Simulations for 7TeV beam with IR3 combined cleaning and TCRYO

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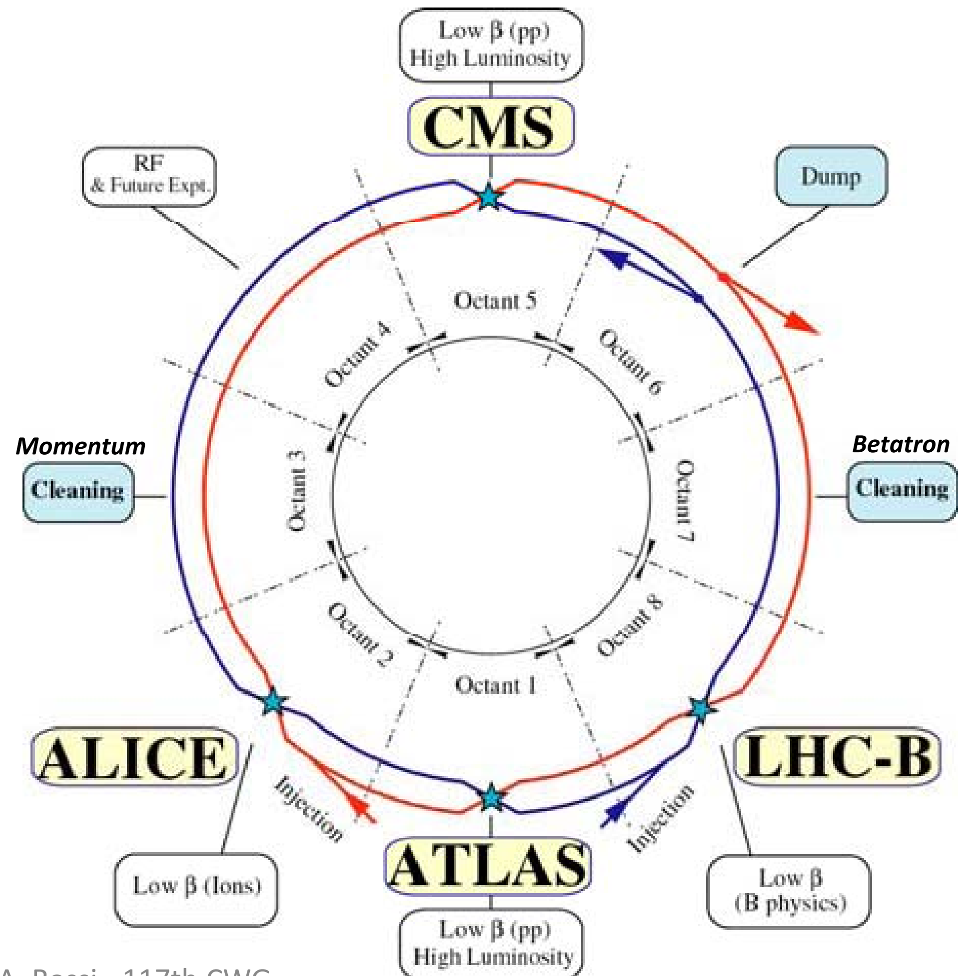
Collimation Phase 2
as complement to Phase 1

1. Additional secondary collimators and scrapers in the IR3 and IR7 warm regions (already prepared): Cu jaws with higher stopping power and lower impedance
    - CERN white paper
    - SLAC – LARP
    - EuCARD
2. Collimators into super-conducting dispersion suppressors (cryo-collimators) in IR7, IR3 and IR2
    - EuCARD (cryo-coll)
3. New … Combined Betatron/Momentum Cleaning in IR3

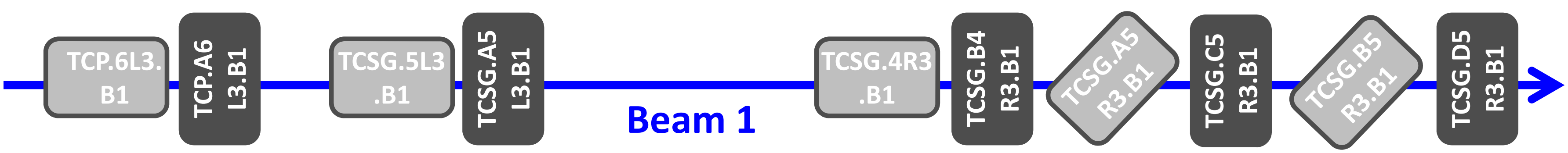


IR3 combined cleaning

- While we lose efficiency with the combined system, we win with the collimators in the cryogenic dispersion suppressors.
- SC link cable in IR3 OK for 500 kW losses at primary collimators (nominal). Maybe require additional passive absorbers.
- LHC collimation with 28 collimators less than now ➔ faster setup and less beam time required. Lower impedance (20 TCP/TCS instead of 38 TCP/TCS)!
- Limitations with Single Event Upset in IR7 are avoided as losses are relocated to IR3 (100 times less radiation to electronics for same beam loss in IR3).
- System in IR7 kept operational in case of problems (spare system).
- Much better flexibility to react to limitations.

