Optimisation of the Drive Beam Recombination Complex

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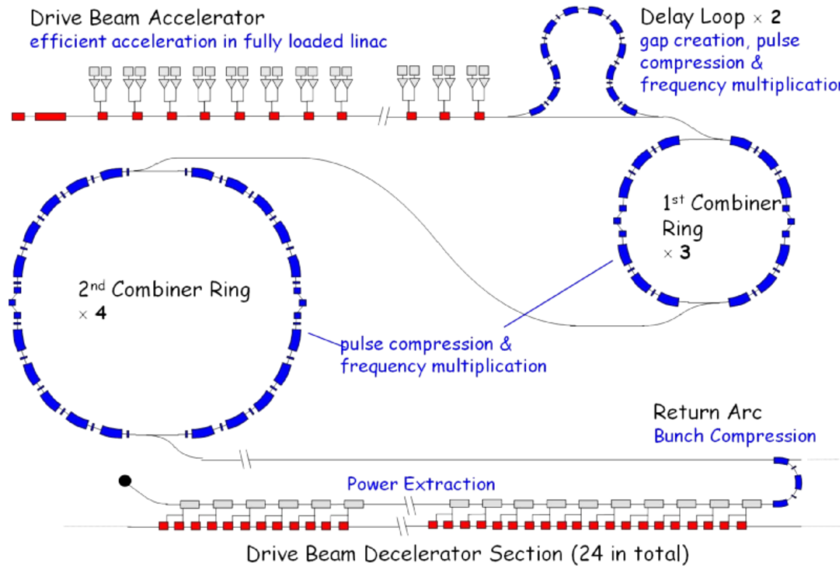
Outline

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

2ns ≡ 60cm between bunches

2928 bunches
11.994 GHz
244 ns

83ps ≡ 2.5cm between bunches

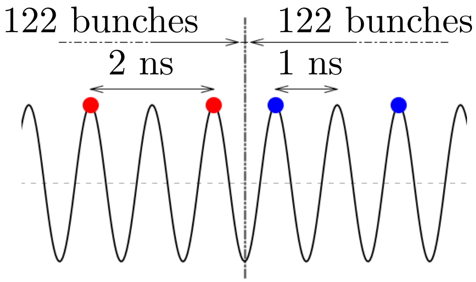
70760 bunches (≡ 142μs) train

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



[1] 2mm inside the complex

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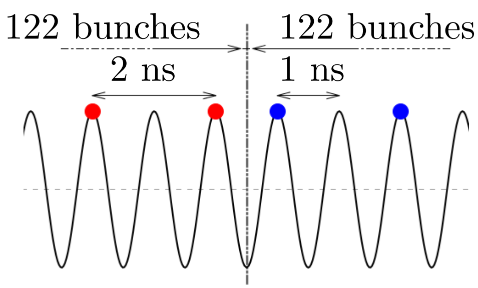
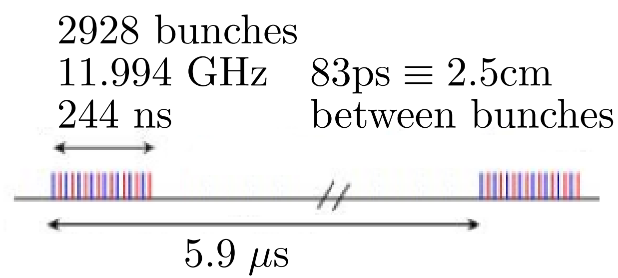


Extraction:

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



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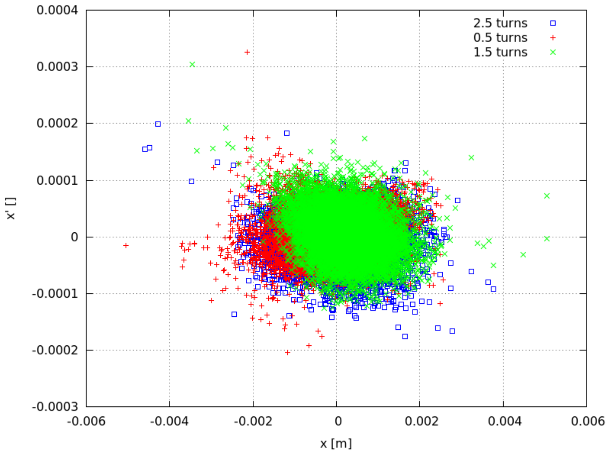
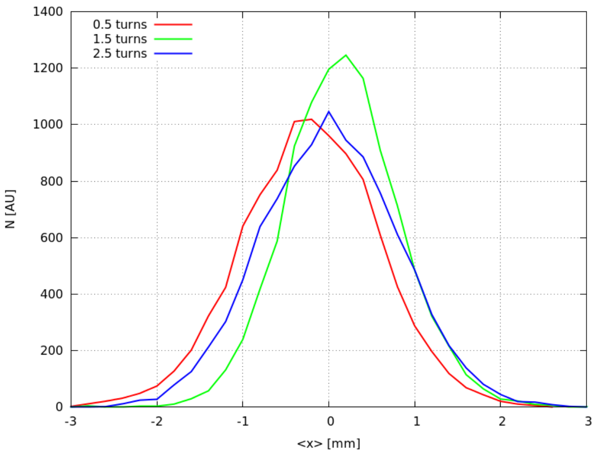
Transverse Emittance

Combiner Ring 1:

Because we have different bunches taking different paths:

- They may not all be centred at extraction
- They may not all have the same twiss
- Individual or average emittances are not the best figure of merit
- We can project all bunches into one and compute the train emittance from there

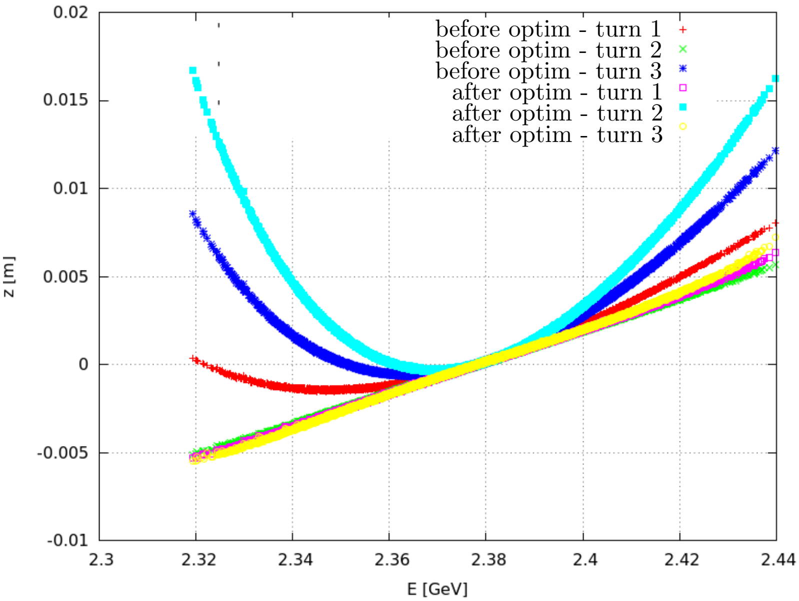




Longitudinal chirp - T_{566} aberration

- `Placet2` tracking showed a strong T_{566} aberration
- Identified has a longitudinal effect of divergence
- Corrected using sextupoles in dispersive regions

