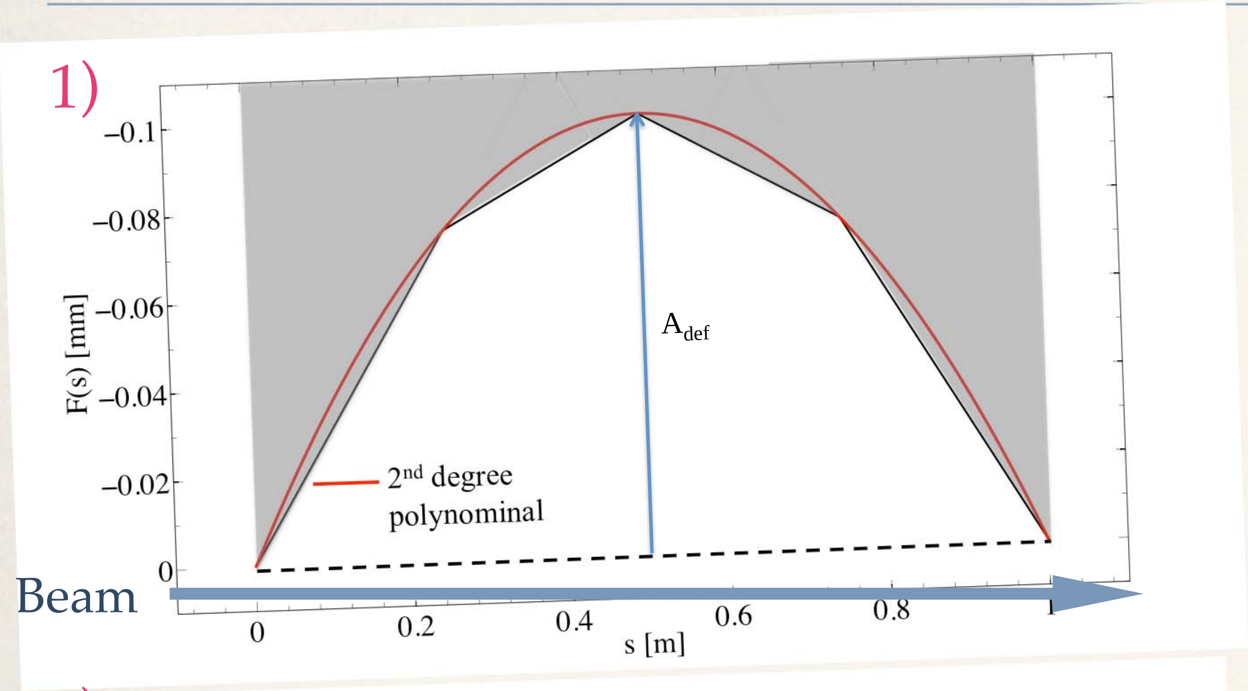
2. Inwards with respect to the beam

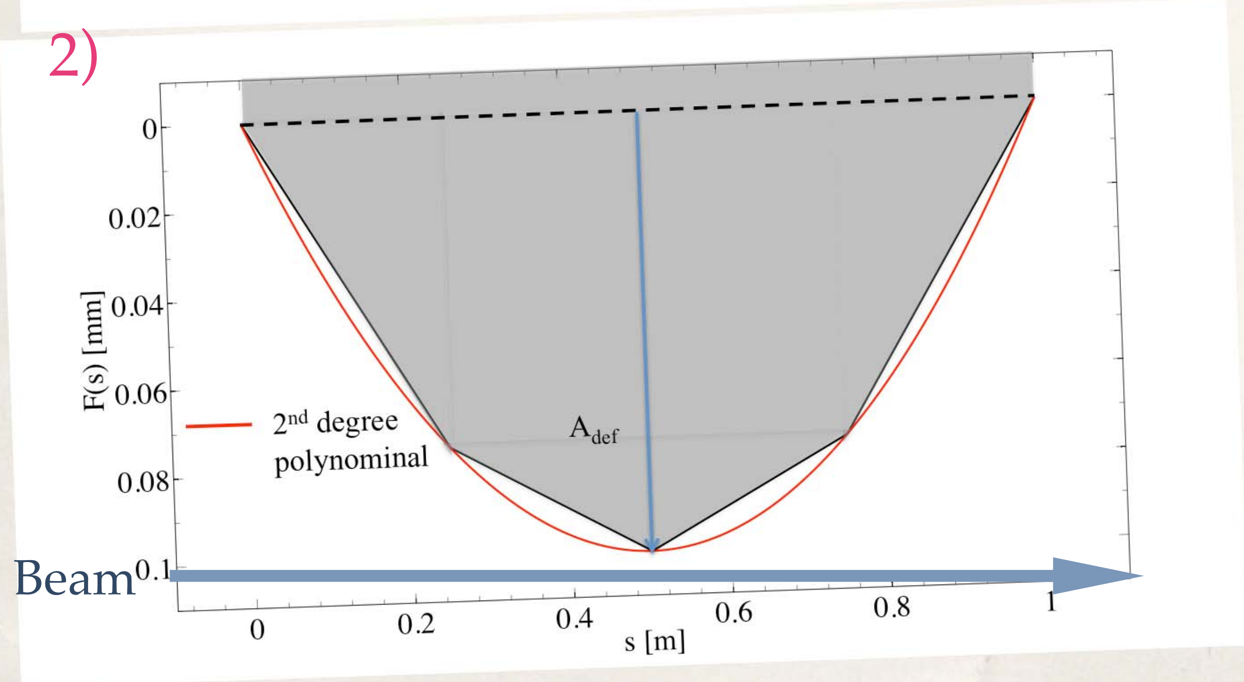
4 slices following the parabolic deformation:

