

# A Capture Section Design for the CLIC Positron Source

A. VIVOLI\*

Thanks to:

L. RINOLFI (CERN)

R. CHEHAB (IPNL & LAL / IN2P3-CNRS)

O. DADOUN, P. LEPERCQ, A. VARIOLA (LAL / IN2P3-CNRS)

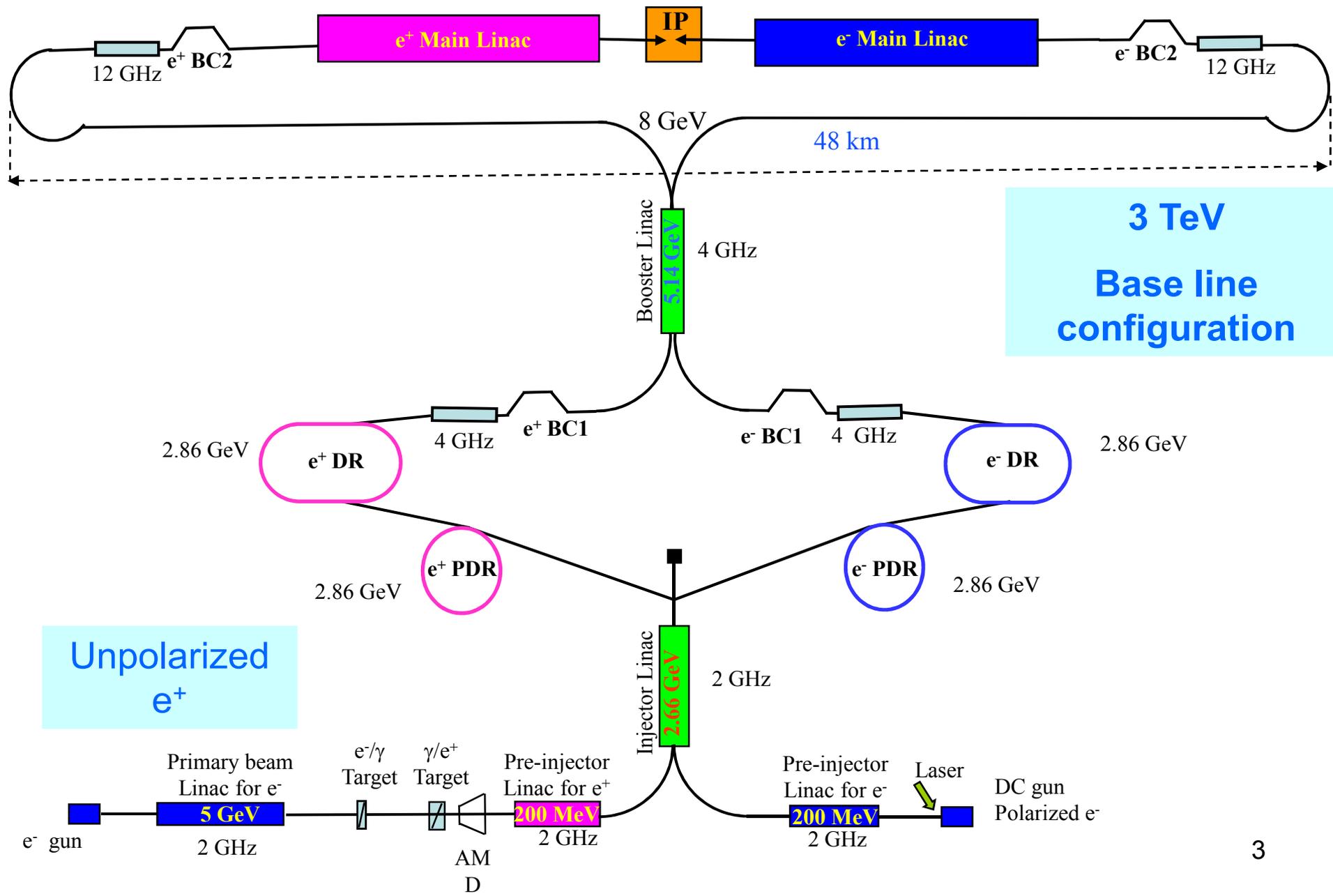
V. STRAKHOVENKO (BINP)

\* E-mail : [Alessandro.Vivoli@cern.ch](mailto:Alessandro.Vivoli@cern.ch)

# CONTENTS

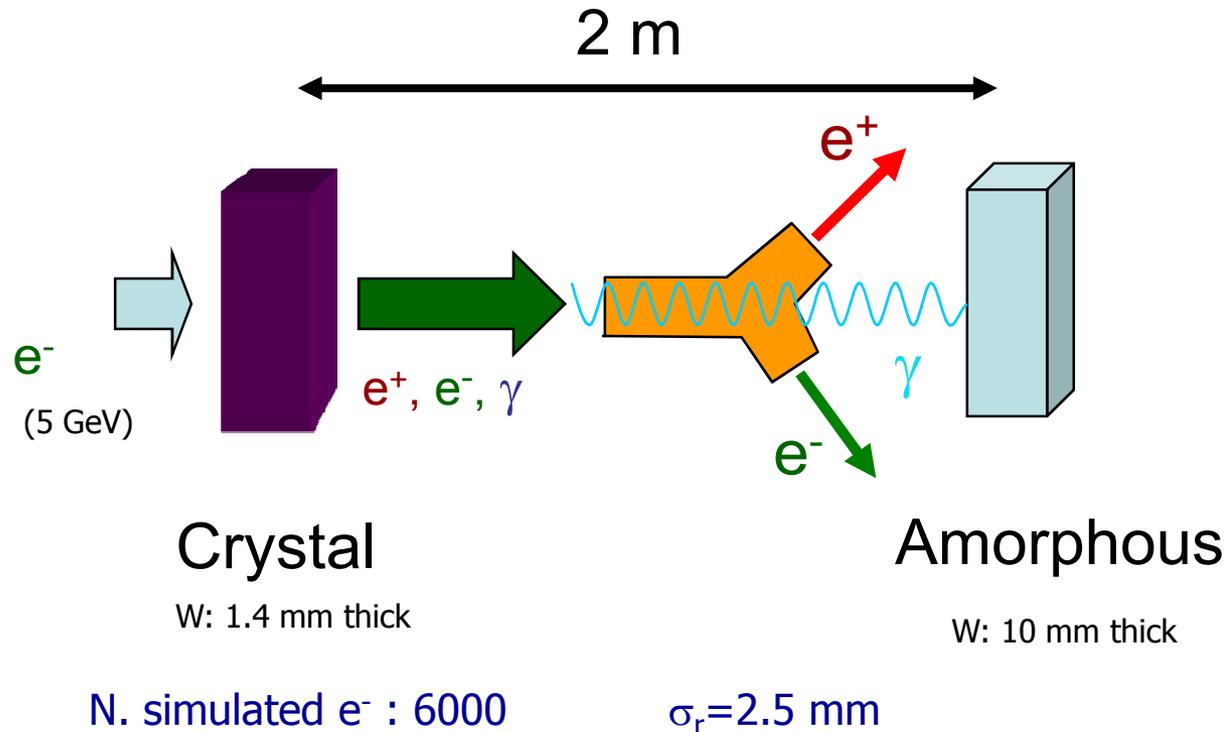
- General scheme of the CLIC positron source
- Design and Simulation of the elements
- Future steps