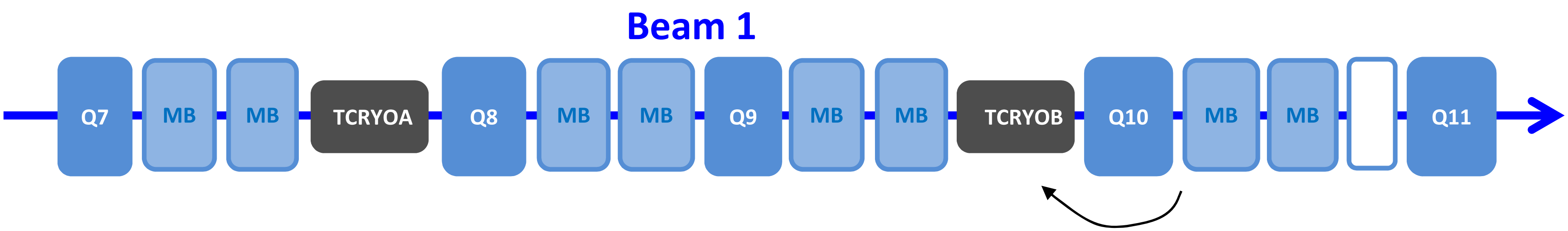
IR3 collimator layout for momentum/betatron cleaning

Beam 1			Beam 2		
Phase I	Phase II	angle, material	Phase I	Phase II	angle, material
	TCP.6L3.B1	Hor		TCP.6R3.B2	Hor
	TCP.A6L3.B1 replacing TCHSH.6L3.B1	Ver		TCP.A6R3.B2 replacing TCHSH.6L3.B2	Ver
TCSG.5L3.B1	TCSG.5L3.B1	Hor	TCSG.5L3.B2	TCSG.5R3.B2	Hor
	TCSG.A5L3.B1 replacing TCSM.5L3.B1	Ver, Carbon Hor, Copper		TCSG.A5R3.B2 replacing TCSM.5R3.B2	Ver, Carbon Hor, Copper
TCSG.4R3.B1	TCSG.4R3.B1	Hor	TCSG.4R3.B2	TCSG.4L3.B2	Hor
	TCSG.B4R3.B1 replacing TCSM.4R3.B1	Ver, Carbon Hor, Copper		TCSG.B4L3.B2 replacing TCSM.4L3.B2	Ver, Carbon Hor, Copper
TCSG.A5R3.B1	TCSG.A5R3.B1	Skew = 170 deg	TCSG.A5R3.B2	TCSG.A5L3.B2	Skew = 170 deg
	TCSG.C5R3.B1 replacing TCSM.A5R3.B1	Ver, Carbon Skew, Copper		TCSG.C5L3.B2 replacing TCSM.A5L3.B2	Ver, Carbon Skew, Copper
TCSG.B5R3.B1	TCSG.B5R3.B1	Skew = 113 deg	TCSG.B5R3.B2	TCSG.B5L3.B2	Skew = 11 deg
	TCSG.D5R3.B1 replacing TCSM.B5R3.B1	Ver, Carbon Skew, Copper		TCSG.D5L3.B2 replacing TCSM.B5L3.B2	Ver, Carbon Skew, Copper



IR3 collimator layout in DS region

Beam 1			Beam 2		
Phase I	Phase II	angle	Phase I	Phase II	angle
	TCRYO.AR3.B1	Hor, Tungsten		TCRYO.AL3.B2	Hor, Tungsten
	TCRYO.BR3.B1	Hor, Tungsten		TCRYO.BL3.B2	Hor, Tungsten



TCRYO are 2 jaws, 1 m tungsten collimators

Simulation input parameter

- Beam energy: 7TeV
- Beam optics V6.503, sextupoles on
- Collision, nominal β^*

	Crossing	Separation	Solenoid
IP1	1	0	
IP2	1	1	0
IP5	1	0	
IP8	1	1	0

- Halo = sheet beam on primary collimators (0.5 μm impact parameter, Gaussian transverse distribution)
- No energy spread

