

Collector Ring Injection/Extraction Septum Magnets Status

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**Online
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Injection/Extraction Elements in the Ring

TCR1

CR

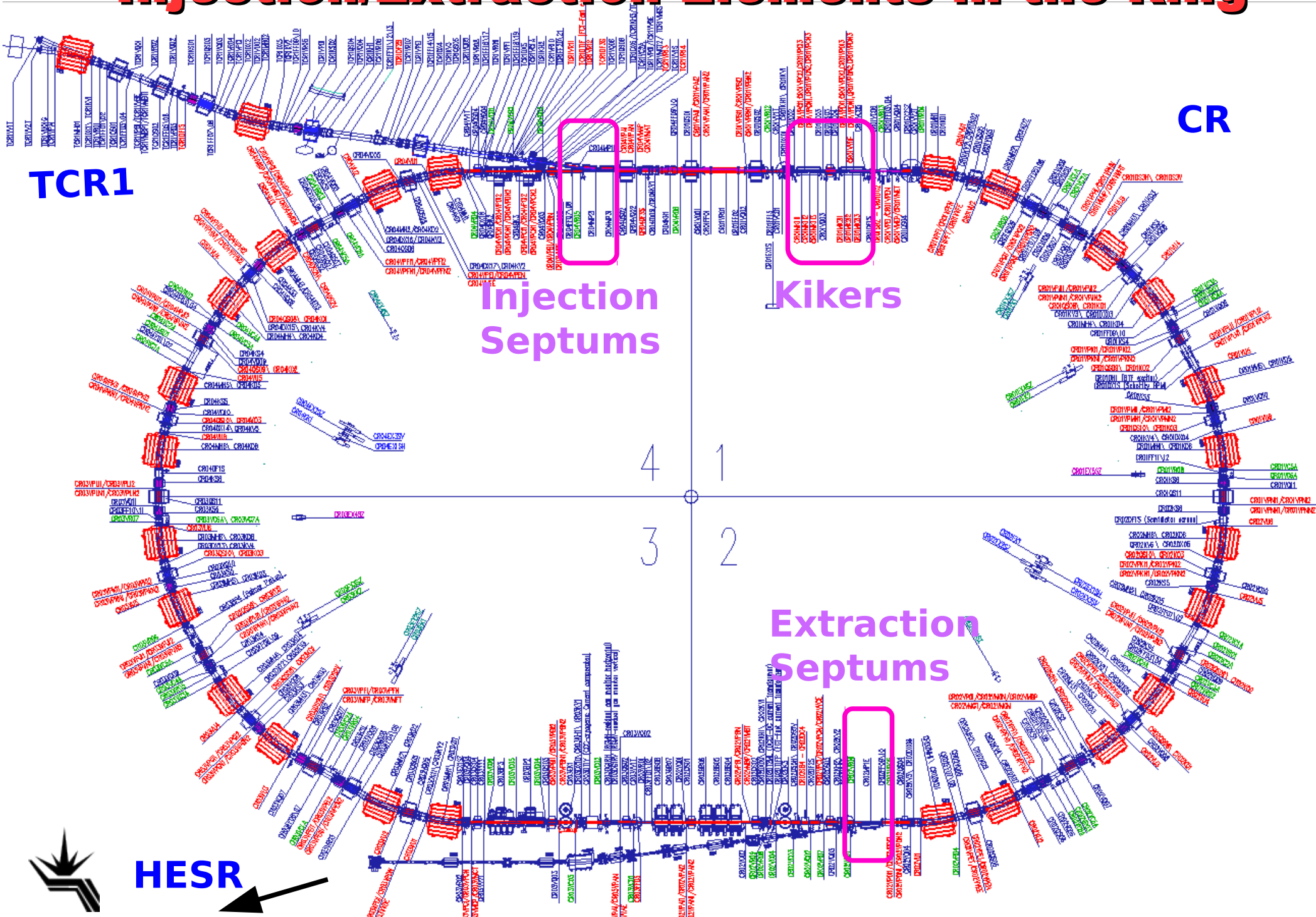
Injection
Septums

Kickers

Extraction
Septums

4 1
3 2

HESR



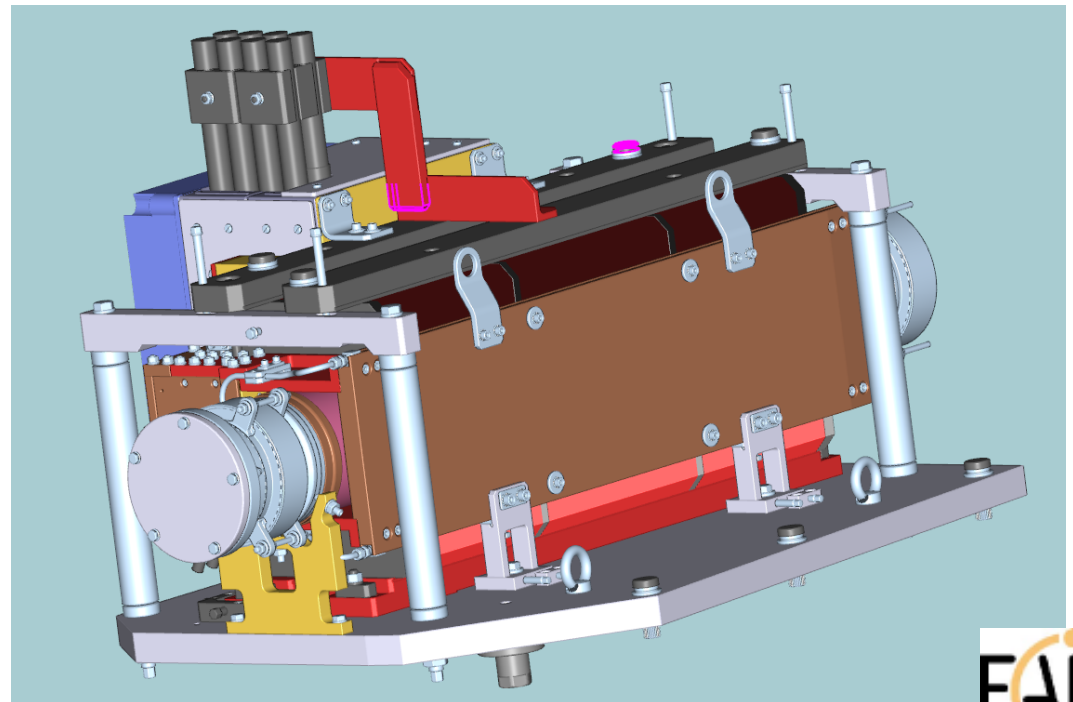
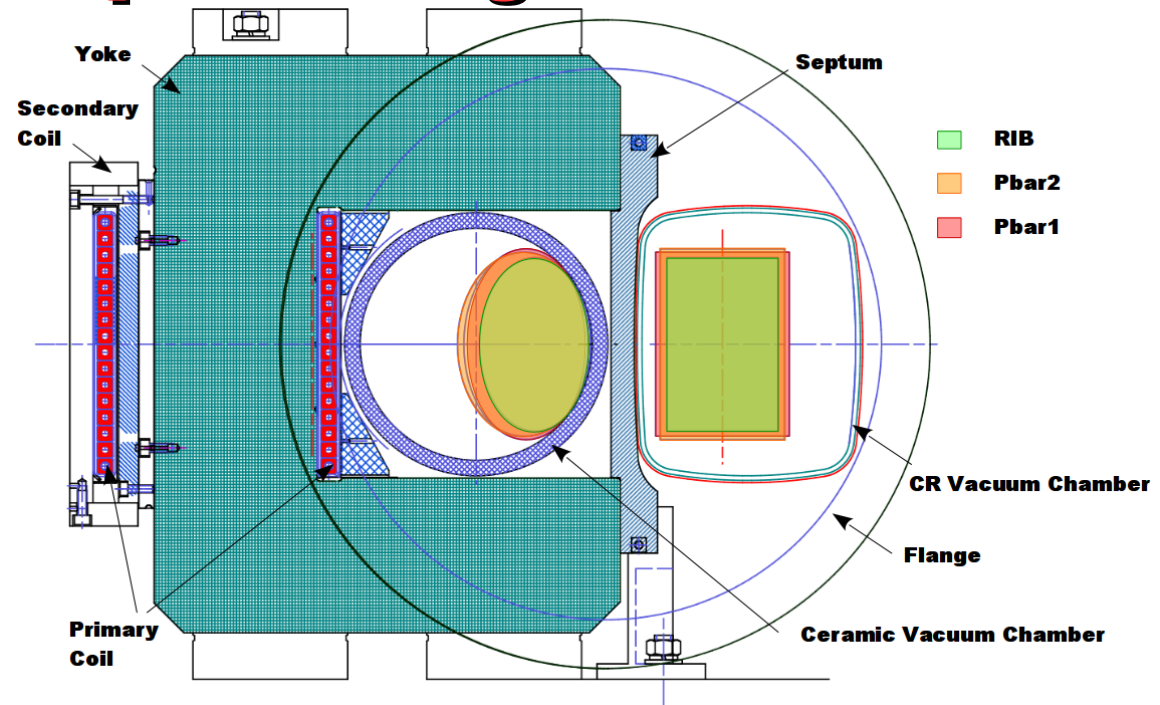
Status: Injection Septums

<u>PSPas</u>	Subproject	Responsibility	S	CDR	FDR	PR FoS	FAT FoS	SAT FoS	SP	FAT SP	DL	SAT SP	IN	CO	
2.5.2.5.1-2	Injection and extraction septum magnets	P. Shatunov	X												Design, Magnetic simulations, Blueprints are done Procurement, Production preparations started
2.5.3.3.1-2	Injection and extraction septum power supply	D. Senkov	X												Design is done. Number of PS types reduced. CDR is upcoming.
2.5.5.1-2	Injection/ Extraction Kicker	A. Kasaev	X												CDR is upcoming.
2.9.2	Magnets	A. Starostenko,	X	X											Additional corrector is in design
2.9.3	Power Converters	D.Senkov,	X	X											All fine
2.9.6	Diagnostics	Yu.Rogovsky	X	X											Additional BPM is in design
2.9.7	Vacuum	A.Krasnov													Design is done. Specs+CDRs planned