# CLIC Main Beam Injector Complex (2009)



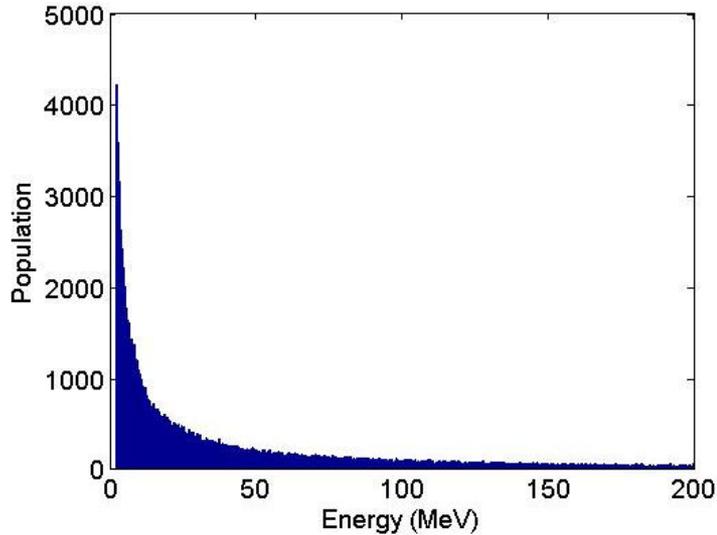
# POSITRON SOURCES USING CHANNELING FOR ILC & CLIC

- PROPOSED POSITRON TARGET FOR CLIC

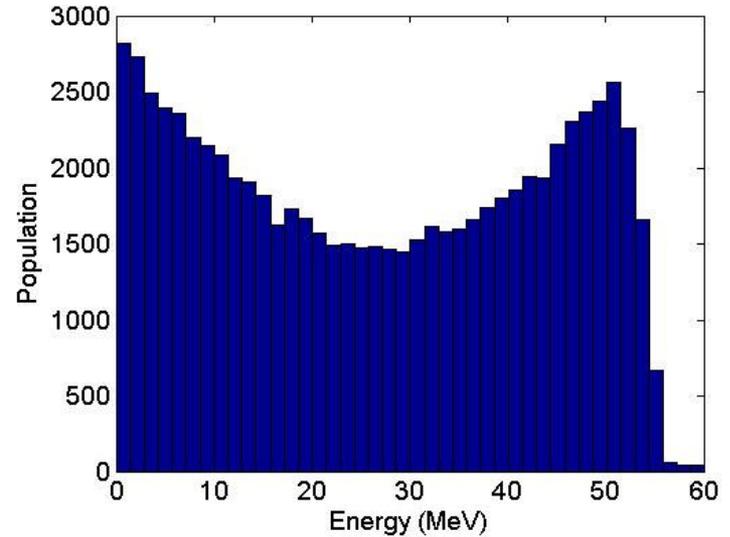


# Gamma Production

CHANNELING By V. Strakhovenko



COMPTON By T. OMORI

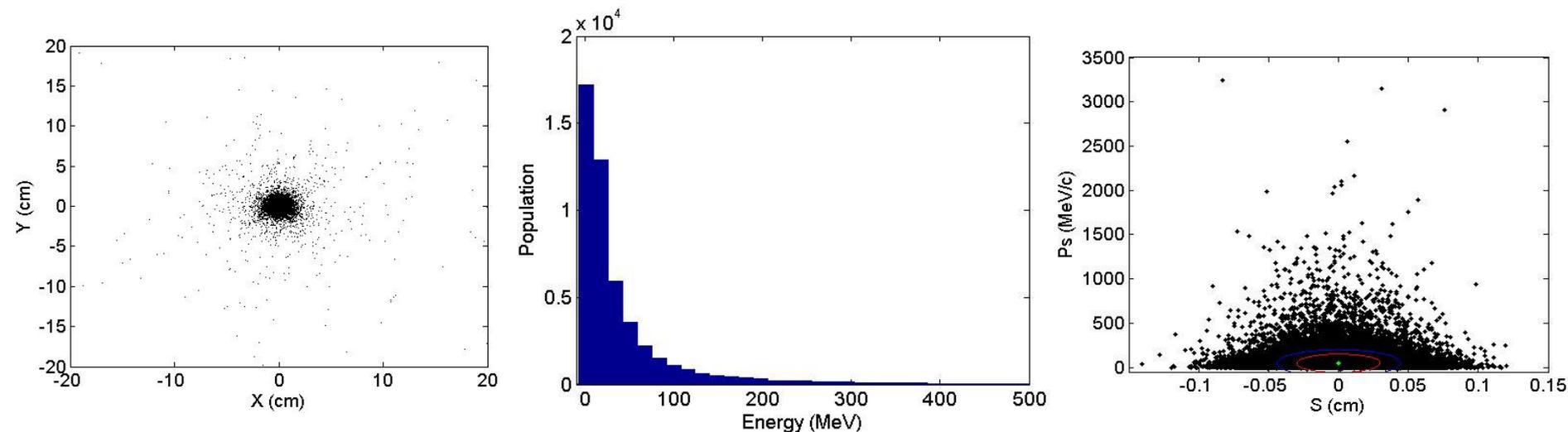


COMPTON:  $N_\gamma = 75177$   $N_\gamma / N_{e^-} = 0.75$   $E_\gamma = 27.7$  MeV  $E_{e^-} = 1.8$  GeV

CHANNELING:  $N_\gamma = 119813$   $N_\gamma / N_{e^-} = 19.97$   $E_\gamma = 160.2$  MeV  $E_{e^-} = 5.0$  GeV