A_{def} = 100 μm for 1m long jaws (TCS,TCLA,TCT)

A_{def} = 60 μm for 0.6m long jaws (TCP)

Jaw Imperfections





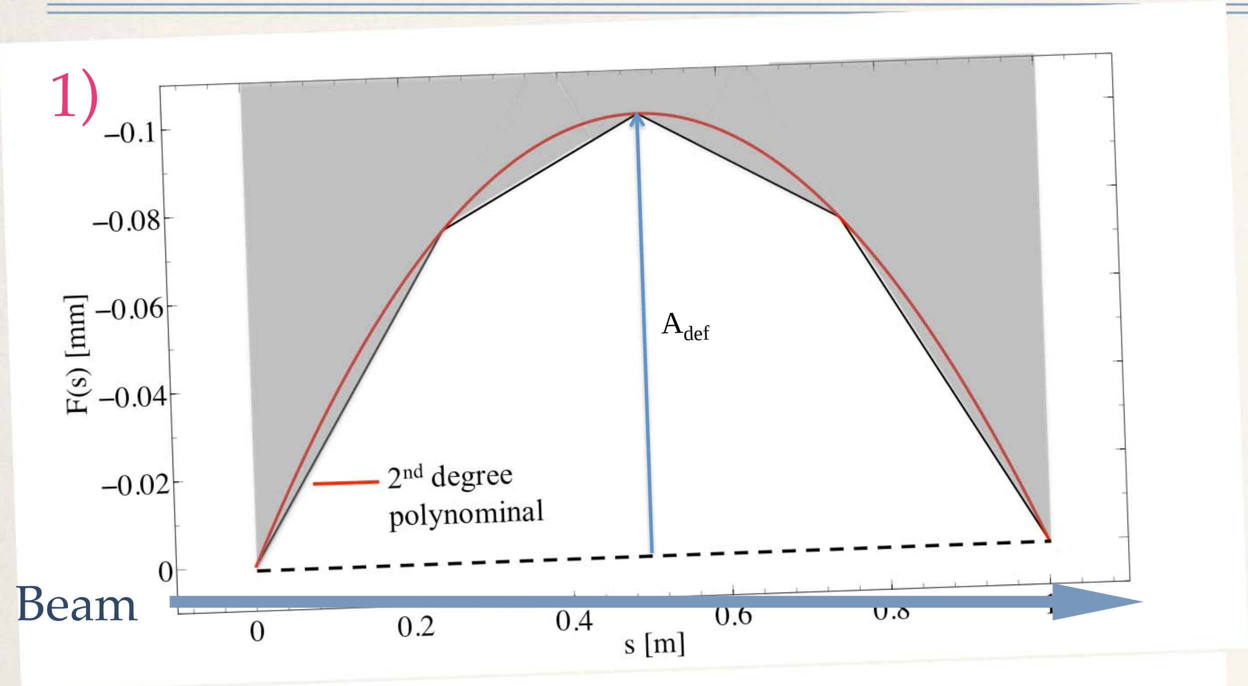
- Systematic jaw deformation:

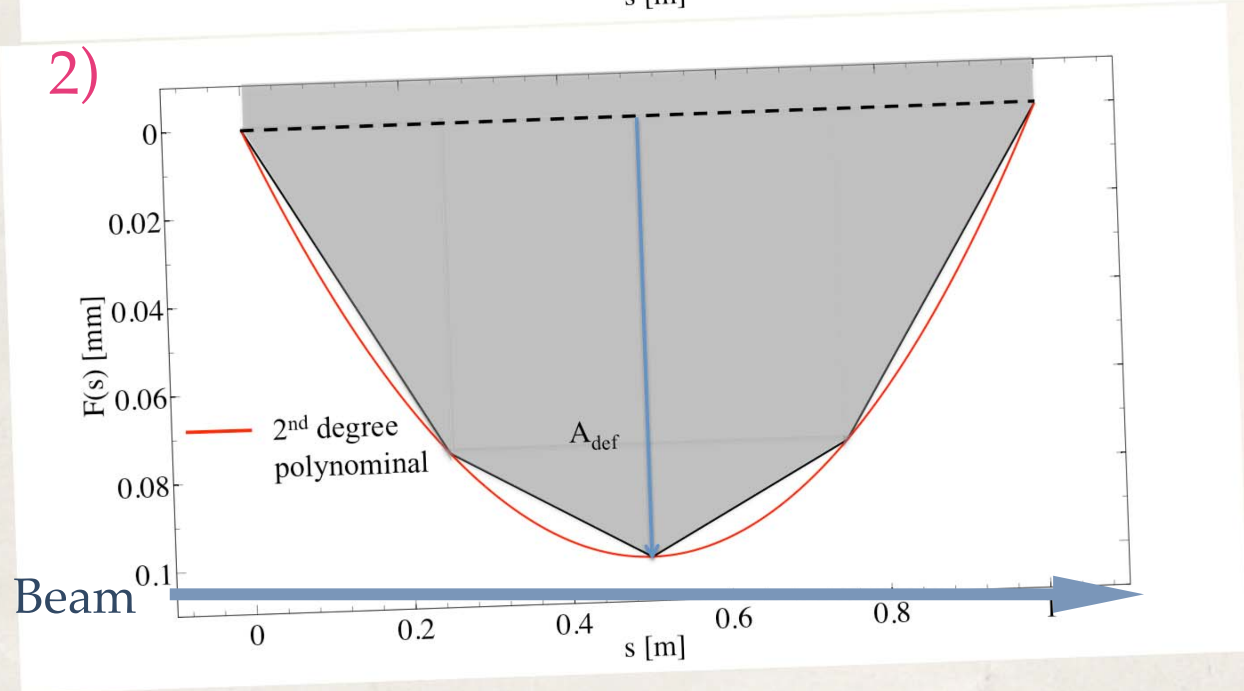
1. Outwards with respect to the beam

2. Inwards with respect to the beam

- Random tilt : 200μrad r.m.s.

Jaw Imperfections





- Systematic jaw deformation:

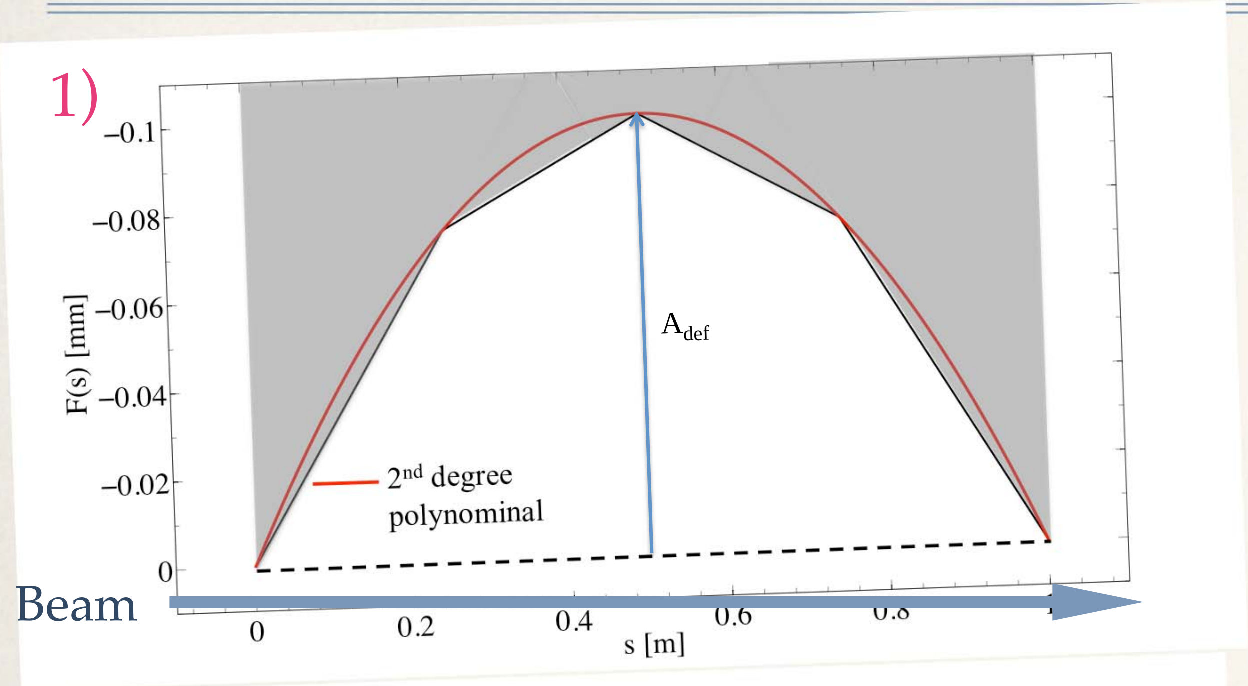
1. Outwards with respect to the beam

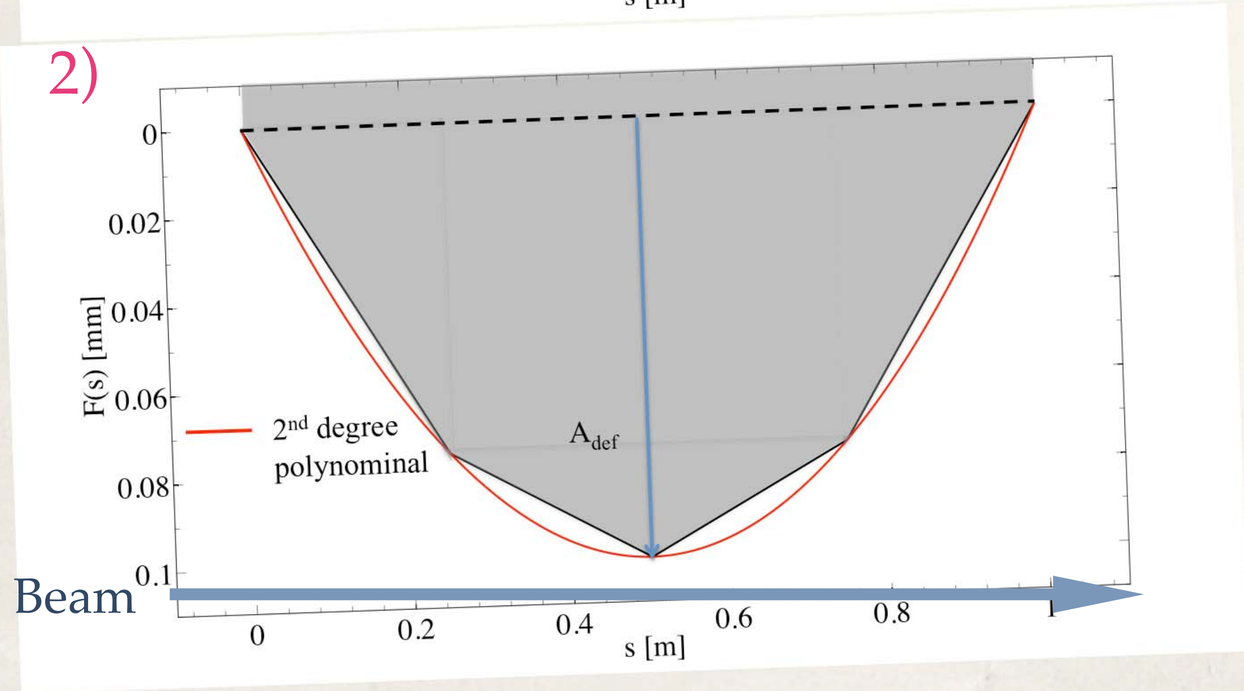
2. Inwards with respect to the beam

- Random tilt : 200µrad r.m.s.

- Random offset with respect to beam centre : 50µm r.m.s.

Jaw Imperfections





- Systematic jaw deformation:

1. Outwards with respect to the beam

2. Inwards with respect to the beam

- Random tilt : 200μrad r.m.s.

- Random offset with respect to beam centre : 50μm r.m.s.

- Random error on gap size: 0.1σ r.m.s

Jaw Imperfections

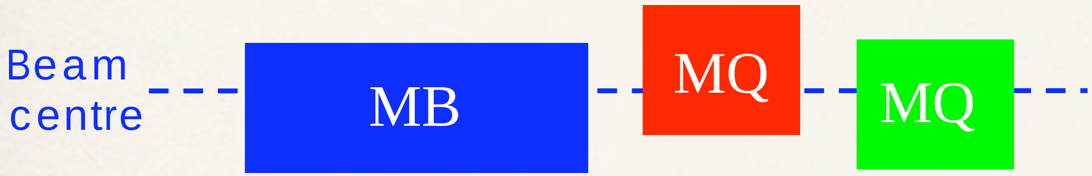
Data to implement jaw imperfections in FLUKA geometry

