Simulation of the e+ Source up to the CLIC Damping Ring

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Thanks to:

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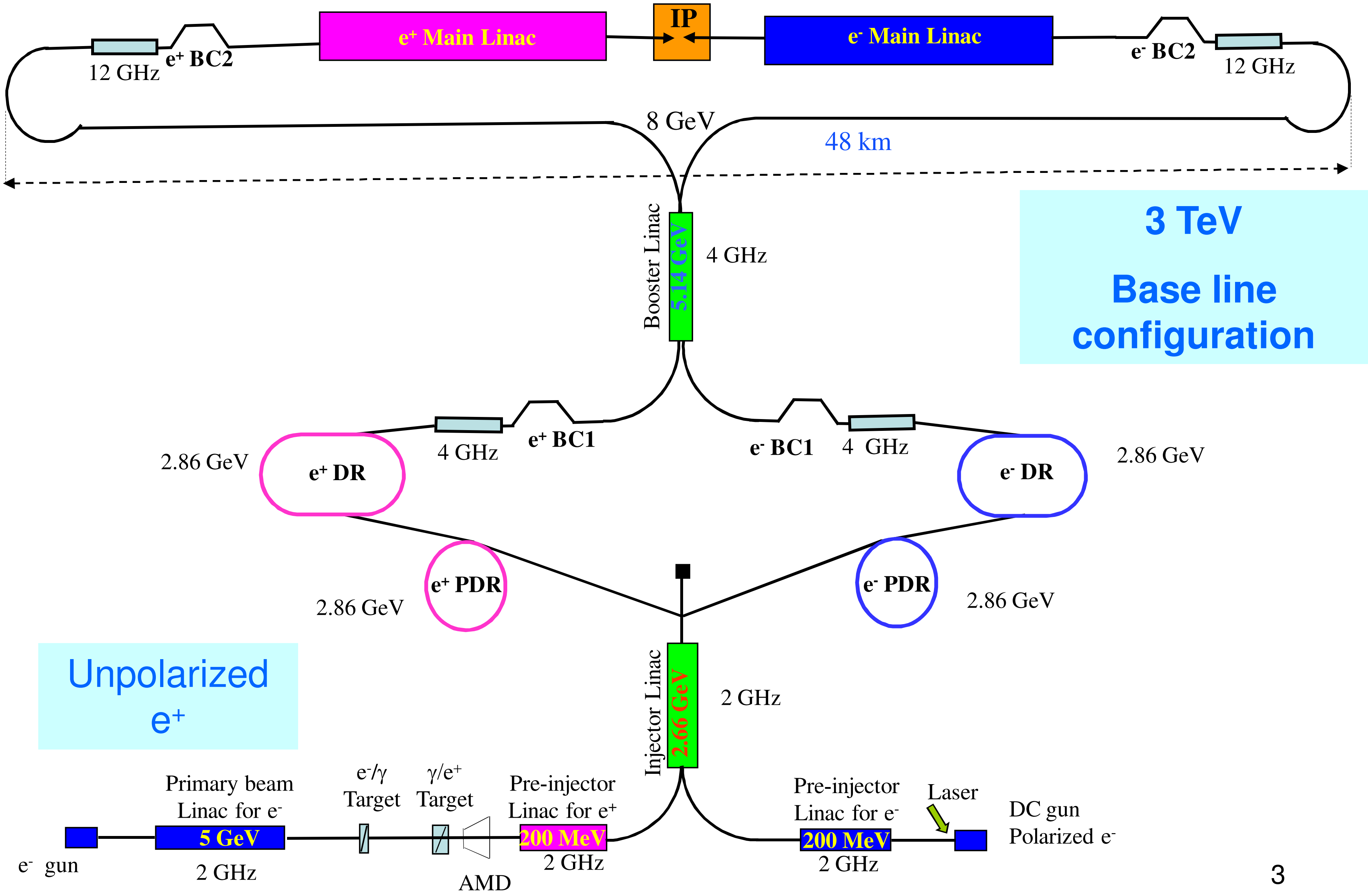
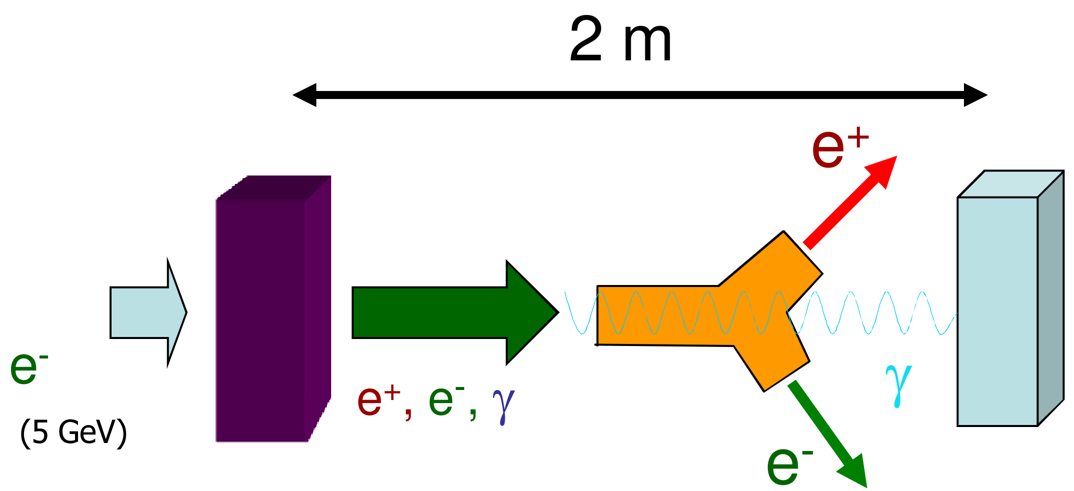
- General scheme of the CLIC positron source
- Design and Simulation of the elements
- Conclusions

CLIC Main Beam Injector Complex (2009)