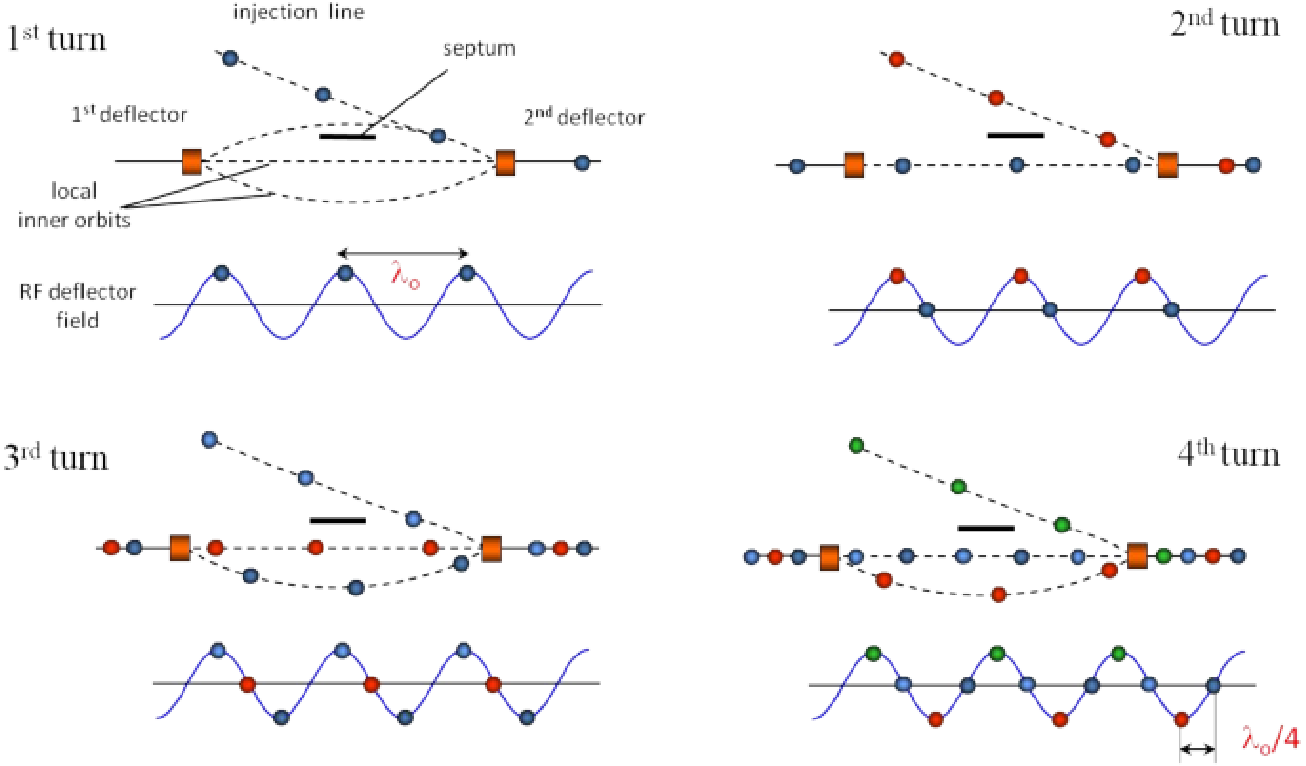
Combiner Ring 1



$$Z_{\text{Drift}} \sim Z_0 + L\frac{x'^2 + y'^2}{2} \propto Z_0 + L(\Delta E)^2$$

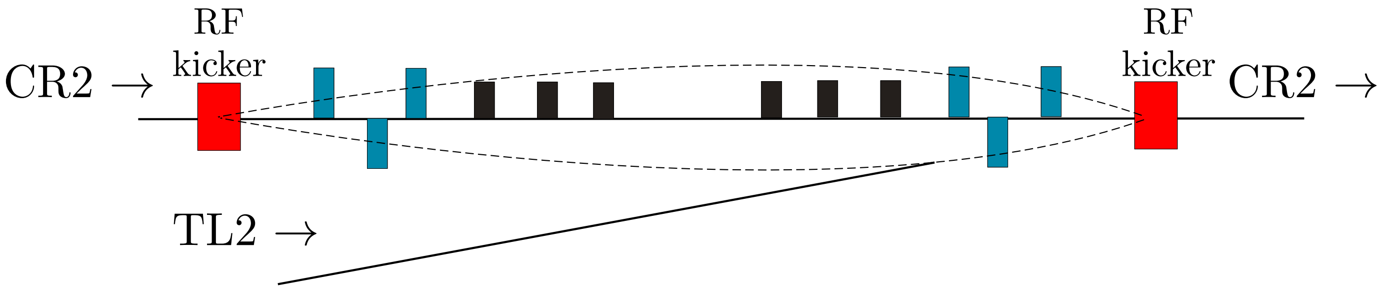
CR2 injection scheme

- 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



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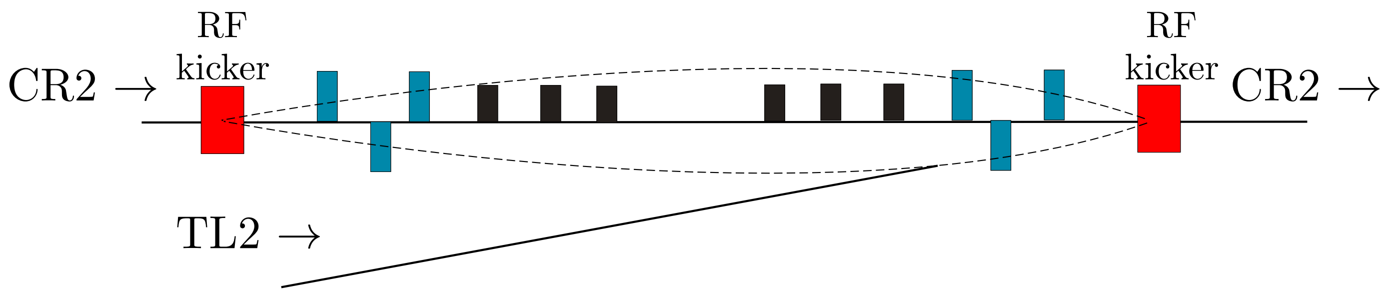