# name	slicenumber	halfgap[m]	gap_offset[m]	tilt jaw1[rad]	tilt jaw2[rad]	length[m]	material
TCP.C6L7.B1	1	0.84994E-02	0.48648E-05	-0.28651E-03	0.22164E-03	0.15000E+00	C
TCP.C6L7.B1	2	0.84913E-02	0.00000E+00	-0.86508E-04	0.21644E-04	0.15000E+00	C
TCP.C6L7.B1	3	0.84913E-02	0.00000E+00	0.11349E-03	-0.17836E-03	0.15000E+00	C
TCP.C6L7.B1	4	0.85131E-02	-0.48648E-05	0.31349E-03	-0.37836E-03	0.15000E+00	C
TCP.B6L7.B1	1	0.70974E-02	0.20384E-05	-0.22718E-03	0.18503E-03	0.15000E+00	C
TCP.B6L7.B1	2	0.70954E-02	0.00000E+00	-0.27179E-04	-0.14967E-04	0.15000E+00	C
TCP.B6L7.B1	3	0.70965E-02	-0.11225E-05	0.17282E-03	-0.21497E-03	0.15000E+00	C
TCP.B6L7.B1	4	0.71256E-02	-0.42834E-05	0.37282E-03	-0.41497E-03	0.15000E+00	C
TCSG.A6L7.B1	1	0.85841E-02	0.38271E-04	-0.54896E-03	0.39176E-03	0.25000E+00	C
TCSG.A6L7.B1	2	0.85165E-02	0.18620E-04	-0.34896E-03	0.19176E-03	0.25000E+00	C
TCSG.A6L7.B1	3	0.84979E-02	0.00000E+00	-0.14896E-03	-0.82394E-05	0.25000E+00	C
TCSG.A6L7.B1	4	0.84989E-02	-0.10299E-05	0.51036E-04	-0.20824E-03	0.25000E+00	C
TCSG.B5L7.B1	1	0.10113E-01	0.25360E-04	-0.40144E-03	0.19476E-03	0.25000E+00	C
TCSG.B5L7.B1	2	0.10088E-01	0.17989E-06	-0.20144E-03	-0.52441E-05	0.25000E+00	C
TCSG.B5L7.B1	3	0.10089E-01	-0.65552E-06	-0.14391E-05	-0.20524E-03	0.25000E+00	C
TCSG.B5L7.B1	4	0.10114E-01	-0.26311E-04	0.19856E-03	-0.40524E-03	0.25000E+00	C
TCSG.A5L7.B1	1	0.10319E-01	-0.24041E-04	-0.15198E-03	0.39233E-03	0.25000E+00	C
TCSG.A5L7.B1	2	0.10295E-01	0.00000E+00	0.48016E-04	0.19233E-03	0.25000E+00	C
TCSG.A5L7.B1	3	0.10301E-01	0.60020E-05	0.24802E-03	-0.76735E-05	0.25000E+00	C
TCSG.A5L7.B1	4	0.10333E-01	0.36045E-04	0.44802E-03	-0.20767E-03	0.25000E+00	C
TCSG.D4L7.B1	1	0.66635E-02	0.78668E-05	-0.26293E-03	0.78659E-04	0.25000E+00	C
TCSG.D4L7.B1	2	0.66557E-02	0.00000E+00	-0.62934E-04	-0.12134E-03	0.25000E+00	C
TCSG.D4L7.B1	3	0.66708E-02	-0.15168E-04	0.13707E-03	-0.32134E-03	0.25000E+00	C
TCSG.D4L7.B1	4	0.67281E-02	-0.38202E-04	0.33707E-03	-0.52134E-03	0.25000E+00	C

(data sent by Thomas to Marcus & Vasilis on 17/06/2008)

Machine Alignment errors

Apply a random offset to magnet beam screens
(no magnetic error)



	Design		Measured	
Type	$\sigma^{r.m.s}{}_{\Delta x}$[mm]	$\sigma^{r.m.s}{}_{\Delta y}$[mm]	$\sigma^{r.m.s}{}_{\Delta x}$[mm]	$\sigma^{r.m.s}{}_{\Delta y}$[mm]
MB	2.40	1.56	1.83	1.10
MQ	2.00	1.20	1.36	0.76
MQX	1.00	1.00	1.53	1.53
MQWA	2.00	1.20	0.67	0.41
MQWB	2.00	1.20	0.67	0.41
MBW	1.50	1.50	1.96	1.49
BPM	0.50	0.50	1.36	0.76