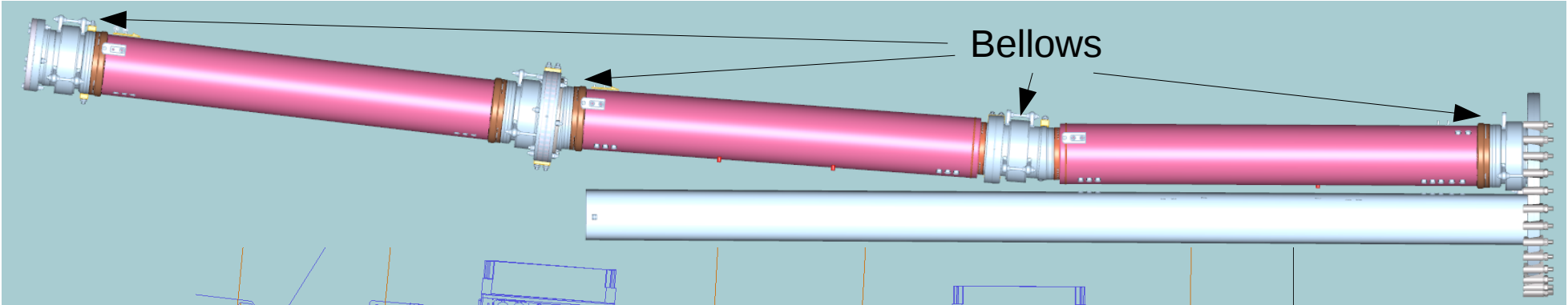


Injection Septum Magnet

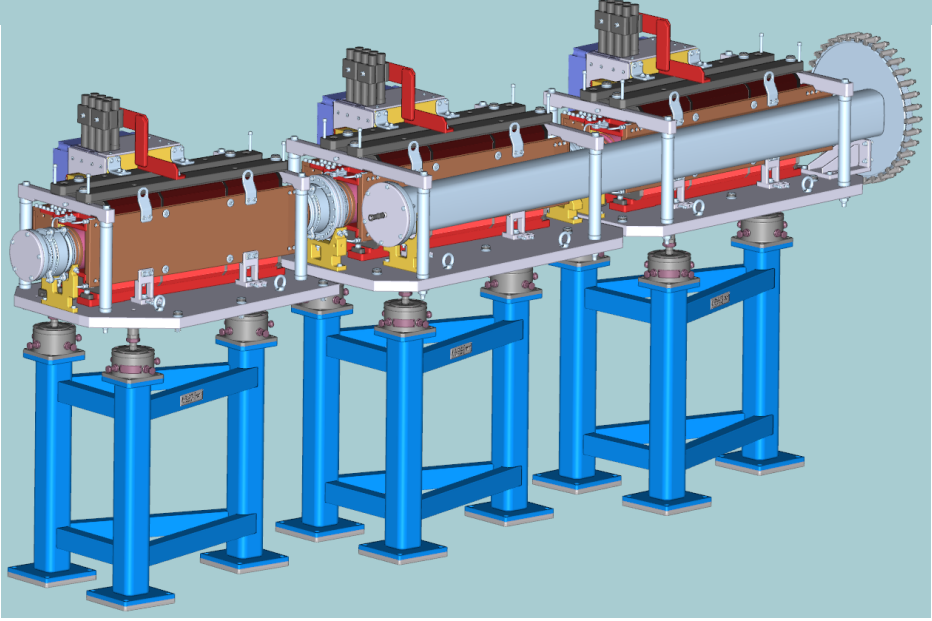
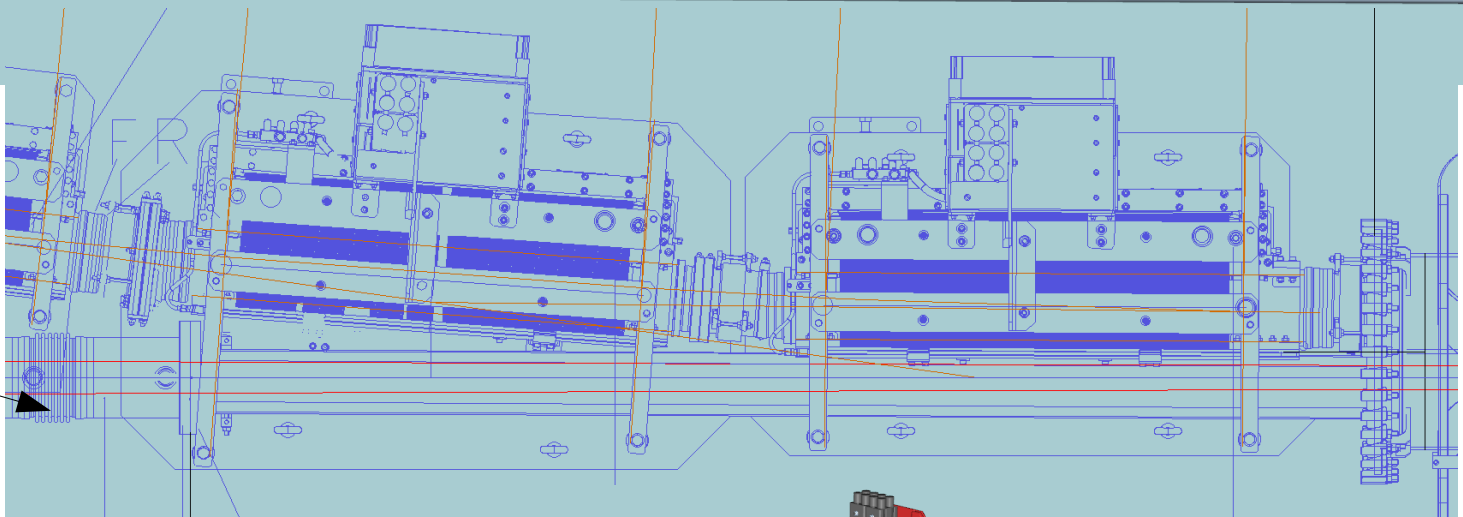
Maximum magnetic field in the aperture	0.6 T
Minimum magnetic field in the aperture	0.3 T
Pole gap height	173 mm
Air gap width	173 mm
Flux density in yoke	1.2 ÷ 1.5 T
Relative integral magnetic field quality in the vacuum chamber	10^{-2}
Effective magnetic length	0.940 m
Yoke length	0.874 m
Yoke width	≤ 0.420 m
Yoke height	≤ 0.420 m
Assembled magnet mass	≤ 1.0 t
Orbit radius	21.666 m
Maximum deflection angle	0.04233 rad
Field rise time (0 to max)	0.75ms
Lamination thickness	1.0 mm
Packing factor	0.98



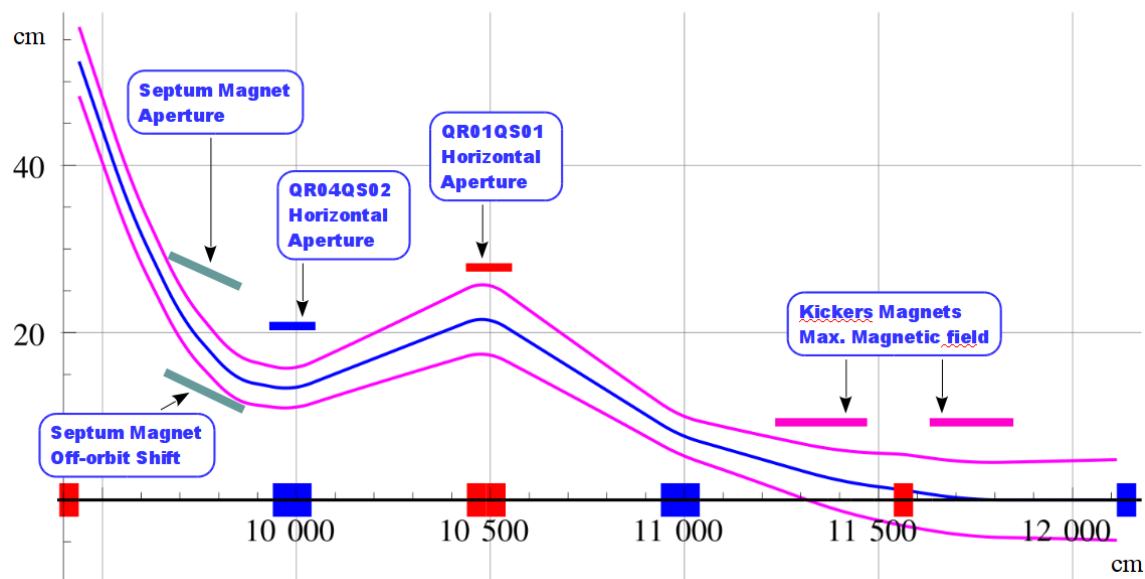
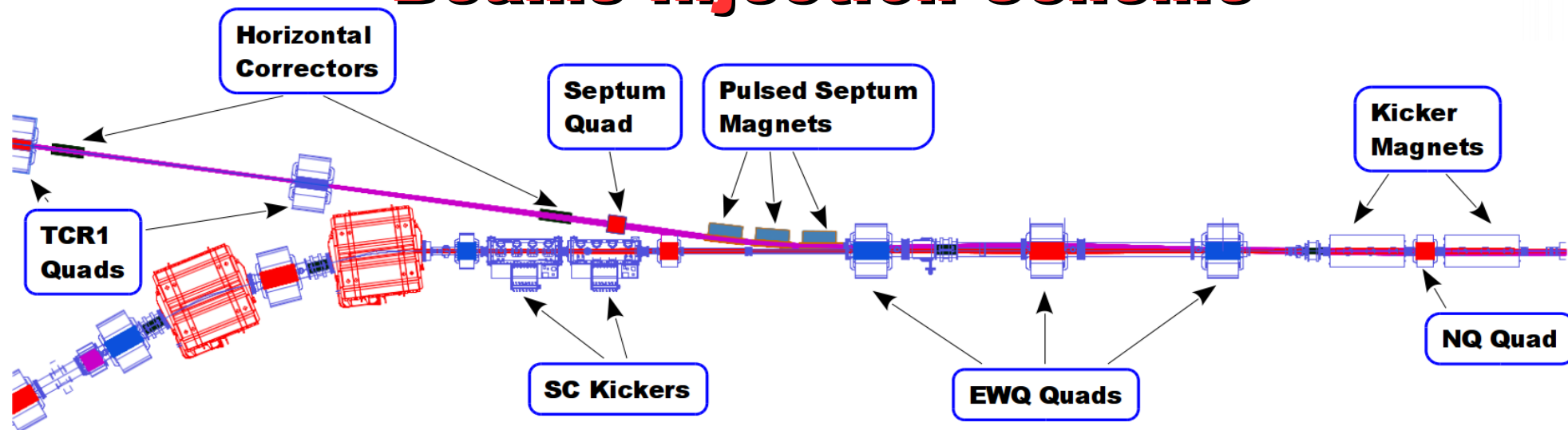
Question from previous session



