Review of e+ transport from capture to Pre Damping Ring

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Thanks to:

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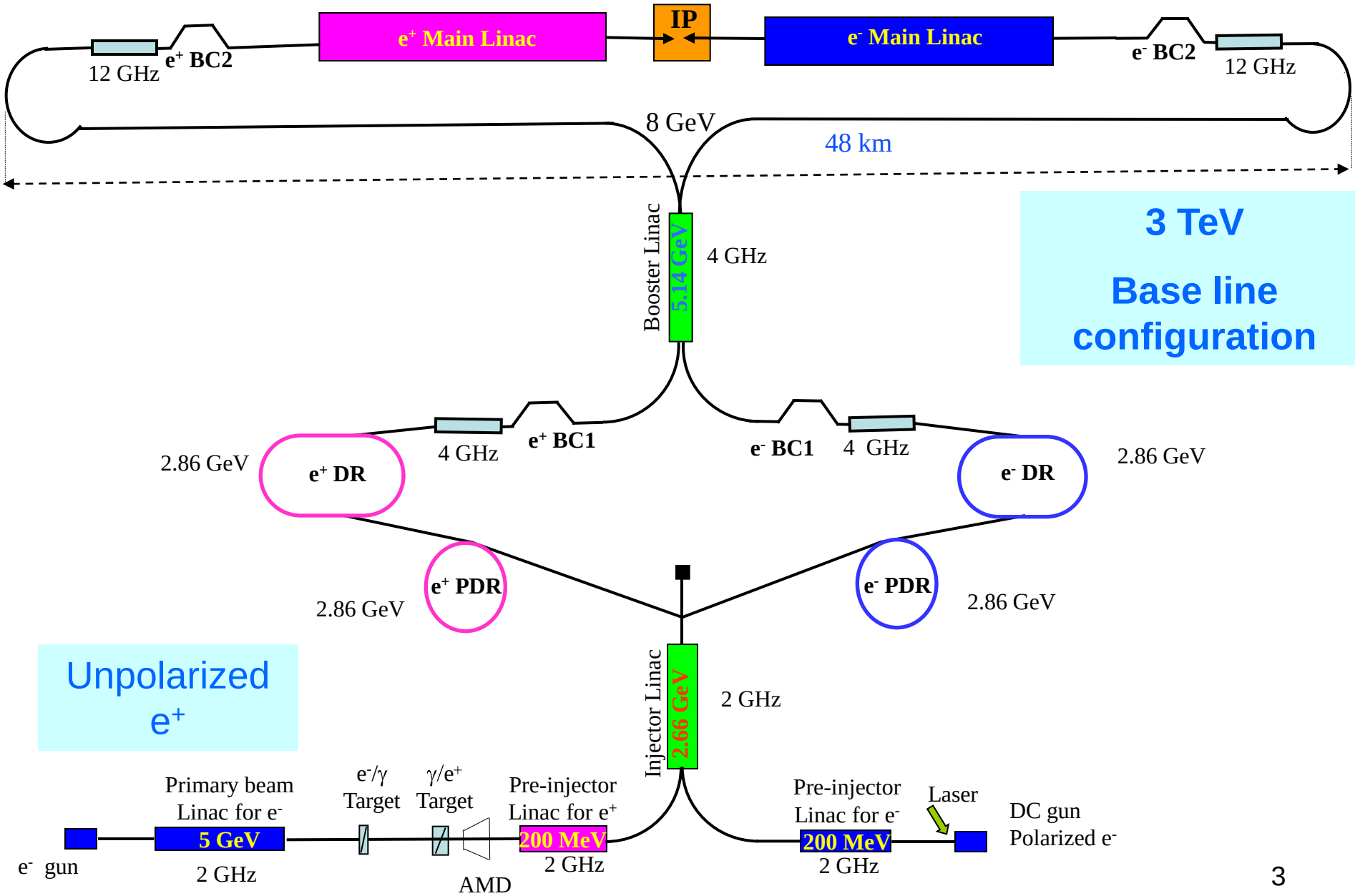
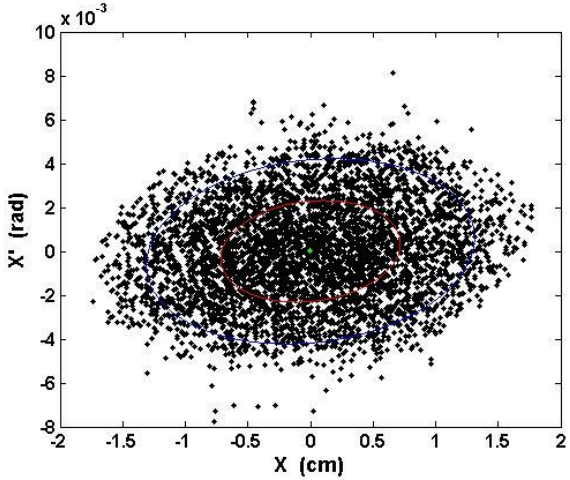
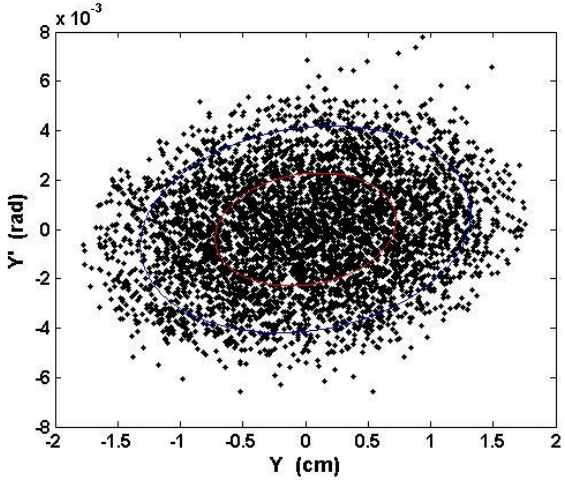
- General scheme of the CLIC positron source
- Design and Simulation of the sections
- Pre-Damping Ring Acceptance
- Conclusions

