CLIC-DBRC update - TTA and 12x recombination

Raul Costa

CERN

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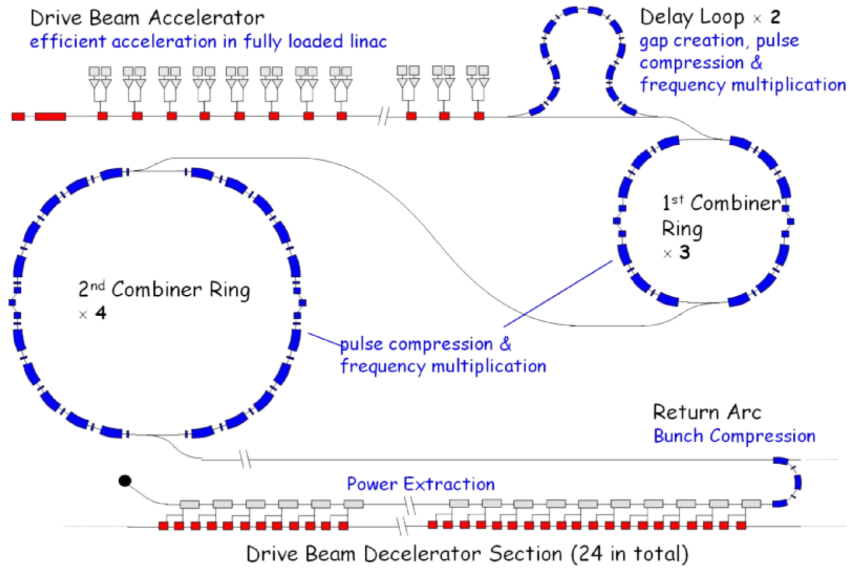
CLIC Beam Physics Meetings

Raul Costa, Andrea Latina, Eduardo Marin

DBRC's role

The DBRC is located after the drive beam linac. It's main role is to create high current pulses for the PETS.



122 bunches
0.49975 GHz
244 ns

$2\text{ns} \equiv 60\text{cm}$ between bunches

2928 bunches
11.994 GHz
244 ns

$83\text{ps} \equiv 2.5\text{cm}$ between bunches

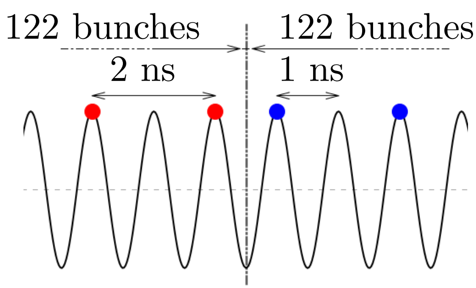
70760 bunches ($\equiv 142\mu$s) train

5.9 μs

DBRC's design parameters

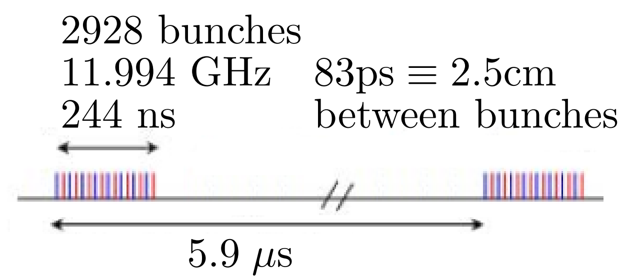
Injection:

- $E = 2.38\text{GeV}$
- $\Delta E = 0.85\%$
- $\varepsilon_{x,y} = 100\mu\text{m}$
- $\sigma_z = 1\text{mm}$[1]
- Longitudinal chirp
- $f = 0.49975\text{GHz}$
- 122 bunch trains phase-coded



Extraction:

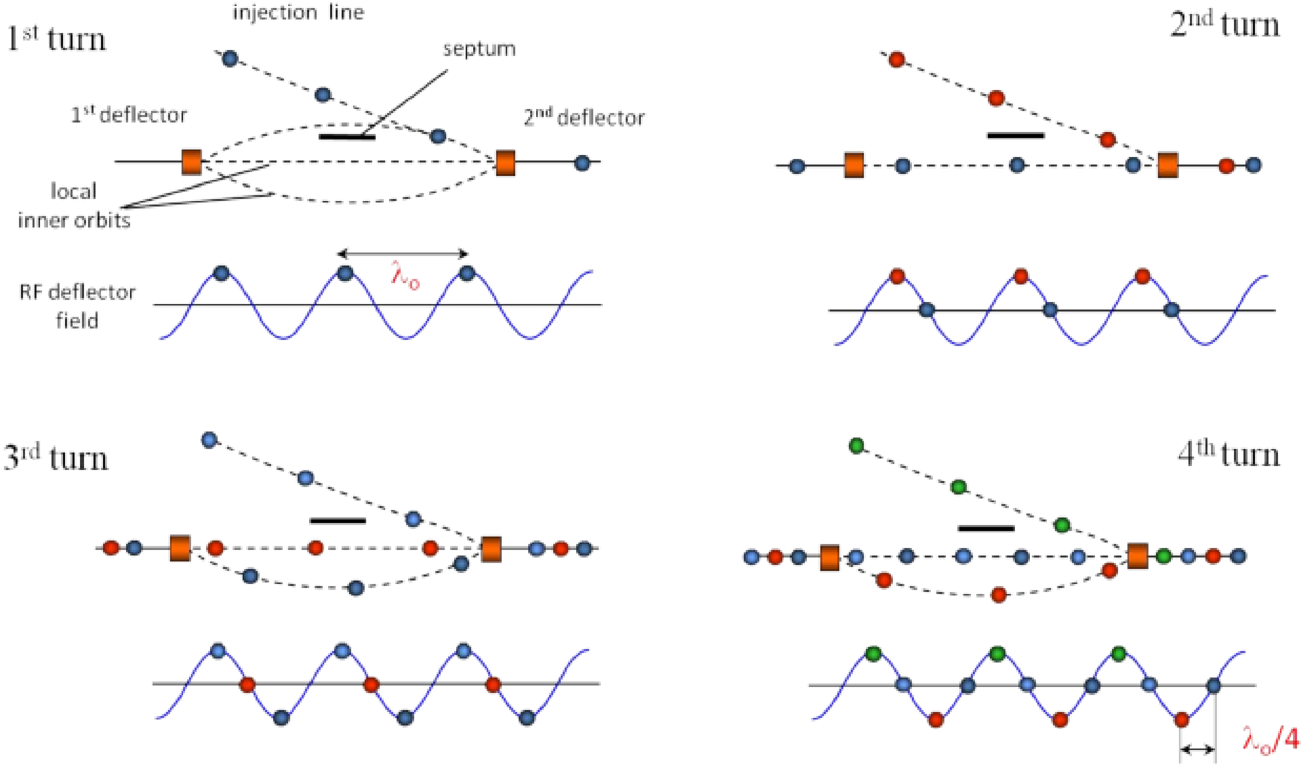
- $E = 2.38\text{GeV}$
- $\Delta E = 0.85\%$
- $\varepsilon_{x,y} = 150\mu\text{m}$
- $\sigma_z = 1\text{mm}$
- Longitudinal chirp
- $f = 11.994\text{GHz}$
- short pulse time structure



