Ultra low β_y^* studies in the ATF2 2023 campaign and future campaigns

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CLIC PROJECT MEETING

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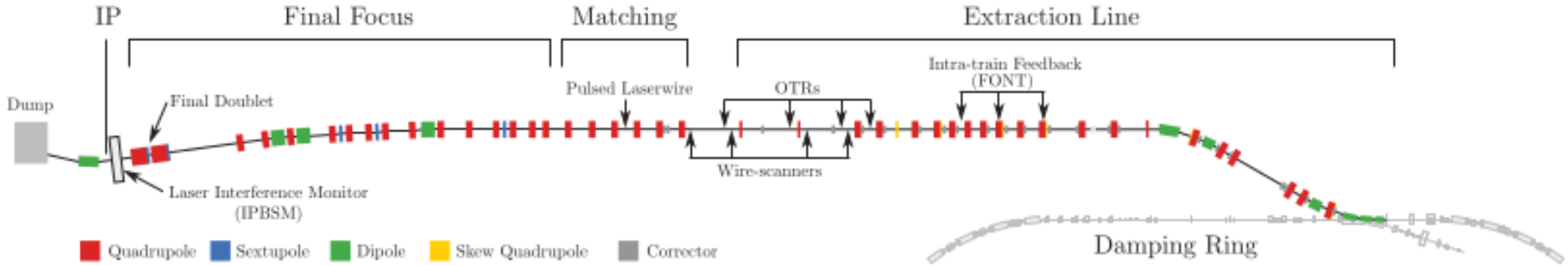
Outline

- ATF2 purpose
- Ultra-low β_y^* studies
- Tuning method
- Optics measurements and matching
- Future campaigns
- Conclusions

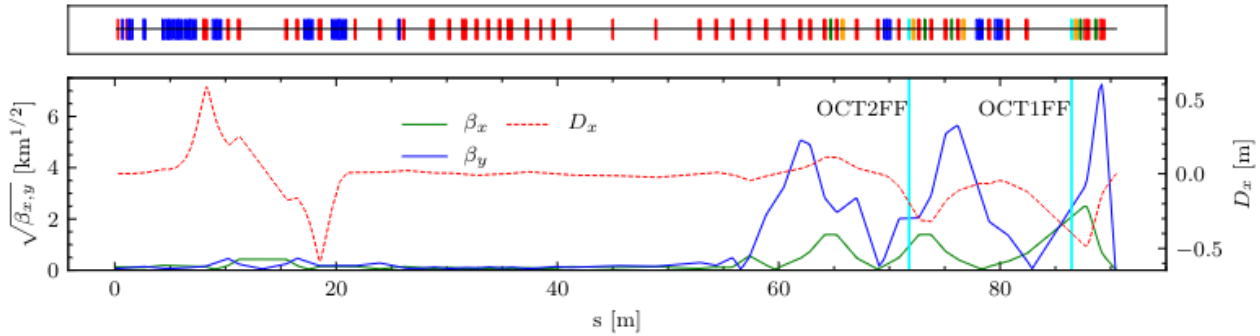
ATF2 purpose

- Project to build and operate a facility for the final focus system of future colliders.
- Feasibility studies on local chromaticity correction scheme.
- Focusing an electron beam to 40 nm vertical for ILC-like FFS optics and to 20 nm vertical for CLIC-like FFS optics.



Ultra low β_y^* studies

- Chromaticity as the CLIC BDS.
- Tuning performance increased by using 25β_x^*
- For tuning procedure, a pair of octupoles was installed to cancel 3rd order aberrations.



[A. Pastushenko et al, Tunability Study of the Ultra-Low β* Optics at ATF2 with New Octupole Setup and Tuning Knobs, JACoW IPAC, 2021, 752–755. https://doi.org/10.18429/JACoW-IPAC2021-MOPAB231]