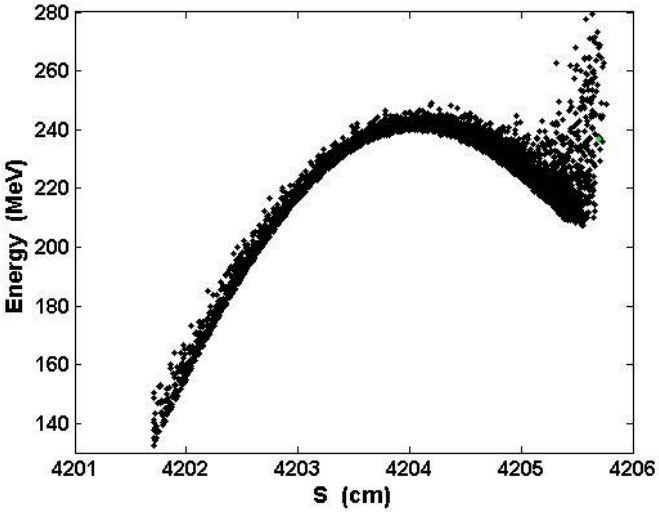
CLIC Main Beam Injector Complex (2009)



Capture Results

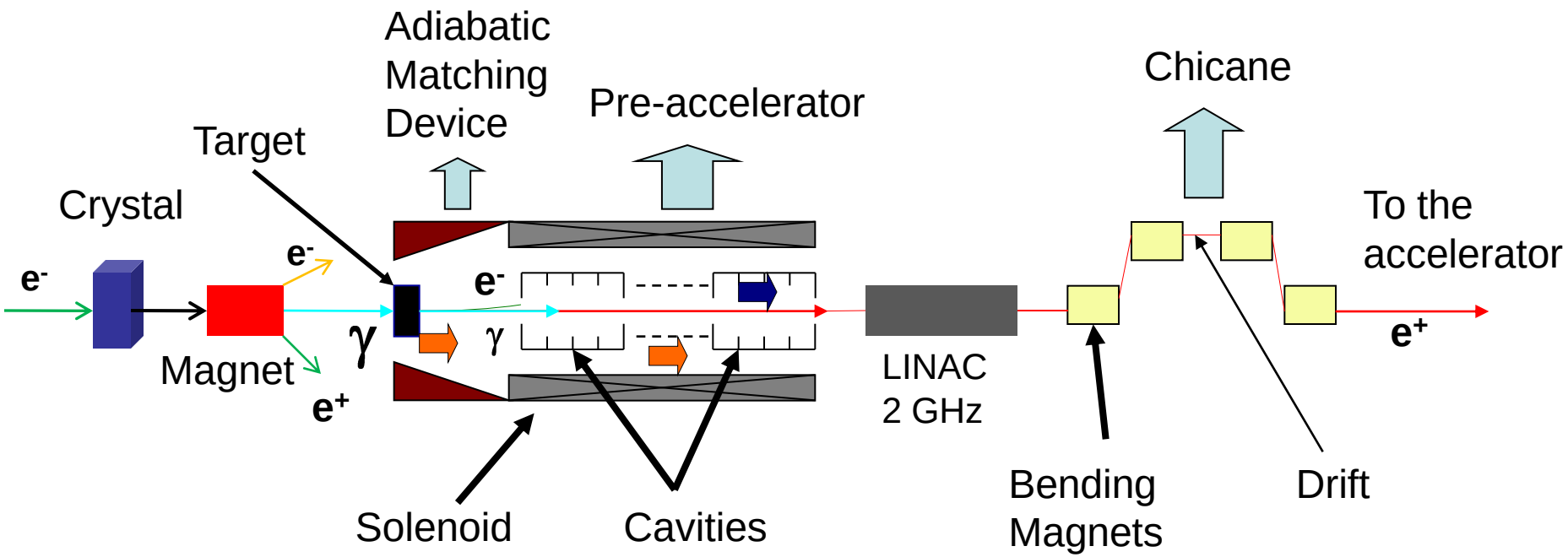






s cm	N. e^+	Yield e^+/e^-	$\gamma\varepsilon_x$ π mm mrad	$\gamma\varepsilon_y$ π mm mrad	<E> MeV	σ_E MeV	σ_z mm	ε_z π cm MeV
4204	4653	0.78	7395	7332	229.4	41.0	9.9	37.9

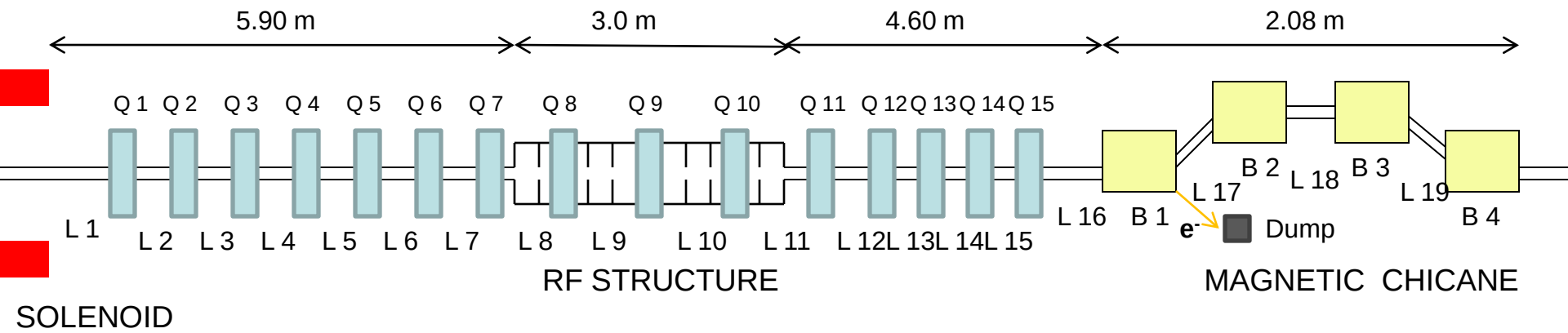
Capture Section (+ Bunch Compressor)