# Positron Production

By O. DADOUN



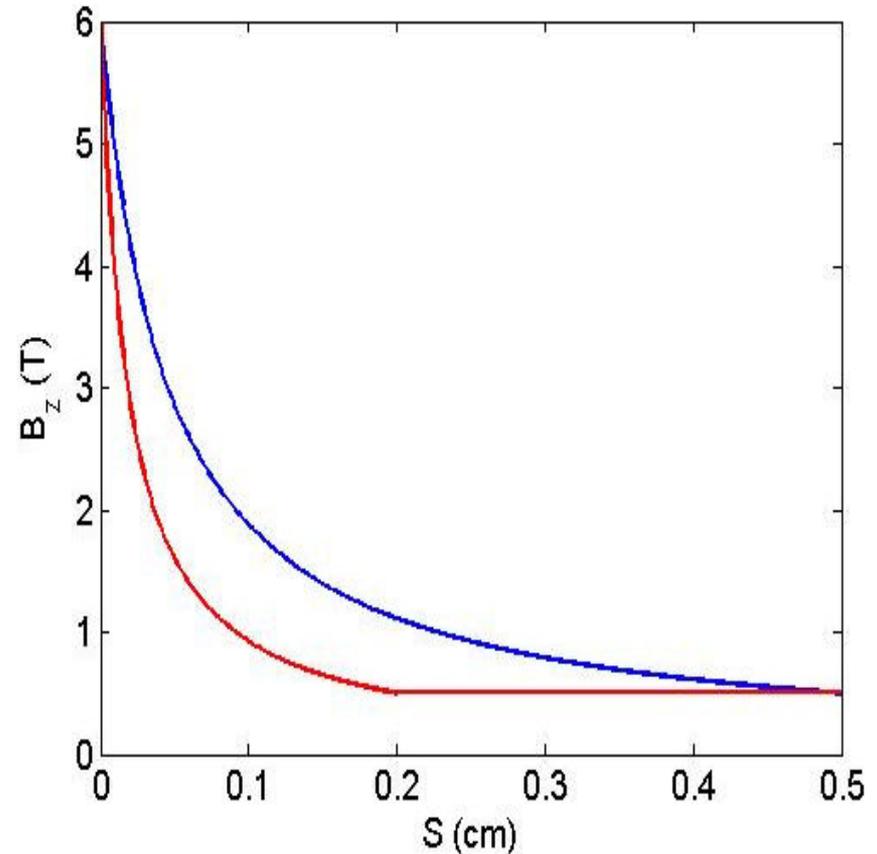
Positron Beam Parameters at the target

N. $e^+$	Yield $e^+/e^-$	$\epsilon_x$ (rms) $\pi$ mm mrad	$\epsilon_y$ (rms) $\pi$ mm mrad	$\langle E \rangle$ MeV	$\sigma_E$ MeV	$\sigma_z$ (rms)* mm
49750	8.29	98075	118943	50	103	0.300*

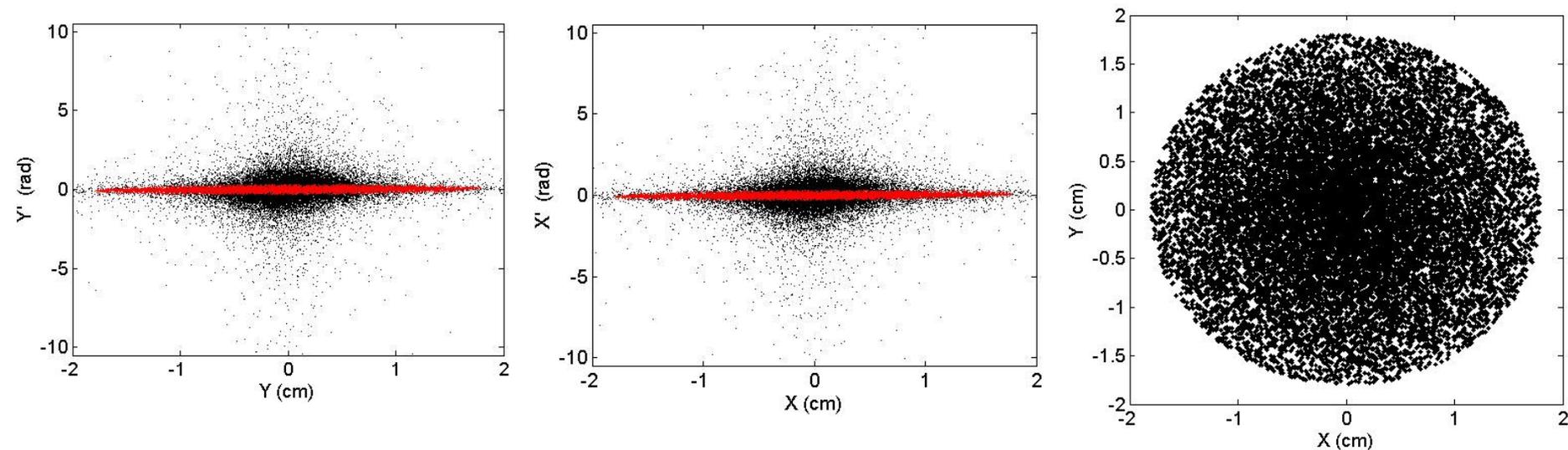
# Adiabatic Matching Device

- 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 :

