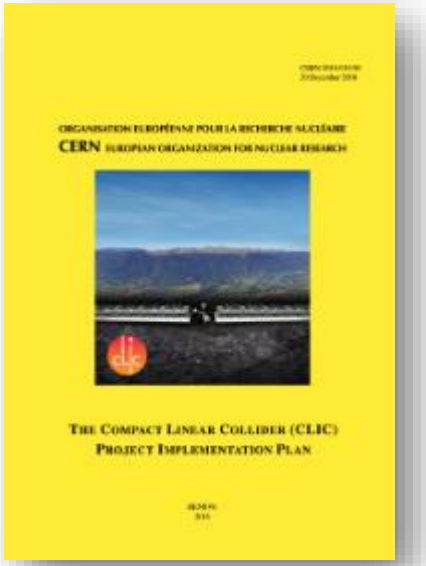
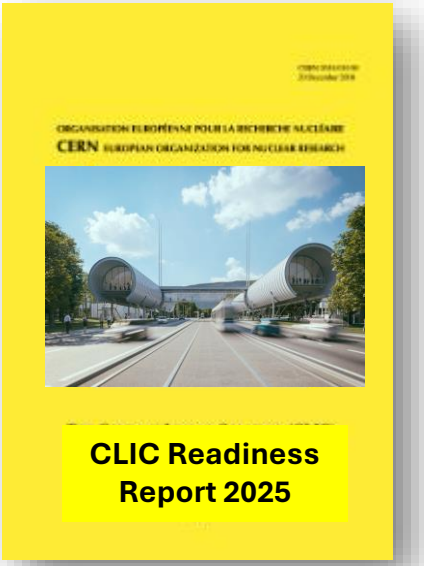
Readiness Report, The systems chapter

- ❑ Overview of the chapter
- ❑ Main changes with respect to the PIP report
- ❑ Conclusion





CLIC Project Meeting Dec. 11th 2024
Steffen Doebert on behalf of all the chapter contributors

Chapter 3, Systems Overview

Contributions by: Yannis, Andrea, Yongke, Daniel, Vera, Rogelio, Raul, Alexej, Adnan, Igor...

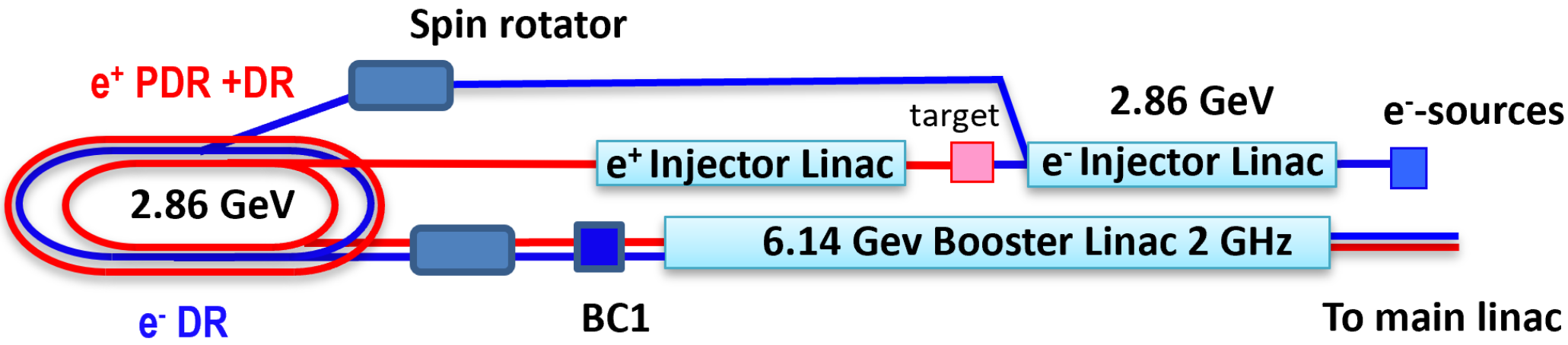
Main intended changes

- **Redesign of the main beam injector complex, aim to save cost and electricity.**