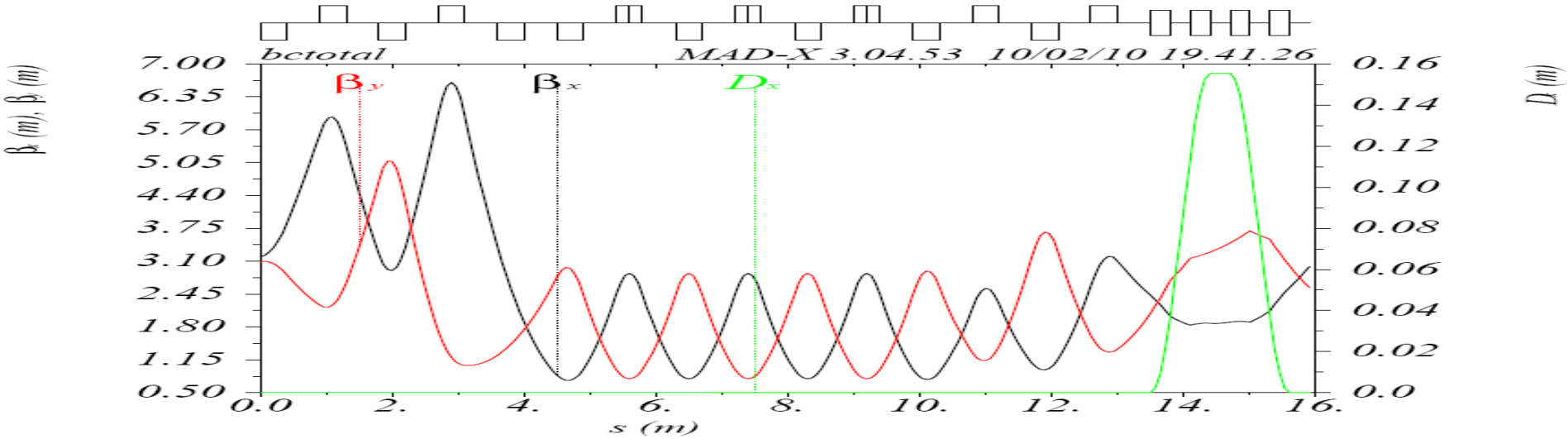


Magnetic field

Electric field

Bunch Compressor Design





Bunch Compressor Elements

Quadrupoles:

- Number: N = 15
- Length: L = 40 cm
- Gradient: G = 0.6 – 2.9 T/m
- Aperture: r = 5-20 cm

Accelerating cavities:

- Number of cavities: N = 1 TW
- Length: L = 3 m
- Average Gradient: E_z = 14.5 MV/m
- Frequency: ν = 2 GHz

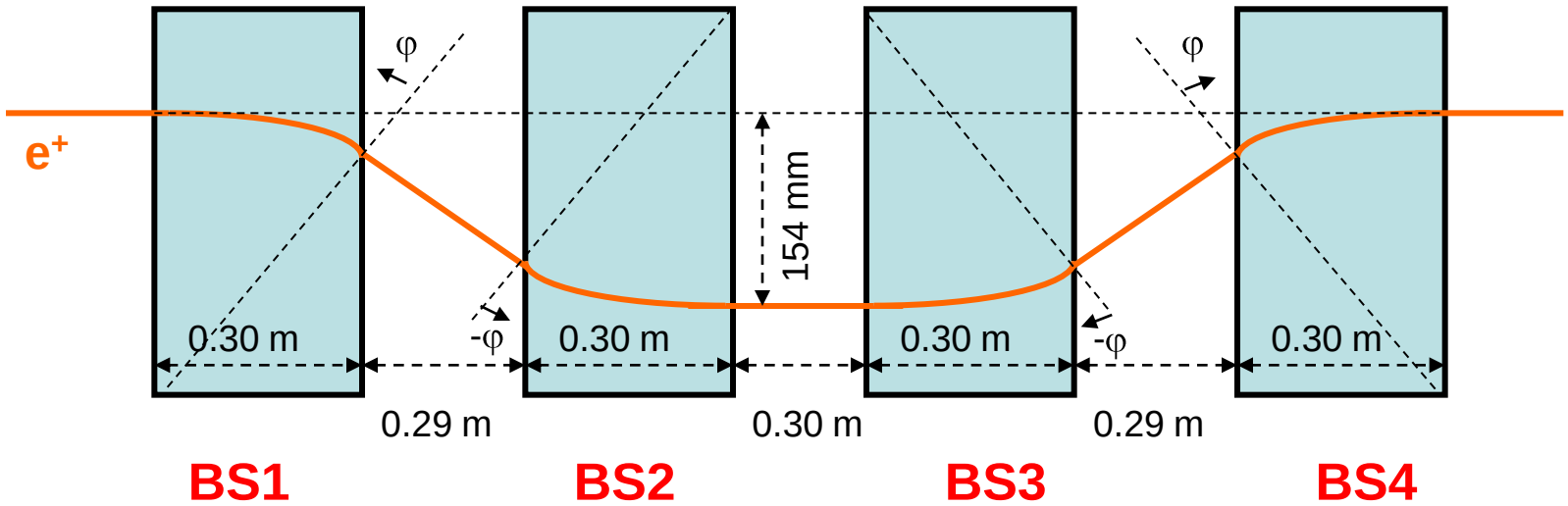
Bending Magnets:

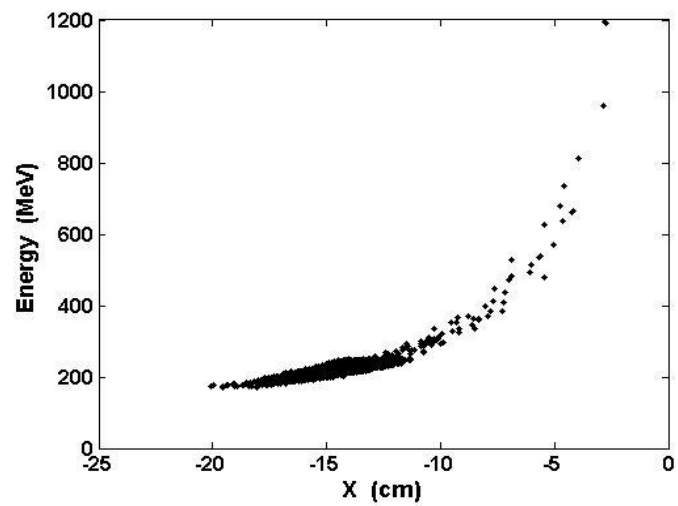
- Number: N = 4
- Length: L = 30 cm
- Magnetic Field: B = 0.584 T

Drift Spaces:

- Number: N = 19
- Aperture: r = 5 cm
- Length: L = 90-30 cm

MAGNETIC CHICANE

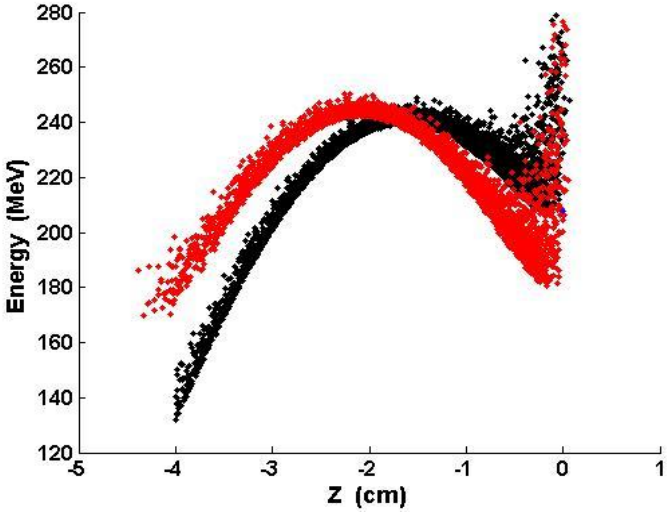


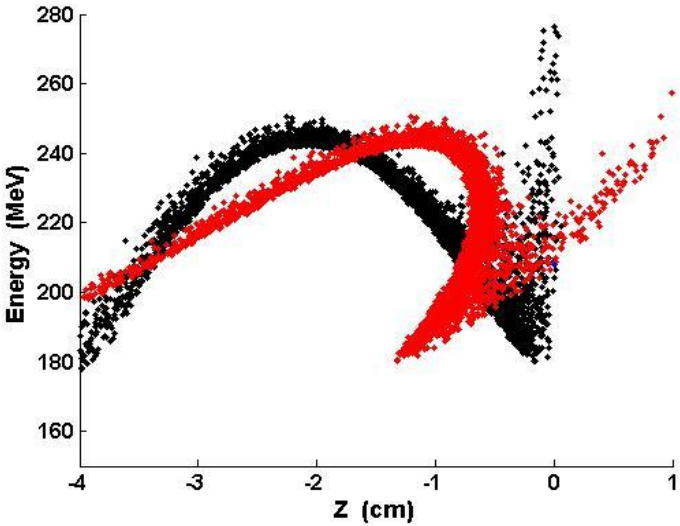


Chicane Modeling:

- Bending angle: φ = 14.76 deg
- Drift: λ = 30 cm
- Diaphragm: r = 3.6 cm

Bunch Compressor Results

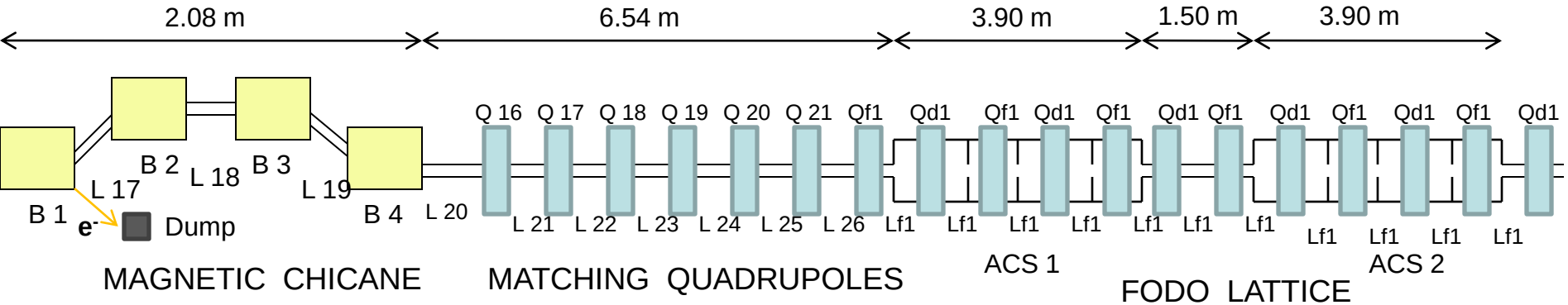


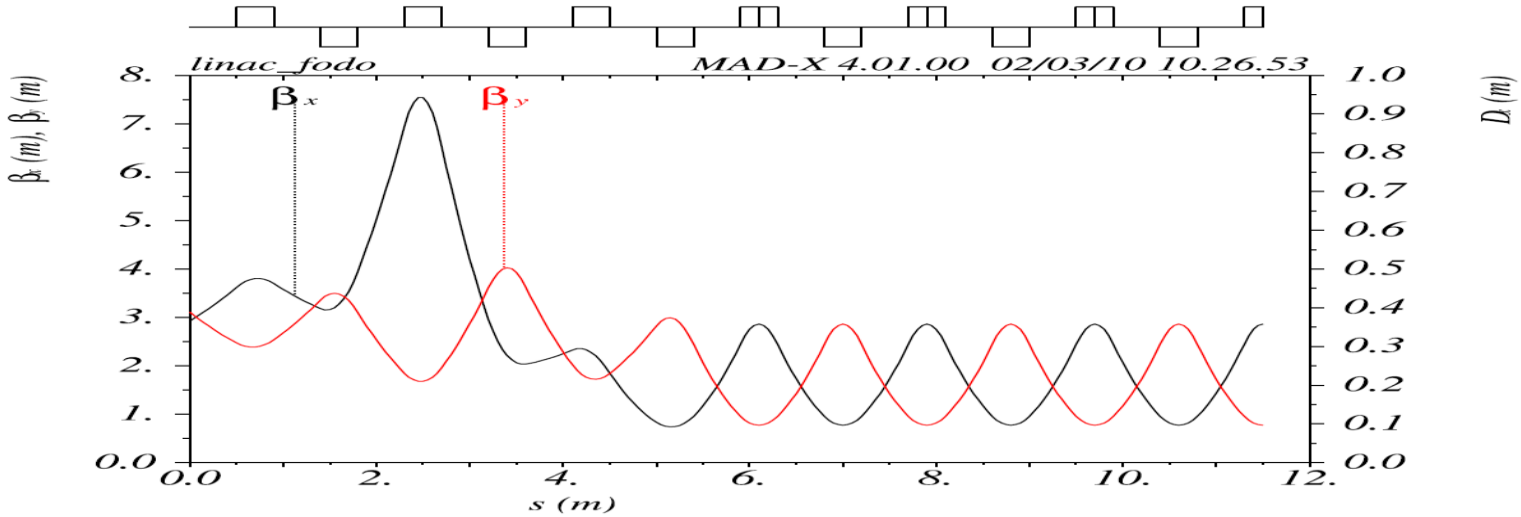


s cm	N. e^+	Yield e^+/e^-	$\gamma\varepsilon_x$ π mm mrad	$\gamma\varepsilon_y$ π mm mrad	<E> MeV	σ_E MeV	σ_z mm	ε_z π cm MeV
5772	4411	0.74	7461	7583	221.2	17.7	7.3	12.9

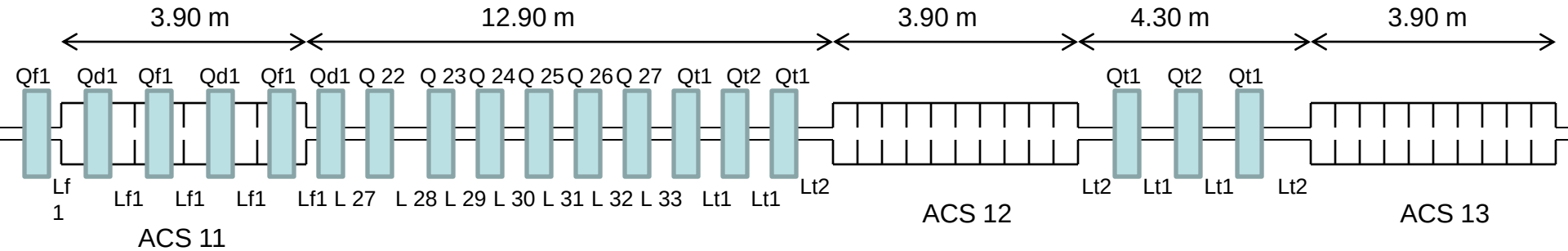
Injector Linac I (820 MeV)