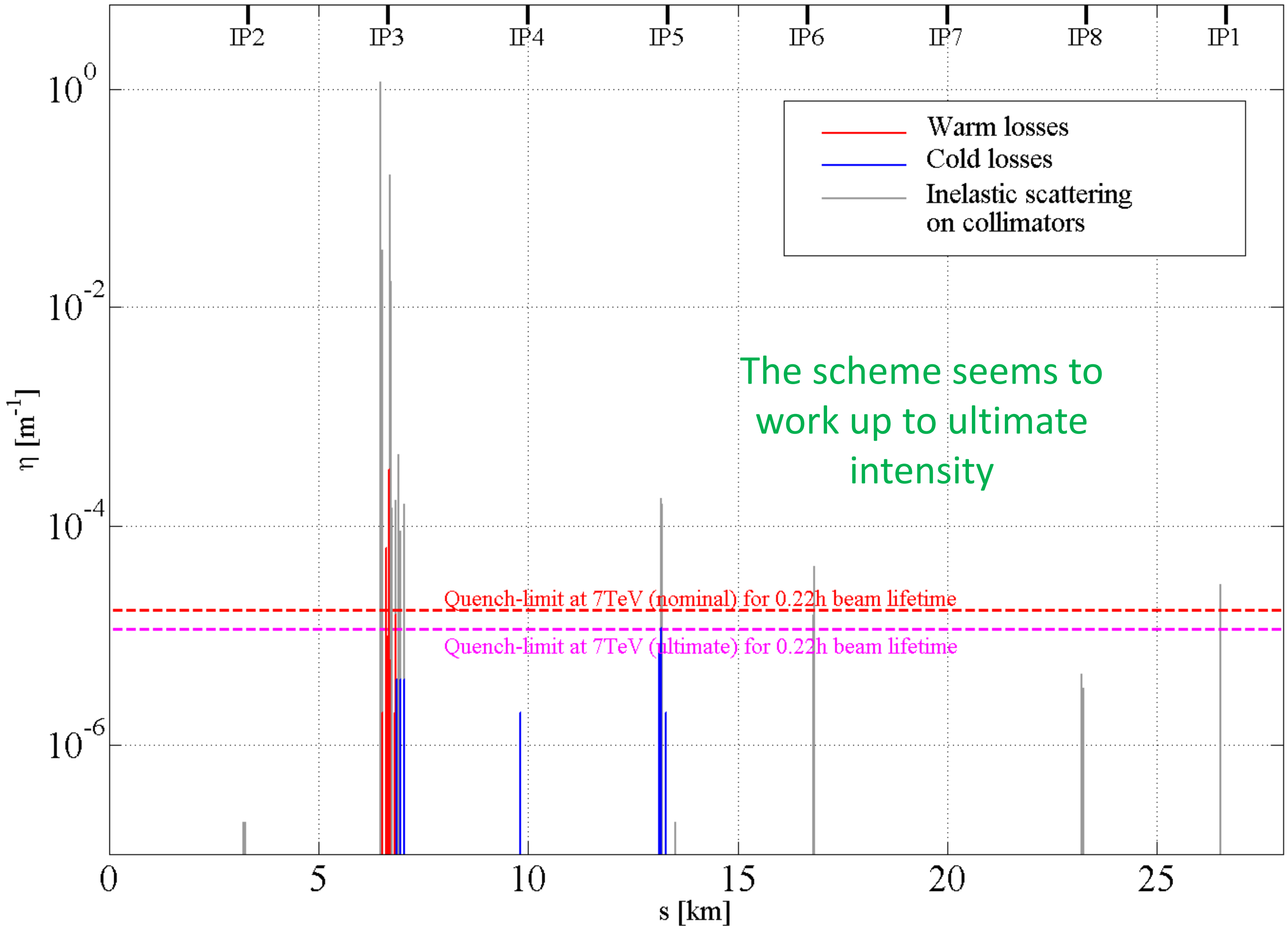
Collimator setting

	Family	Half gap setting [σ]
LSS7	TCP IR7	open
	TCSG IR7	open
	TCLA IR7	open
LSS6	TCDQ	8
	TCS TCDQ	7.5
LSS3	TCP IR3	6
	TCSG IR3	7
	TCLA IR3	10
	TCRYO IR3	20
LSS1	TCTH	8.3
	TCTV	8.3
	TCL	8.3
LSS2	TCTH	8.3
	TCTV	8.3
LSS5	TCTH	8.3
	TCTV	8.3
	TCL	10
LSS8	TCTH	8.3
	TCTV	8.3