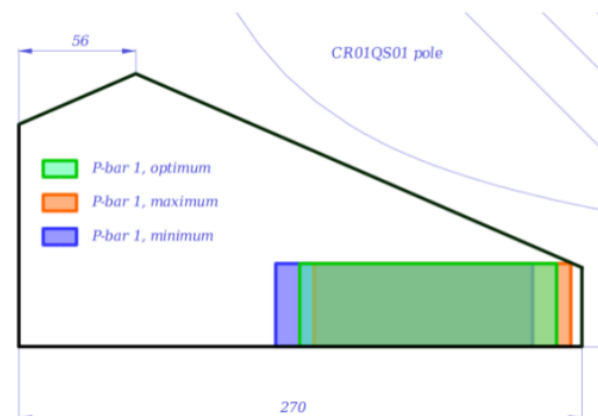
Bellows



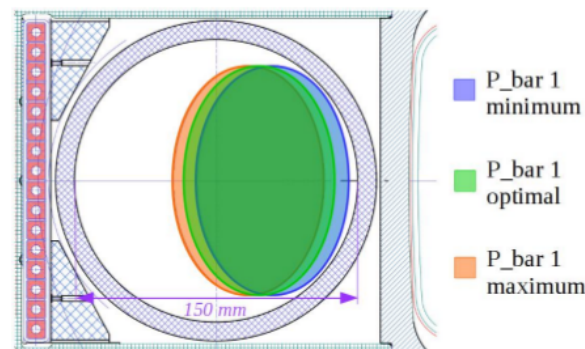
Beams Injection Scheme



Septum beam size: 80 ÷ 123 mm
 Septum vacuum chamber: \varnothing 150mm



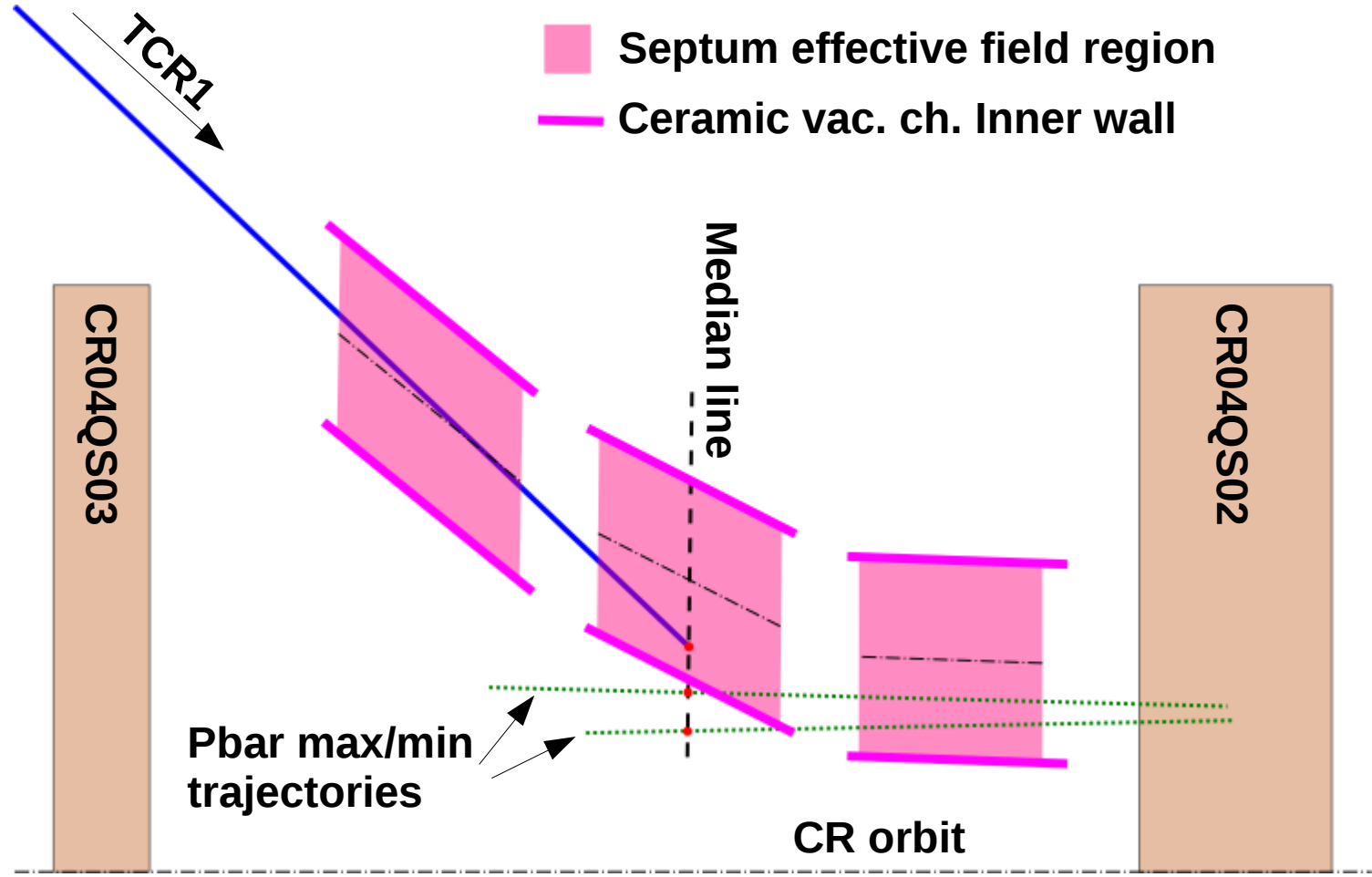
Aperture limitation in CR01QS01



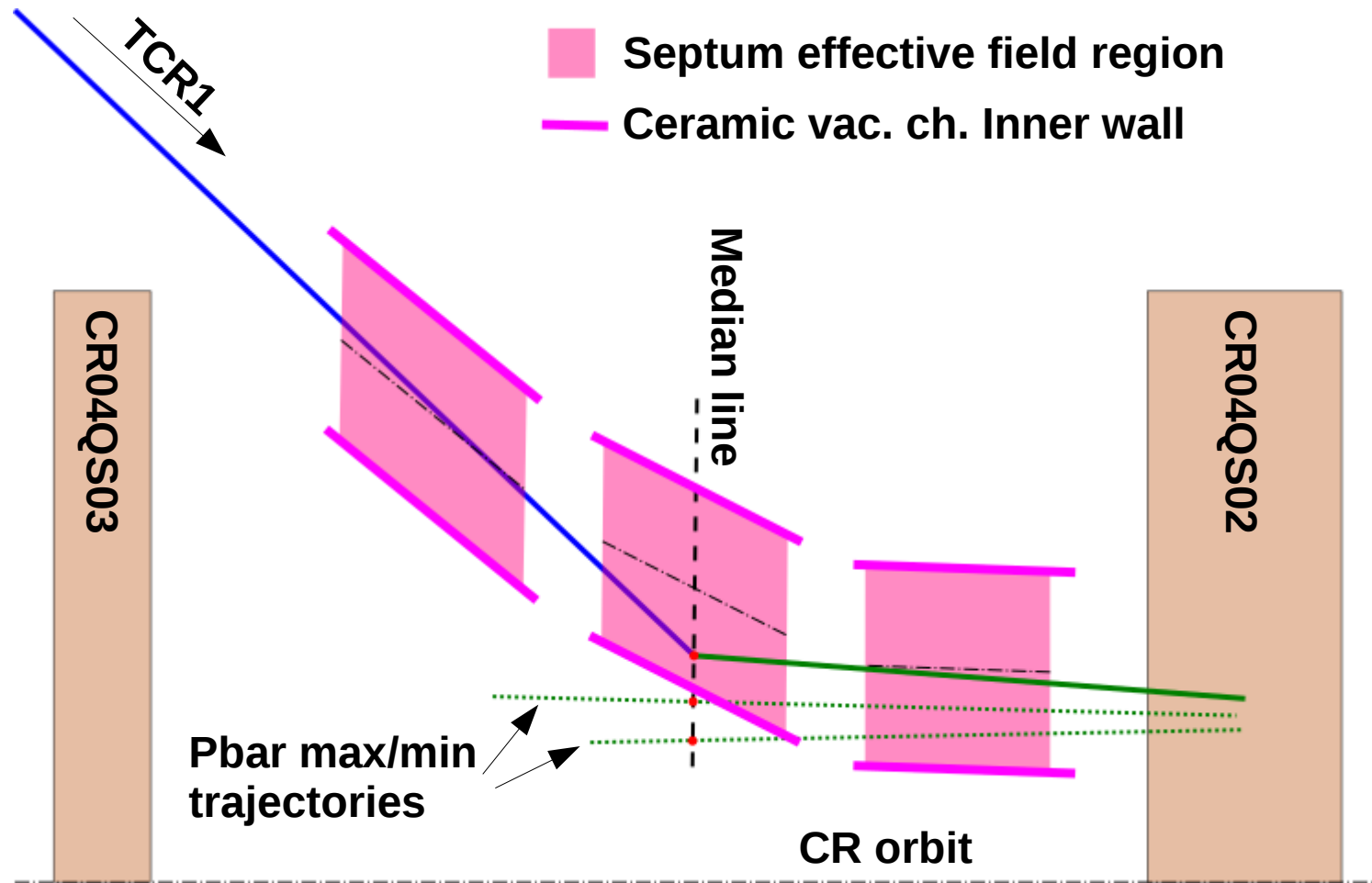
Aperture limitation in septum



Beams Injection: Matching with TCR1



Beams Injection: Matching with TCR1



Ref. Orbit Kickers: 0.055458 T

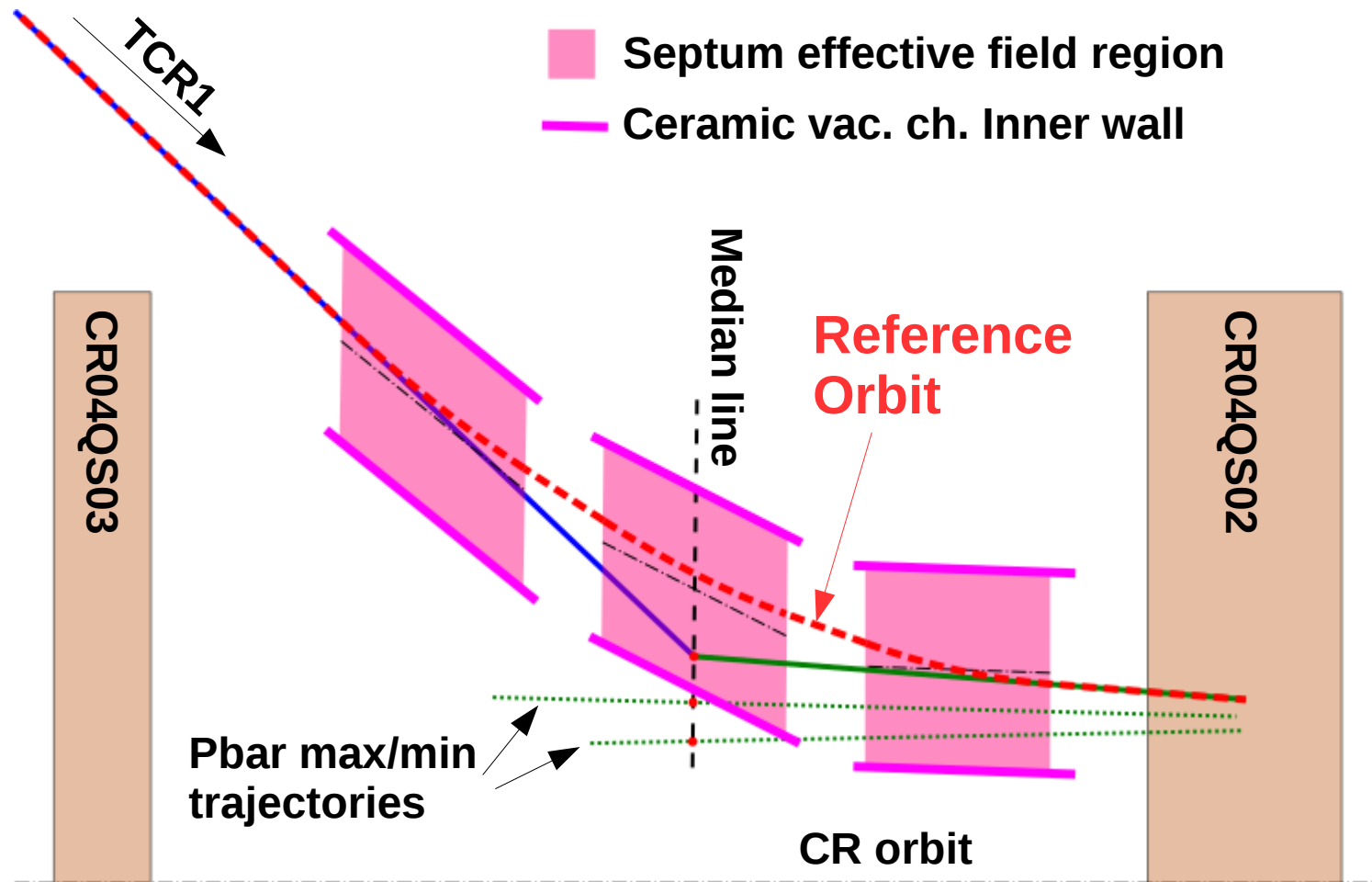
Kicker max: 0.054T

Beam size in CR01QS01: ± 62 mm