  New RF structure design, focus on 380 GeV, higher positron yield, lower drive linac energy, new layout
- **New drive beam klystron, higher efficiency, number of klystrons, RF-structure parameters, some updates in the beam dynamics of the combination complex and decelerators**
- **DR updates, new 2 GHz RF-system integrated, updated performance**
- **RTML optimization, new bunch compressors, performance optimization, new booster accelerating structure**
- **Luminosity performance updates, emittance bumps and machine tuning**
- **Beam delivery: Performance and layout updates (here only 380 GeV)**

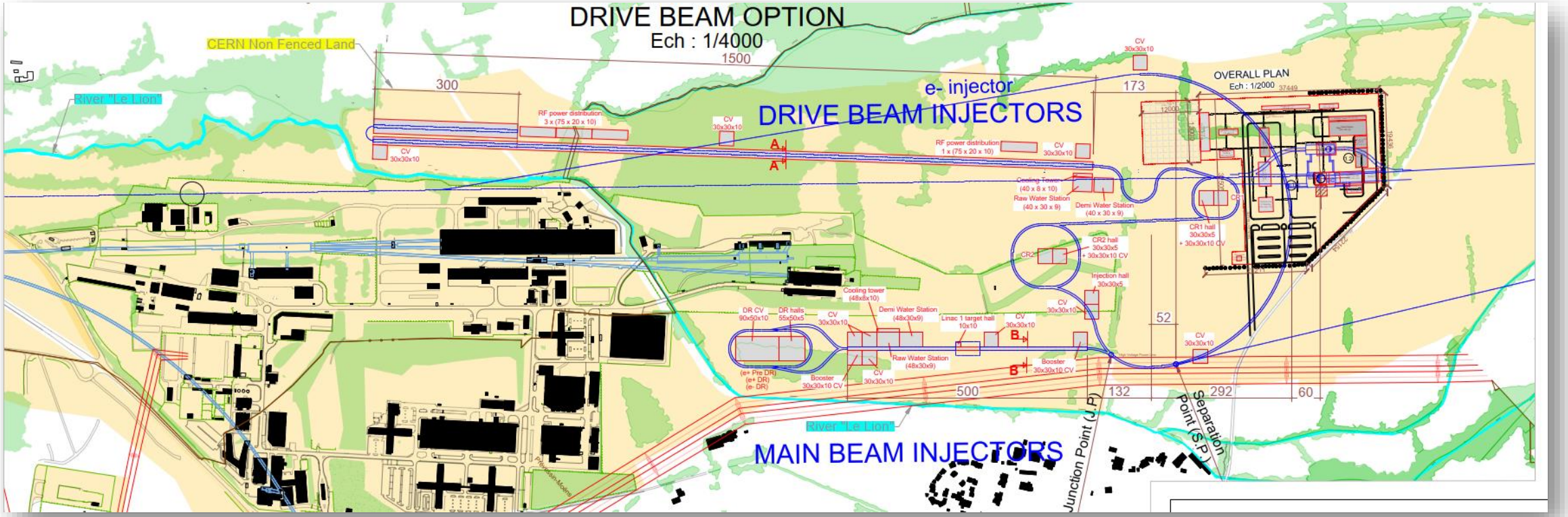
- **Not much new in: Main linac, post collision line and machine-detector interface**

Main Beam Injectors
New design and layout



More details by Adnan and Yongke

Main Beam Injectors
New design and layout



Edward Fraser Mactavish et al.

Drive Beam
New klystron, beam dynamics update

New ideas for CLIC 1GHz klystron for DB linac

High Efficiency 24 MW, 1 GHz, CLIC TS MBK performance summary (PIC CTS/3D)