POSITRON SOURCES USING CHANNELING FOR ILC & CLIC

- **PROPOSED POSITRON TARGET FOR CLIC**



Crystal

W: 1.4 mm thick

Amorphous

W: 10 mm thick

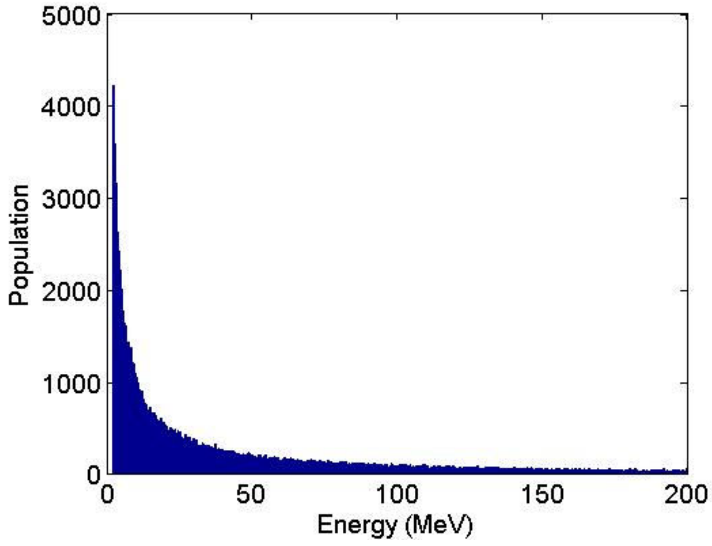
N. simulated e^- : 6000

σ_r=2.5 mm

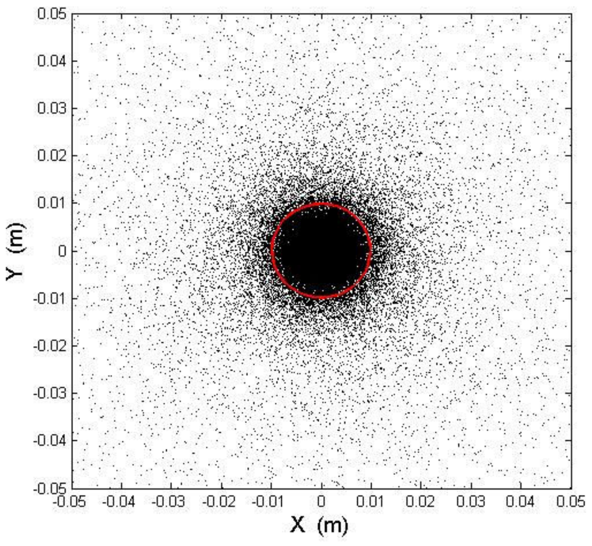
Gamma Production

By V. STRAKHOVENKO

PHOTONS SPECTRUM



SPOT SIZE

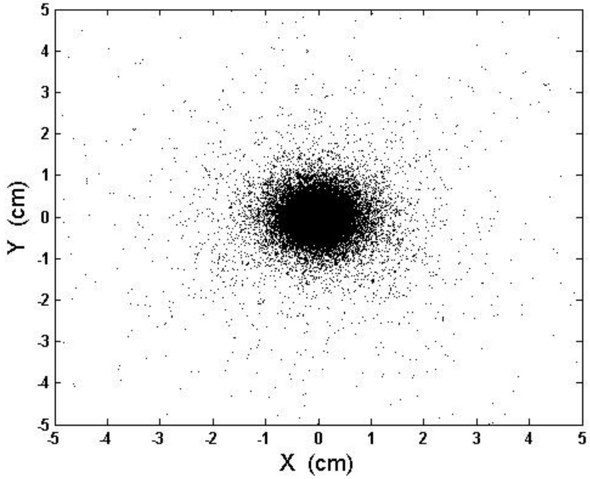


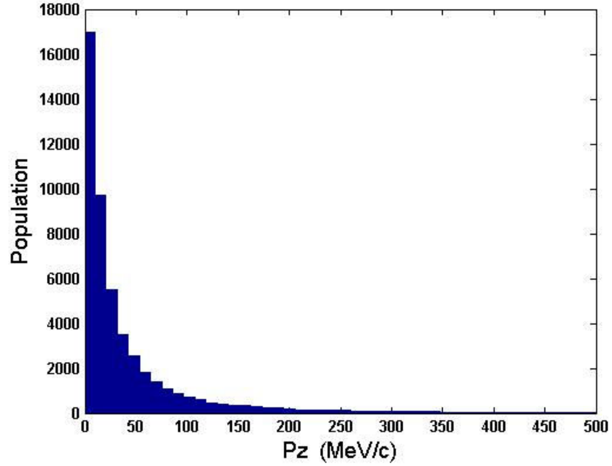
CHANNELING: $N\gamma = 111942$ $N\gamma / Ne^- = 18.657$ $E\gamma = 170.37$ MeV $Ee^- = 5$ GeV

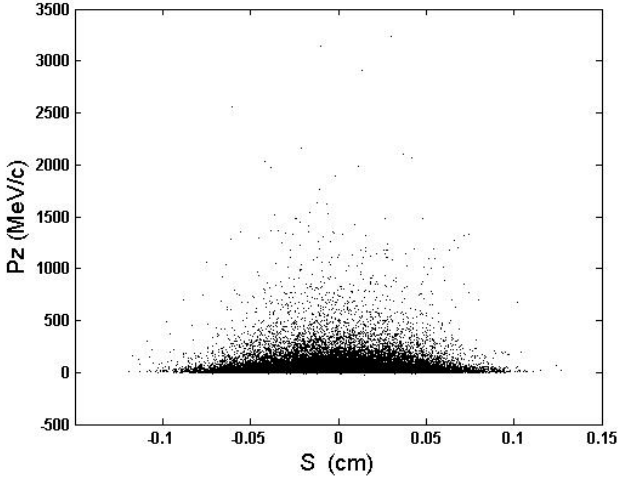
$\sigma_r = 9.85$ mm

Positron Production

By O. DADOUN







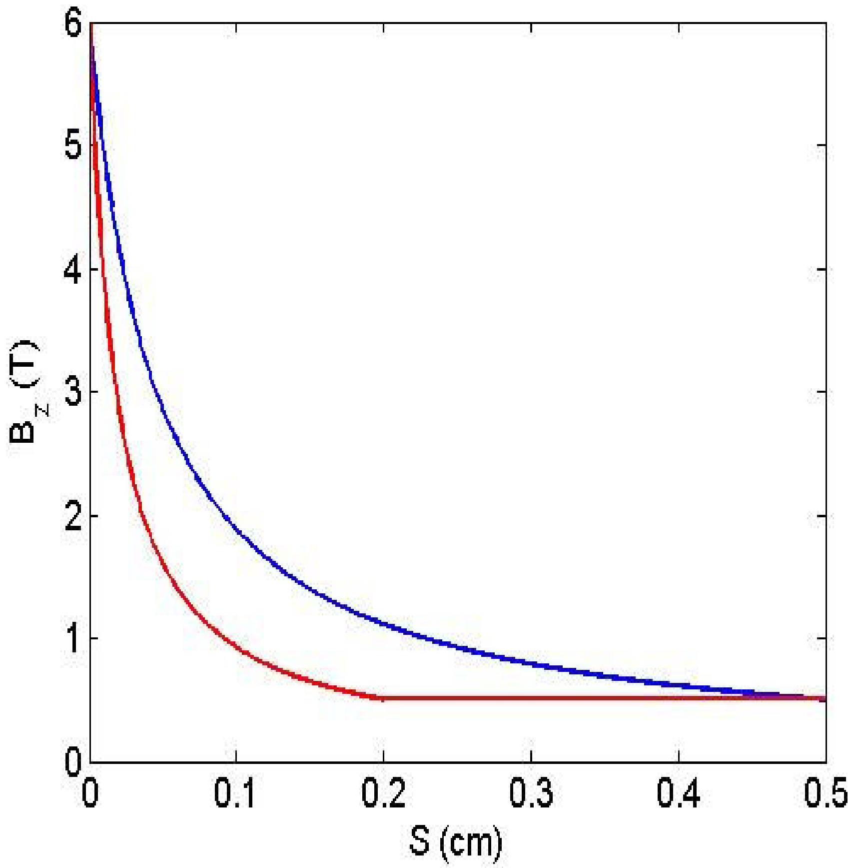
Positron Beam Parameters at the target

N. e^+	Yield e^+/e^-	ε_x (rms) π mm mrad	ε_y (rms) π mm mrad	**<E>** MeV	σ_E MeV	σ_z (rms)* mm
49500	8.25	63614	77903	54.51	115.5	0.301*

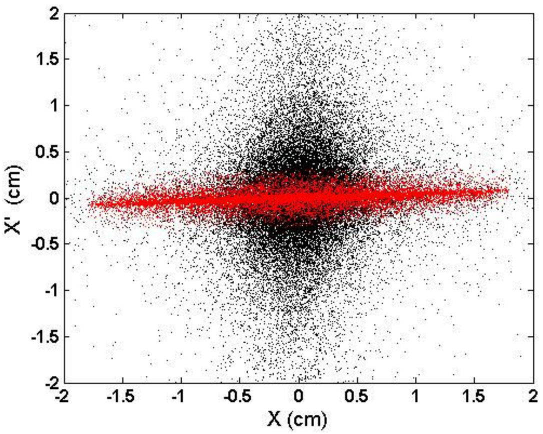
Adiabatic Matching Device

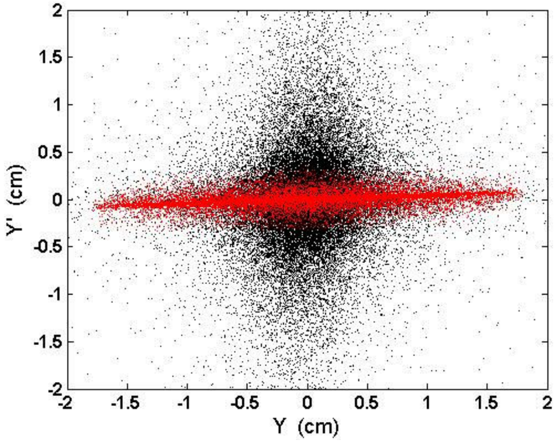
- Length: L = 20-50 cm
- Magnetic field at the target : $B_0 = 6$ T
- Magnetic field at the end : B(L) = 0.5 T
- Magnetic Field Behaviour :