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



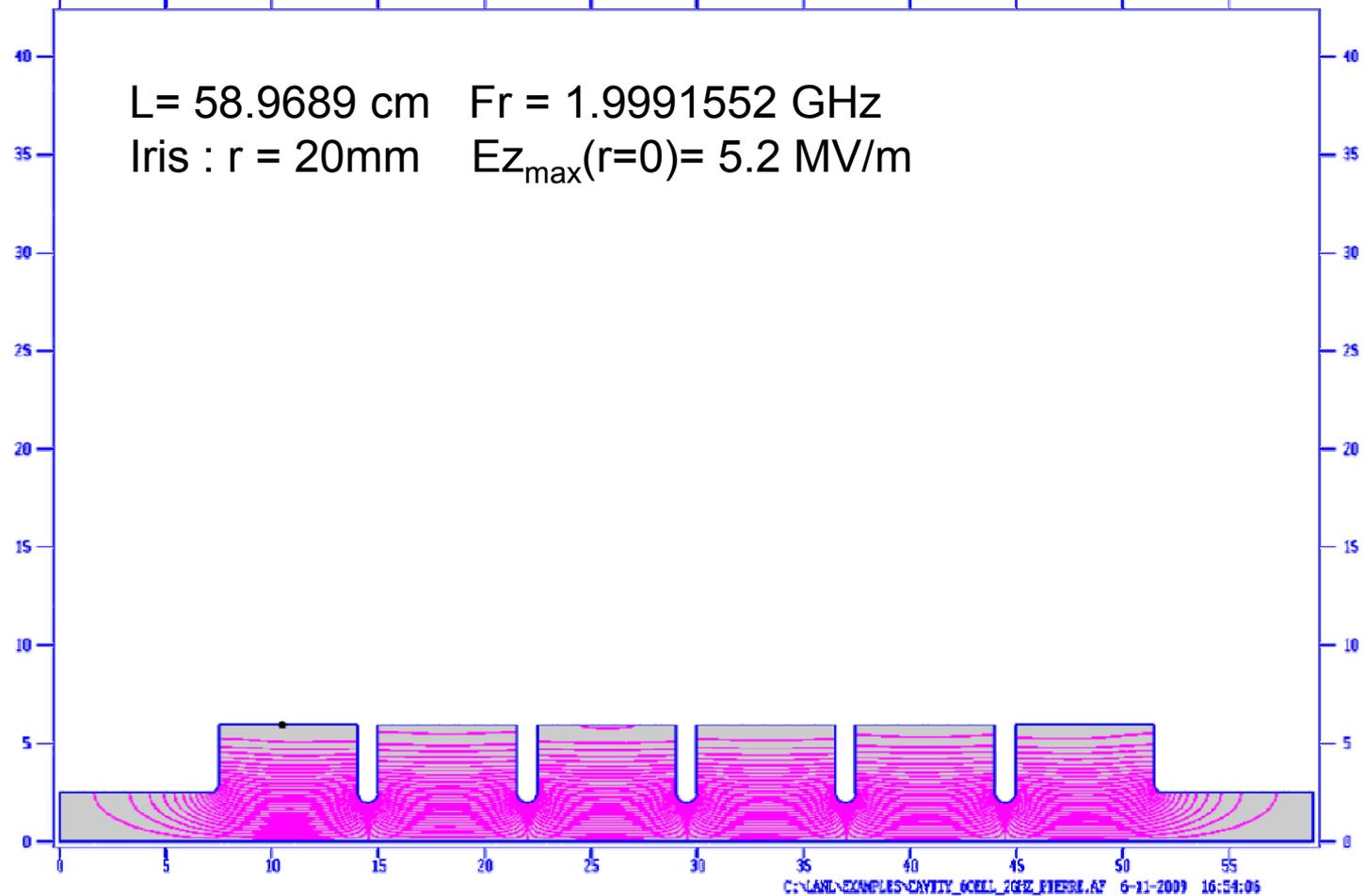
# AMD RESULTS



AMD cm	$N^* \cdot e^+$	Yield $e^+/e^-$	$\epsilon_x$ $\pi$ mm mrad	$\epsilon_y$ $\pi$ mm mrad	$\langle E \rangle$ MeV	$\sigma_E$ MeV	$\sigma_z^*$ mm	$\epsilon_z$ $\pi$ cm MeV
50	11695	1.95	502	508	70.6	176.6	10.0*	170.8
20	16488	2.75	679	684	79.0	164.7	8.7*	136.0

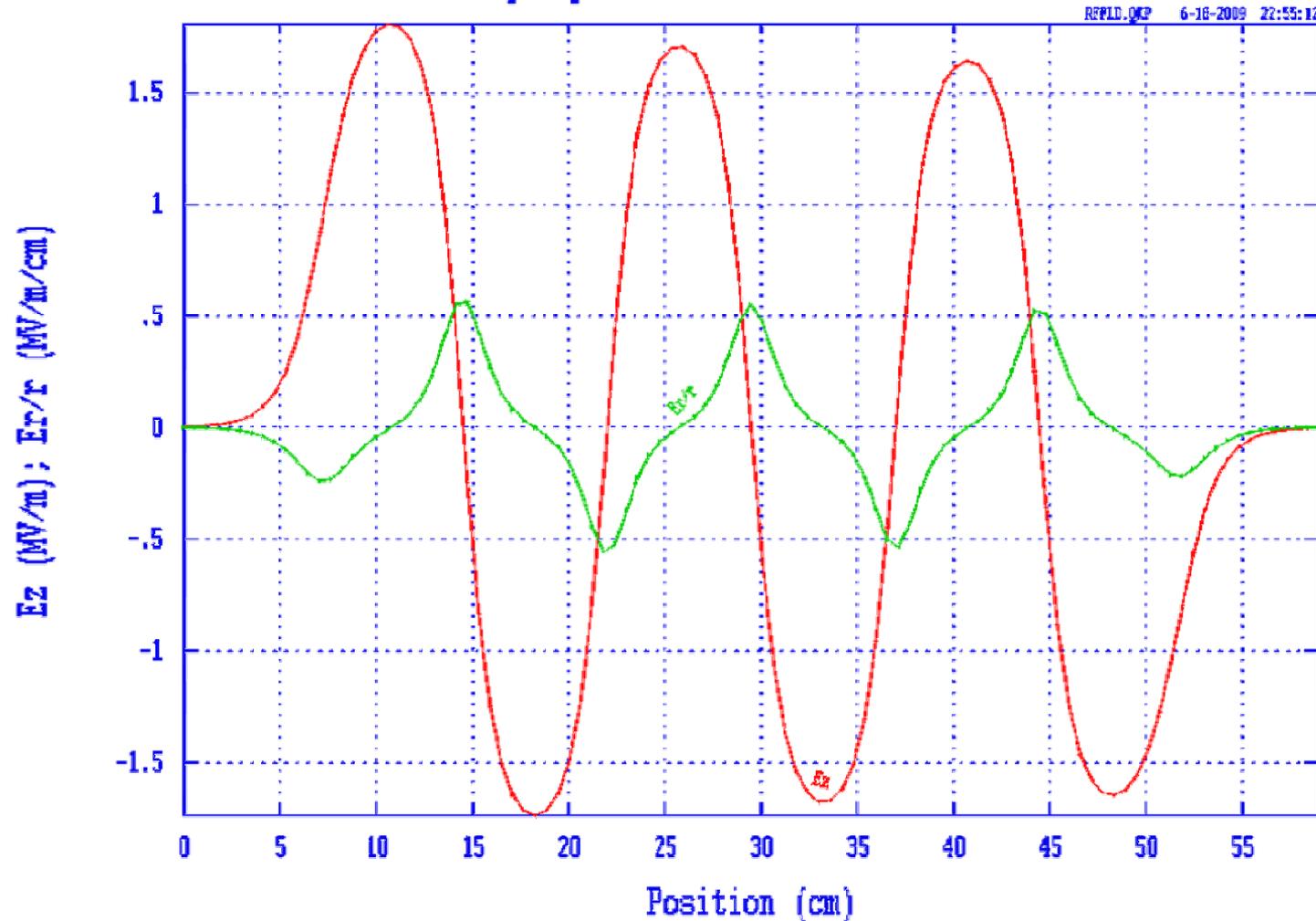
# CAVITY 100 KW CW (P. Lepercq)