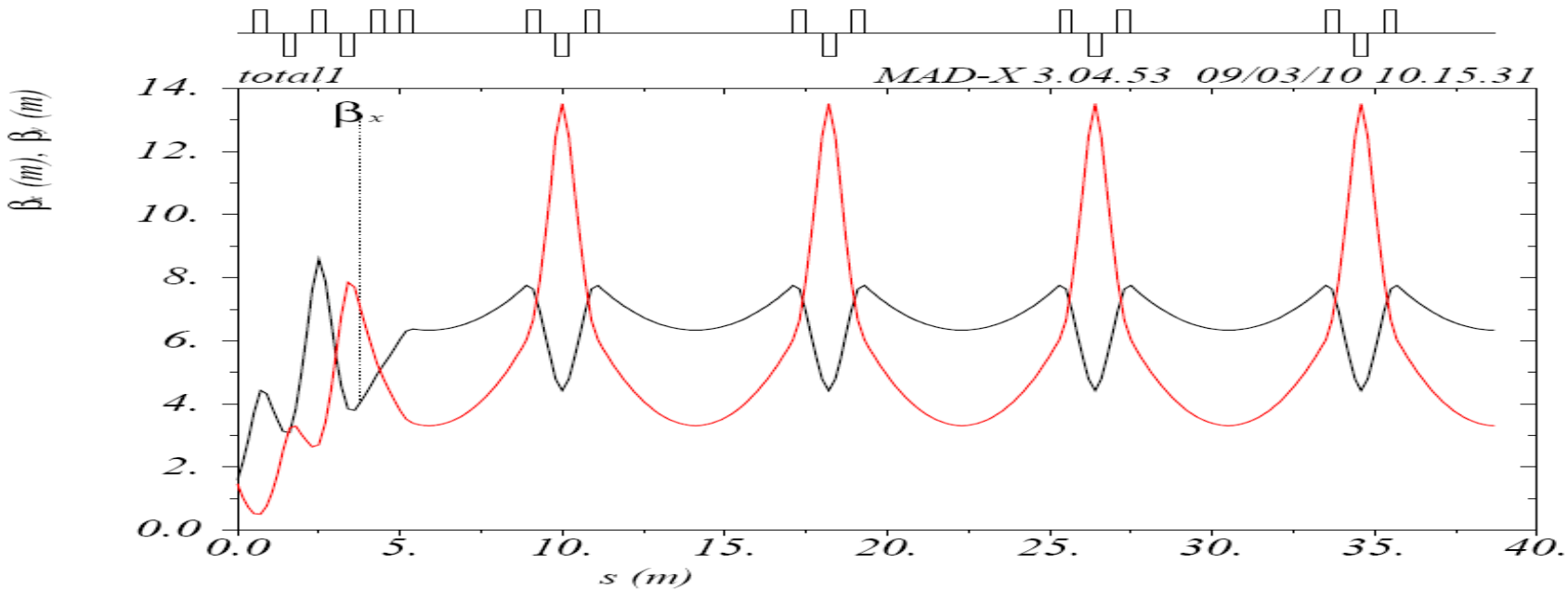
From A. Ferrari et al., CLIC Note 626-655-723



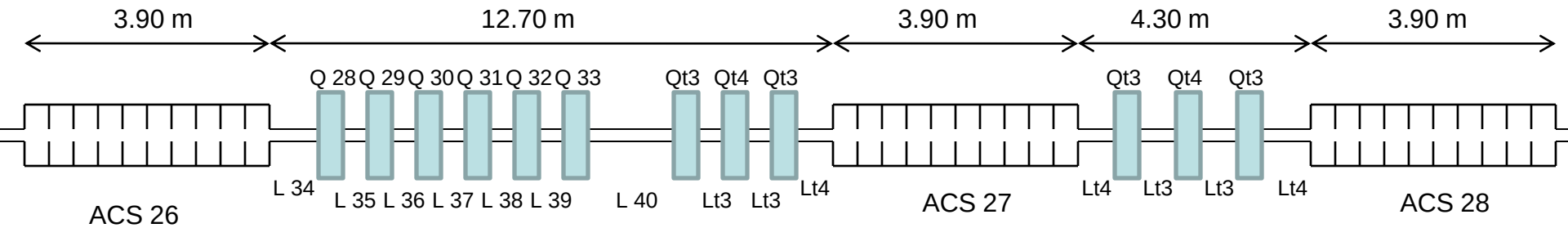


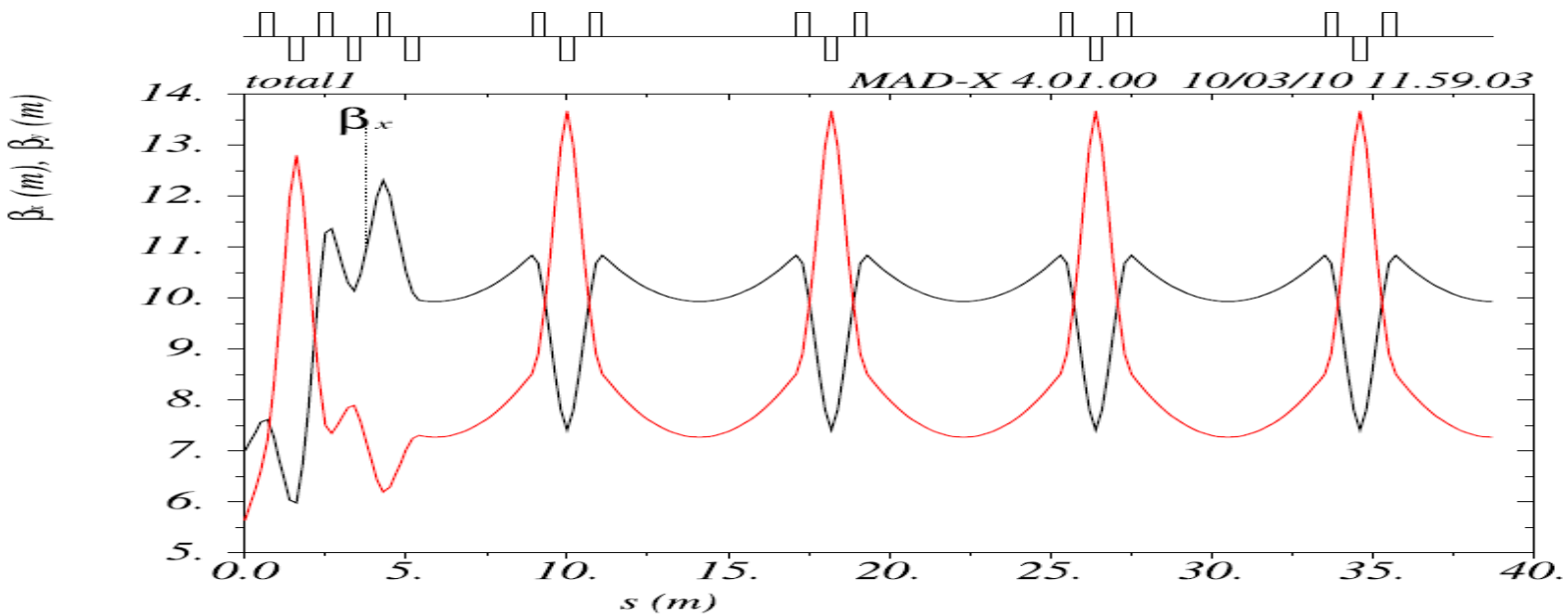
Injector Linac II (1.66 GeV)