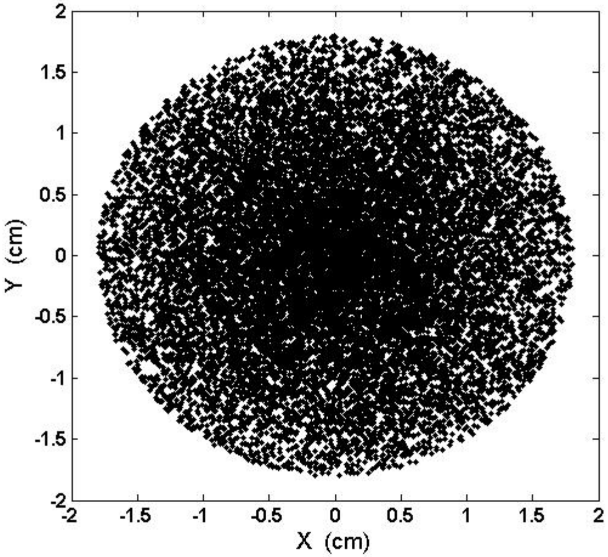
$$B(z) = \frac{B_0}{1 + \mu z}$$



AMD RESULTS



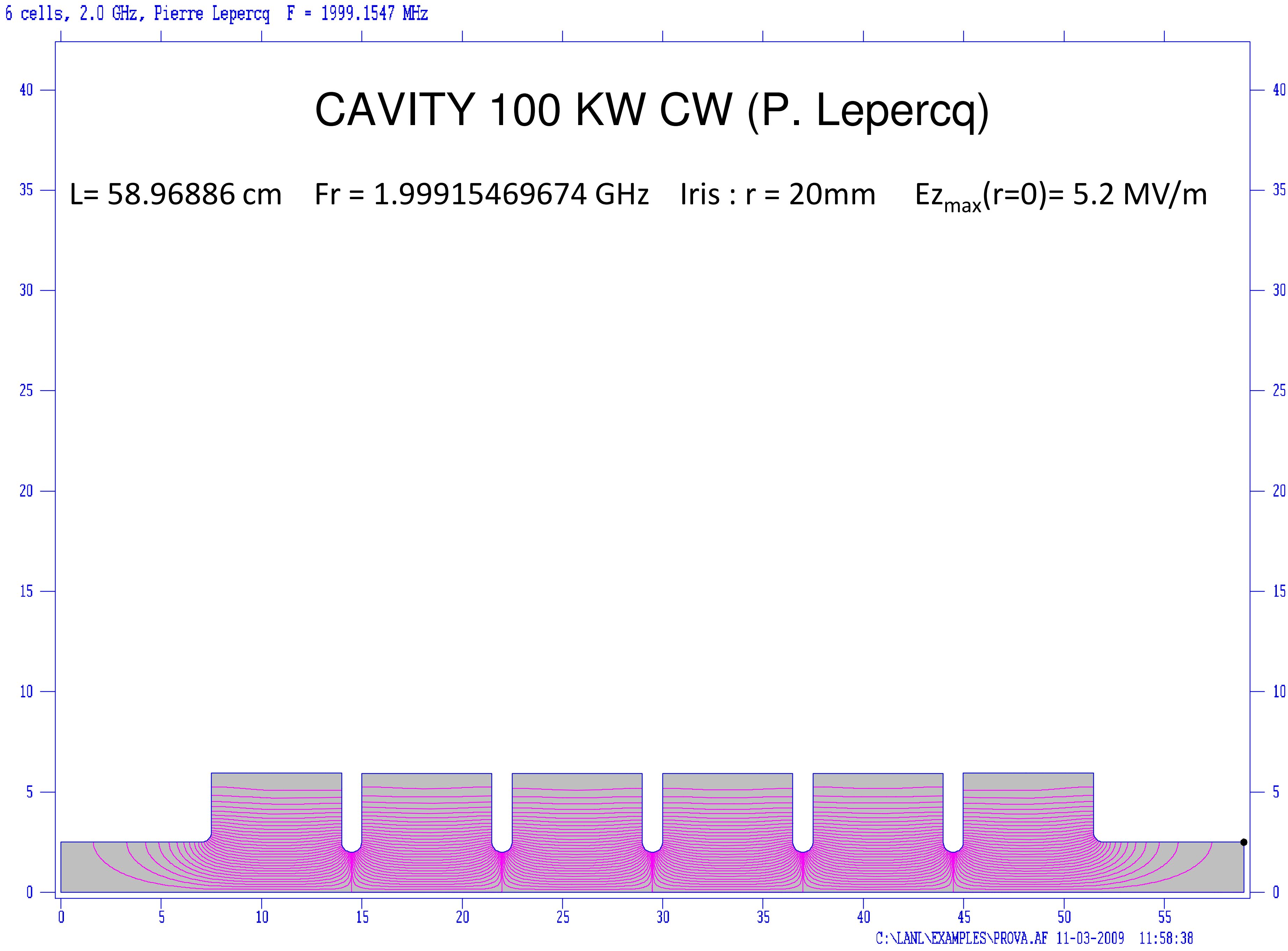


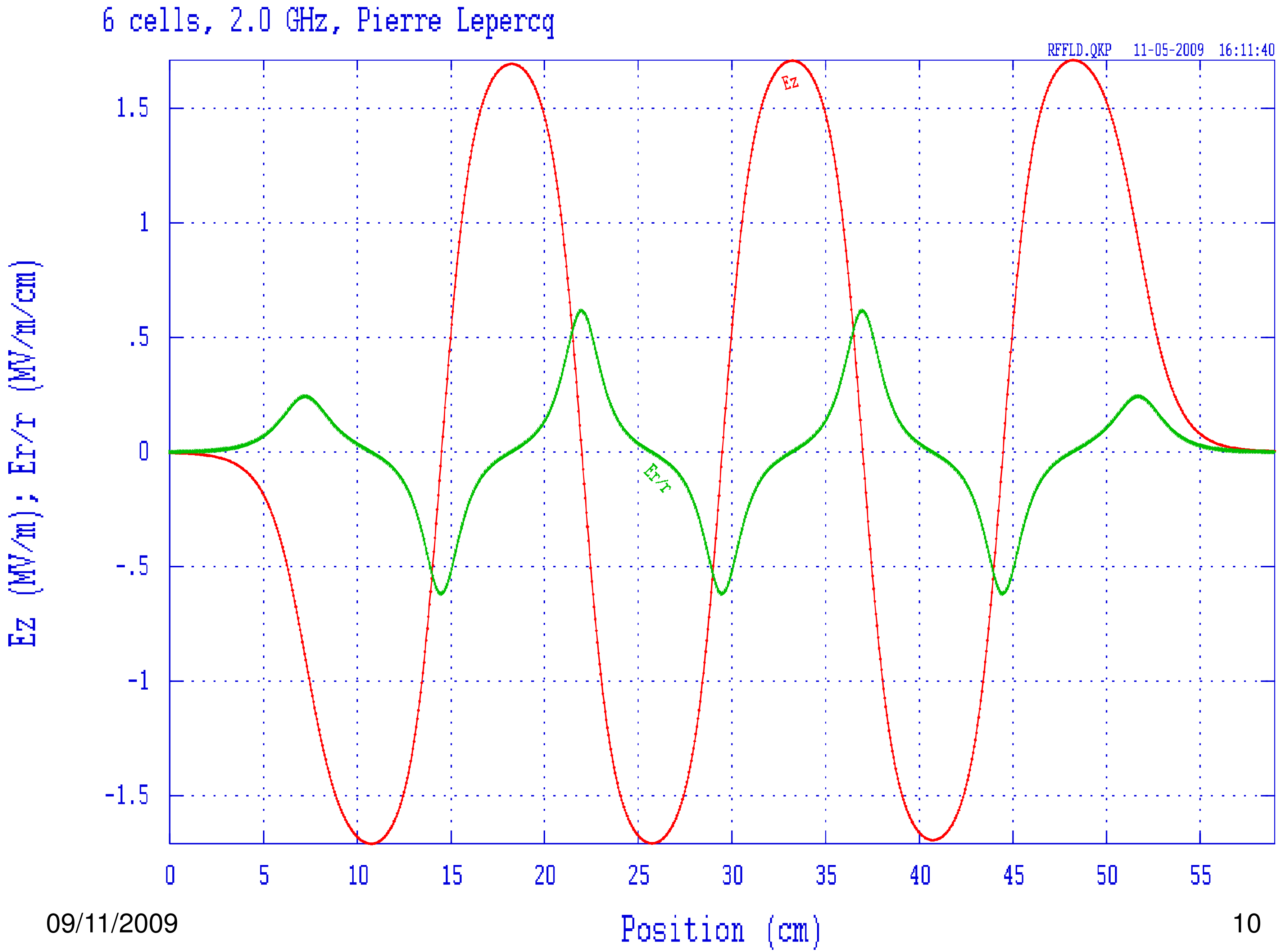


AMD cm	N*. **e+**	Yield **e+/e-**	ε_x π mm mrad	ε_y π mm mrad	**<E>** MeV	σ_E MeV	σ_z * mm	ε_z π cm MeV
20	16476	2.75	682	681	78.9	164.7	8.7*	136.2

