



Injection and dump optics for FCC-hh

mostly a recap from FCC week

W. Bartmann, FCC-hh design meeting, 15-Sept-22

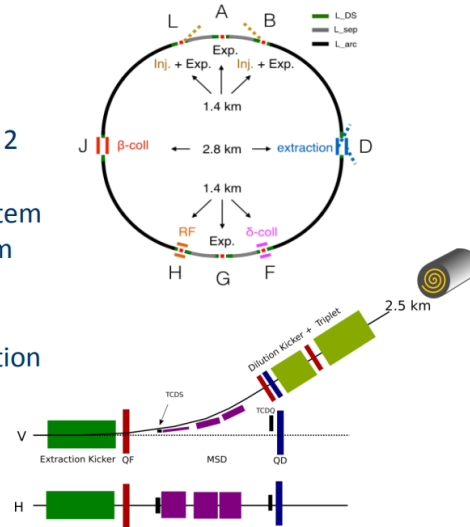
Questions to be addressed and conclusion

- Can we combine in one straight section of 2.16 km the FCC-hh injection and dump systems?
- Yes ... with more complicated HW, failure scenarios and operation, but no fundamental performance limit identified

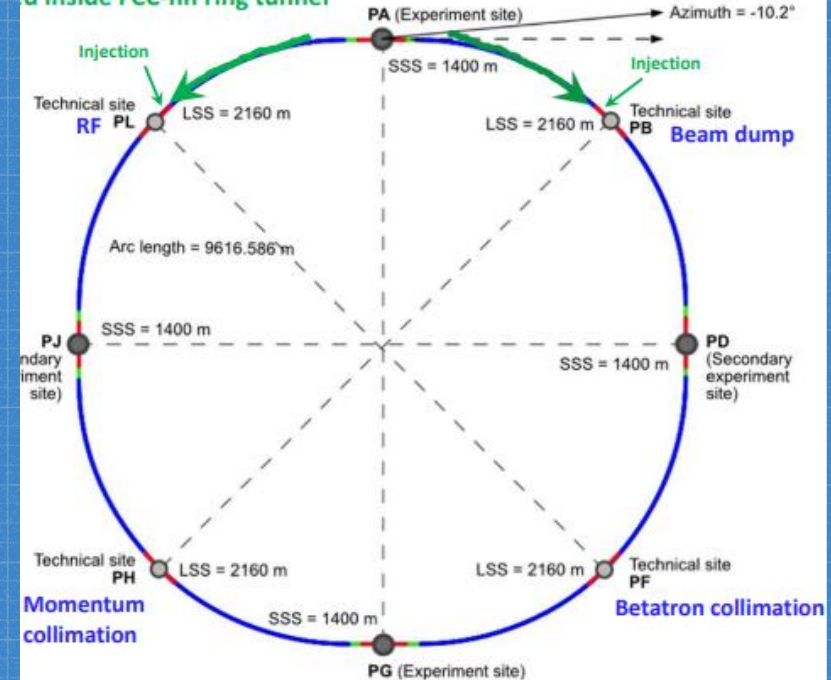
Injection/extraction - old vs new layout

OLD Baseline:

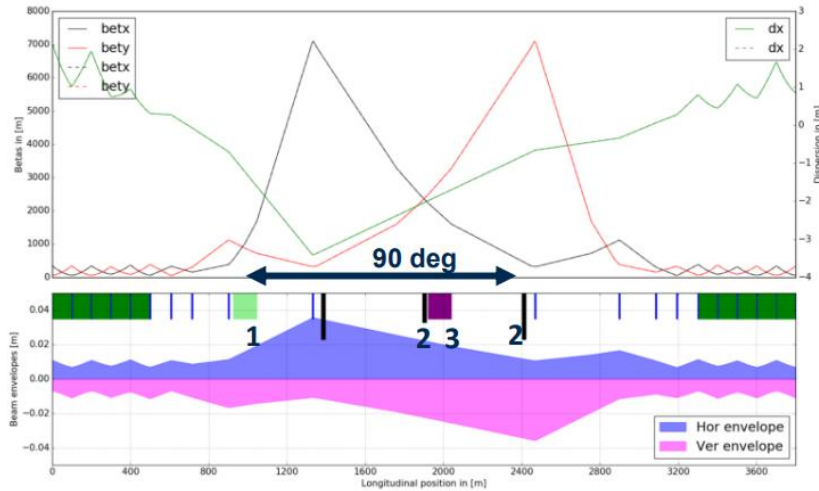
- IPD, 2.8 km for extraction of beam 1 and 2
- 2.5 km dumpline with dilution kicker system to create sweep pattern at graphite beam dump
- Design mainly driven by machine protection
 - Safely extract 8.5 GJ beam
 - Reduce failure probabilities
 - Avoid downtime in case of failure