- With this design, we managed to obtain $\varepsilon_x = 151\mu$m, $\varepsilon_y = 147\mu$m during 4 bunch recombination

Preliminary results

Projected emittance growth:

sector	$\varepsilon_x[\mu m]$	$\Delta\varepsilon_x[\%]$	$\varepsilon_y[\mu m]$	$\Delta\varepsilon_y[\%]$
Dogleg	98.2	0.16	100	2.4
DL	120	22	107	6.7
CR1	141	18	122	14
CR2	151	8*	147	20*

Notes:

- CR2 results show only 4 bunch recombination
- If we use average emittances, CR2 optimization achieves $\varepsilon_x = 148\mu\text{m}$, $\varepsilon_y = 147\mu\text{m}$

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)

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- There is a strong T_{566} aberration
- Sextupoles in dispersive regions can fix T_{566}

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- Projected emittance is a better optimization target
- There is a strong T_{566} aberration
- Sextupoles in dispersive regions can fix T_{566}

- CR2 injection design has been updated
- Preliminary results at CR2 are approaching design budget: $\varepsilon_x = 151\mu\text{m}$ $\varepsilon_y = 147\mu\text{m}$ projected over 4 bunch recombination

Outlook

Next Steps:

- Optimization of CR2 for projected emittance and T_{566}
- Tracking of full recombined train to the end of TTA

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- Implement more realistic septa at the joints

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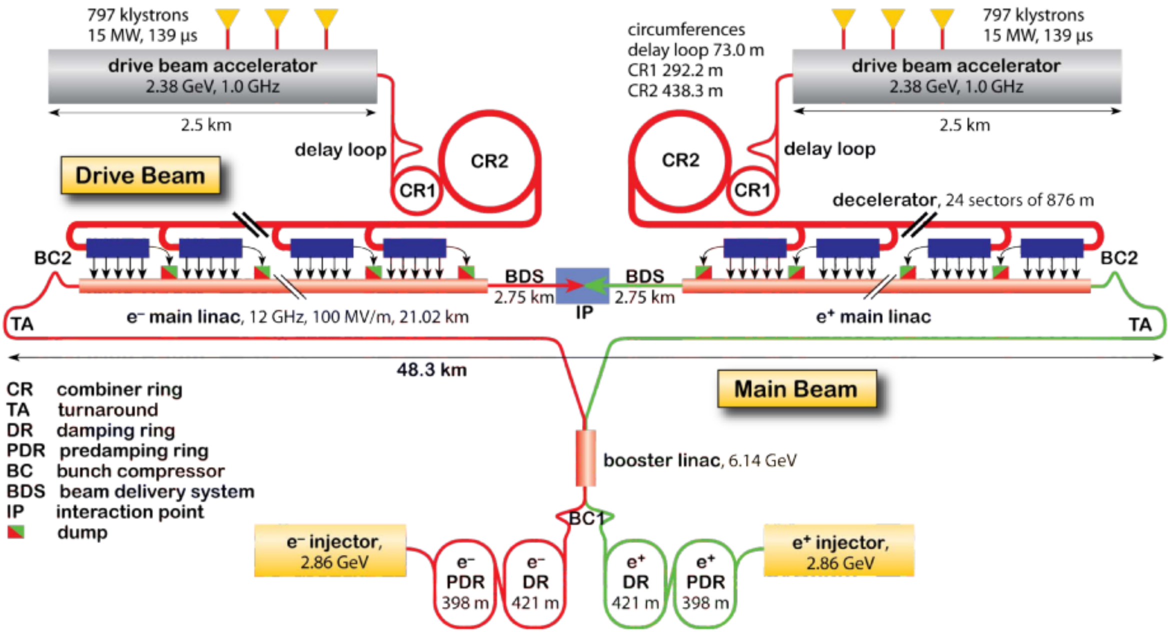
- Check magnet strength and longitudinal phase error tolerances
- Implement misalignments and beam-based alignment

Final Slide



Thank you