Injector Linac III (2.82 GeV)





Injector Linac Elements

Quadrupoles:

- Number: N = 192
- Length: L = 40 cm
- Gradient: G = 1.0 – 11.2 T/m
- Aperture: r = 5-20 cm

Accelerating structures:

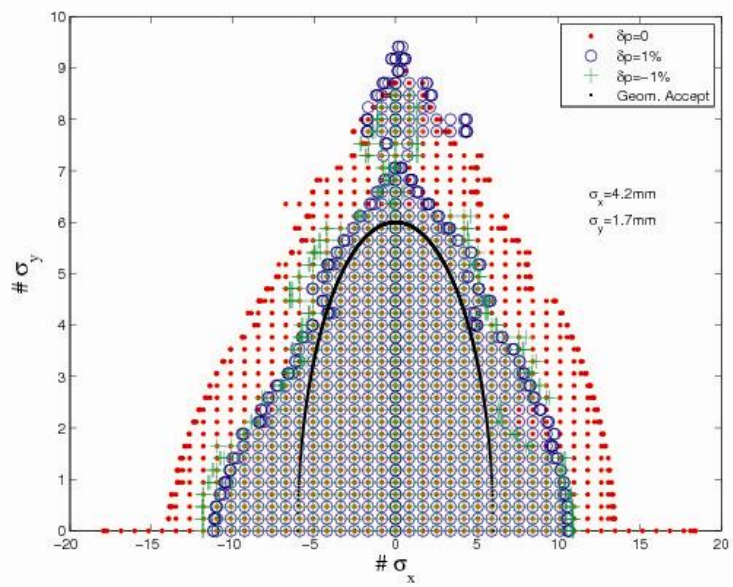
- Number of cavities: N = 47 TW
- Length: L = 3.90 m
- Average Gradient: E_z = 14.5 MV/m
- Frequency: ν = 2 GHz

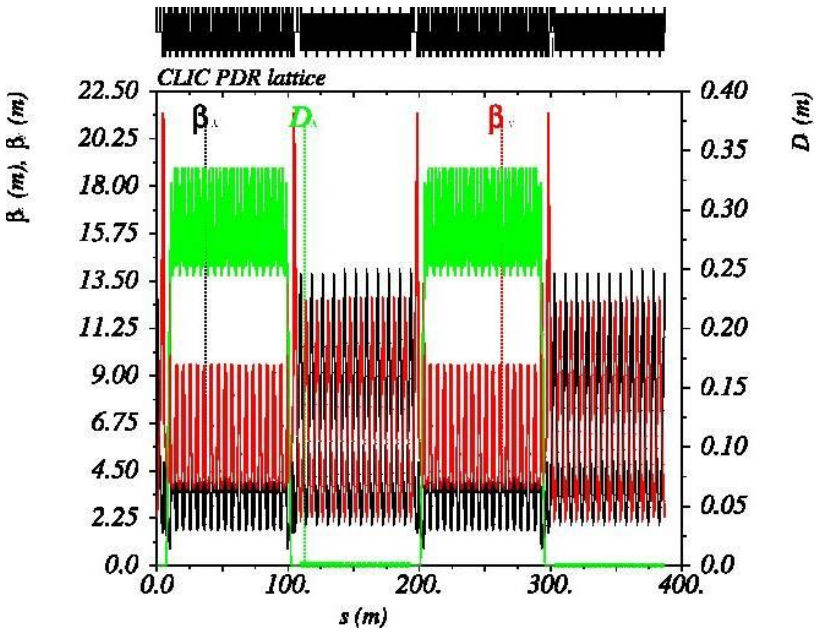
Drift Tubes:

- Number: N = 50
- Aperture: r = 5 cm
- Length: L = 200 - 280 cm

Pre-Damping Ring Acceptance

F. Antoniou





Energy Acceptance from tracking simulations: $\frac{\Delta p^{max}}{p} = 1.2\%$

From particle tracking: $6\sigma_x^i \sim x^{max} = \sqrt{\beta_x \epsilon_x^{max}} + D_x \frac{\Delta p^{max}}{p}$ $\Rightarrow$ $\epsilon_x^{max} = 20\,\epsilon_x^{rms}$

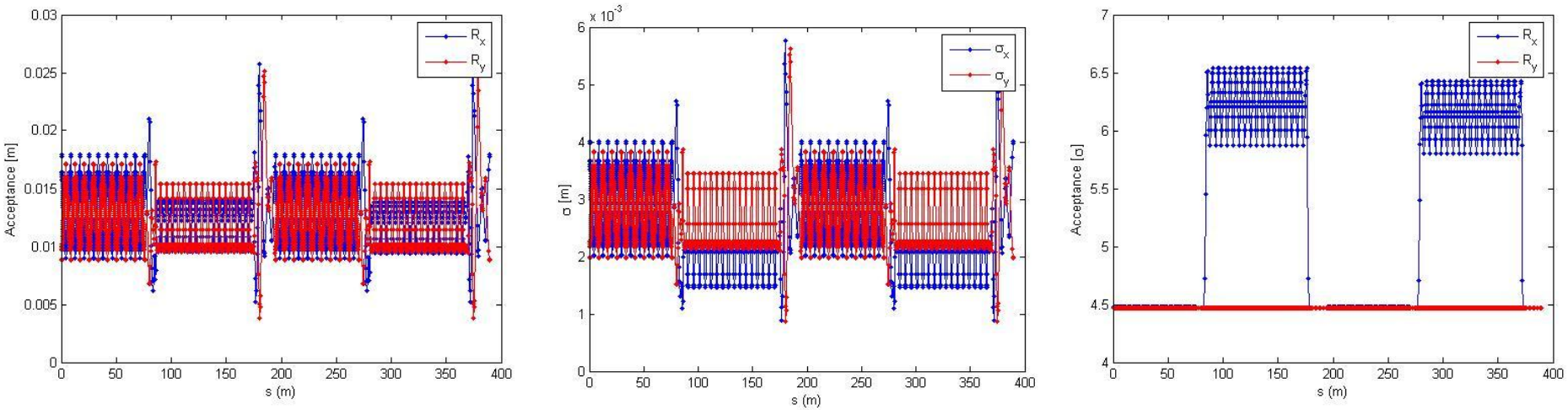
Horizontal Acceptance: $A_x = \gamma\beta\epsilon_x^{max} = 20\,\gamma\beta\epsilon_x^{rms} = 20 * 0.007mrad = 0.14mrad$