6 cells, 2.0 GHz, Pierre Lepercq F = 1999.1552 MHz

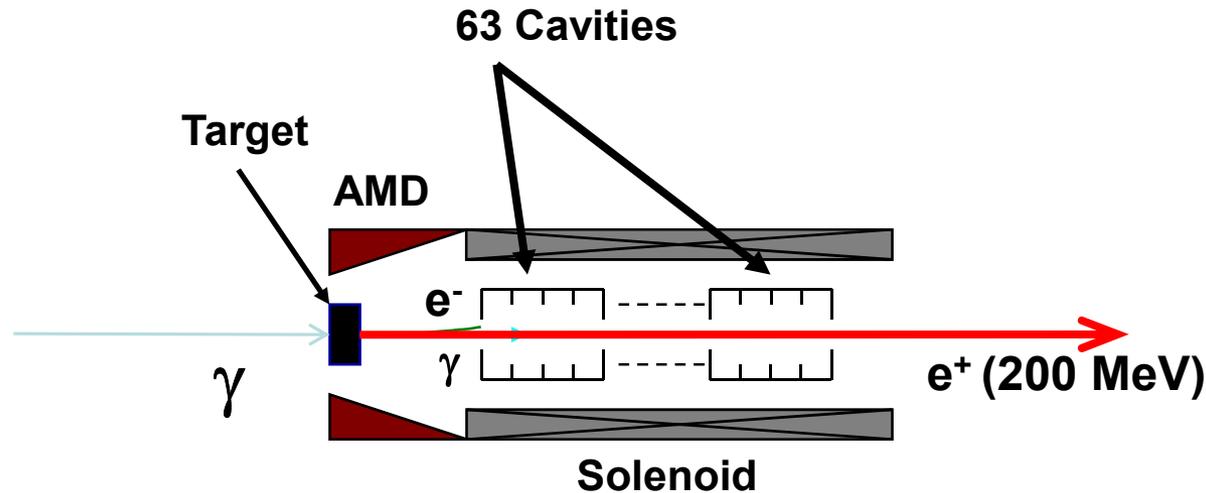


# CAVITY 100 KW CW (P. Lepercq)

6 cells, 2.0 GHz, Pierre Lepercq



# Capture Section Design



## AMD

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

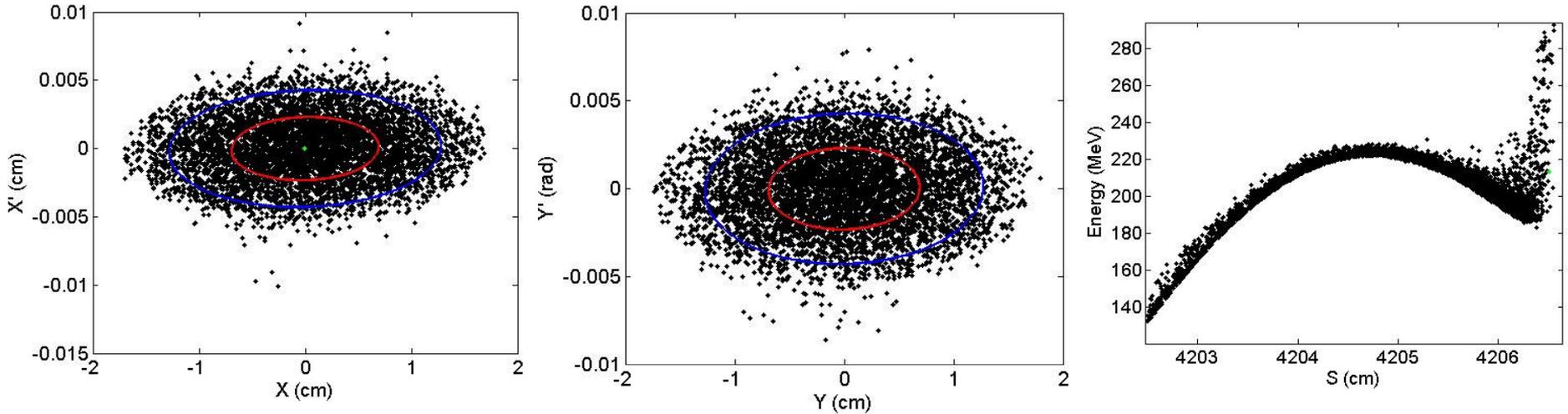
## SOLENOID

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

## Accelerating cavities:

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

# Capture Results



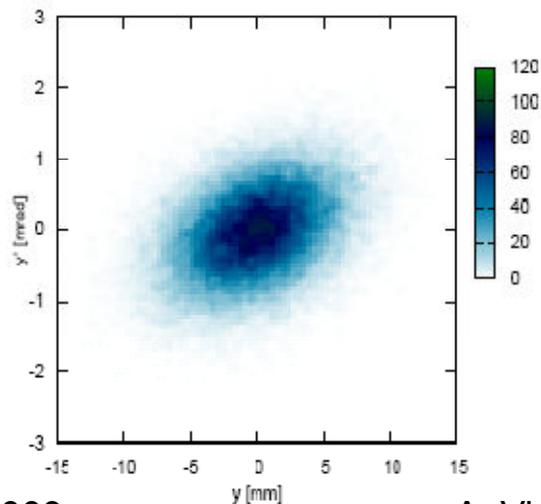
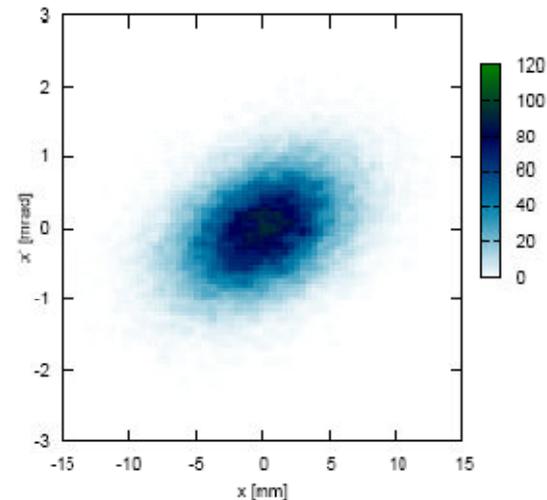
To be optimized...

S cm	N. e <sup>+</sup>	Yield e <sup>+</sup> /e <sup>-</sup>	$\gamma\varepsilon_x$ $\pi$ mm mrad	$\gamma\varepsilon_y$ $\pi$ mm mrad	$\langle E \rangle$ MeV	$\sigma_E$ MeV	$\sigma_z$ mm	$\varepsilon_z$ $\pi$ cm MeV
4200	5780	0.96	6704	6681	210.9	44.97	9.9	43.6

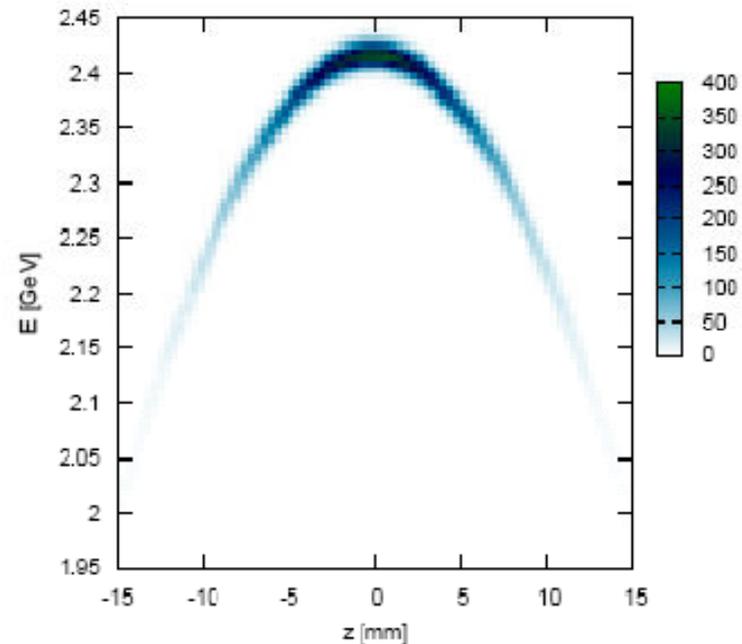
# Phase spaces for the Injector Linac @ 2.4 GeV