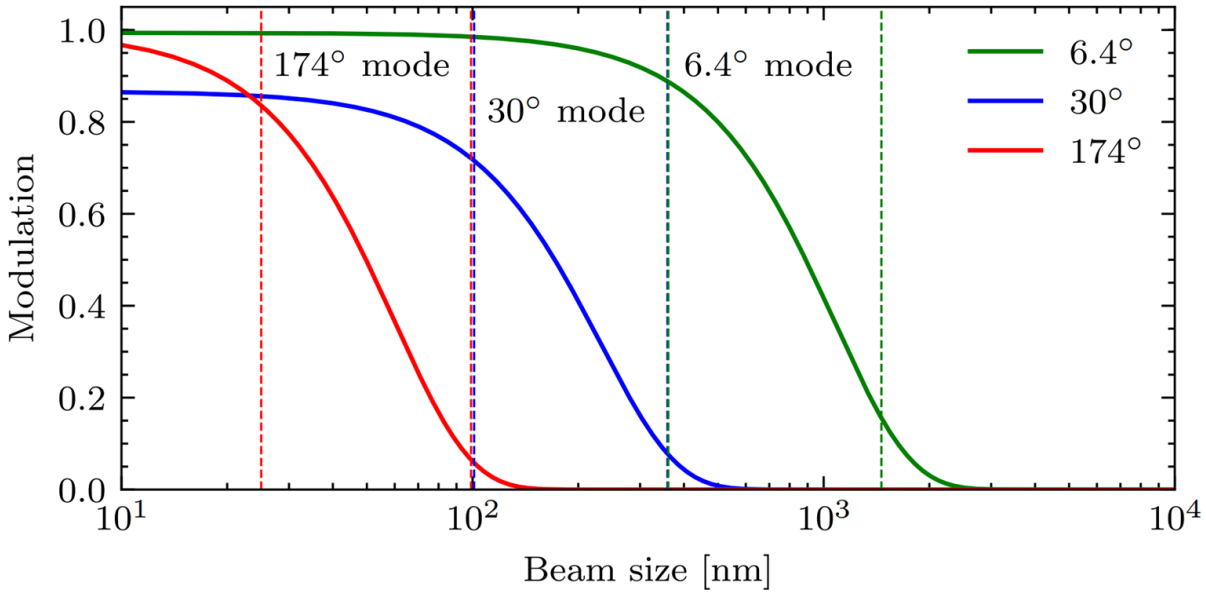
	ATF2 optics		ILC	CLIC	CLIC
	Nominal $10\beta_x^* \times \beta_y^*$	Ultra-low $\beta_x^* \times 0.25\beta_y^*$			
Beam energy [GeV]	1.3		250	380	3000
Vertical emittance [pm]	12		0.035	0.008	0.003
Horizontal emittance [nm]	1.2		5.0	2.55	0.2
Energy spread [%]	0.008		0.2	0.3	0.3
Beta-function β_x^*/β_y^* [mm]	40/0.1	4/0.025	13/0.4	8/0.07	4/0.12
Vertical chromaticity $\frac{L^*}{\beta_y^*}$	10000	40000	10000	86000	50000
Vertical beam size [nm]	37	27 (20[a])	7.7	2.4	1.0

[a]with octupoles.

[Pastushenko, A. (2022). Optimization of CLIC Final Focus System at 380 GeV and implementation studies for Ultra-low β* at ATF2. https://cds.cern.ch/record/2871709]