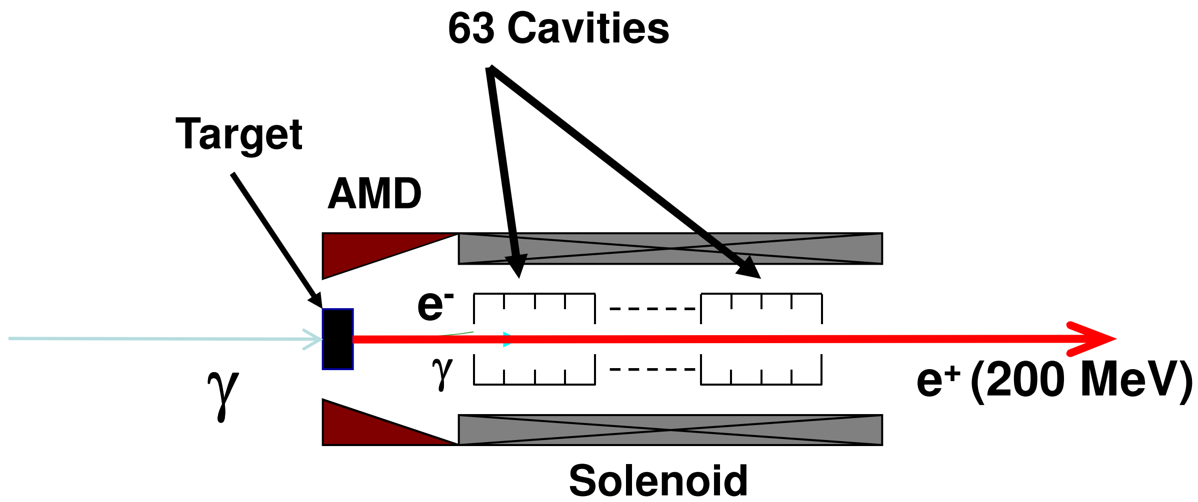
CAVITY 100 KW CW (P. Lepercq)

L= 58.96886 cm   Fr = 1.99915469674 GHz   Iris : r = 20mm $Ez_{max}(r=0)$= 5.2 MV/m




6 cells, 2.0 GHz, Pierre Lepercq
RFFLD.QKP 11-05-2009 16:11:40
Ez
Er/r
Ez (MV/m) ; Er/r (MV/m/cm)
Position (cm)
1.5
1
.5
0
-.5
-1
-1.5
0
5
10
15
20
25
30
35
40
45
50
55

Capture Section Design



AMD

- Length : L = 20 cm
- Magnetic Filed: B = 6 - 0.5 T
- Final Aperture: r = 2 cm

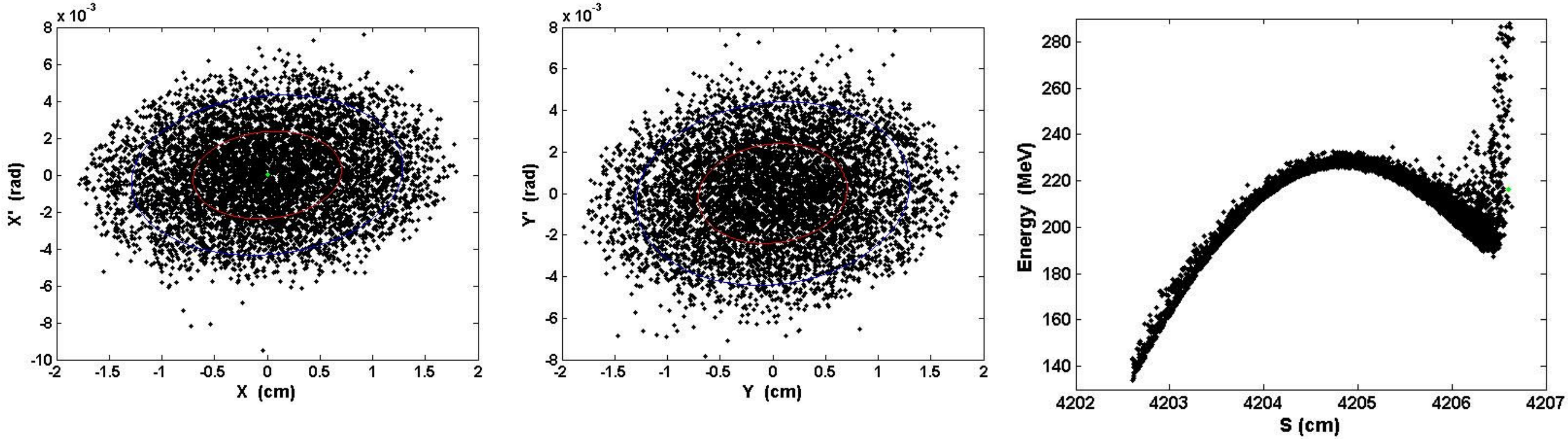
SOLENOID

- Length : L = 41 m
- Magnetic Filed: B = 0.5 T
- Drift Tube Aperture: r = 2 cm

Accelerating cavities:

- Number of cavities: N = 63
- Length: L = 60 cm
- Max Energy Gain: ΔE = 5.95 MeV
- Maximum Gradient: E_z (r=0) = 25 MV/m
- Frequency: ν = 2 GHz