## Transverse

By A. LATINA



## Longitudinal

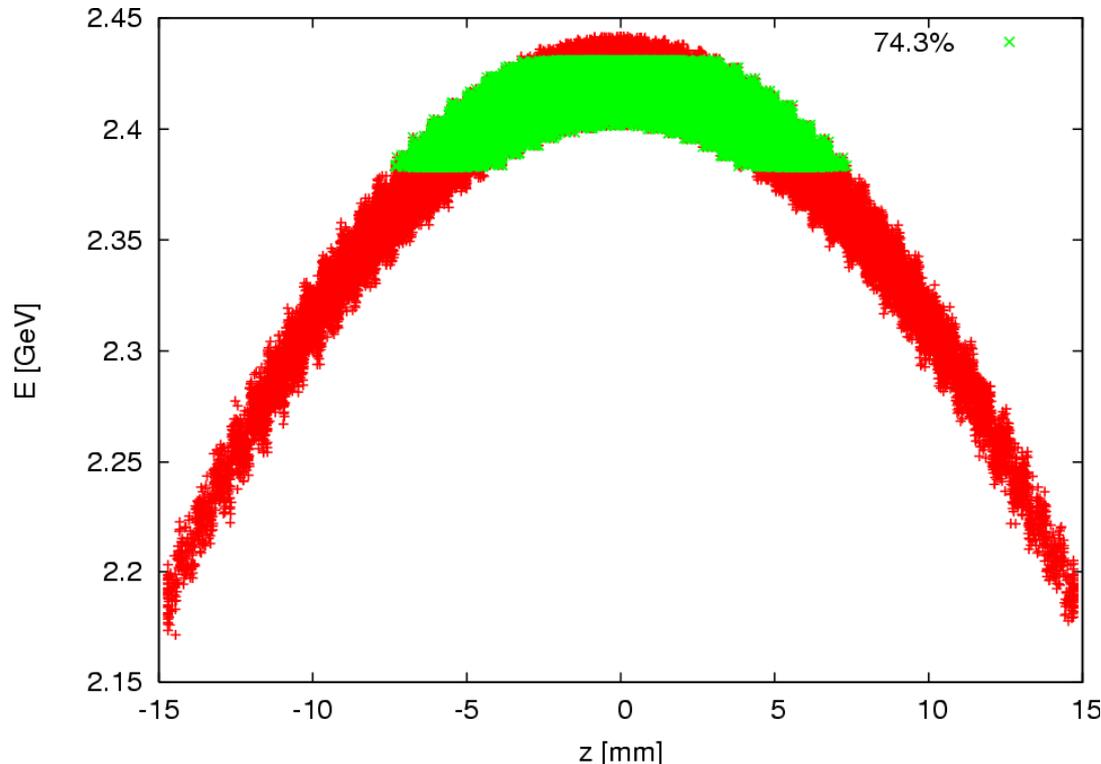


Bunch length (rms) = 5 mm

Energy spread (rms) = 65 MeV

# Phase spaces for the Injector Linac @ 2.4 GeV

By A. LATINA



Longitudinal distribution

$$E_{\text{mean}} = 2.4 \text{ GeV}$$

$$N_{e^+} = 6.4 \times 10^9 /$$

bunch

$$\Delta E = 17 \text{ MV/m}$$

Total distribution:

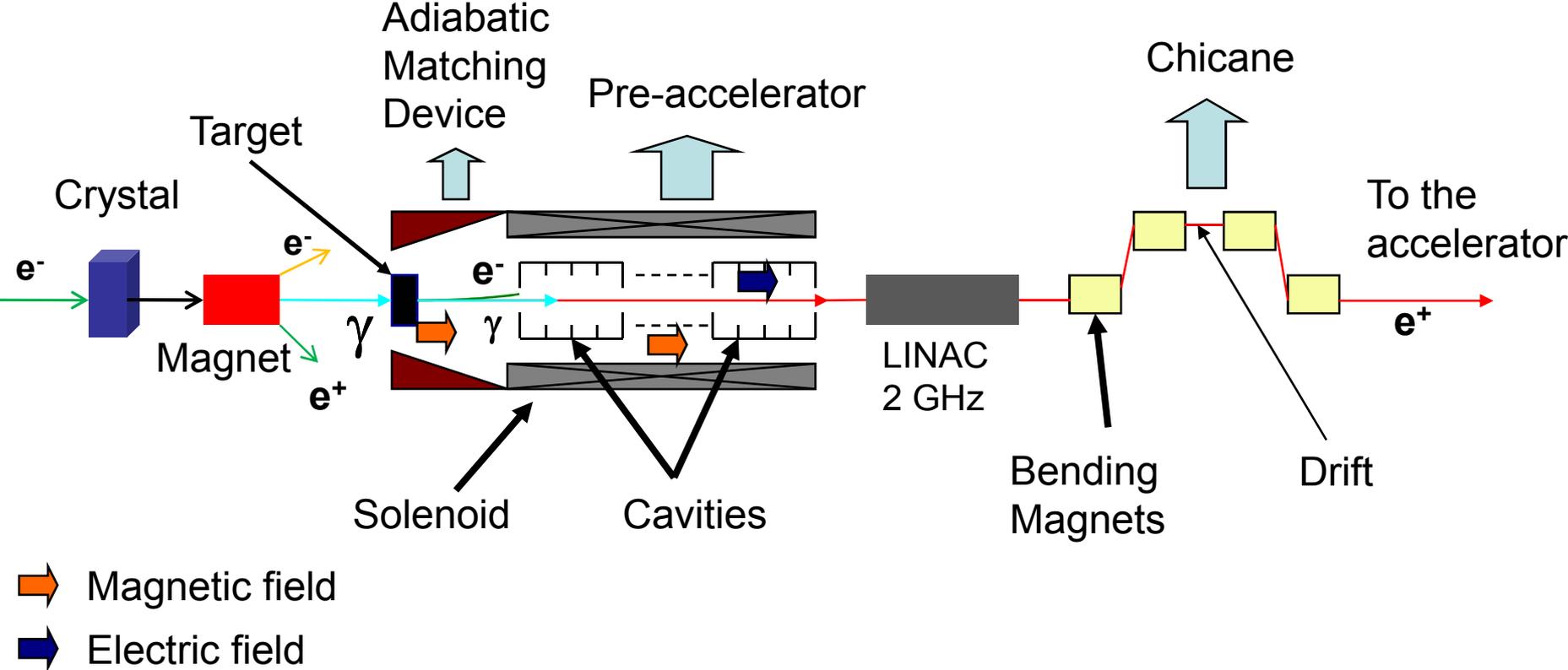
$$\sigma_E = 1.5 \%$$

rms bunch length 5  
mm

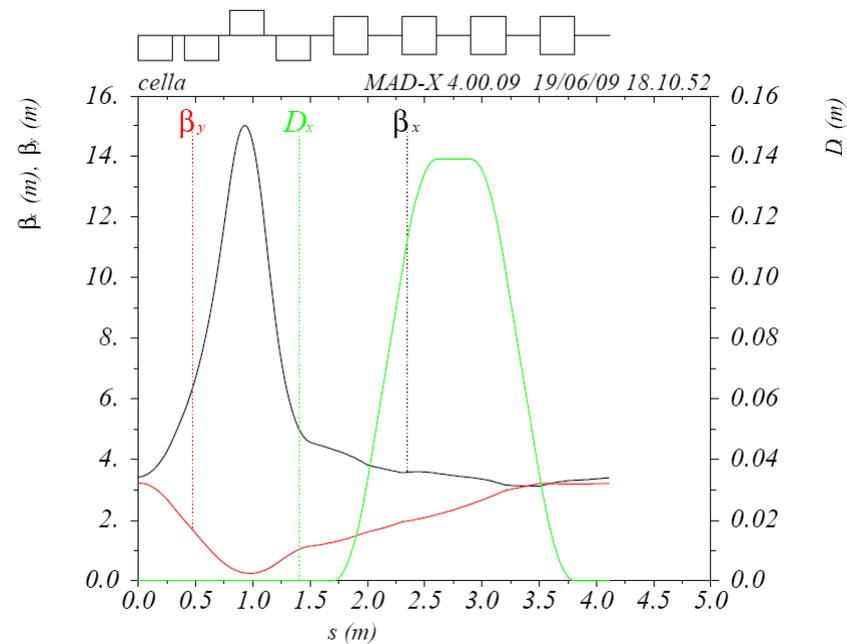
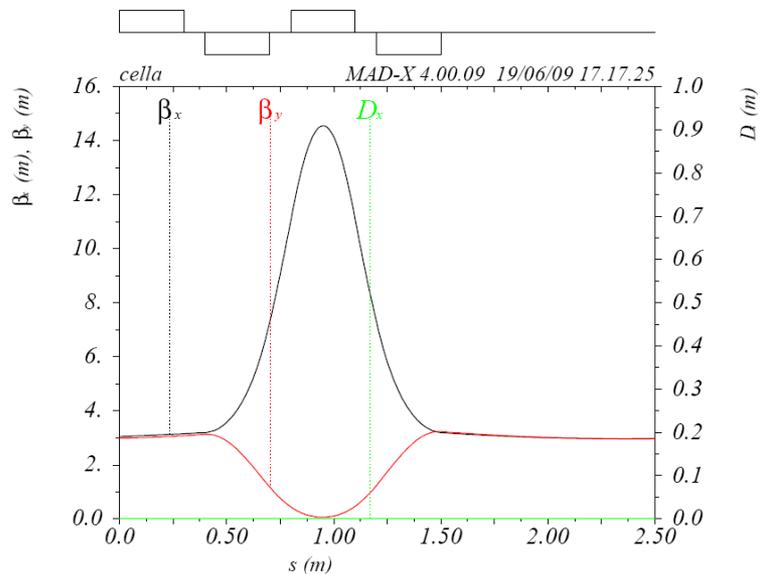
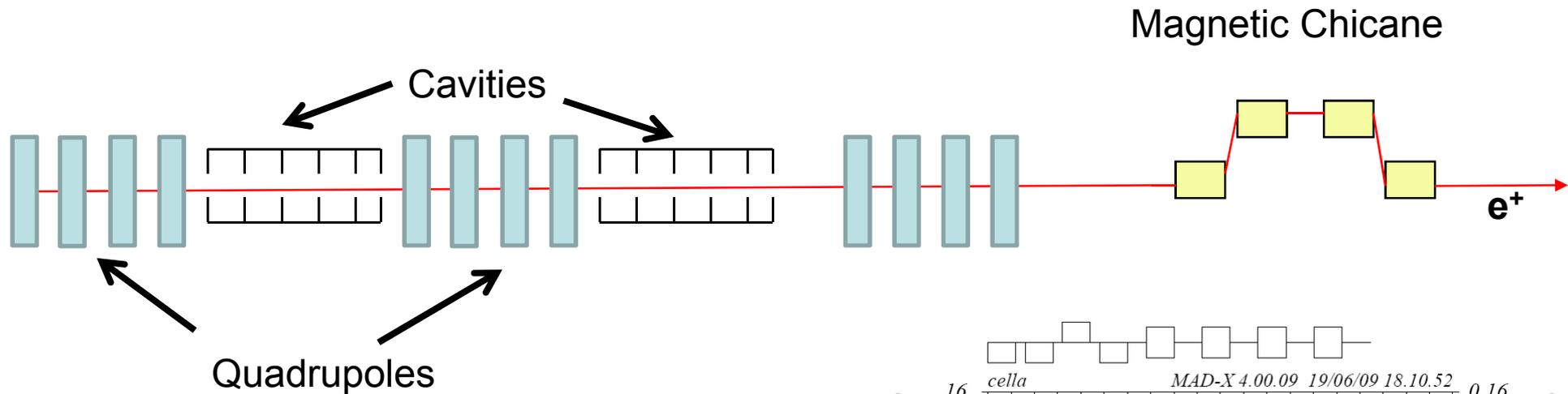
For acceptance  $\Delta E/E = 2 \%$   
FW

Capture = 74 % of  $e^+$   
rms bunch length 3.2 mm

# Capture Section (+ Bunch Compressor)



# Bunch Compressor Design



26/06/2009

A. Vivoli, CLIC Positron Source,  
POSIPOL 2009, LYON

16

# Bunch Compressor Elements

## Quadrupoles:

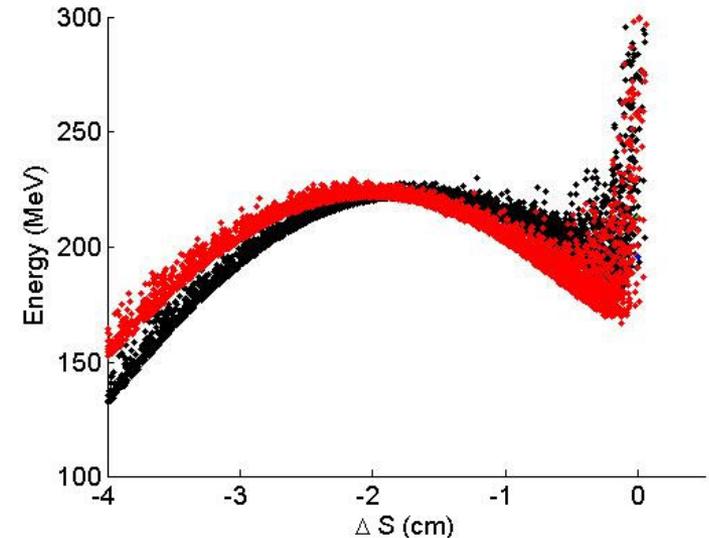
- Number:  $N = 20$
- Length:  $L = 30$  cm
- Gradient:  $G = 0.5 - 5$  T/m
- Aperture:  $r = 5$  cm