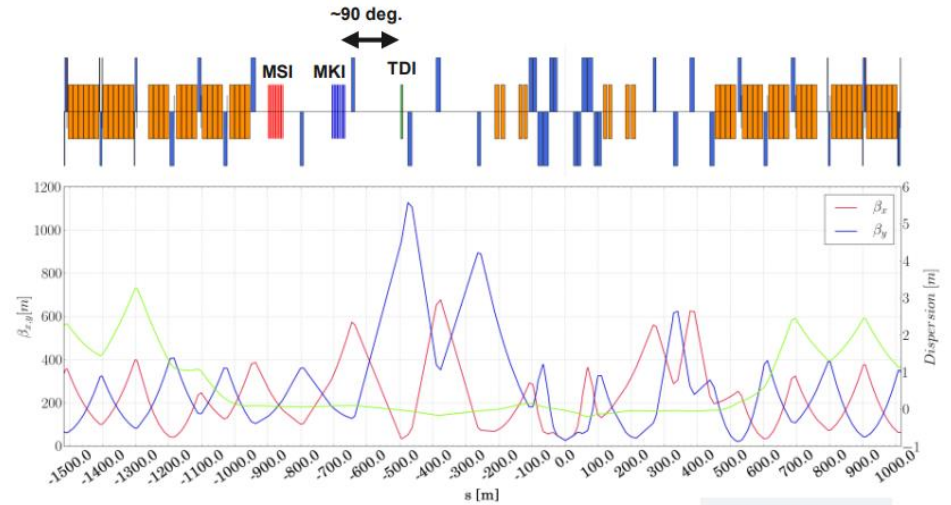
Proposed lines to be installed inside FCC-hh ring tunnel