[1] 2mm inside the complex

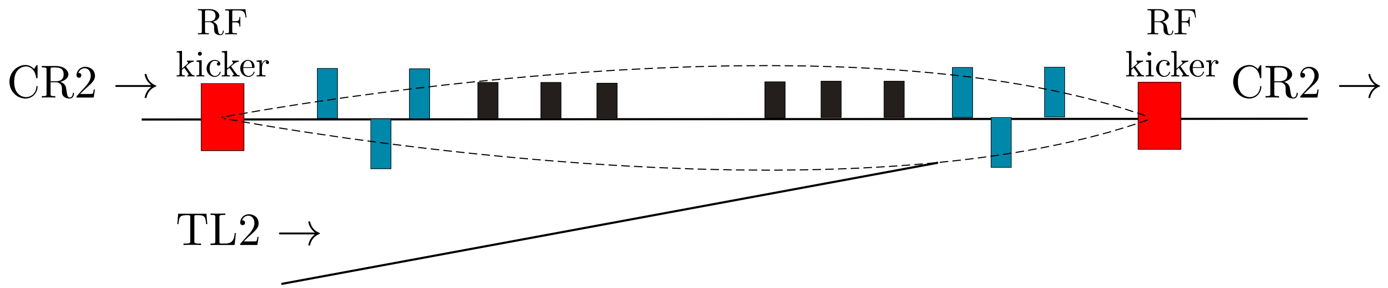
CR2 injection scheme

- CR2 uses two 3 GHz RF kickers to inject the bunches into orbit
- This means that the third turn of the ring suffers a "bump" in the opposite direction of the septum.

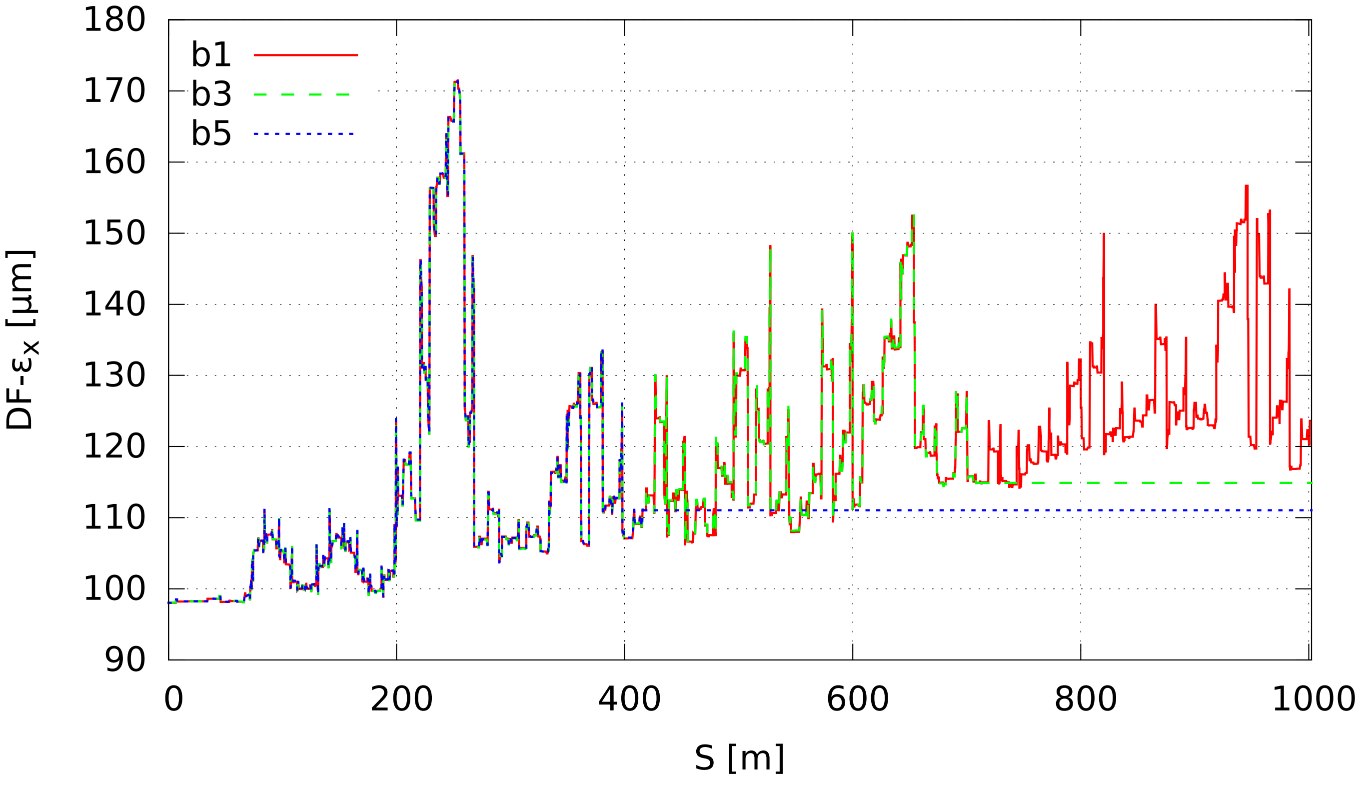


CR2 injection scheme (new lattice)