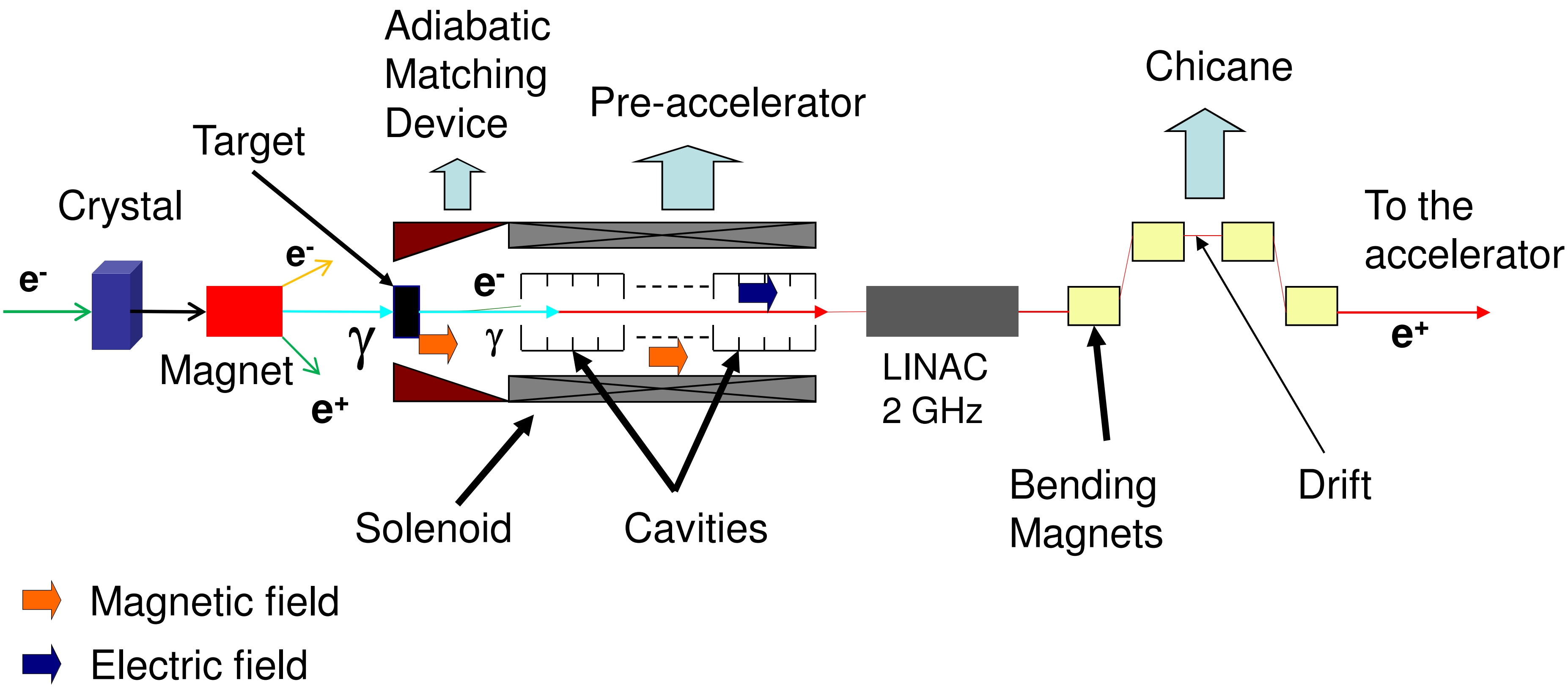
Capture Results



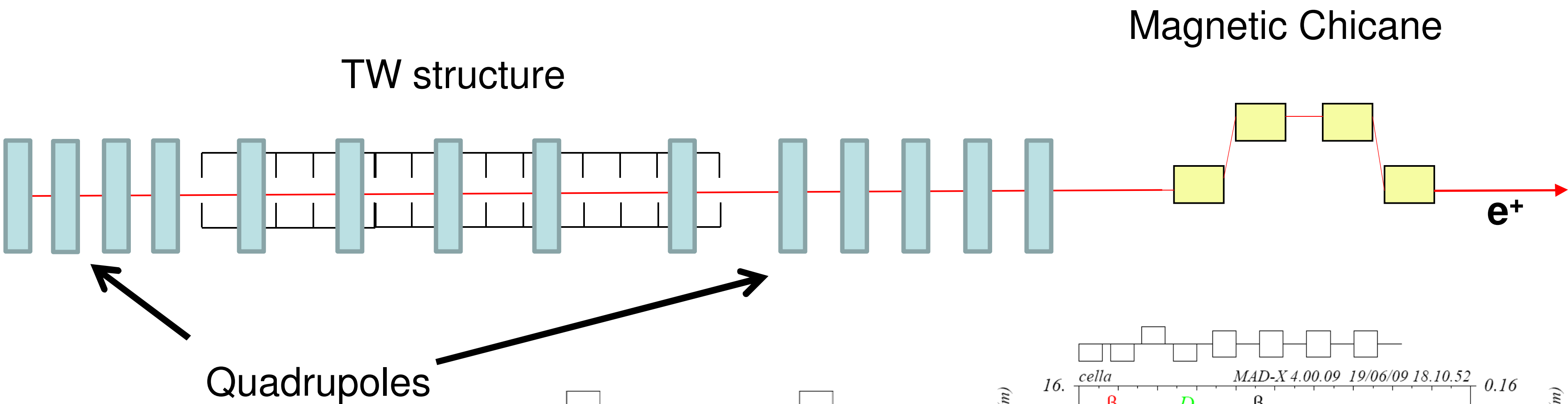
To be optimized…

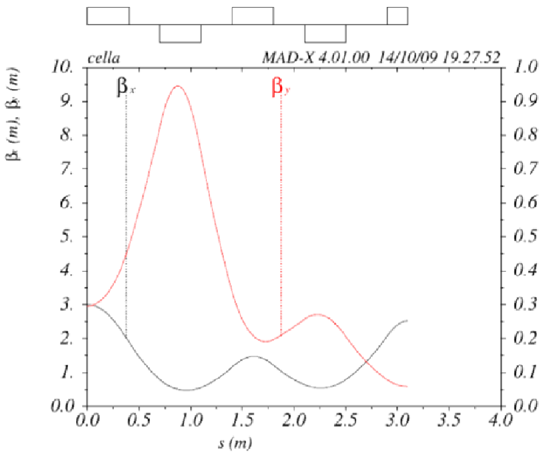
S cm	N. e^+	Yield e^+/e^-	$\gamma\varepsilon_x$ π mm mrad	$\gamma\varepsilon_y$ π mm mrad	<E> MeV	σ_E MeV	σ_z mm	ε_z π cm MeV
4200	6186	1.03	6939	7051	214.1	35.0	9.9	33.5

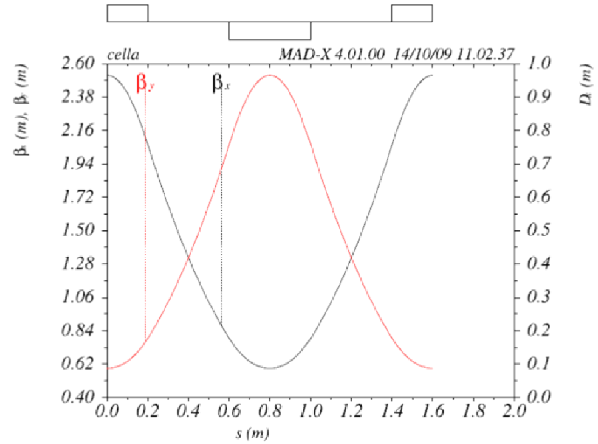
Capture Section (+ Bunch Compressor)

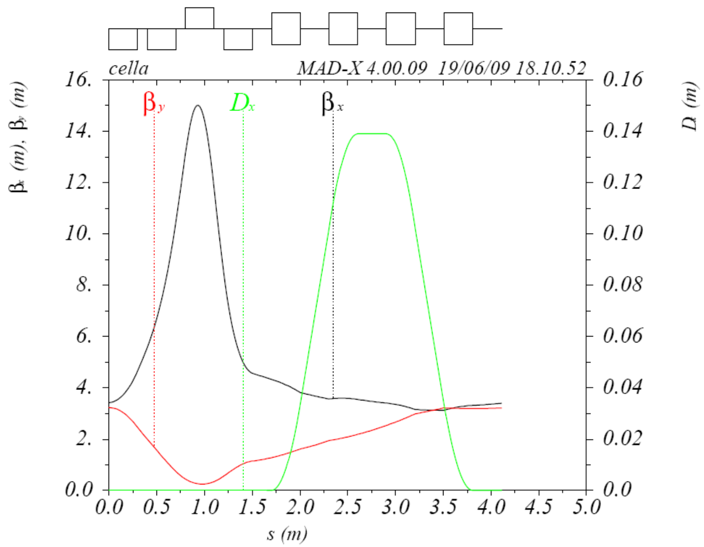


Bunch Compressor Design





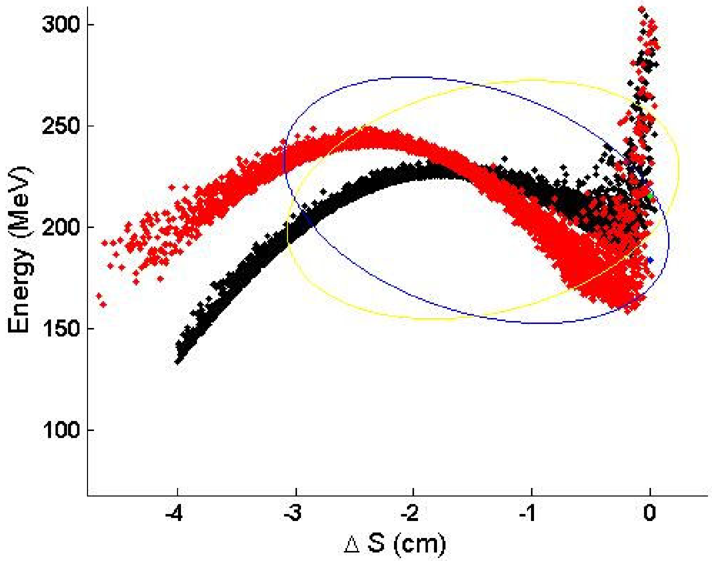




Bunch Compressor Elements

Quadrupoles:

- Number: N = 14
- Length: L = 20-40 cm
- Gradient: G = 1.5 – 4.7 T/m
- Aperture: r = 5-15 cm



Accelerating cavities:

- Number of cavities: N = 1 TW
- Length: L = 3.9 m
- Average Gradient: E_z = 14.5 MV/m
- Frequency: ν = 2 GHz