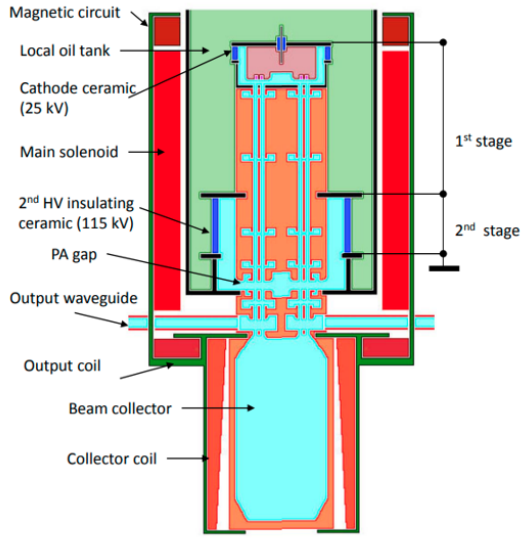
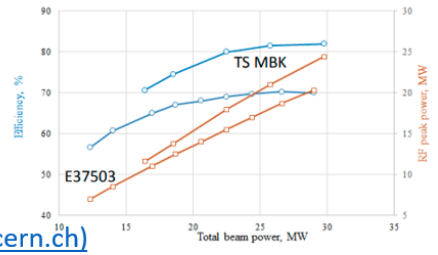


TABLE I. DESIGN AND SIMULATED PARAMETERS (CST/3D) OF THE CLIC TS MBK AND CANON MBK E3750 CATALOGUE DATA

Parameter	TS MBK	E37503	Unit
Operating frequency	1000	1000	MHz
Voltage at the 1st stage	25	160	kV
Voltage at the 2nd stage	140		
Total beam current	212	180	A
Number of beamlets	30	6	
Number of cavities	6	6	
Perveance at the 1st stage	1.77	0.47	$\mu A/V^{3/2}$
Perveance at the 2nd stage	0.133		
Output RF power	24.1	20	MW
Saturated power gain	52	54	dB
Saturated efficiency	82	70	%
Length of RF circuit	900	1500	mm



CLIC project meeting 15 June 2021 Igor Syratchev (cern.ch)

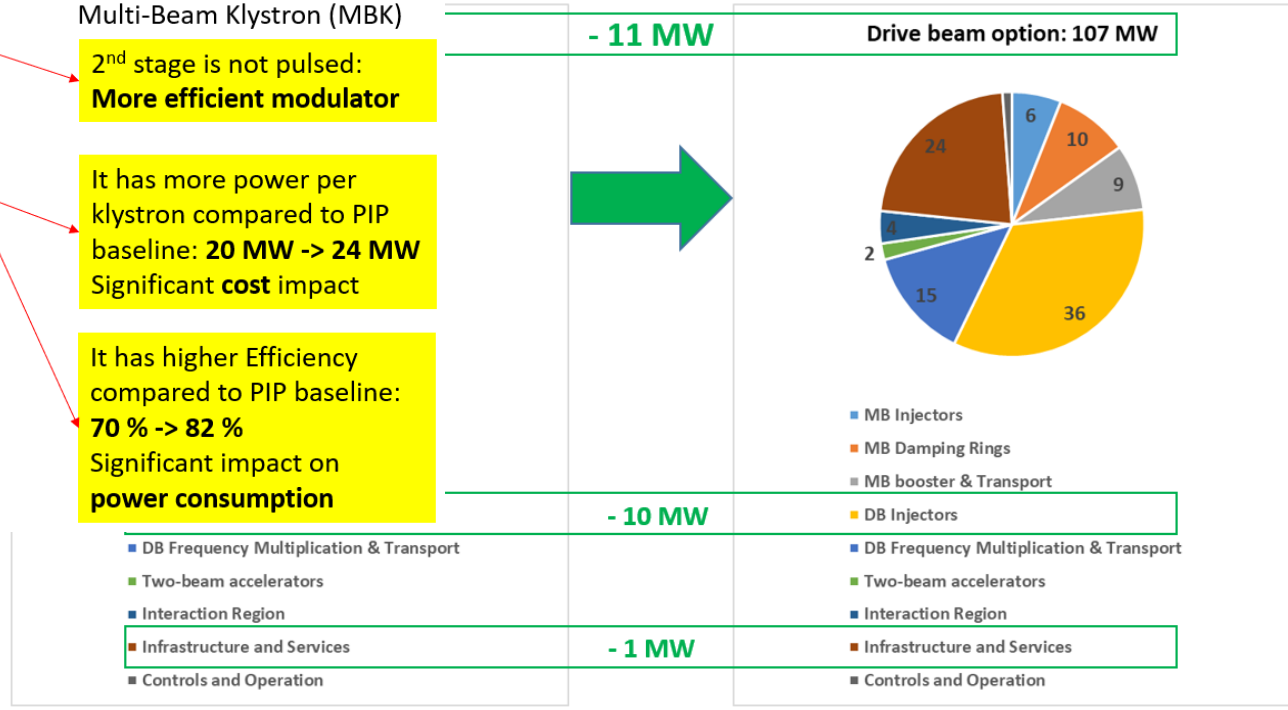
Novel design Two-Stage (TS) Multi-Beam Klystron (MBK)

