



# FULL 3-D LATTICE S-&-C Band Based Injector

Edu Marin<sup>1</sup>, R. Munoz Horta<sup>1</sup>  
emarin@cells.es

<sup>1</sup>CELLS, Barcelona, Spain

January 21<sup>st</sup>, 2020

**WP6: Beam Dynamics**

**2<sup>nd</sup> Annual Meeting, Athens**

Acknowledgments: **M. Croia**



## Inputs

- User's Input
- New Module Configurations
- Injector Distribution (S-Band)
- Injector Distribution (C-Band)

## XLS New Design

- Twiss Functions
- 6-D Tracking Results (S-band)
- 6-D Tracking Results (C-band)

## Conclusions



# XLS Requirements

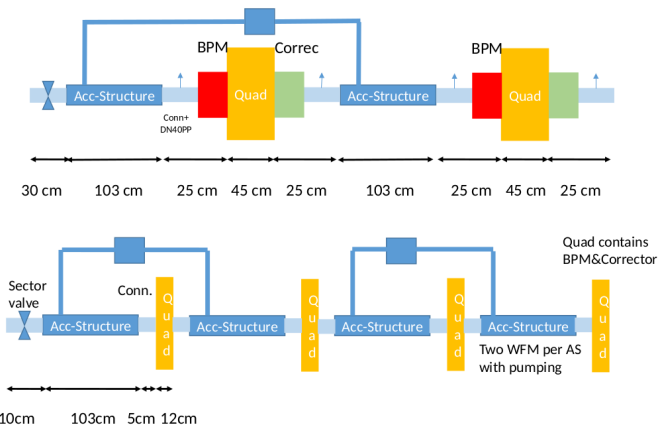


## User's Input:

- ▶ Design a lattice which delivers  $e^-$  beams with peak currents of 5 kA
- ▶ Beam energy @L2 ranging from 2.75 GeV to 5.5 GeV
- ▶ Acc. Structures will run at high and low gradients
  - ▶ high gradient **HG= 65 MeV/m**
  - ▶ low gradient **LG= 20 MeV/m**

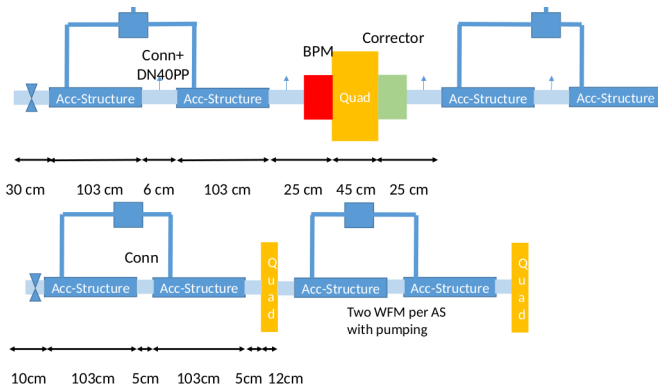
## From beam dynamics (consensus):

- ▶ Beam energy at exit of L0 should be 300 MeV
- ▶ Beam energy at exit of L1 should be 1 GeV



RF Fill Factor increased from 42% to 71%\*

\* Provided by M. Aichelar

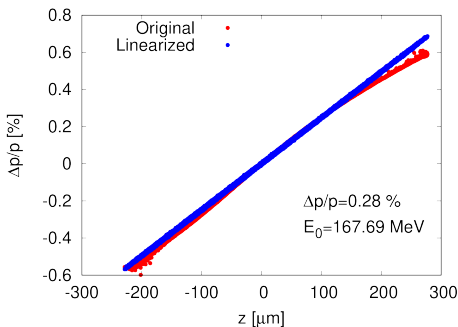


RF Fill Factor increased from 53% to 76%\*

\* Provided by M. Aichelar



- ▶ Injector Operation Mode: Velocity Bunching
- ▶ Output Energy: 168 MeV
- ▶ Normalized Energy Spread: 0.28%
- ▶ #  $e^- \approx 31$  k
- ▶ Bunch Charge: 75 pC



- ▶ Twiss parameters  
 $\beta_{x,y} = 50$  m  
 $\alpha_{x,y} = 2.0$
- ▶ Emittances  
 $\gamma\epsilon_{x,y} = 0.21$   $\mu\text{m}$
- ▶ Bunch length  
 $\sigma_z = 113$   $\mu\text{m}$

\* provided by A. Giribono



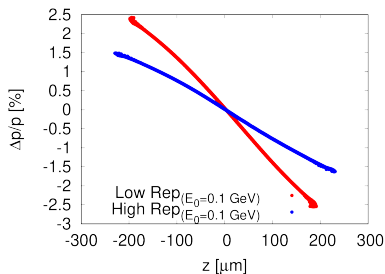
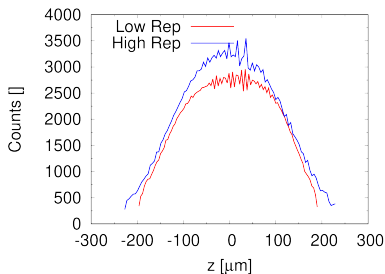
- ▶ Twiss  $\beta_{x,y} = 4.5 \text{ m}$      $\alpha_{x,y} = -0.3$      $\gamma\epsilon_{x,y} = 0.15 \text{ } \mu\text{m}$ 