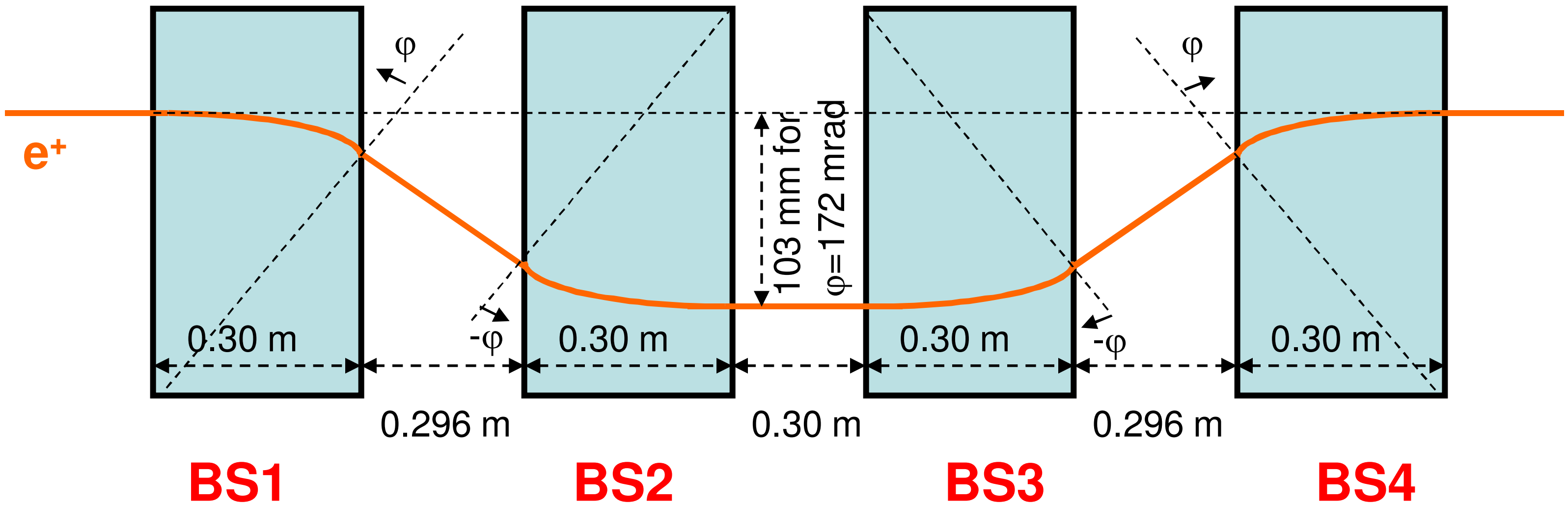
Bending Magnets:

- Number: N = 4
- Length: L = 30 cm
- Magnetic Field: B = 0.3513 T

Drift Tubes:

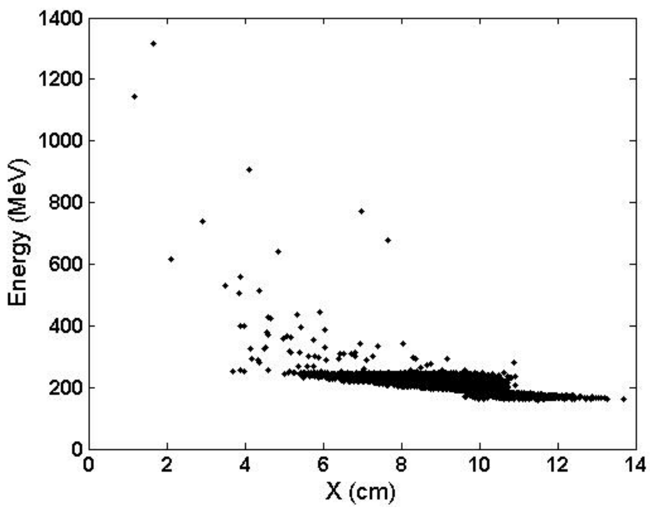
- Number: N = 28
- Aperture: r = 5-10 cm
- Length: L = 10 - 40 cm

MAGNETIC CHICANE

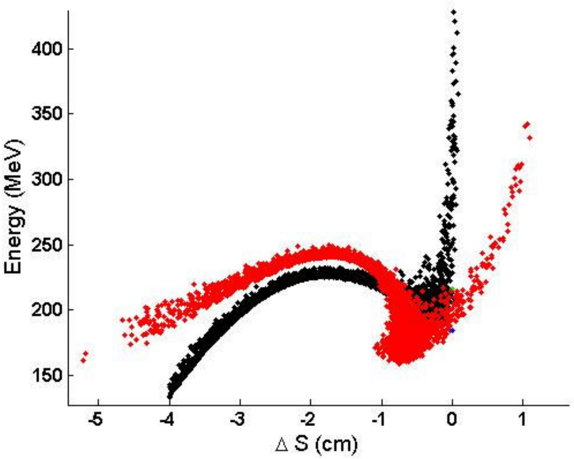


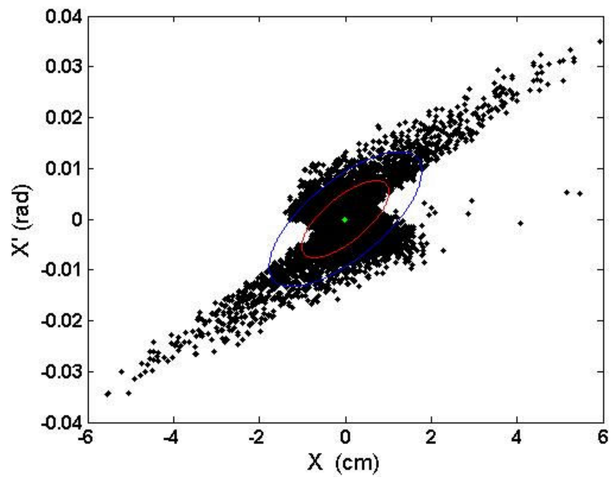
Chicane Modeling:

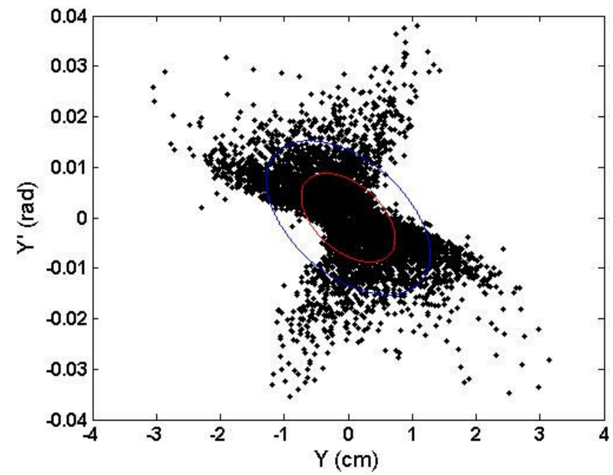
- Bending angle: $\varphi = 9.87$ deg
- Drift: $\lambda = 30$ cm
- Diaphragm: $r = 4.0$ cm