Machine Alignment errors

Data for FLUKA team:

Aperture model

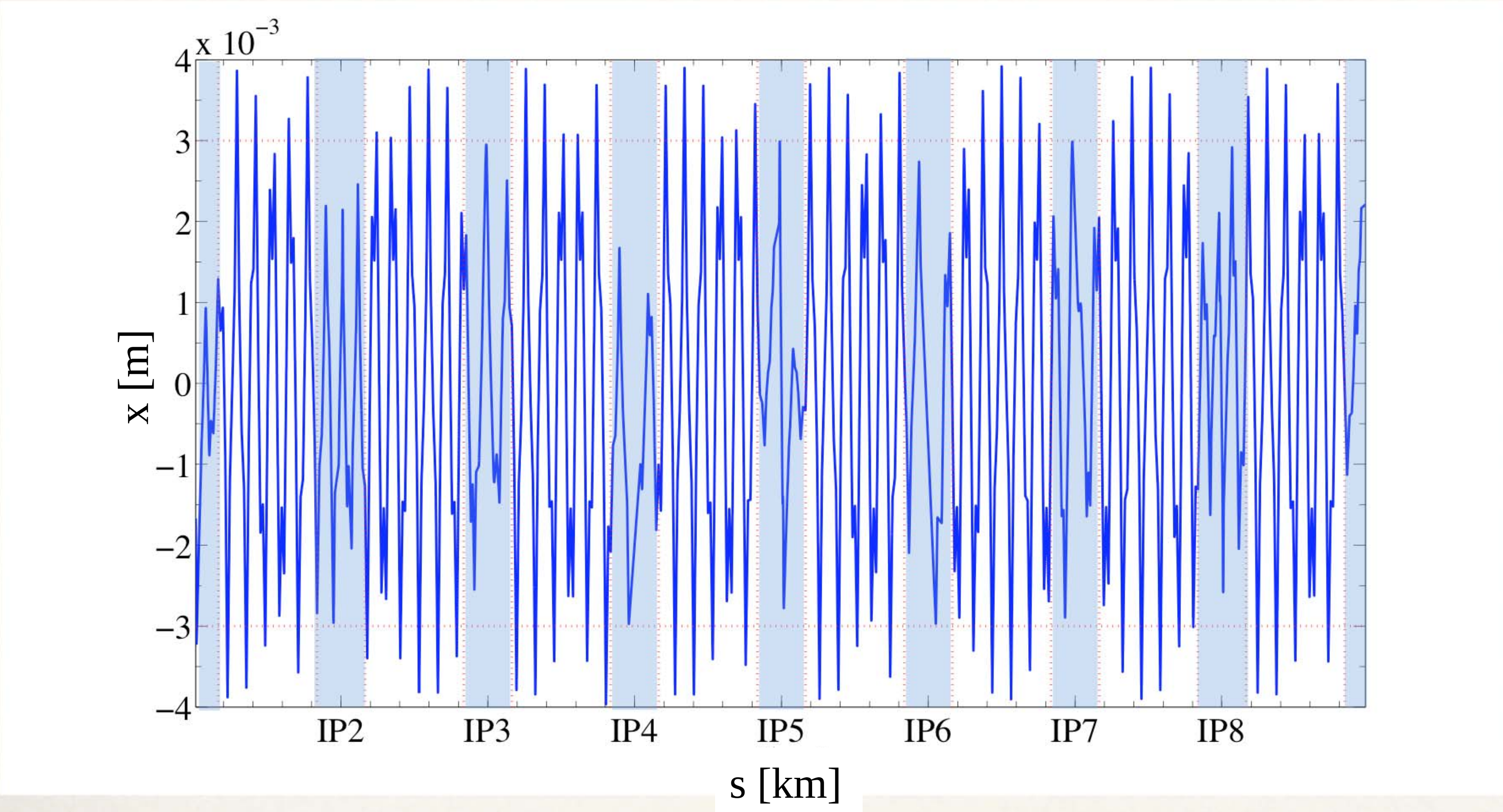
* KEYWORD	NAME	PARENT	S	L	APER_1	APER_2	APER_3	APER_4
$ %s	%s	%s	%le	%le	%le	%le	%le	%le
"RCOLLIMATOR"	"TAS.1R1"	"TAS"	20.850000	1.800000	0.017000	0.017000	0.017000	0.017000
"DRIFT"	"DRIFT_7"	"DRIFT"	21.214000	0.364000	0.000000	0.000000	0.000000	0.000000
"MARKER"	"BPMSW.S.1R1.B1"	"BPMSW"	21.214000	0.000000	0.030000	0.030000	0.030000	0.030000
"DRIFT"	"DRIFT_8"	"DRIFT"	21.347500	0.133500	0.000000	0.000000	0.000000	0.000000
"MONITOR"	"BPMSW.1R1.B1"	"BPMSW"	21.347500	0.000000	0.000000	0.000000	0.000000	0.000000
"MONITOR"	"BPMSW.1R1.B2"	"BPMSW"	21.347500	0.000000	0.000000	0.000000	0.000000	0.000000
"DRIFT"	"DRIFT_8"	"DRIFT"	21.481000	0.133500	0.000000	0.000000	0.000000	0.000000
"MARKER"	"BPMSW.E.1R1.B1"	"BPMSW"	21.481000	0.000000	0.030000	0.030000	0.030000	0.030000
"DRIFT"	"DRIFT_9"	"DRIFT"	22.554400	1.073400	0.000000	0.000000	0.000000	0.000000
"MARKER"	"VSSL.S.1R1.B1"	"VSSL_016H"	22.554400	0.000000	0.018950	0.023850	0.023850	0.023850
"DRIFT"	"DRIFT_10"	"DRIFT"	22.965000	0.410600	0.000000	0.000000	0.000000	0.000000
"QUADRUPOLE"	"MQXA.1R1"	"MQXA"	29.335000	6.370000	0.018950	0.023850	0.023850	0.023850