Pre-Damping Ring Acceptance

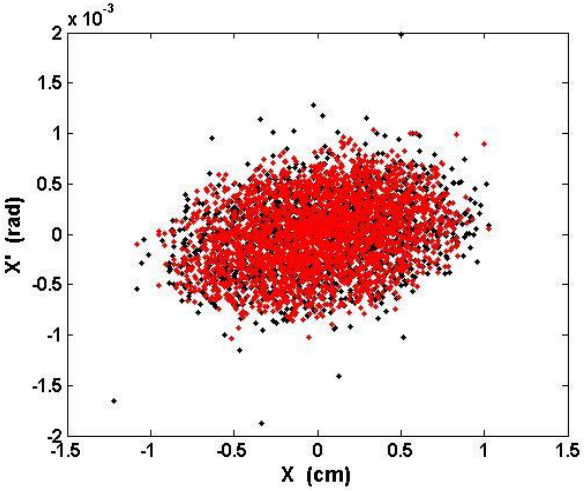
F. Antoniou

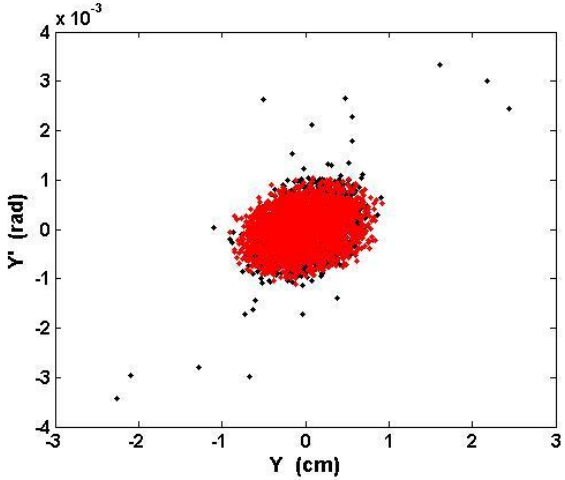
From particle tracking: $6\sigma_y^i \sim y^{max} = \sqrt{\beta_y \epsilon_y^{max}}$ $\Rightarrow$ $\epsilon_y^{max} = 36\,\epsilon_y^{rms}$

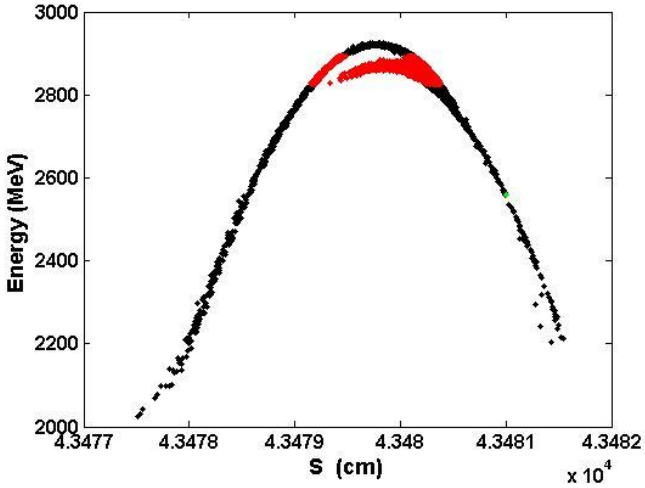
Vertical Acceptance: $A_y = \gamma\beta\epsilon_y^{max} = 36\,\gamma\beta\epsilon_y^{rms} = 36 * 0.007mrad = 0.252mrad$



Injector Linac Results







s cm	N. e^+	Yield e^+/e^-	$\gamma\varepsilon_x$ π mm mrad	$\gamma\varepsilon_y$ π mm mrad	<E> MeV	σ_E MeV	σ_z mm	ε_z π cm MeV
4348	4204	0.70	7685	8105	2825.4	126.3	5.4	61.6

Final Results

Positrons inside PDR Acceptance: 2720.
Final Accepted Yield: e+/e- =0.453.

Positrons required in PDR: $4.6 \cdot 10^9$ e^+.

Bunch population of primary electron beam on crystal: $4.6\ 10^9/0.453 \approx 10 \cdot 10^9$ e^-.

Peak Energy deposition density on amorphous target:

PEDD = $22.14*10\ 10^9 / 7.5\ 10^9 = 29.5$ J/g < 35 J/g *(Dadoun et al., CLIC Note 808)*

Conclusions

- Optimization of the capture section for non-polarized positrons is ongoing.
- New design to avoid possible issues to be done soon.
- Experimental tests of target survivability are desiderable.
- Configuration at 500 GeV and double charge possible with 2 fixed tungsten targets for the moment.
- Simulations with new capture results to be performed.

THANKS.

The End