Ref. Orb to Vac.Ch. Wall: 40mm



Beams Injection: Matching with TCR1



Ref. Orbit Kickers: 0.055458 T

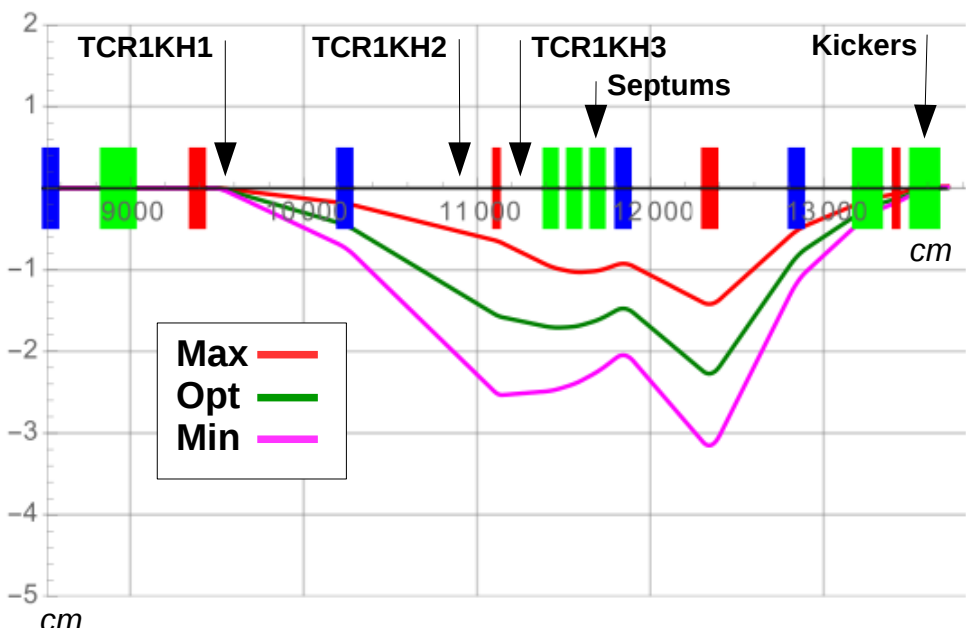
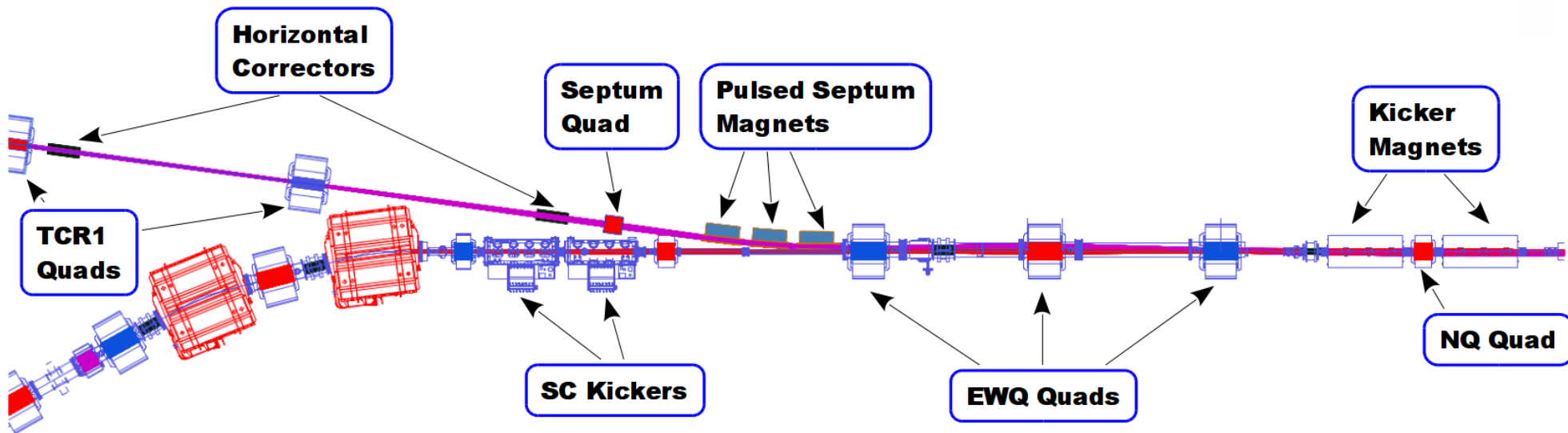
Kicker max: 0.054T

Beam size in CR01QS01: ± 62 mm

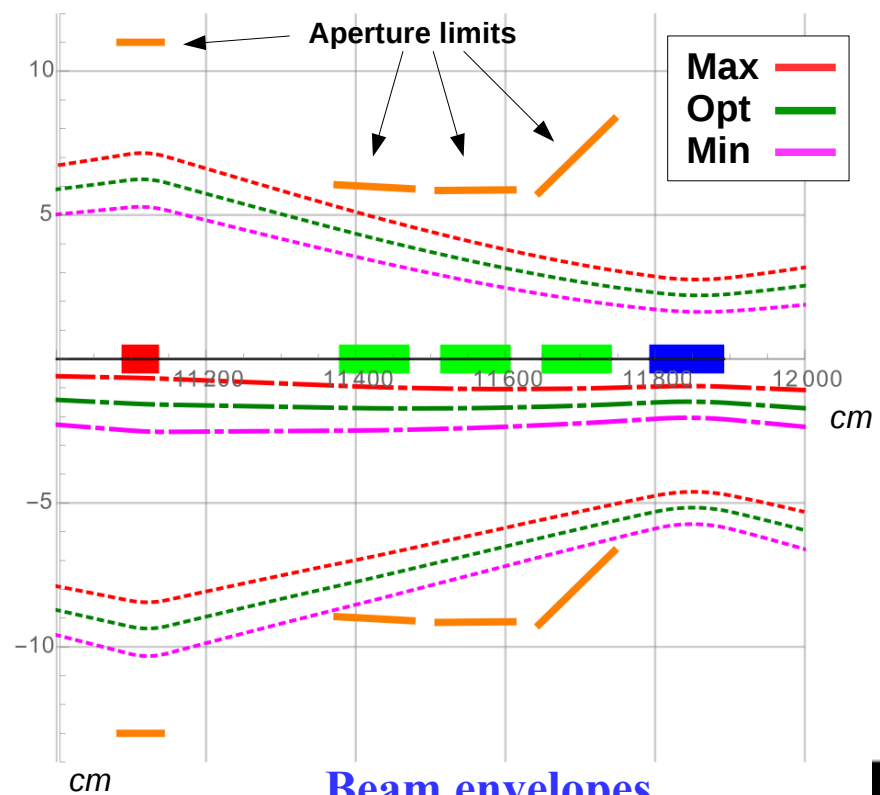
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Beams Injection: Matching with TCR1



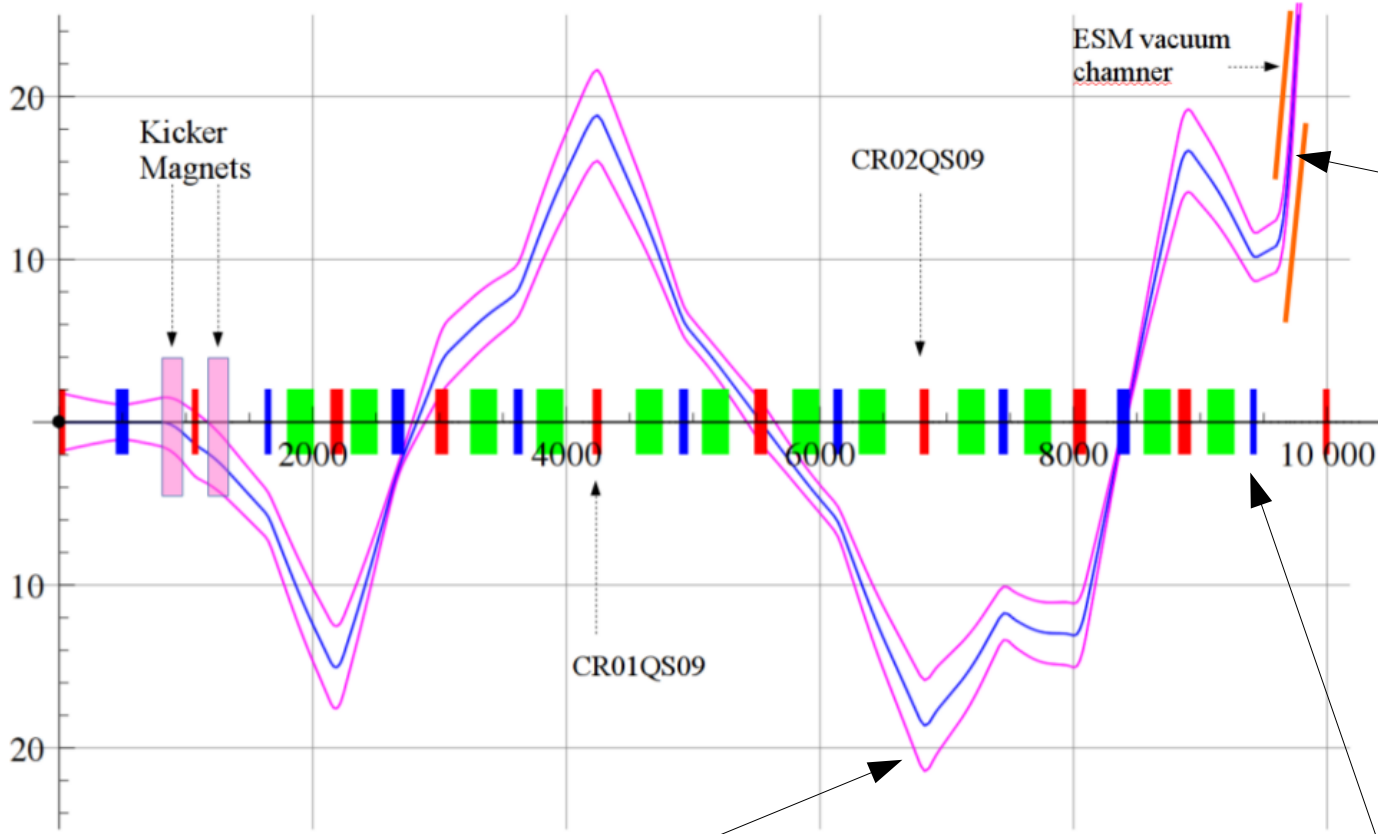
Trajectories



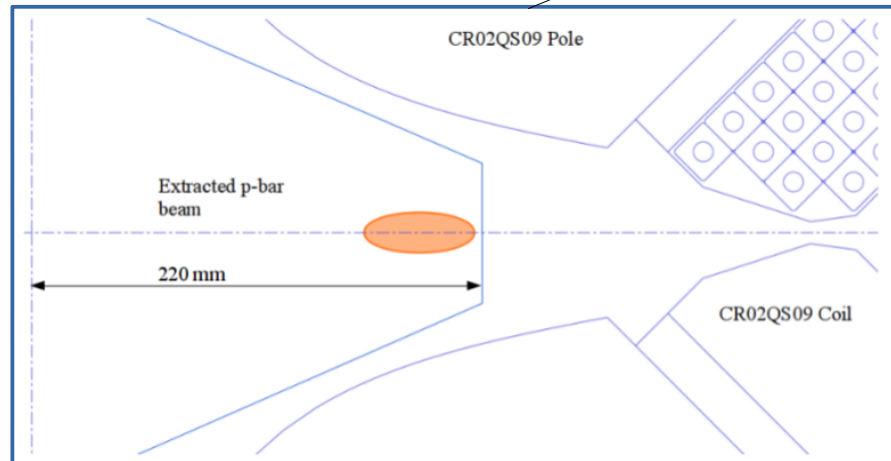
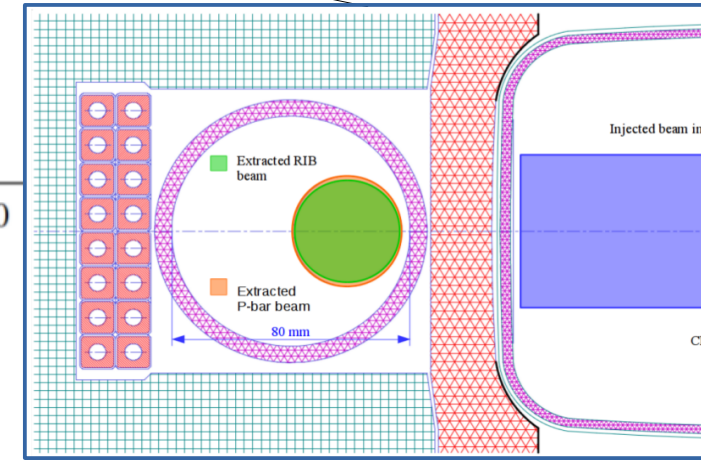
Beam envelopes
In septums