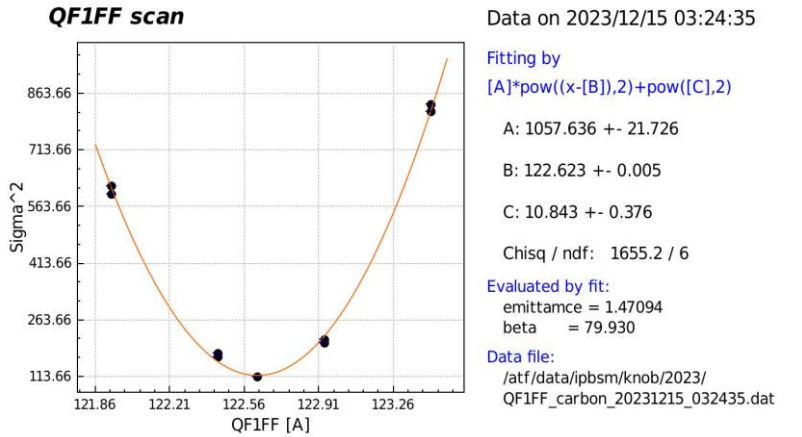
Tuning method

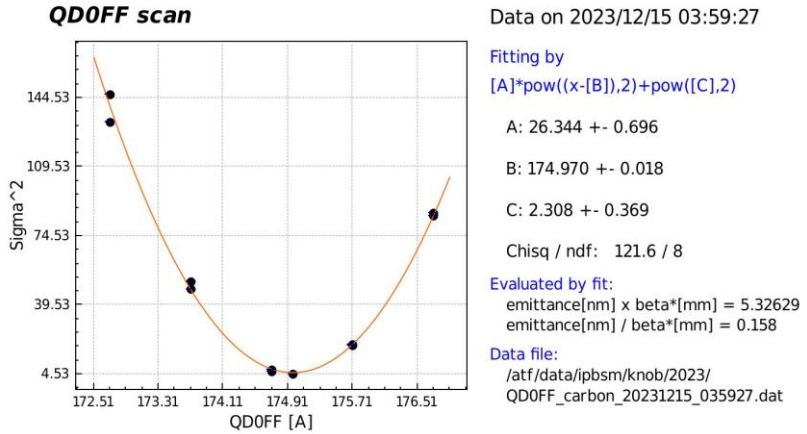
1. Orbit correction and dispersion measurements
2. Performing wire scan
3. Optics matching and measurement
4. Beam size with IPBSM



Optics measurement

- December operations (40x1) : $\sigma_y^* \approx 130$ nm
- 2 dedicated shifts for ultra low studies in December 2023 with 25x0.25 optics
- First time after 4 years from the last ultra-low β_y^* studies.
- Uploaded the most recent ultra-low β_y^* optics.
- Perform orbit and dispersion corrections.

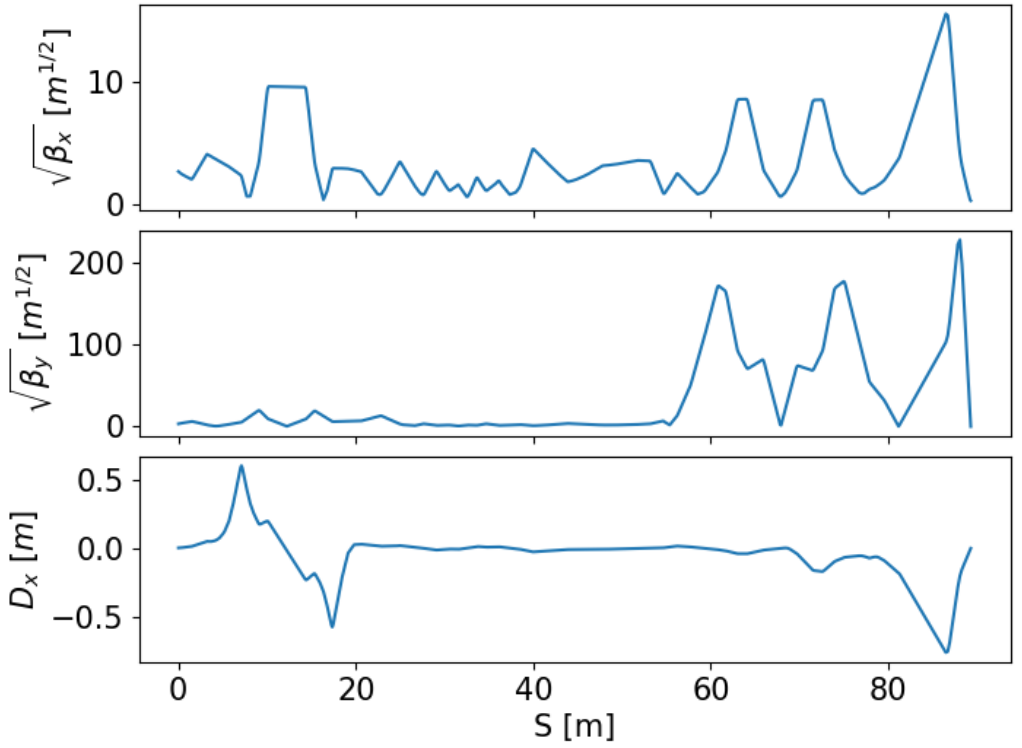




Optics matching

- Starting from the extraction line, matching the twiss at the IP.
- $\beta^*_{x,y}$ + phase advance matching.

	Start	Final	Target
β^*_x [mm]	79	85	100
β^*_y [µm]	76	29	25



Future campaigns

- Next studies possibly in April 2024.
- Ultra low β_y^* needs wire scan and optics matching several times to have the right optics in the machine.
- To measure the required beam size a stable performance of 174° mode IPBSM is needed.
  - Stabillity of the IPBSM necessary (even in nominal).
  - More time for tuning.

Conclusions

- New ultra-low β_y^* studies with 25x0.25 optics after march 2020.
- Achieved a vertical beta of 29 µm (target 25 µm).
- Beam size not measured.
- More time of ultra-low β_y^* studies for better measurements.

Thank you!