2nd stage is not pulsed: **More efficient modulator**

It has more power per klystron compared to PIP baseline: **20 MW -> 24 MW** Significant **cost** impact

It has higher Efficiency compared to PIP baseline: **70 % -> 82 %** Significant impact on **power consumption**

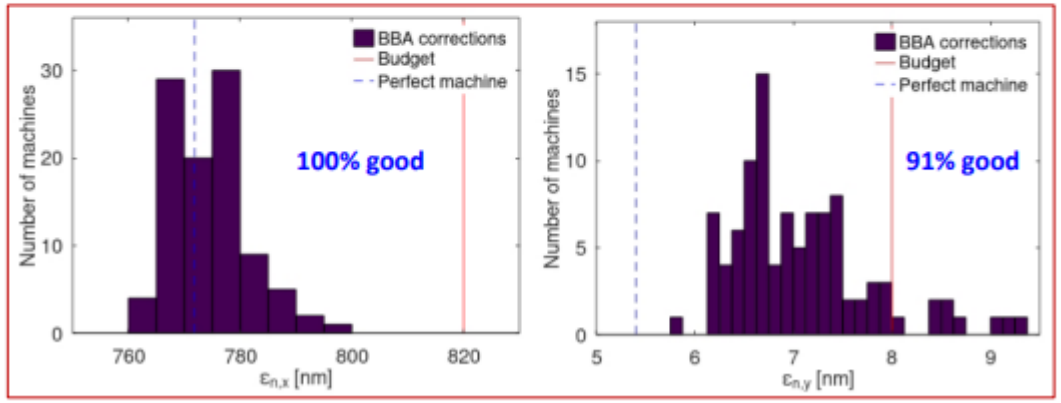
…W MBK vs 24MW TS-MBK



Details: Alexej Grudiev, CLIC Mini Week, Dec. 2023

RTML,
New optimized bunch compressors, booster linac, BBA and beam transport

- Results (100 random misaligned machines)
  - 91% good machines (required: 90%)
  - To be optimised, though satisfied
  - * To understand why X emittance is much better than Y