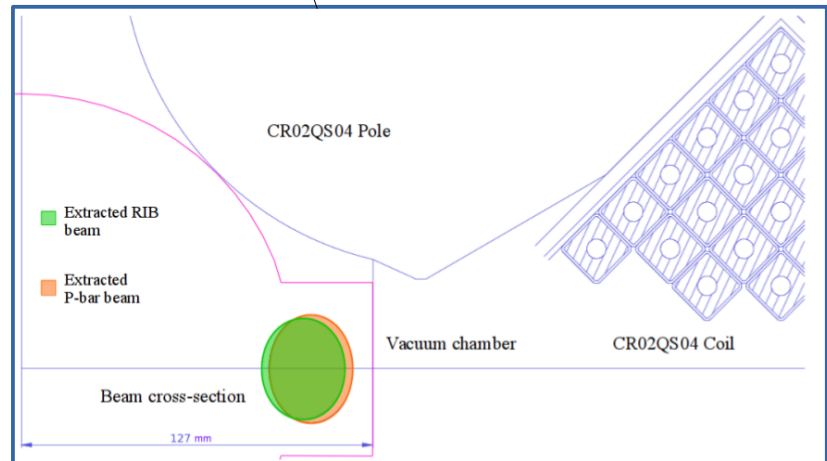
Beams Extraction Scheme



Beam cross-sections @ septa



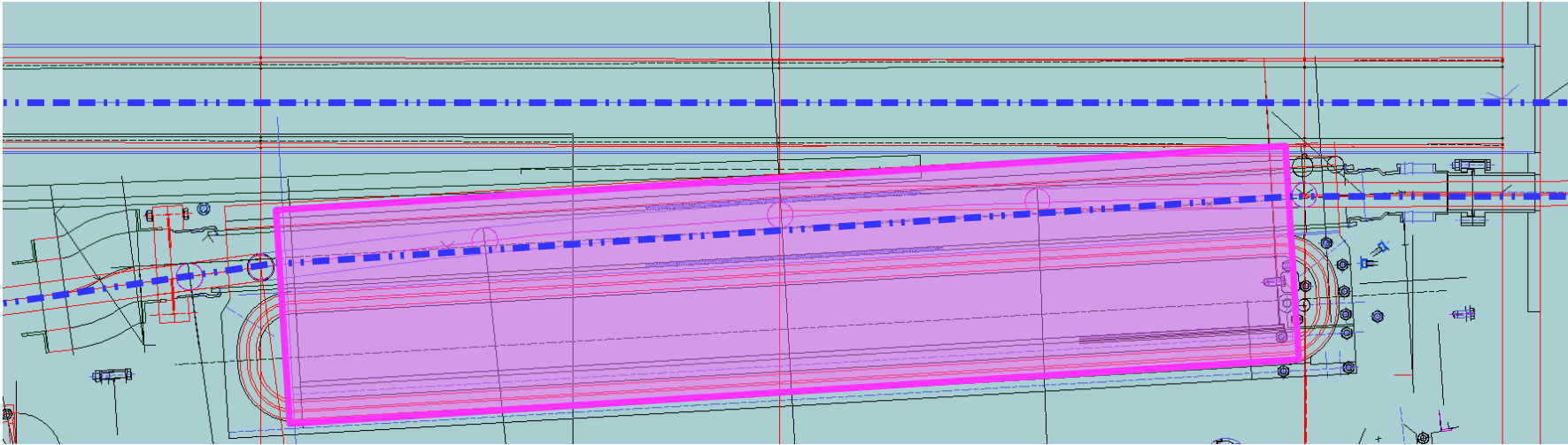
Beam cross-sections @CR02QS09 WQ



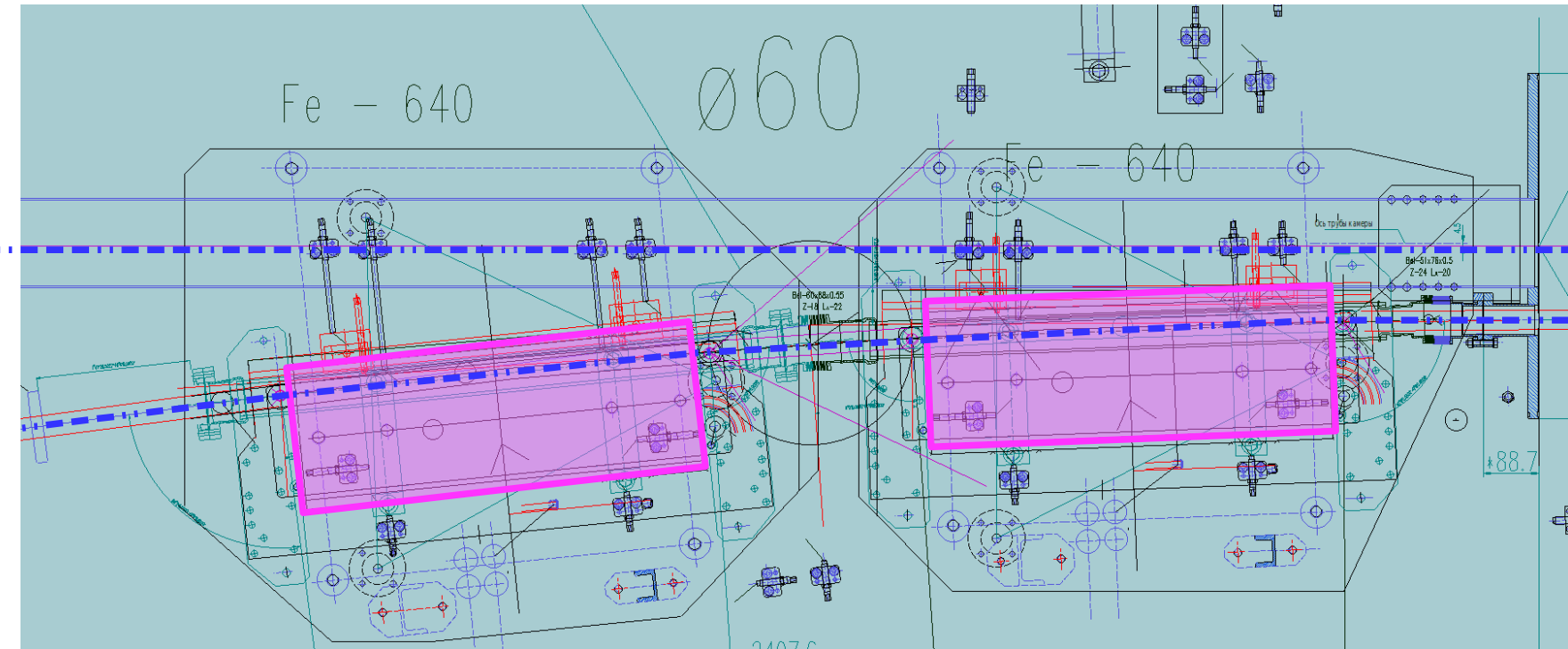
Beam cross-sections @CR02QS04 NQ



Extraction Septum Update



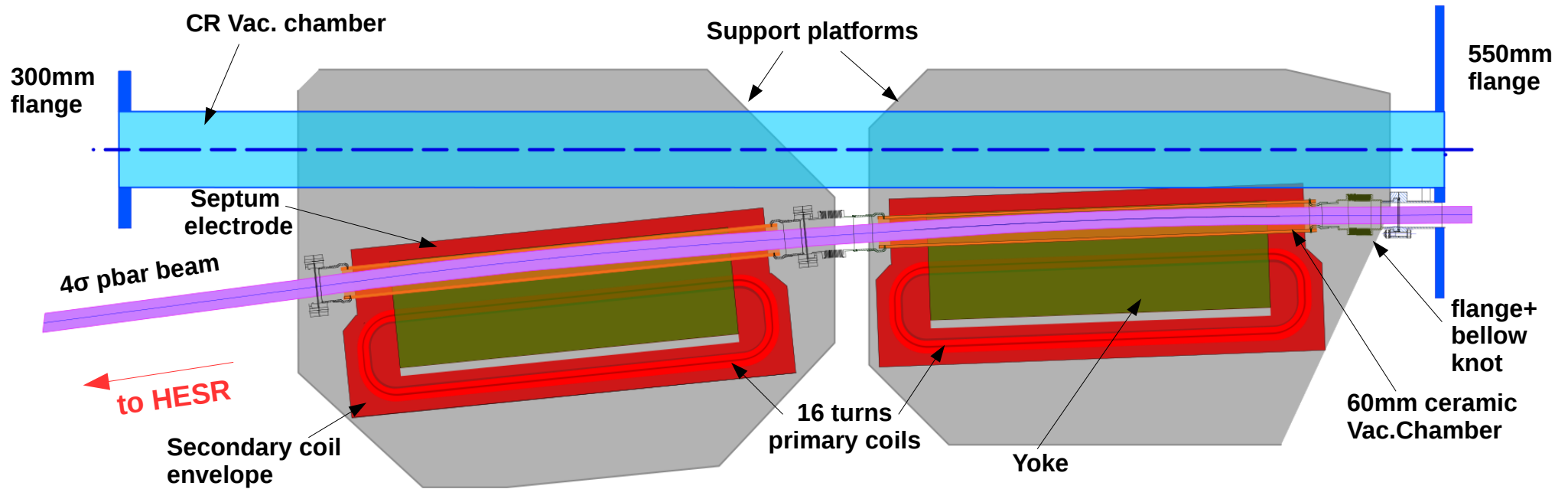
One magnet option



Two magnets option



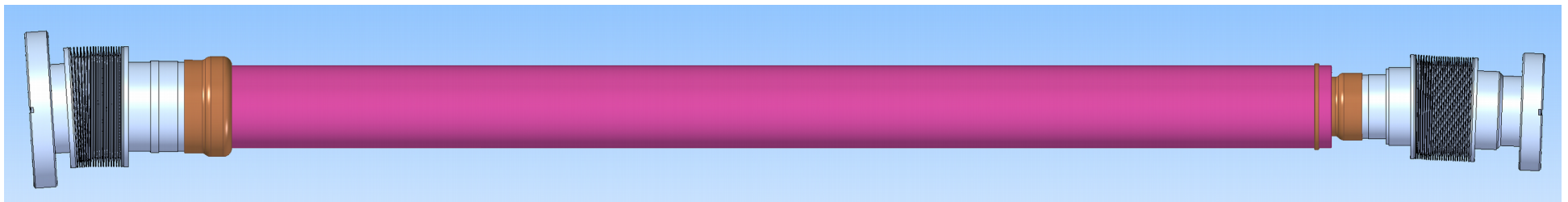
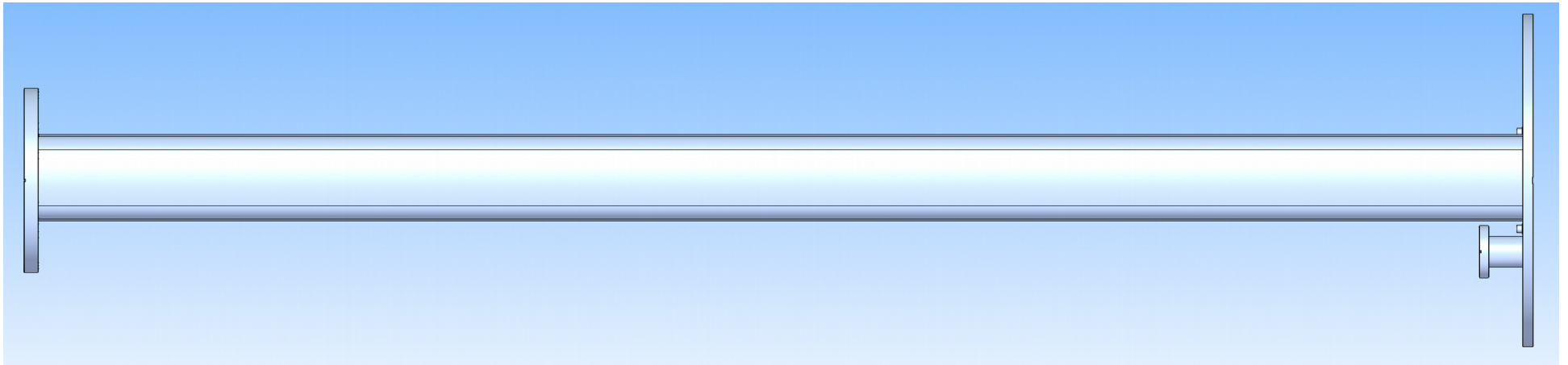
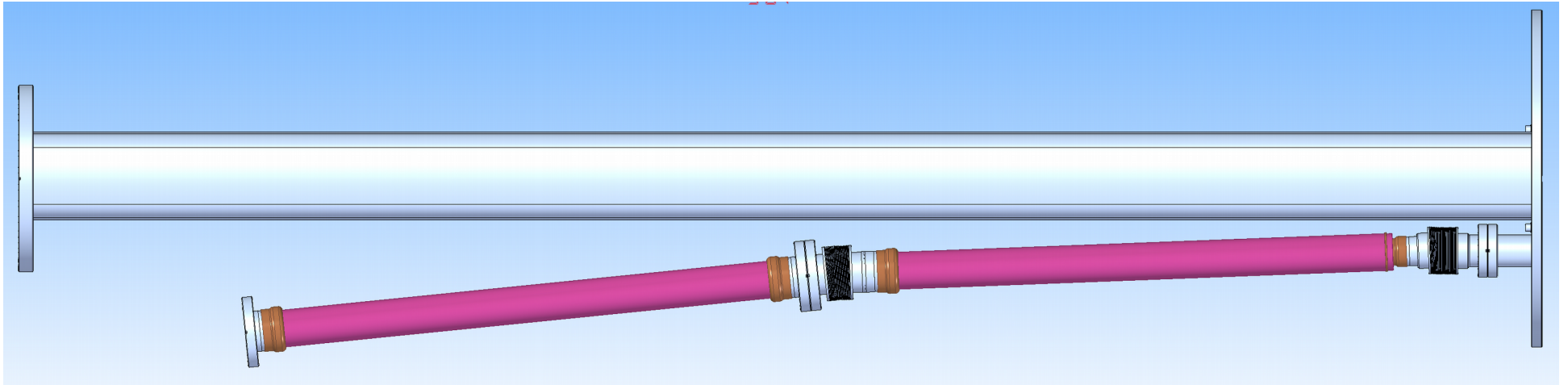
Extraction Septum Update