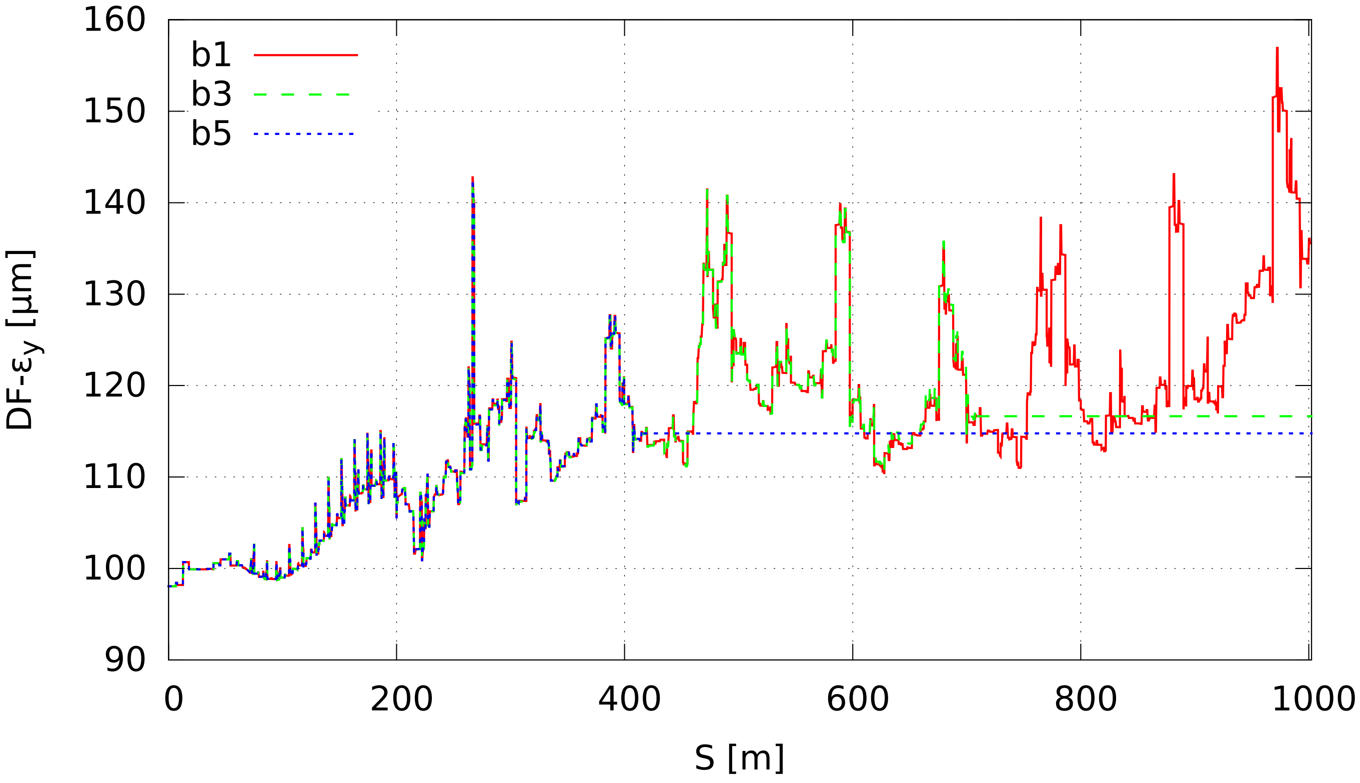
- **Since turn 3 has an offset, the sextupoles act as quadrupoles (and sextupoles, and dipoles)**
- The septum was moved to inject after the sextupoles