Bunch Compressor Results



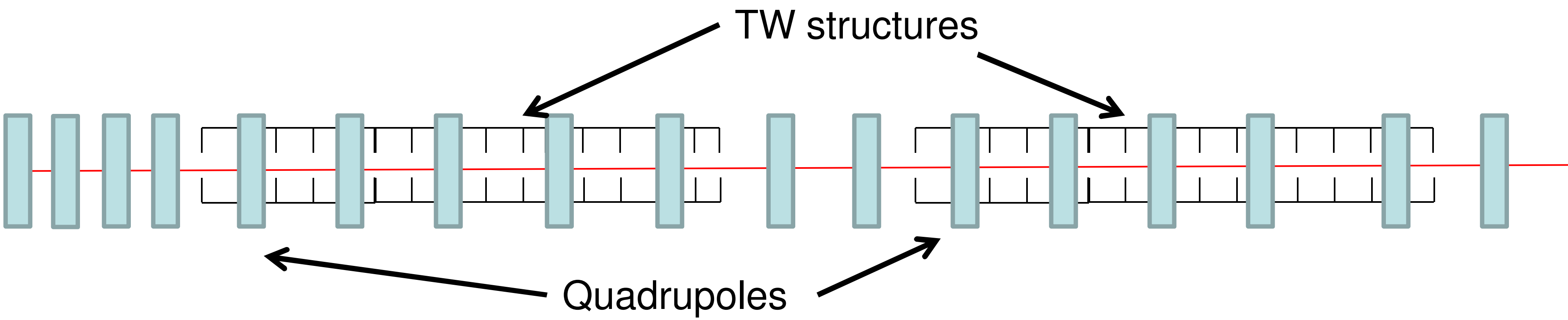


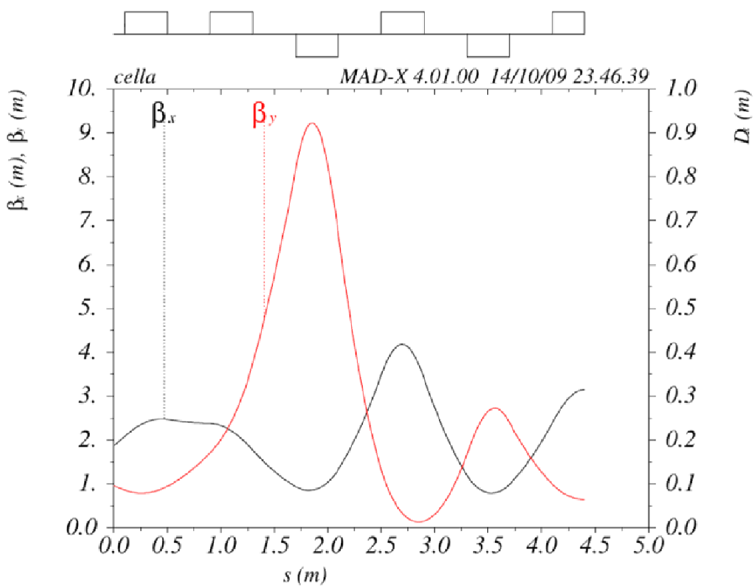


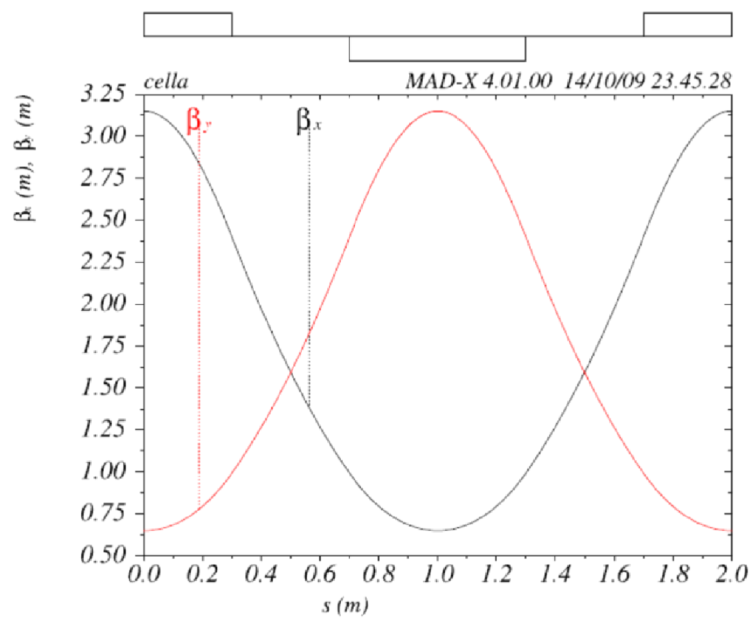
S **cm**	N. e^+	Yield e^+/e^-	$\gamma\varepsilon_x$ π mm mrad	$\gamma\varepsilon_y$ π mm mrad	**<E>** MeV	σ_E MeV	σ_z mm	ε_z π cm MeV
5688	5895	0.98	22678	23479	211.8	26.0	7.7	18.35

Injector Linac I (800 MeV)

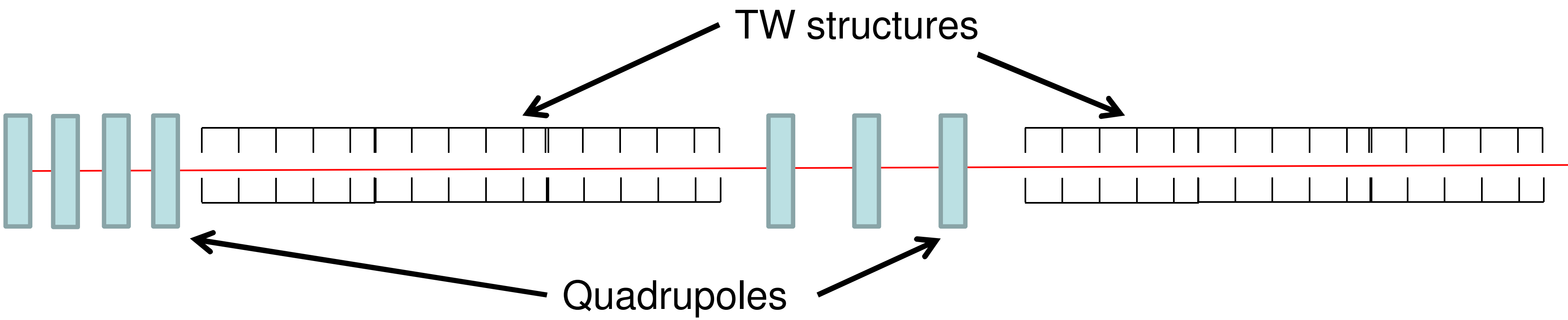
From A. Ferrari et al., CLIC Note 626-655-723

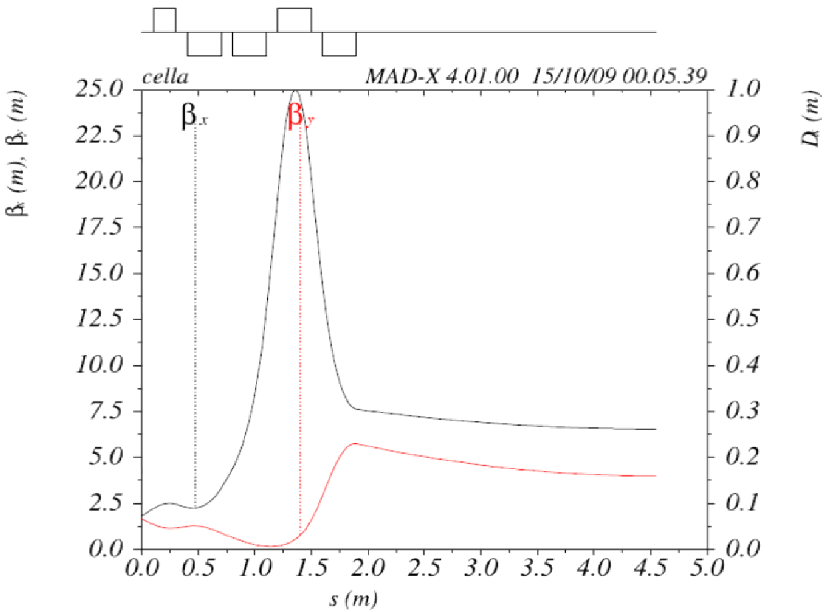


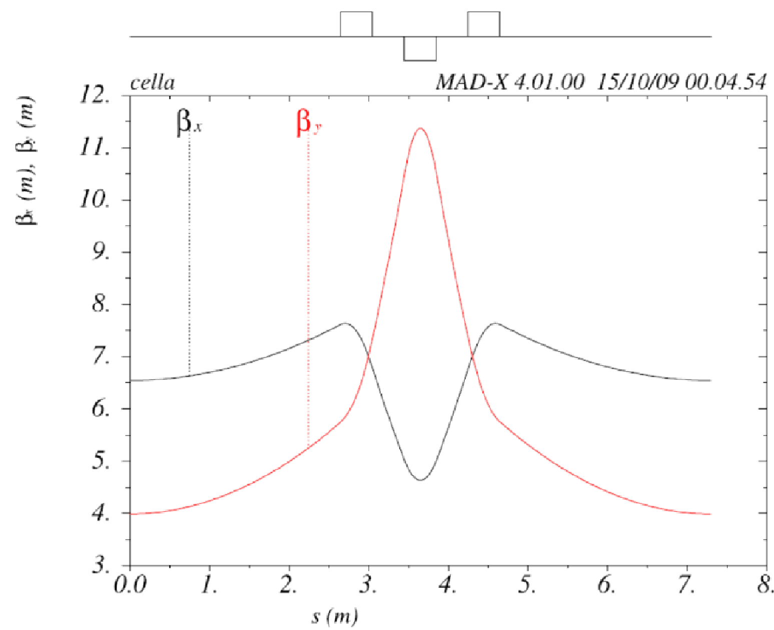




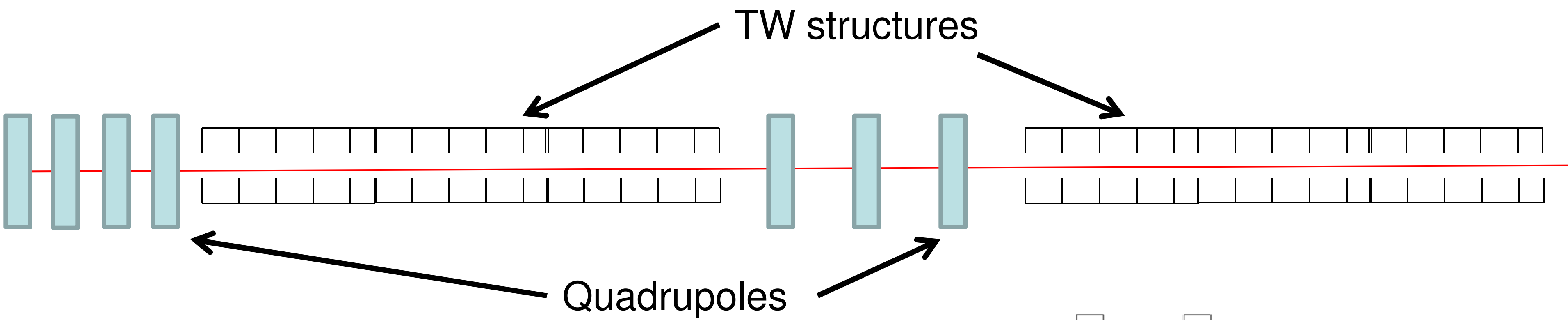
Injector Linac II (1.5 GeV)