Number of magnets	2
Magnetic field	1.2T
Radius of curvature	11070mm
Effective length	687.35mm
Final orbit deviation angle	7.513°
Yoke length	640mm
Voltage	2.5kV
Pulse length	3 msec
Gap	65 mm
Integral mag. field quality	0.001 ?

- **Reduced voltage: 5kV → 2.5kV**
- **Reduced current: 5kA → 4kA**
- **Reduced inductance**
- **Increased height/width of the gap**
- **Better fitting of the beam**
- **Cheaper vacuum chamber**
- **Whole iron weight rise: ~1%**
- **Whole copper weight rise: ~25%**
- **Types of PS: 2 → 1**
- **Number of PS: 1 → 2**
(ISPS prototype+3 PS + ESPS prototype + 1PS)

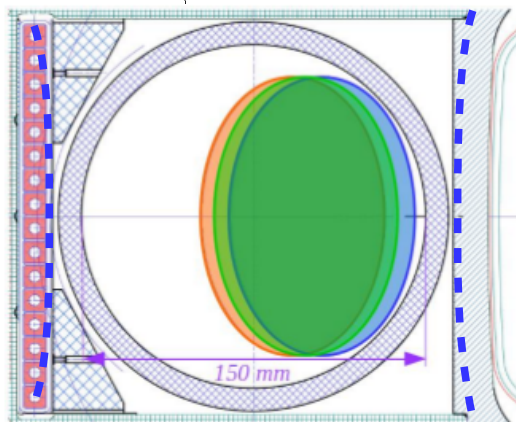
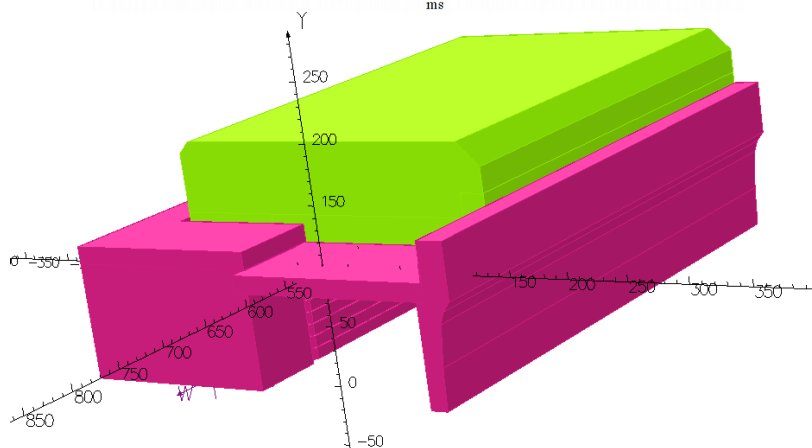
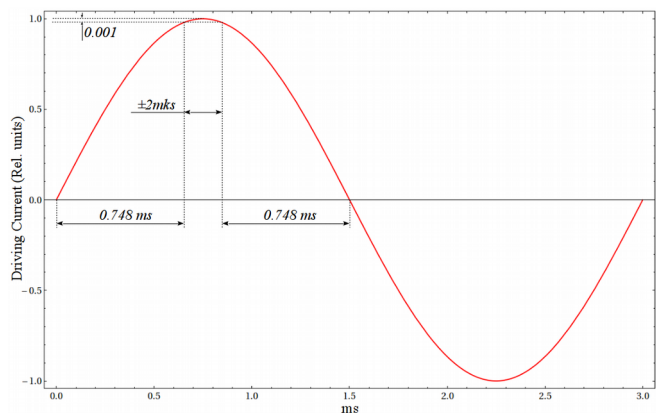
Extraction Septum Vacuum Chamber