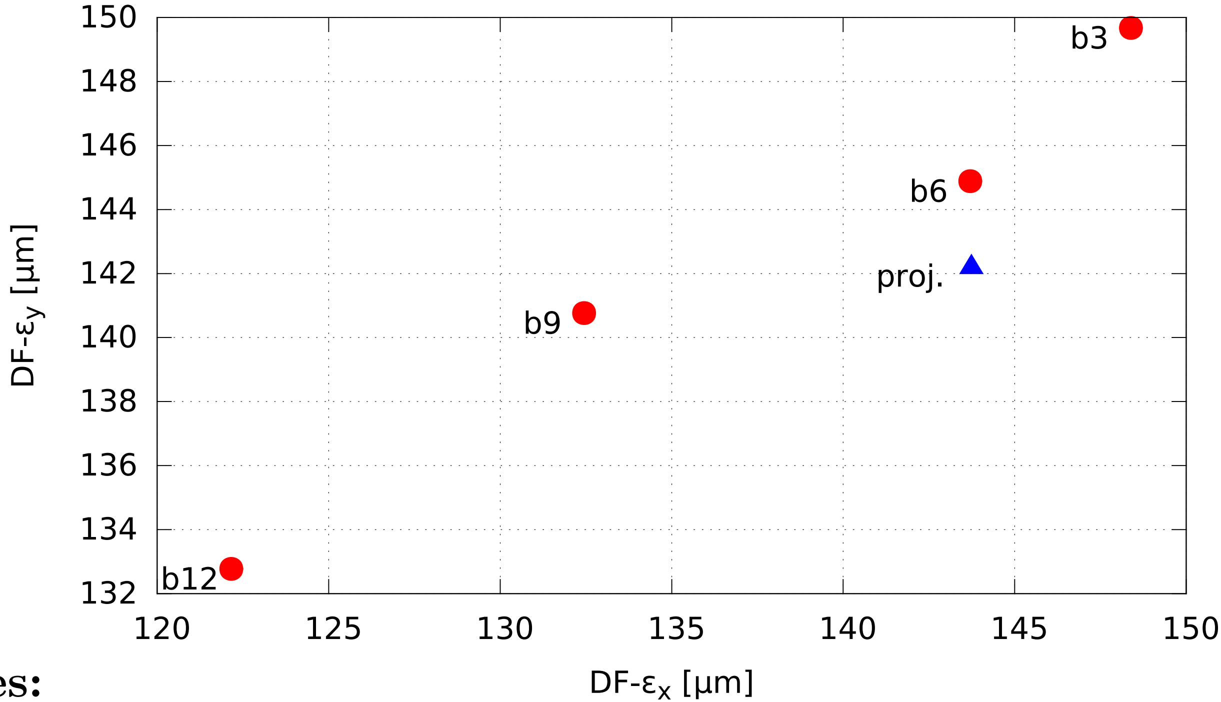
Emittance optimization - up to CR1



Emittance optimization - up to CR1



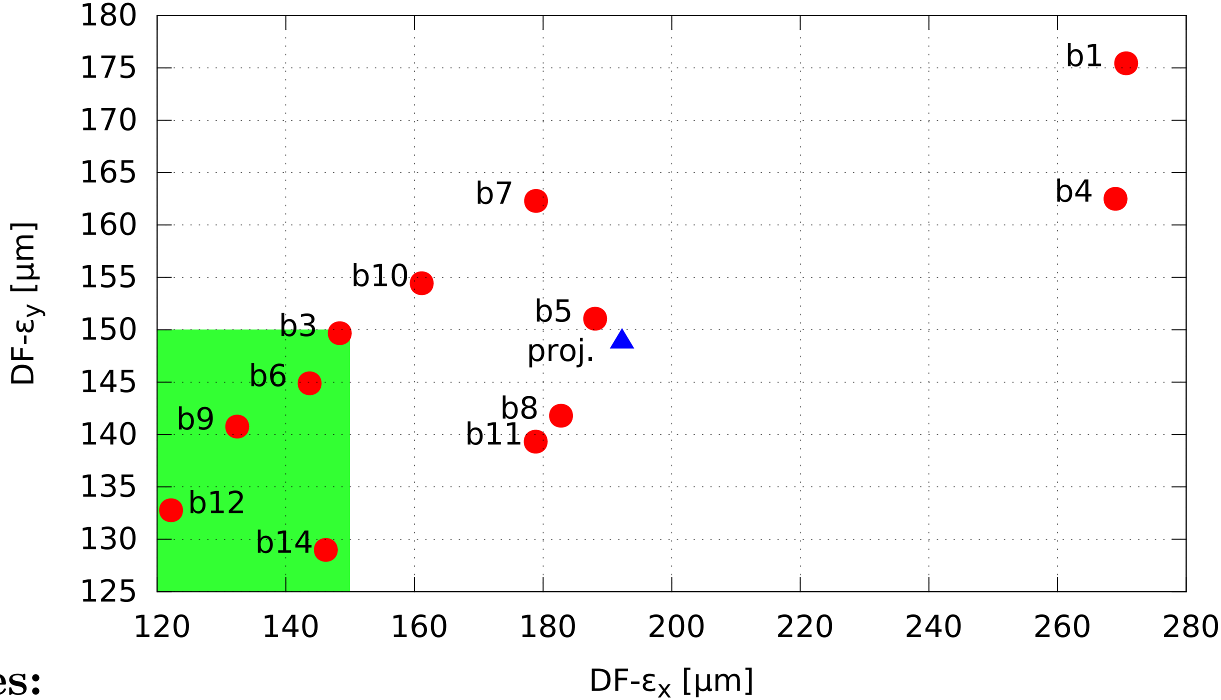
At the end of the complex (4x)



Notes:

- CR2 was optimized with the bunch thtat takes 1.5 turns in CR1
- This results are with the new CR2 injection bump design

At the end of the complex (12x)

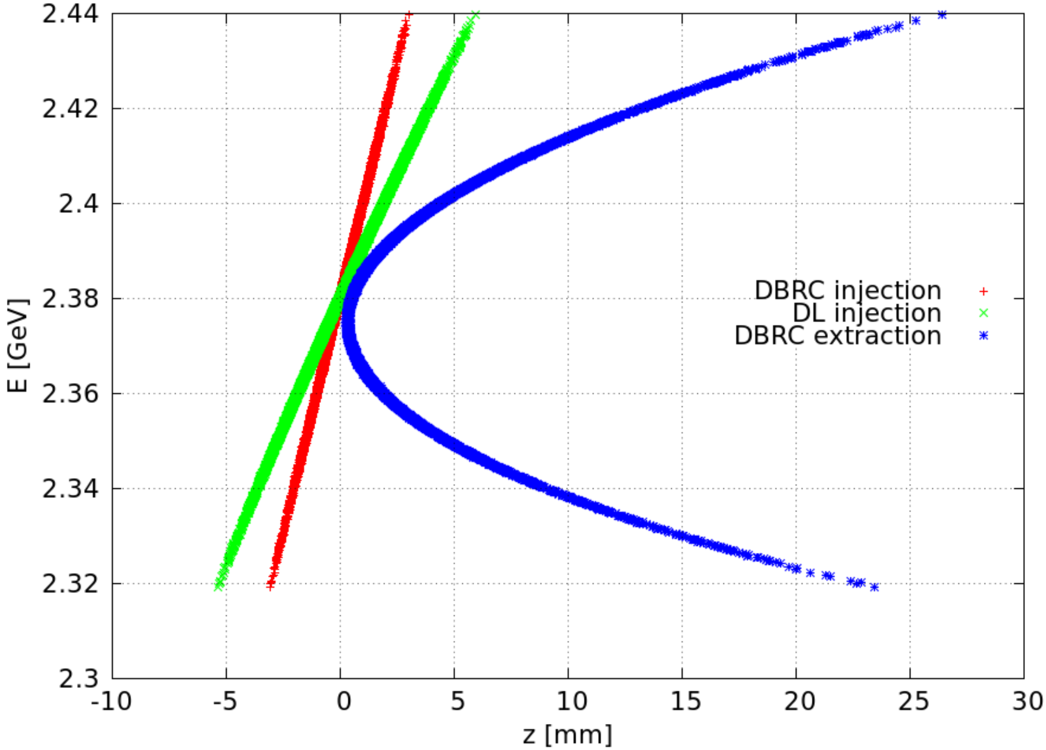


Notes:

- CR2 was optimized with the bunch thtat takes 1.5 turns in CR1
- This results are with the new CR2 injection bump design

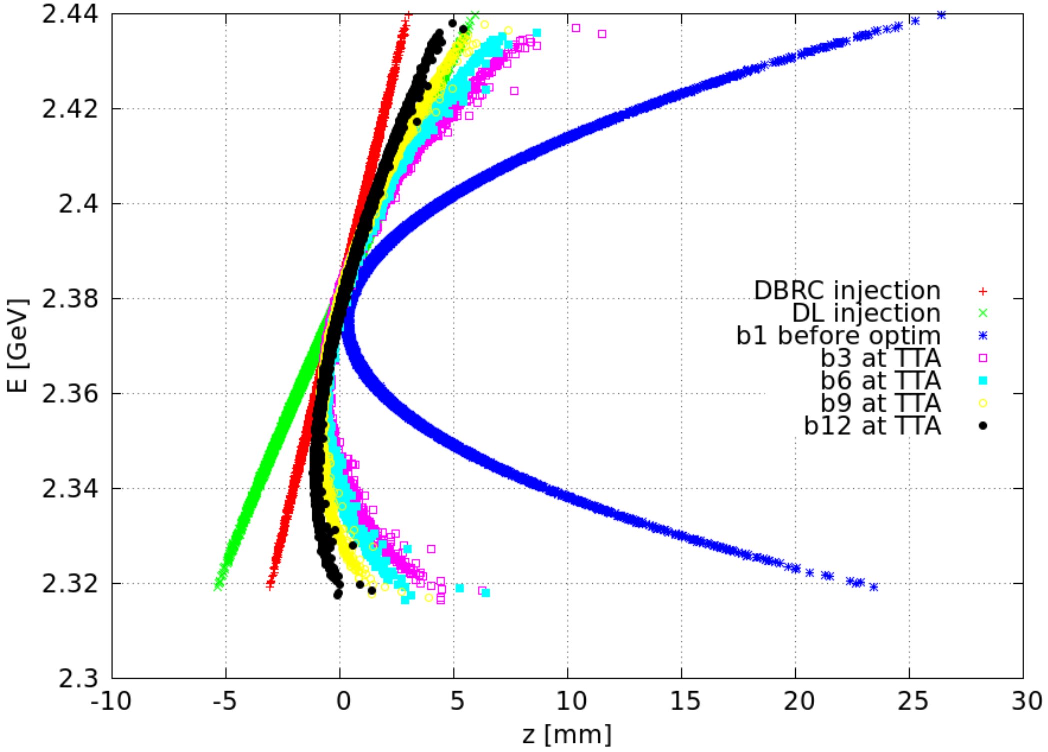
The T_{566} problem

- Shortly after the lattice was implemented in `Placet2` an unexpected T_{566} aberration was identified