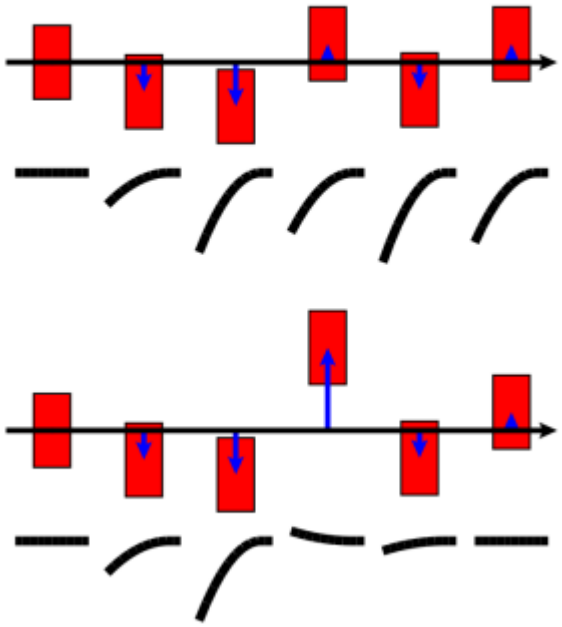


Parameter	Unit	Old		New	
		CDR	PIP	Baseline	Alternative
BC1 RF total voltage	MV	399	477	450.5	
BC1 structure length	m	1.5		1.5	
BC1 RF gradient	MV/m	13.3	15.9	18.770	
BC1 RF peak power	MW	23.8	34.0	47.3	
BC1 RF-to-beam efficiency	%	24.8	22.9	20.8	
BC1 number of klystrons		10 (6)	10	8	
BC1 number of RF structures		20		16	
BC2 RF total voltage	MV	1686.4	1763.0	659.3	
BC2 structure length	m	0.23		0.275	0.275
BC2 structure aperture	mm	**3.63**	**5.44**	**3.33**	
BC2 RF gradient	MV/m	**94**	**98.27**	**74.916**	**37.458**
BC2 RF peak power	MW	**88.4**	**355.6**	**39.3**	**9.8**
BC2 RF-to-beam efficiency	%	24.5	7.5	45.1	56.5
BC2 number of klystrons		**40**	**156**	**8**	**4**
BC2 number of RF structures		**78**		**32**	**64**
BL total voltage	MV	6168.6		6156.3	
BL structure length	m	1.5		1.5	
BL RF gradient	MV/m	14.9		15.089	
BL RF peak power	MW	54.1		55.1	
BL RF-to-beam efficiency	%	20.0		19.9	
BL number of klystrons		138		136	
BL number of RF structures		276		272	

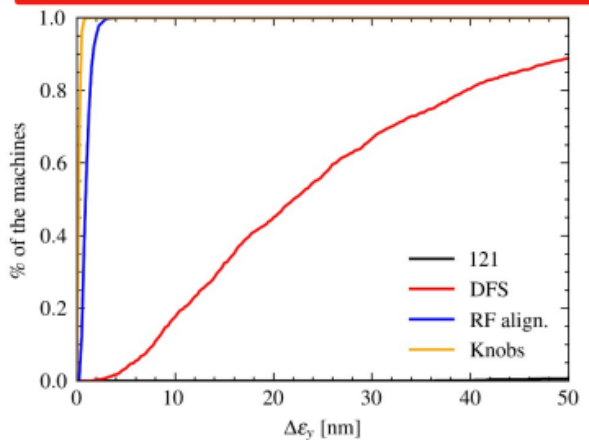
Yongke ZHAO CLIC RTML optimisation

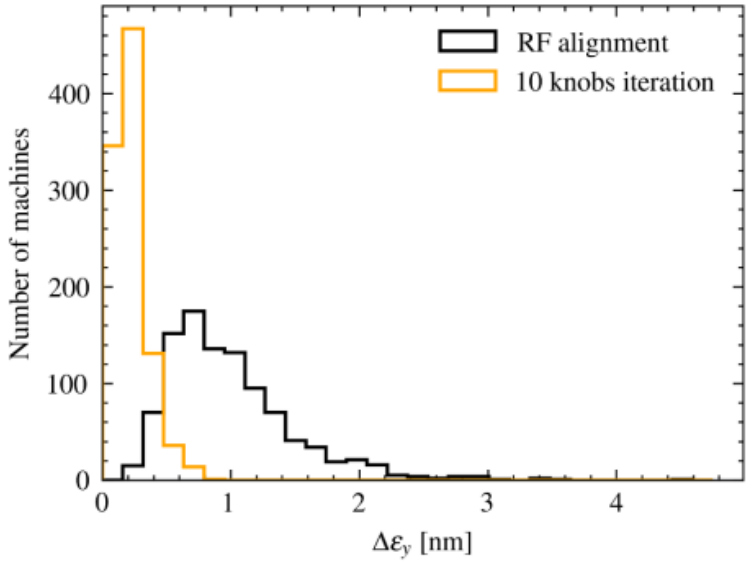
Details: Yongke Zhou, CLIC Project Meeting March 2024

Main LINAC,
Emittance tuning Bumps, BBA performance



- After the knobs tuning:
  - 100% of the machines - < 0.8 nm
  - 95% of the machines - < 0.5 nm
  - RMS 0.12 nm





Details: A. Pastushenko, internal CLIC Meeting

Conclusions

The chapter should be ready on time but of course last minute !