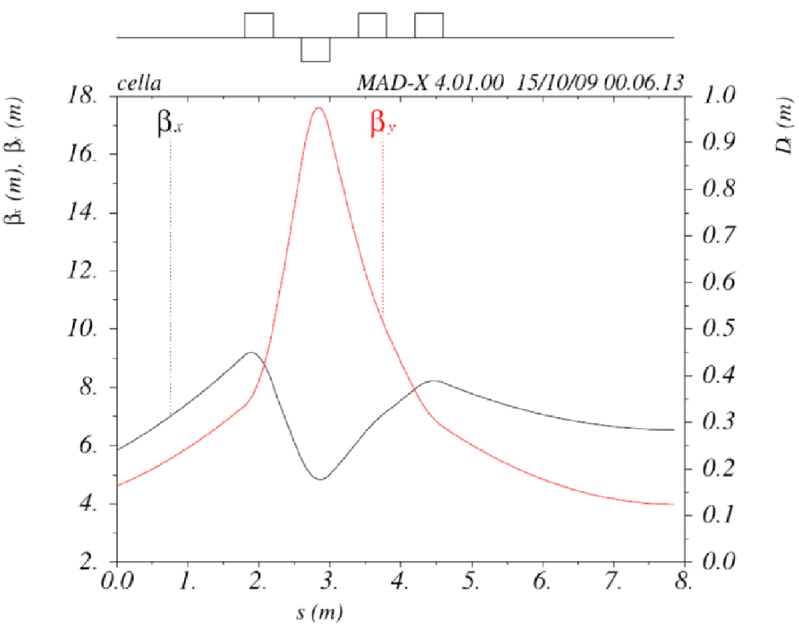


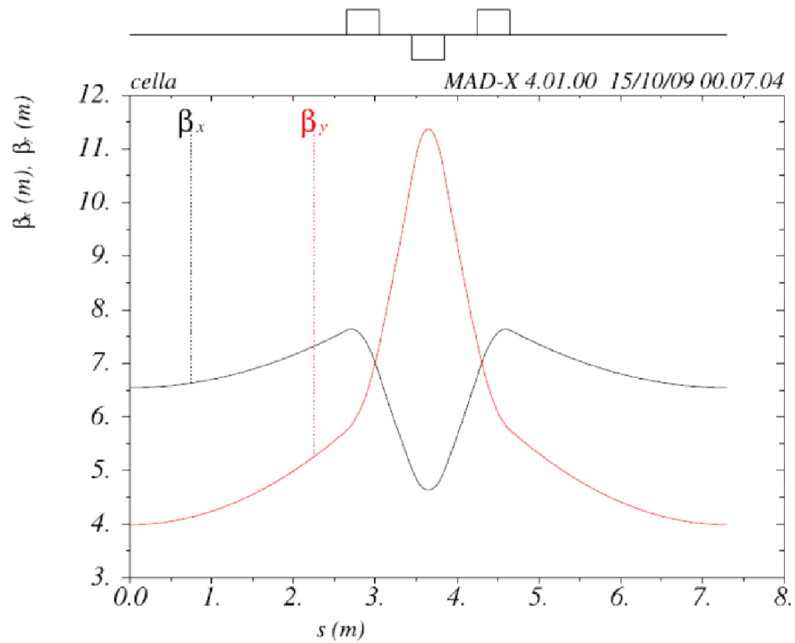




Injector Linac III (2.86 GeV)







Injector Linac Elements

Quadrupoles:

- Number: N = 196
- Length: L = 40-60 cm
- Gradient: G = 1.0 – 18.5 T/m
- Aperture: r = 5-15 cm

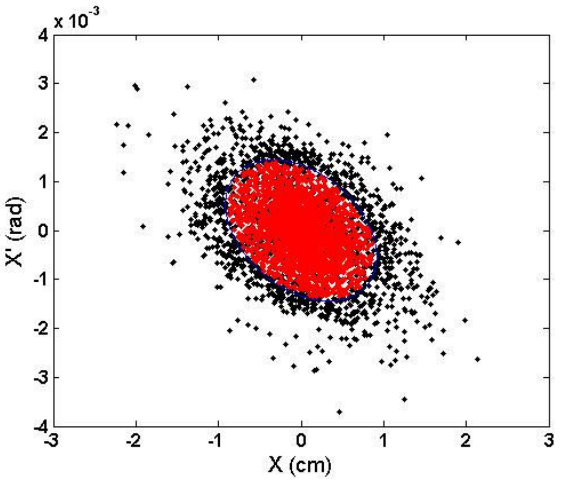
Accelerating cavities:

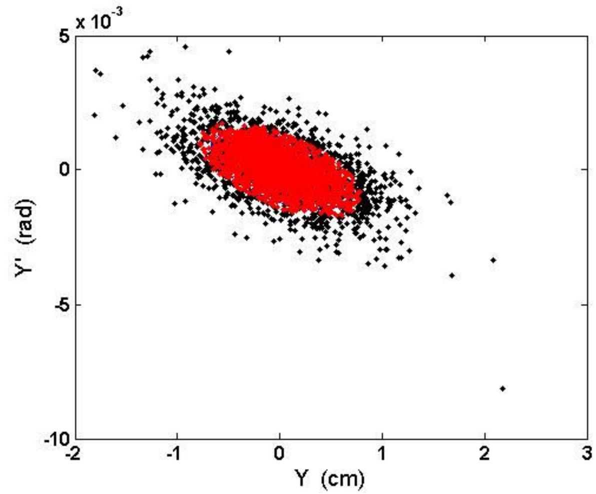
- Number of cavities: N = 49 TW
- Length: L = 3 - 4.5 m
- Average Gradient: E_z = 14.5 MV/m
- Frequency: ν = 2 GHz

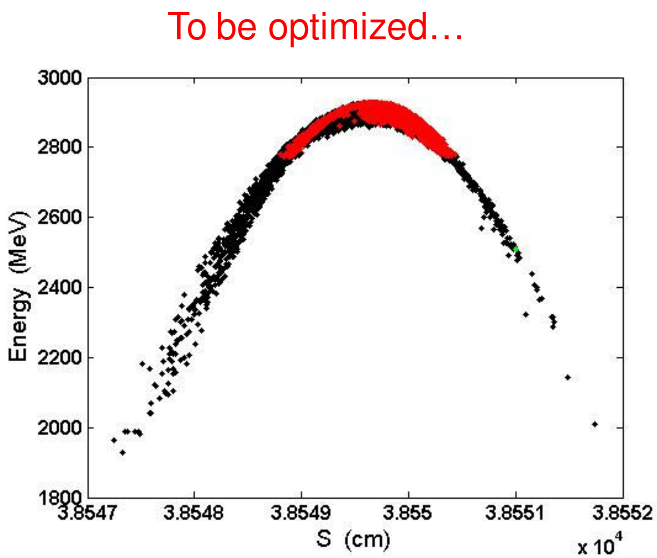
Drift Tubes:

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

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
38550	4558	0.76	19804	14729	2825.1	129.5	6.2	69.5

e^+ in PDR: 2747; Yield e^+/e^- =0.458

Conclusions

- In order to have 4.6 10^9 e^+ in PDR we need:

  4.6 10^9/0.458=10 10^9 e^- in primary electron beam on crystal.
- According to *Dadoun et al.,* CLIC Note in preparation:

  PEDD = 22.14*10 10^9 / 7.5 10^9 = 29.5 J/g < 35 J/g but close.

- Optimization of the parameters for non-polarized positrons is necessary and will be done soon.
- Configuration at 500 GeV and double charge not possible with only 1 fixed tungsten target for the moment.
- Utilization of different codes for simulations (PARMELA, PLACET, GEANT4,…) will be done.

THANKS.

The End