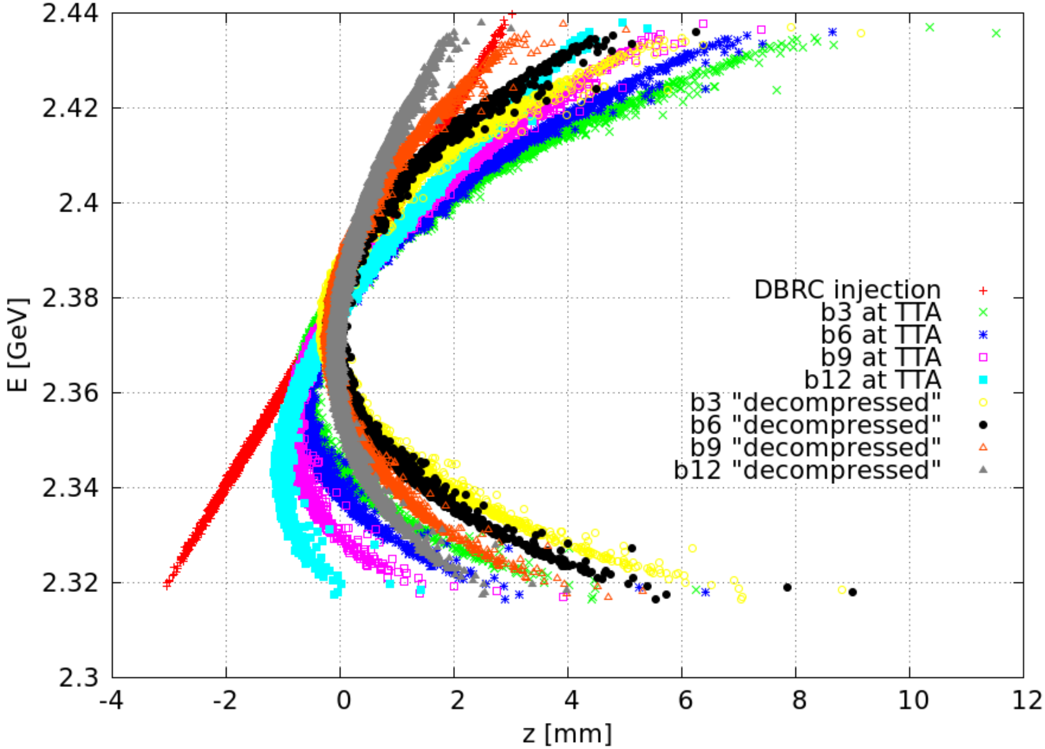
After optimization

- In addition to emittance we also targeted T_{566}
- Using sextupoles in dispersive regions we managed to reduce it



Attempting to recompress

But now that we are at the recompression chicane, it is clear that it is not sufficient. The chicane actually over-compresses due to the T_{566}



12x recombination

In order to low emittance achieve 12x recombination we "only" need to match all CR1 bunches to the properties of bunch 3

Current issues:

- Tracking the 12 bunch paths requires $\sim$ 1min/iteration
- Symplex optimizing takes $O(4-5)$ iterations
- We could easily be looking at months of computing time
- Additionally there seems to be a problem `Placet2`'s parallelization

Preliminary results

Projected DF-emittance growth:

sector	$\varepsilon_x[\mu\text{m}]$	$\Delta\varepsilon_x[\%]$	$\varepsilon_y[\mu\text{m}]$	$\Delta\varepsilon_y[\%]$
DL	117	17	107	7
CR1 (3x)	139	19	122	14
TTA (4x)	143	3	142	16
TTA (12x)	192	38	149	22

Bunch length after recompression:

bunch	b3	b6	b9	b12
σ_z [mm]	0.97	0.76	0.56	0.36

Conclusions

- DBRC `Placet2` lattices are ready for simulations and studies
- Several features (BPMs, dispersion-free readings, etc) have been added or updated in `Placet2`
- Lattice geometry updated (DL, CR1, TL2 and CR2)

- There is a strong T_{566} aberration
- Sextupoles in dispersive regions can reduce T_{566}
- Current T_{566} correction is insufficient for recompression
- We probably need a dedicated study (and optics?) to correct this

- We have proposed a new CR2 injection design
- Preliminary results at CR2 meet design budget: $\varepsilon_x = 143\mu\text{m}$ $\varepsilon_y = 142\mu\text{m}$ projected over 4 bunch recombination
- 12 bunch recombination requires further optimization of CR1

Outlook

Next Steps:

- Improvement of code (parallelization) and computing resources
- Re-optimization of CR1 to better match bunches 1,3 and 5
- Global machine optimization

- Revisit the DL design (implement short path and update long)
- Design and implement more realistic septa

- Check magnet strength and longitudinal phase error tolerances
- Implement misalignments and beam-based alignment

- Write a thesis!!