Injection/extraction - from where we started



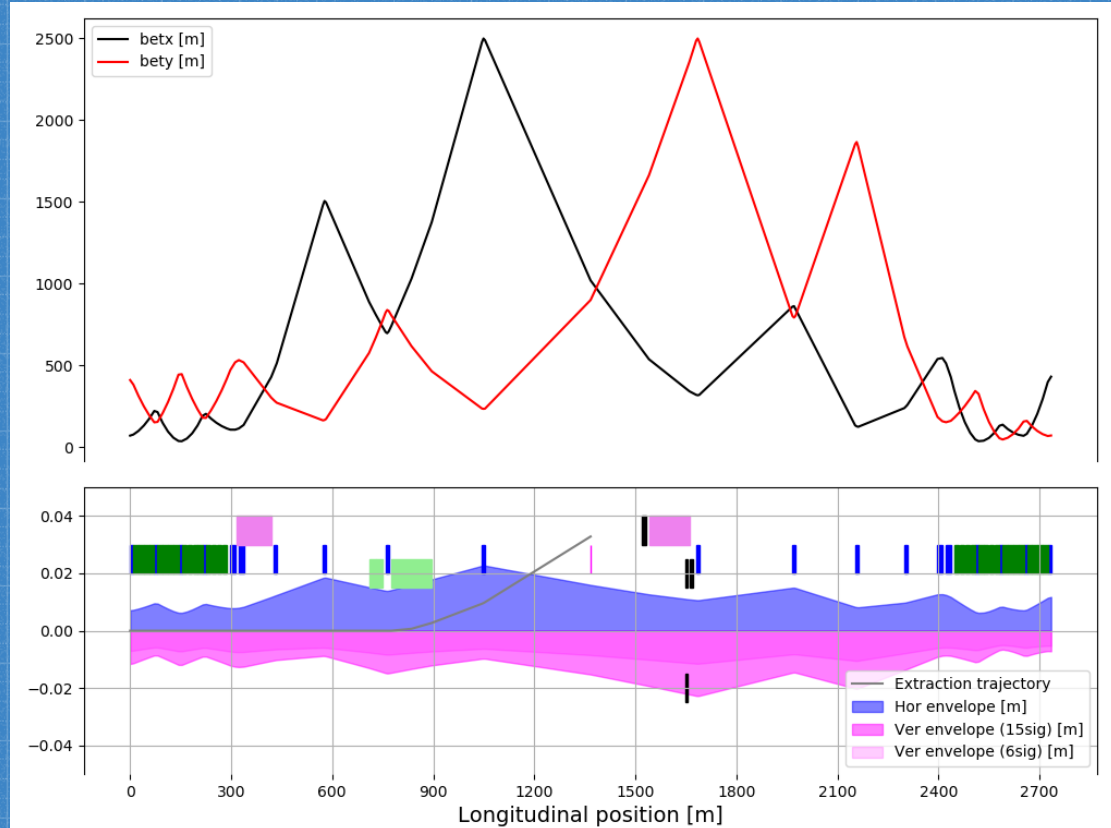
W. Bartmann



M. Hofer

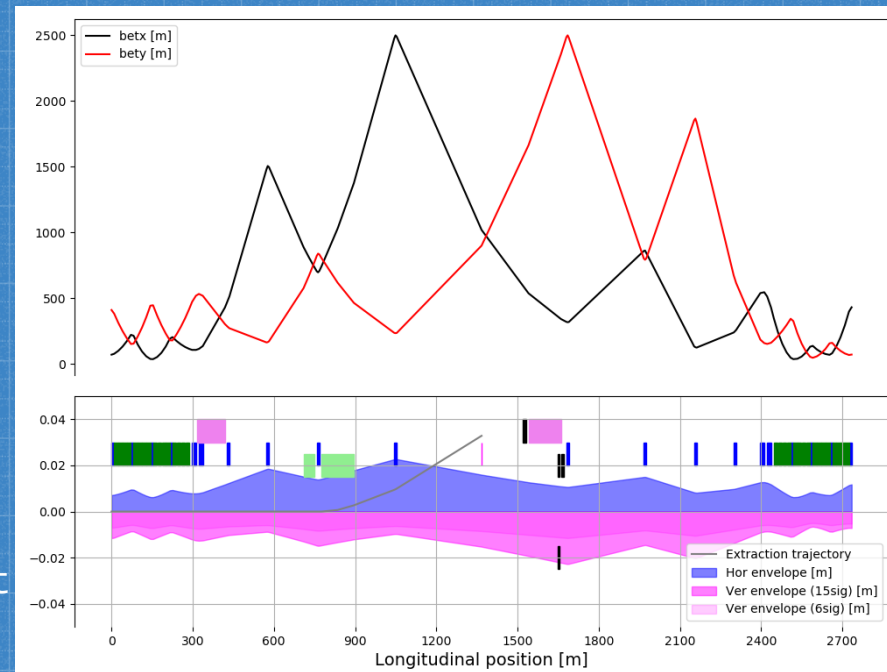
Injection and dump combined

- Overlay main optics constraint of kicker-absorber = 90 deg phase
- Most critical is injection failure impacting all extraction elements



Injection and dump combined

- Kickers and absorbers for inj and extr at about same location
- Move injection septum into better phase wrt kicker
 - kick strength factor 1.8 reduced
 - also reduces mis-kicked trajectory offset
- Extraction design with HW parameters not far from CDR (aperture impacted though)
- Injection failure impact
 - Focussing/defocussing in right sequence → both systems in vertical
 - Extra MKD clearance of 5 mm (21 cf 16 mm)
 - 27 mm extra at quadrupole
 - MSD protection needs careful design (impact on the outside, most likely increased aperture as well)



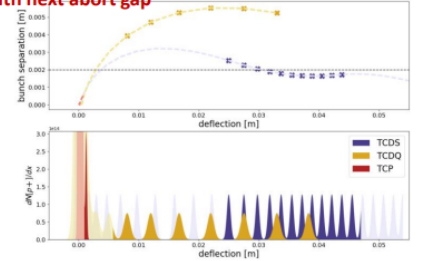
Hardware parameters	Unit	Kicker	Septum
Deflection	mrad	0.18	9.8
Integrated field	T.m	2.0	92
System length	m	40	104
Effective length	m	31.8	84
Rise time	μs	0.43	-
Recharge frequency	Hz	≈ 10	-
Flattop length	μs	2.0	≥ 2.0
Flattop stability		$\pm 5 \cdot 10^{-3}$	$\pm 10^{-5}$
GFR inj. beam h/v (radius)	mm	-	9/-
Beam stay clear circ. beam h/v (radius)	mm	16/16	9/14 (first unit)
Septum width (first unit)	mm	-	8

- 0.1 mrad kick
- Similar aperture

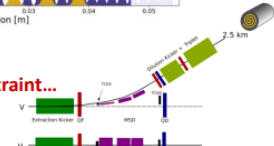
Extraction Kicker Requirement

Extraction Kicker	Unit	Parameter
System Length	m	120
Number of Modules		150
BdL [top]	Tm	7.5
Deflection	mrad	0.045
Aperture height [horiz]	mm	50
Aperture width [vert]	mm	40
module length	m	0.6
Inductance	nH	700
Current	kA	3.3
required risetime [0-100%]	us	1
Voltage	kV	<6

reduce prob. for asynch. dump,
relax requirements + synch. dump
with next abort gap



survive asynch. dump: hard constraint...
... otherwise sacrificial absorber
necessary \rightarrow beyond CDR



- Kick similar
- ~5 mm increased aperture if only 100% miskick, tbc

Injection/dump next

- Thys' modifications in DS have minimal impact on optics in straight → OK
- Run through different failure scenarios of injection and extraction elements, incl global MP studies
- Check inj HW parameters between IPB and IPL and iterate with the goal of a single type of injection HW
- Update list of HW parameters and check for impact on previously chosen technologies and rough cost estimate
 - Consider dilution untouched – some impact on dump line optics, envisage focusing triplet there, so room for adaptation