Low Rep. Rate	High Rep. Rate
---------------	----------------
- Bunch length  $\sigma_z [\mu\text{m}] =$ 

92	100
----	-----
- ▶ Output Energy [MeV]:
 

109	103
-----	-----
- ▶  $\Delta p/p$  [%]:
 

1.2	0.7
-----	-----



\* provided by M. Croia

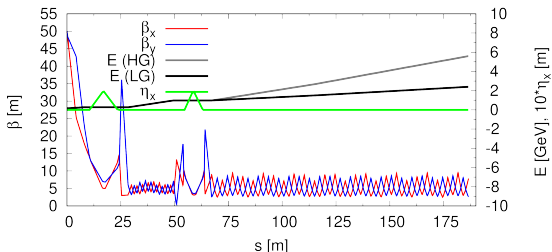




# XLS New Design



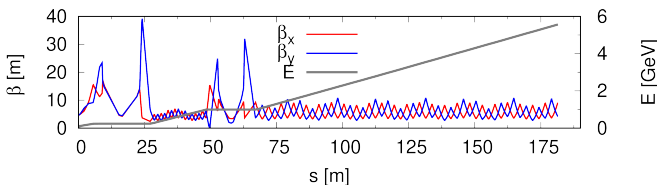
- ▶ 2x (4-dipole chicane)
  - ▶ angle (BC1): 3.0 deg
  - ▶ angle (BC2): 2.1 deg
- ▶ L2 is split in 2 sections:
  - ▶ L2A Phase: 30 deg
  - ▶ L2B Phase: 0 deg
- ▶ Length: 186.5 m
- ▶ 8 bends, 166 Quads, 119 Cavs
- ▶ Max Energy:
  - ▶ LG-mode: 2.75 GeV
  - ▶ HG-mode: 5.6 GeV



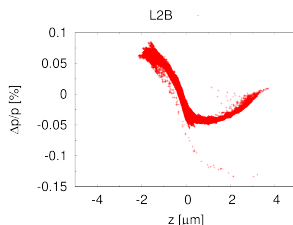
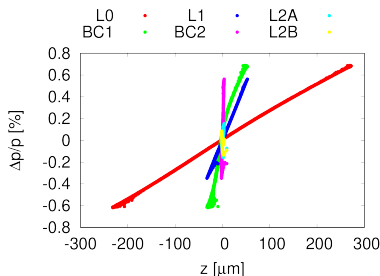
Lattice available at <https://gitlab.cern.ch/XLS-Git/WP6>



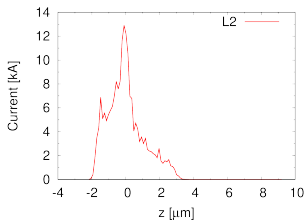
- ▶ 2x (4-dipole chicane)
  - ▶ angle (BC1): 1.3 deg
  - ▶ angle (BC2): 1.4 deg
- ▶ L2 is split in 2 sections:
  - ▶ L2A Phase: 15 deg
  - ▶ L2B Phase: -10 deg
- ▶ Length: 178.5 m
- ▶ 8 bends, 166 Quads, 119 Cavs
- ▶ Max Energy:
  - ▶ LG-mode: 2.75 GeV
  - ▶ HG-mode: 5.6 GeV

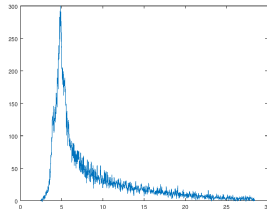
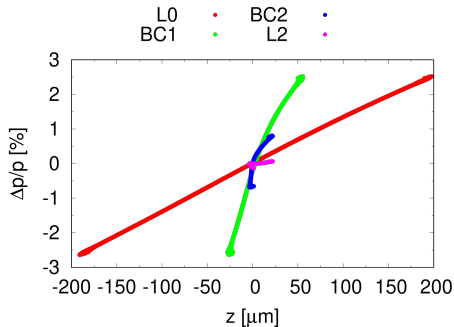


Lattice available at <https://gitlab.cern.ch/XLS-Git/WP6>



- ▶  $\sigma_z = 1.0 \mu\text{m}$  (rms)  
 $1.8 \mu\text{m}$  (fwhm)
- ▶  $\epsilon_{x,y}$  (rms) =  $0.2 \mu\text{m}$
- ▶  $\Delta p/p < 0.04 \%$





- ▶  $\sigma_z = 0.5 \mu\text{m}$  (core)
- ▶  $\epsilon_{x,y}$  (rms) =  $0.15 \mu\text{m}$
- ▶  $\Delta p/p < 0.02 \%$



## Conclusions

New XLS lattice has been obtained using the new module configurations

- ▶ Using the S-band distribution in v.b. mode
- ▶ Using the latest C-band distribution in v.b. mode  
Large tails observed at the end of L2 when using the C-band distribution

## Outlook

- ▶ Still room for optimization
  - ▶ specially for the C-band case (K-linearizer)