Vacuum chamber blueprints and 3D model are ready

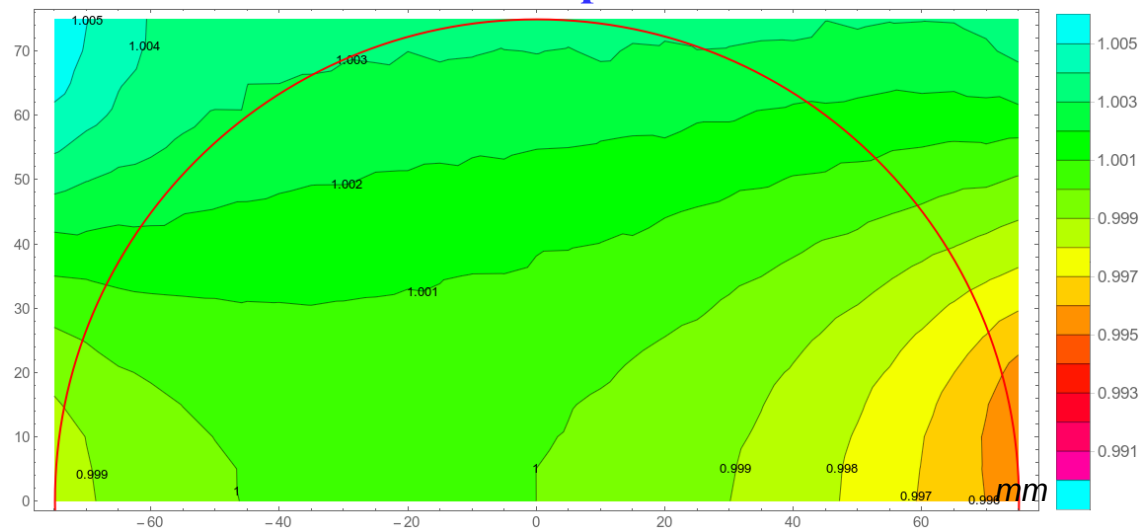


Injection Septum: Magnetic Field Simulations



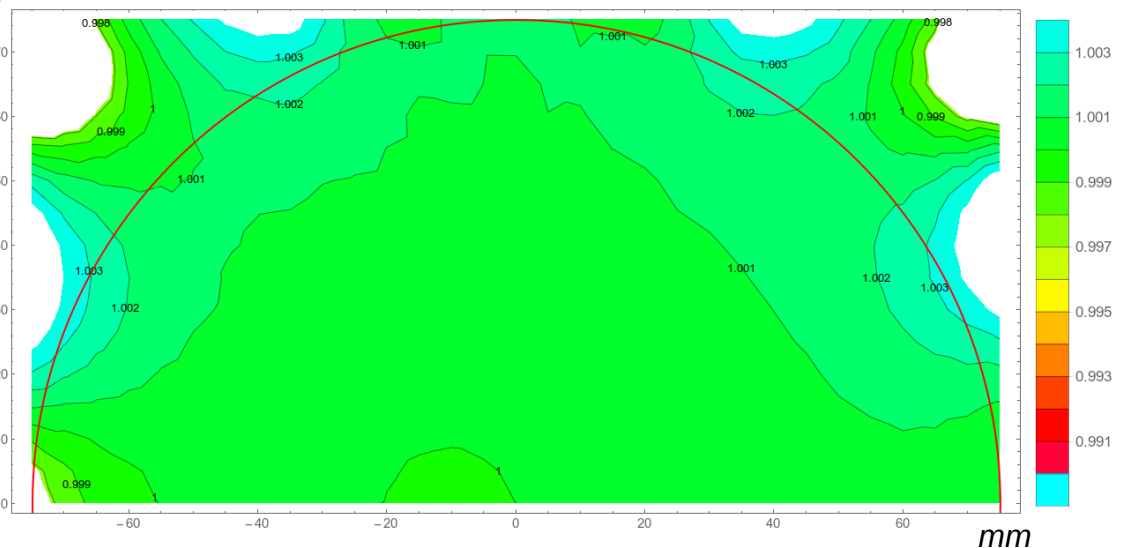
mm

Realistic option



mm

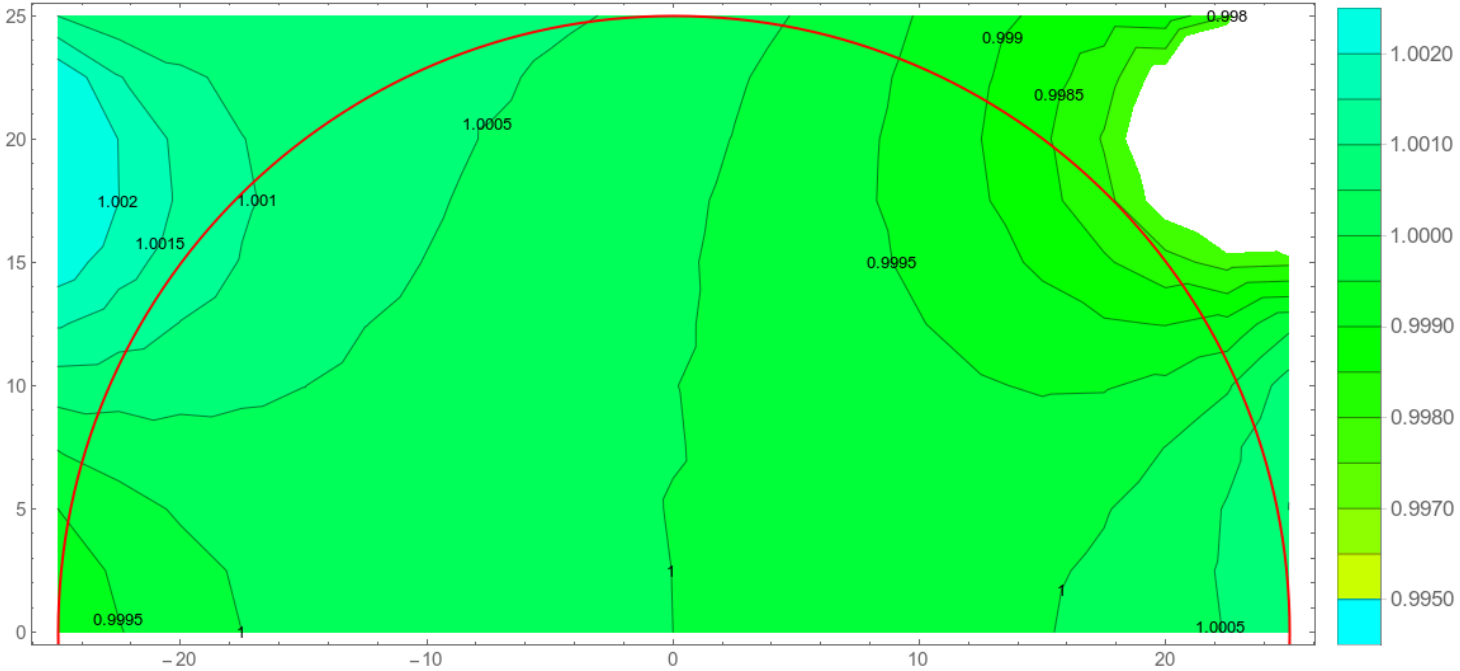
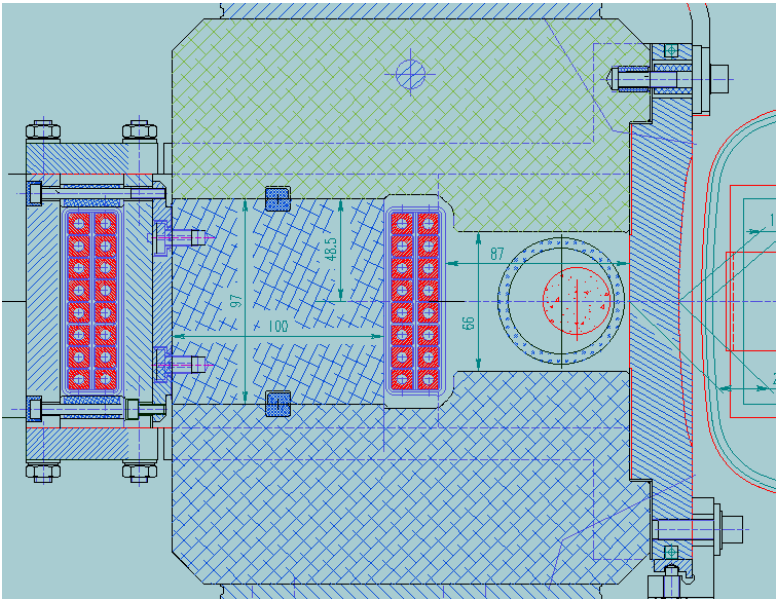
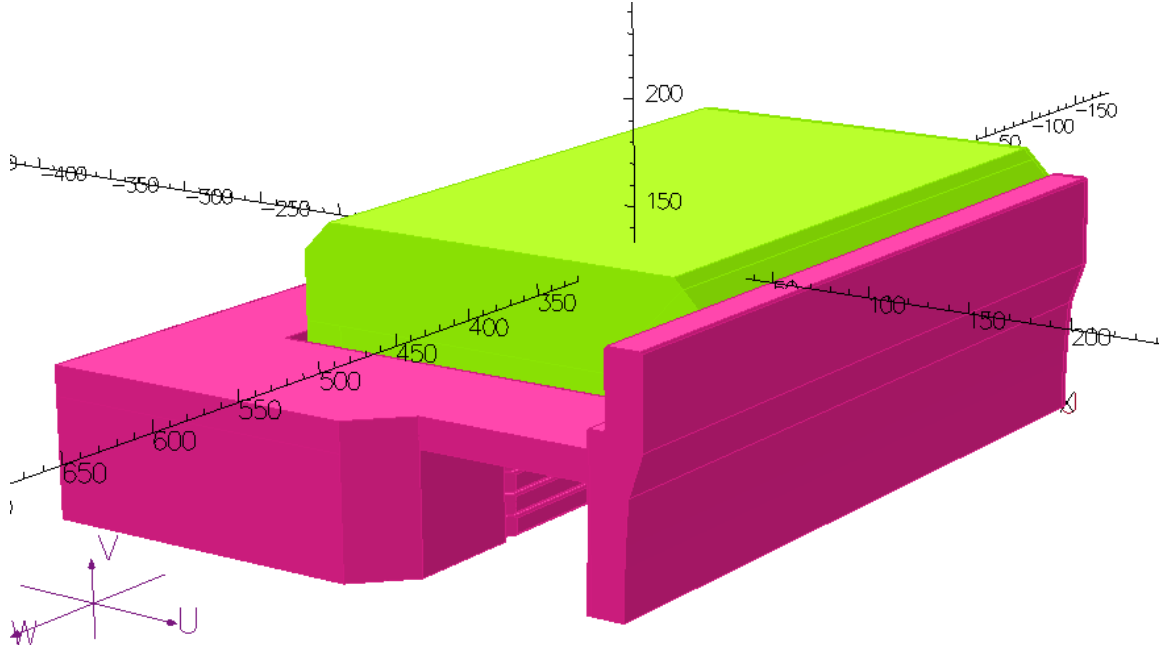
Optimistic option