## Accelerating cavities:

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

## Bending Magnets:

- Number:  $N = 4$
- Length:  $L = 30$  cm
- Magnetic Field:  $B = 0.4985$  T

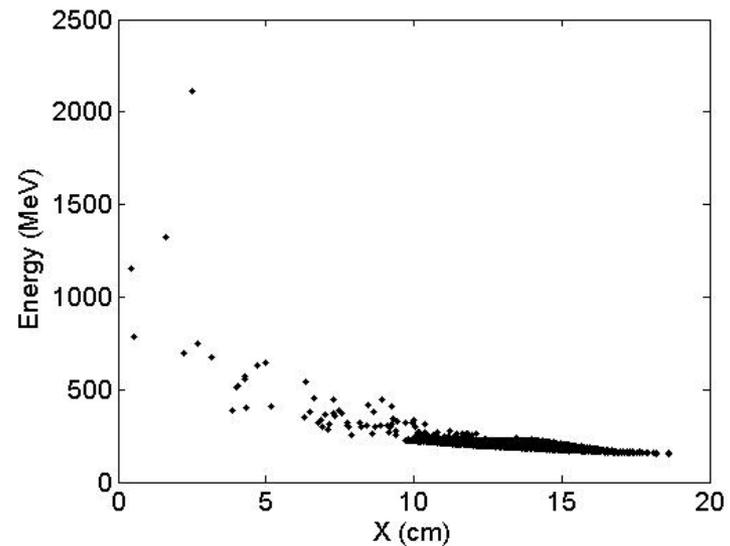
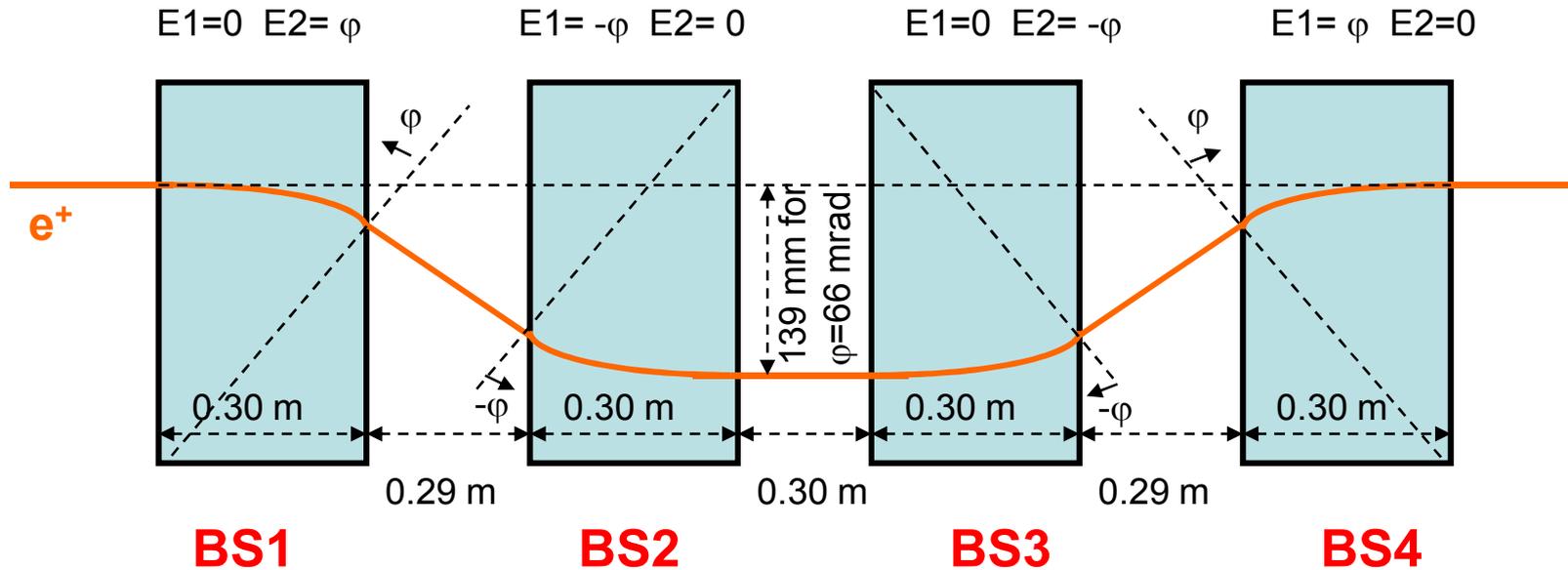


## Drift Tubes:

- Number:  $N = 28$
- Aperture:  $r = 5$  cm
- Length:  $L = 10 - 30$  cm

# MAGNETIC CHICANE

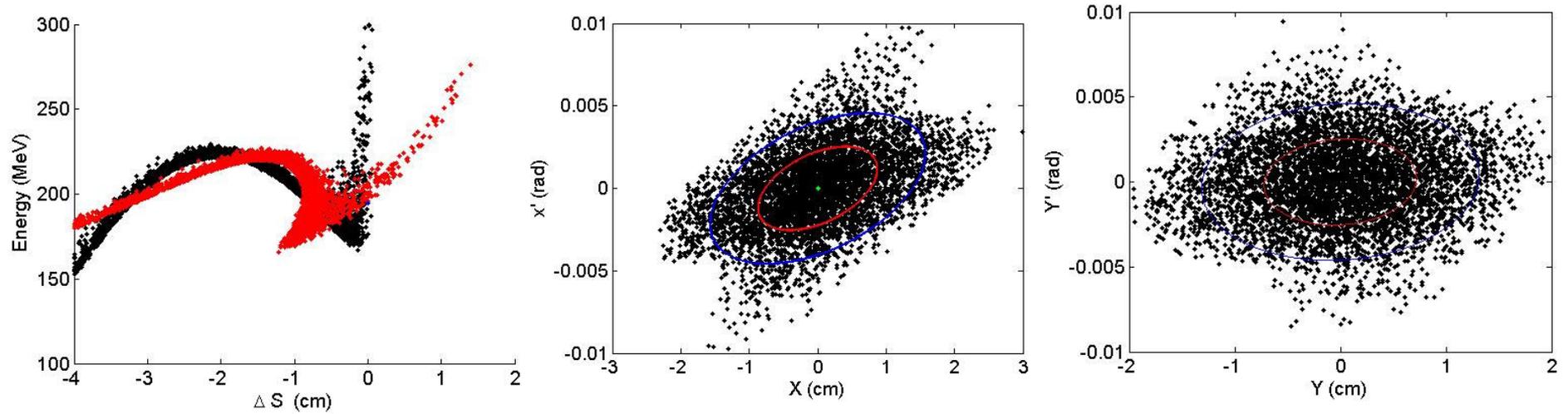
By M. Martini



## Chicane Modeling:

- Bending angle:  $\varphi = 13.17$  deg
- Drift:  $\lambda = 30$  cm
- Diaphragm:  $r = 3.5$  cm

# Bunch Compressor Results



s cm	N. $e^+$	Yield $e^+/e^-$	$\gamma\epsilon_x$ $\pi$ mm mrad	$\gamma\epsilon_y$ $\pi$ mm mrad	$\langle E \rangle$ MeV	$\sigma_E$ MeV	$\sigma_z$ mm	$\epsilon_z$ $\pi$ cm MeV
5597	5395	0.90	7831	7276	203.6	15.2	7.4	11.2

# Future Steps

- Complete the positron source design&simulation up to the pre-damping ring.
- Optimize the parameters for non-polarized positrons.
- Study parameter changes for polarized positrons.
- Employ different codes for simulations (PARMELA, PLACET, GEANT4,...).

THANKS.

The End