Applied offsets (design):

Pos Sta [m]	Pos End [m]	Dx_RMS [m]	Dy_RMS [m]	Type	Dx [m]	Dy [m]
21.214	21.3475	0.0005	0.0005	BPM	-0.000350902	7.57213e-05
22.5544	31.2134	0.001	0.001	MQX	8.67105e-05	0.00140999
31.3959	31.529	0.0005	0.0005	BPM	0.00037614	-0.000712969
31.6566	44.8523	0.001	0.001	MQX	0.000679286	-0.000390789
45.0443	54.763	0.001	0.001	MQX	0.000445983	-0.00127508
58.172	58.3145	0.0005	0.0005	BPM	-0.000295213	0.000290185

(data sent by Thomas to Marcus & Vasilis on 17/06/2008)

Specified Maximum Closed Orbit

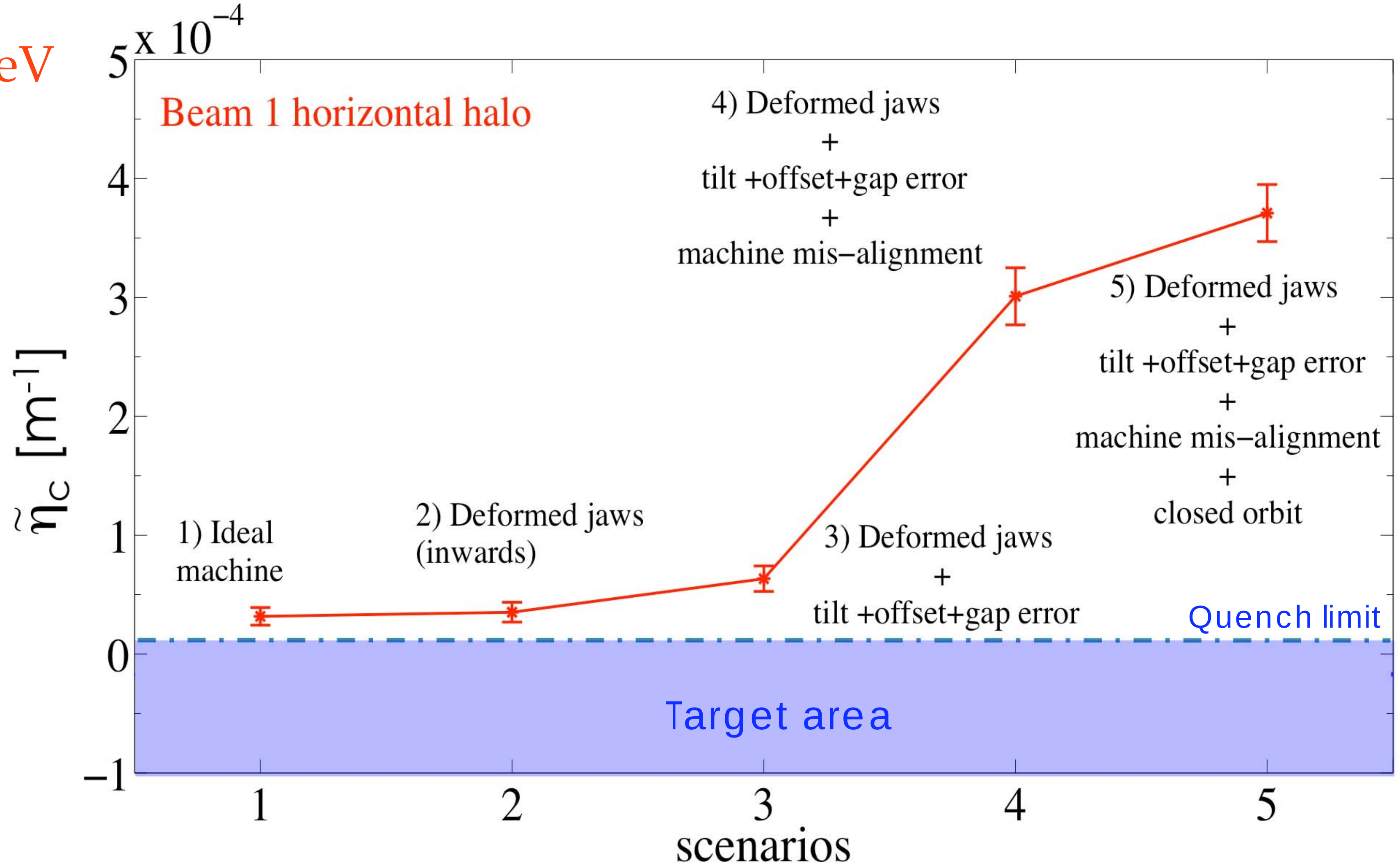


± 4 mm in the arcs
± 3 mm in the straight sections

New data to be provided:
Closed orbit in summary file + Twiss table

Impact of Imperfections on Performance

7TeV



Error bars: statistical error

Inputs for FLUKA available for all cases (uncleaned from fake impacts for scenarios 4 and 5)

Code modifications

Up to now:

- FLUKA inputs contain just coordinates for particles experiencing inelastic scattering in the collimator jaws.

- SixTrack keeps tracking particles experiencing single diffractive scattering in the collimator jaws.

Requirement for new simulations:

- Single diffractive scattering events to be recorded in the FLUKA inputs and not counted twice.
(reason: a factor of 2-2.5 higher cross section predicted by FLUKA).

Phase 2 Simulations (Luisella's PhD)

Outcome of the discussion between Ralph, Luisella and Daniel (29/05/2009):

1. Phase 2 nominal system with and without cryogenic collimators

2. Mixed Phase 1 - Phase 2 system in IR7: CFC jaws for horizontal jaws, metal jaws for skew and vertical collimators.
   - without cryogenic collimators
   - with cryogenic collimators (lower priority)

3. Impact of imperfections: tilted jaws for standard Phase 2 system.