Precision of winding is 0.5mm.
Demand for profile accuracy 0.1mm

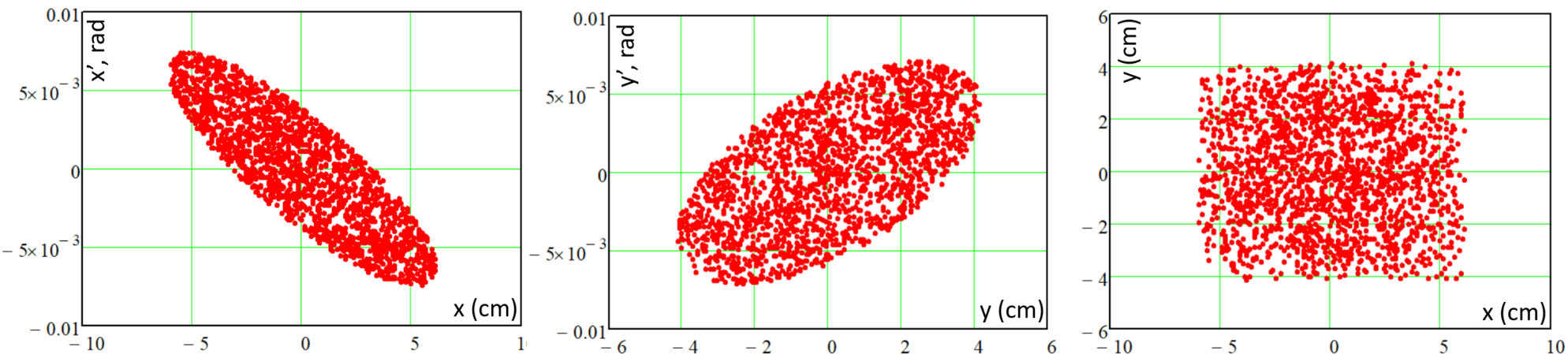


Extraction Septum: Magnetic Field Simulations

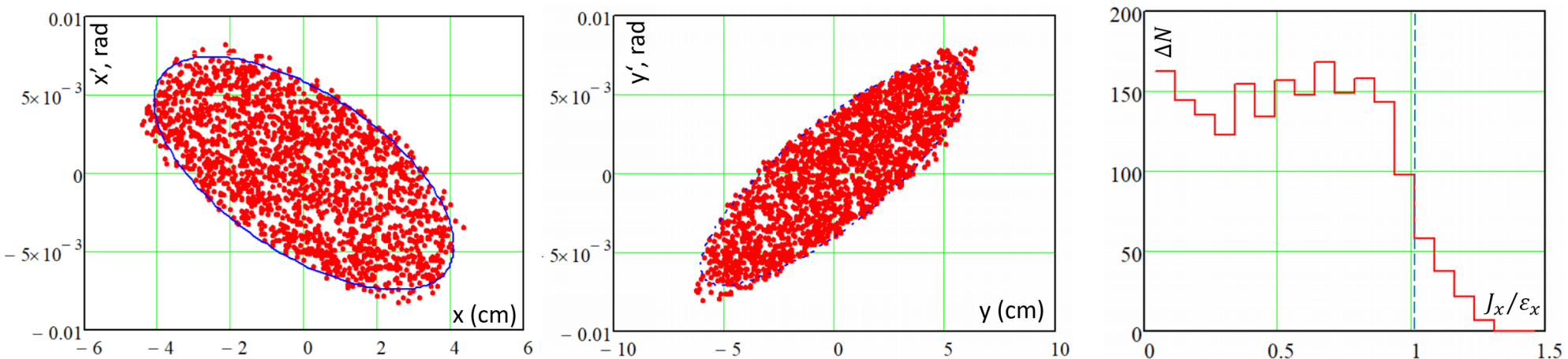


Magnetic Field Quality Requirements

Initial distribution of 2000 particles



Distribution after 3 Septums with $\Delta B/B=0.02$ at radius 60mm



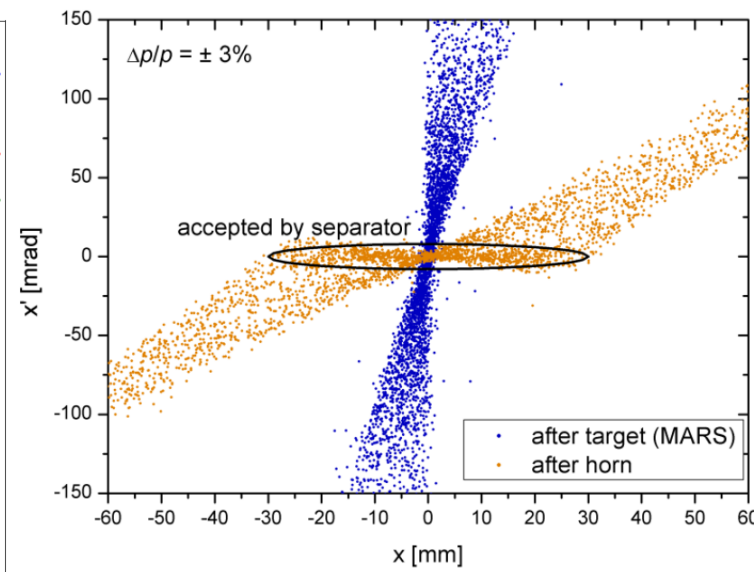
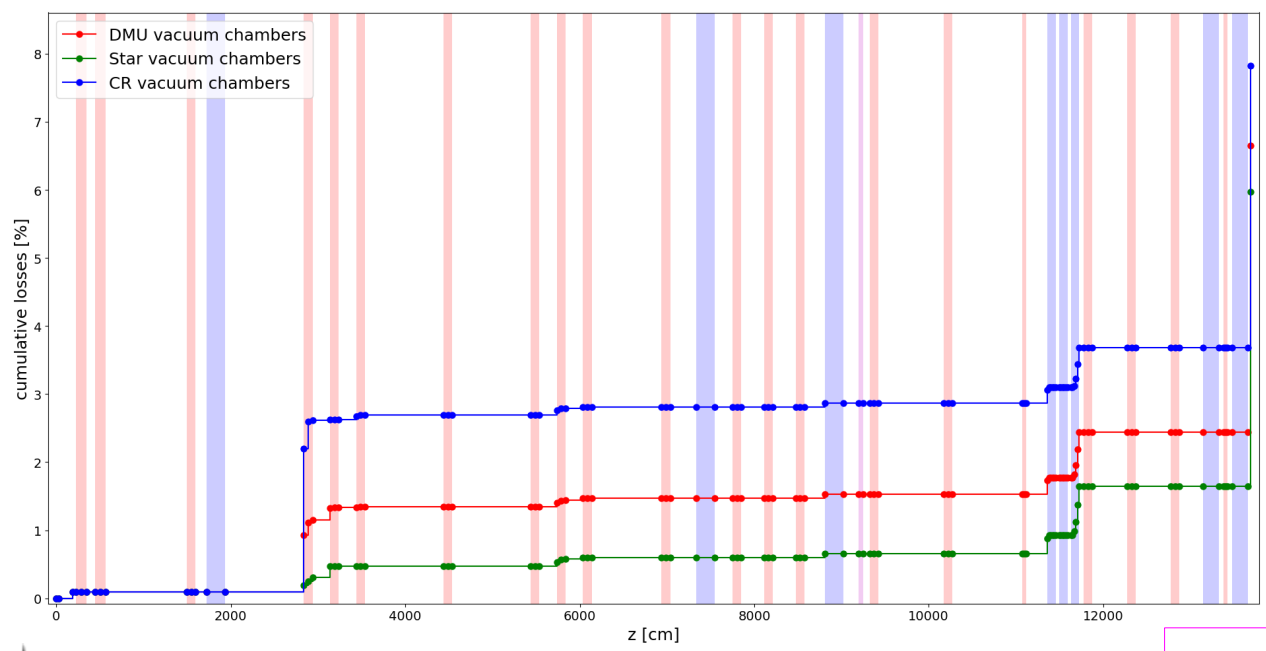
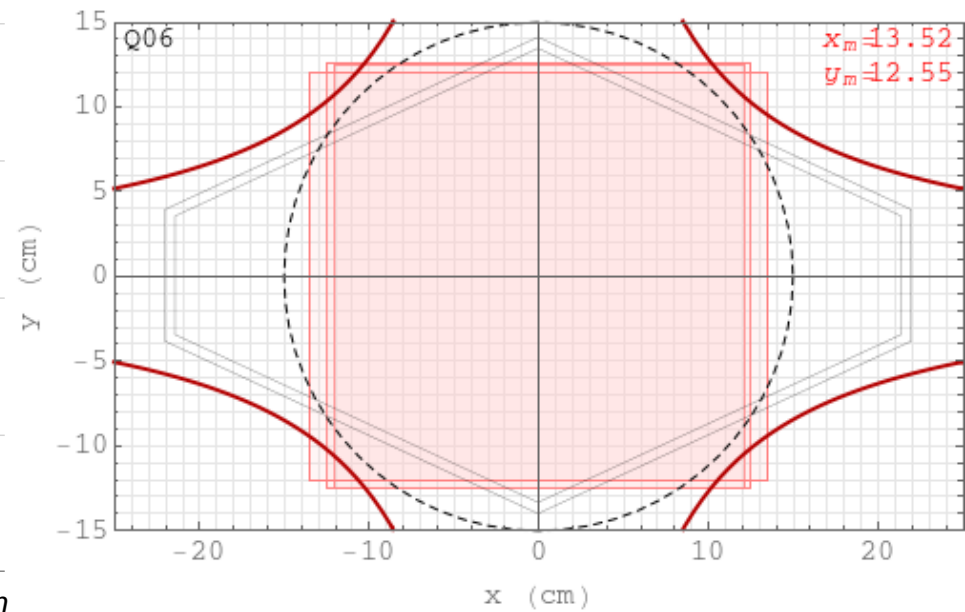
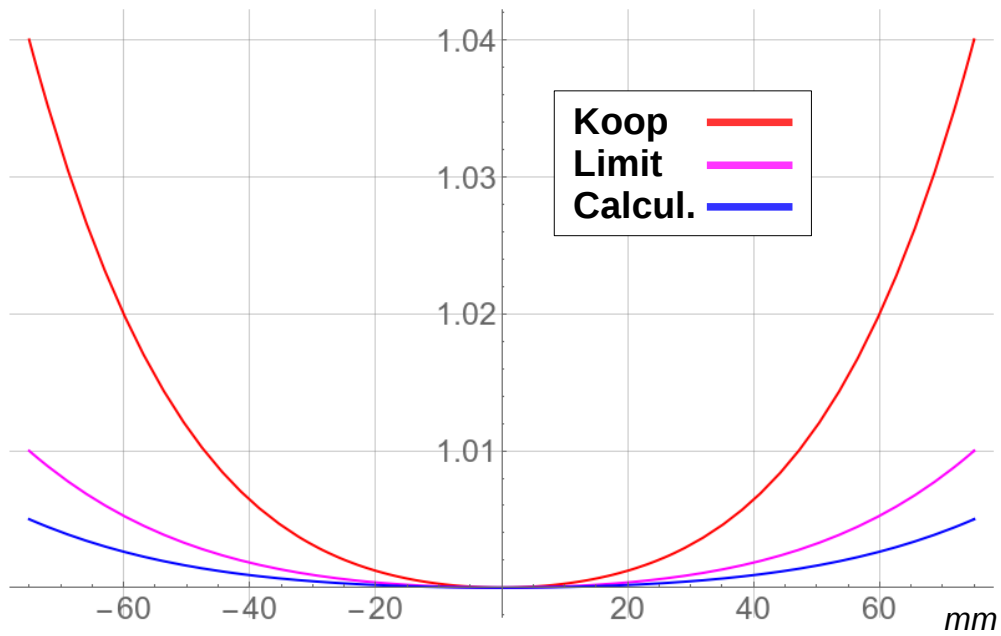
Losses: 94 particles exceeding horizontal amplitude

115 particles exceeding vertical amplitude

~10% off losses



Magnetic Field Quality Requirements

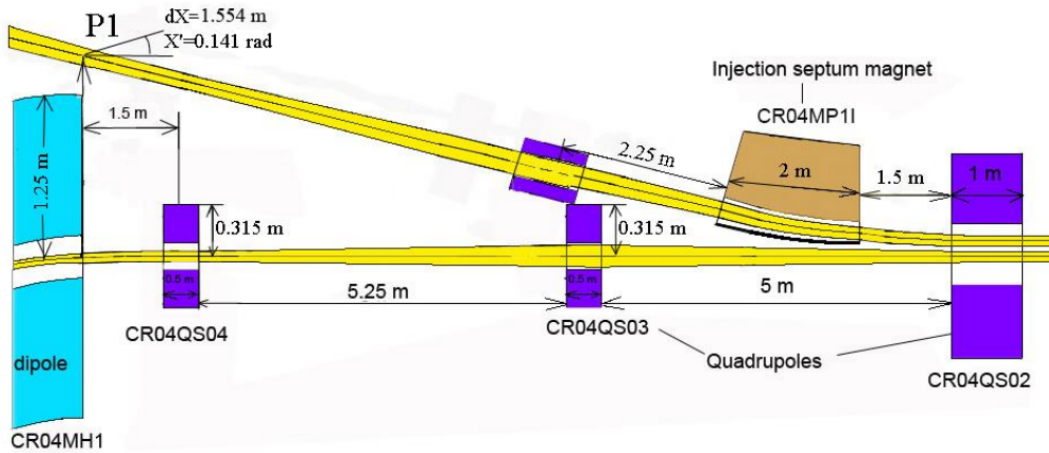


Serban Udrea report at November 2019 Workshop

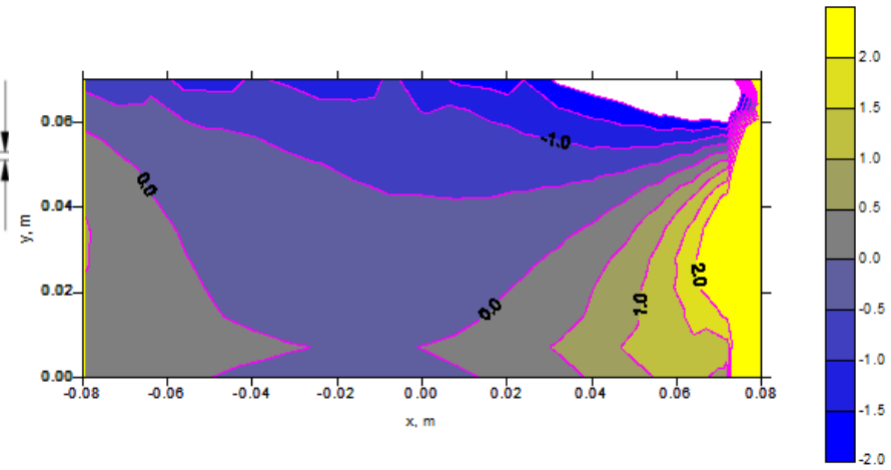
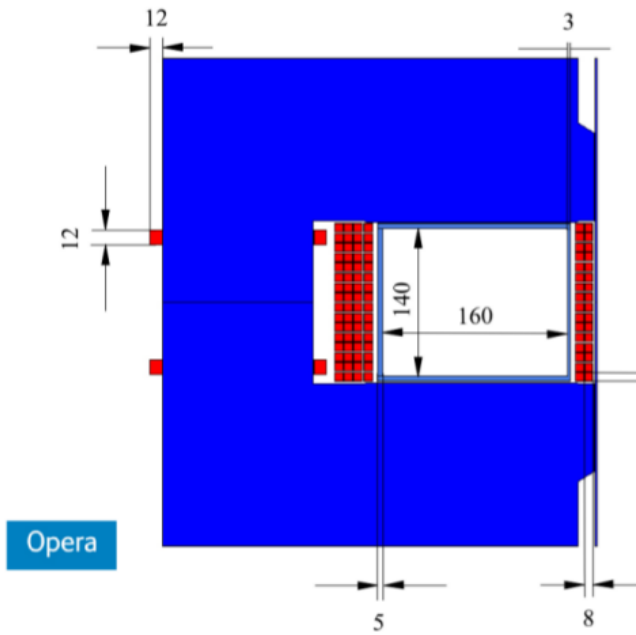
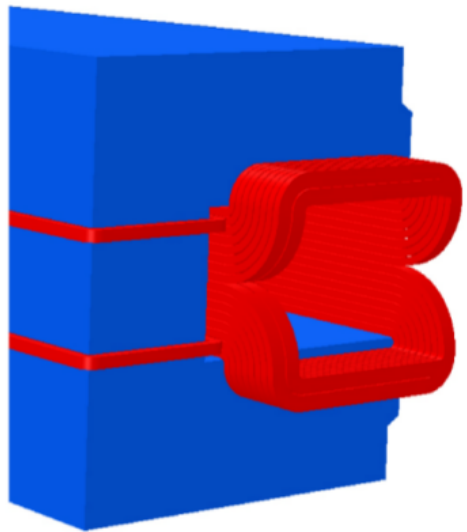
Effective CR sextupole: 0.1 T/m^2
 Real CR sextupole: $\sim 8 \text{ T/m}^2$



Injection Septum Magnet TDR2014



Parameter	Units	Value
Number of magnets		1
Operation mode		pulsed
Maximum field	T	0.85
Minimum field	T	0.425
Bending angle	rad	0.125
Curvature radius	m	15.3
Effective length	m	2.2
Useable horizontal aperture	mm	160
Useable vertical aperture	mm	140
Vertical pole gap height	mm	150
Thickness of vacuum chamber wall (rectangular shape)	mm	5
Septum thickness (including shielding screen and vacuum chamber)	mm	< 25
Field quality (integral)	rel. units	$\pm 1 \times 10^{-3}$
Maximum current	kA	6.4
Inductance	mH	0.95
Resistance	mOhm	9.8
Maximum voltage (dc + ac parts)	V	103
Maximum power	kW	398.2
Average power consumption (for 1.5 s cycle)	kW	30
Maximum ramp rate	T/s	8.5
Maximum current rate	kA/s	64
High field flat top	ms	5
Low field flat top	ms	5
Cycle length	s	1.5
Water pressure drop	bar	2.2
Water flow rate	l/min	25.2
Water temperature rise	°C	40



Further Steps

Injection:

- Spec. Change request → submitted
- Update for detailed injection parameters → ready for submission
- CDR → right after Specs change. Everything is ready.
- FDR → right after CDR. Blueprints are ready.
- Vacuum chambers and tests → August-September 2020
- Production of pre-series and tests → 2021

Extraction:

- Spec. Change request → to be submitted after the workshop
- Update for detailed extraction parameters → to be submitted
- Magnetic field calculations → 1-2 Monthes
- Design finalization → end of summer.
- CDR → Autumn 2020
- FDR → As soon as blueprints will be ready.
- Production goal → start after the production of ISM pre-series.



Thank you!