Conclusions: Planning 1/3

Commissioning scenarios at different energy (with single diffractive scattering in FLUKA inputs)

What	When	Who	Beam/Halo
7 TeV nominal collimator settings, ideal machine (SD scattering test case)	2/3 weeks	Chiara	T.B.D
7 TeV intermediate collimator settings, ideal machine	existing	Chiara	T.B.D
5 TeV intermediate collimator settings, ideal machine	T.B.D.	Daniel?	T.B.D
3.5 TeV intermediate collimator settings, ideal machine	2/3 weeks	Chiara	T.B.D

* Data for 1 beam and 1 halo case, other halos later if needed (decision from FLUKA team)

Conclusions: Planning 2/3

Commissioning scenarios at 3.5 TeV + imperfections

What	When	Who	Beam/Halo
7 TeV intermediate collimator settings + aperture misalignment	Existing	Chiara/ Stefano	Beam1/hor
7 TeV intermediate collimator settings + jaw deformation	Existing	Chiara	Beam1/hor
7 TeV intermediate collimator settings + jaw deformation + tilt + offset + gap error	Existing	Chiara	Beam1/hor
7 TeV intermediate collimator settings + jaw deformation + tilt + offset + gap error + aperture misalignment	Existing (uncleaned)	Chiara	Beam1/hor
7 TeV intermediate collimator settings + jaw deformation + tilt + offset + gap error + aperture misalignment + orbit	Existing (uncleaned)	Chiara	Beam1/hor

Conclusions: Planning 3/3

Phase 2 for Luisella

What	When	Who	Beam/Halo
7 TeV nominal Phase 2 collimator settings without cryo-collimators	Done	Chiara	Beam1, hor., vert., skew
7 TeV nominal Phase 2 collimator settings with and without cryo-collimators	Done	Daniel/ Thomas	Beam1, hor.
7 TeV nominal collimator settings + mixed Phase 1-Phase 2 system	T.B.D	Chiara	T.B.D
7 TeV nominal collimator settings + Phase 2 collimator jaws tilted	T.B.D	Chiara	T.B.D.