IR3 combined cleaning + W-TCRYO

Beam 1 - horizontal sheet beam @ TCP.6L3.B1 (0.5μm impact parameter)

Ideal machine = without imperfections



The scheme seems to work up to ultimate intensity

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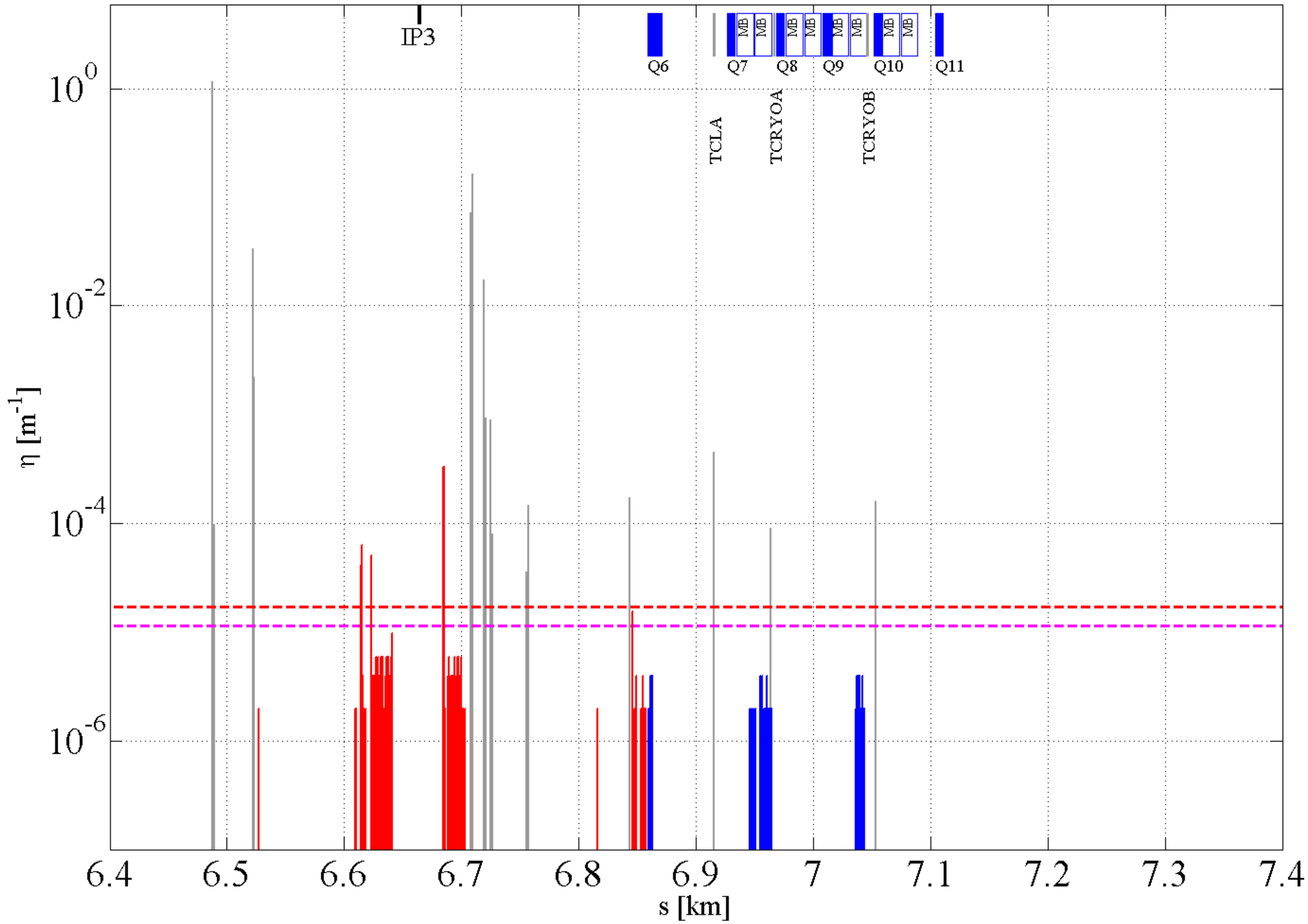

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Beam 1 – vertical sheet beam @ TCP.6L3.B1 (0.5μm impact parameter)

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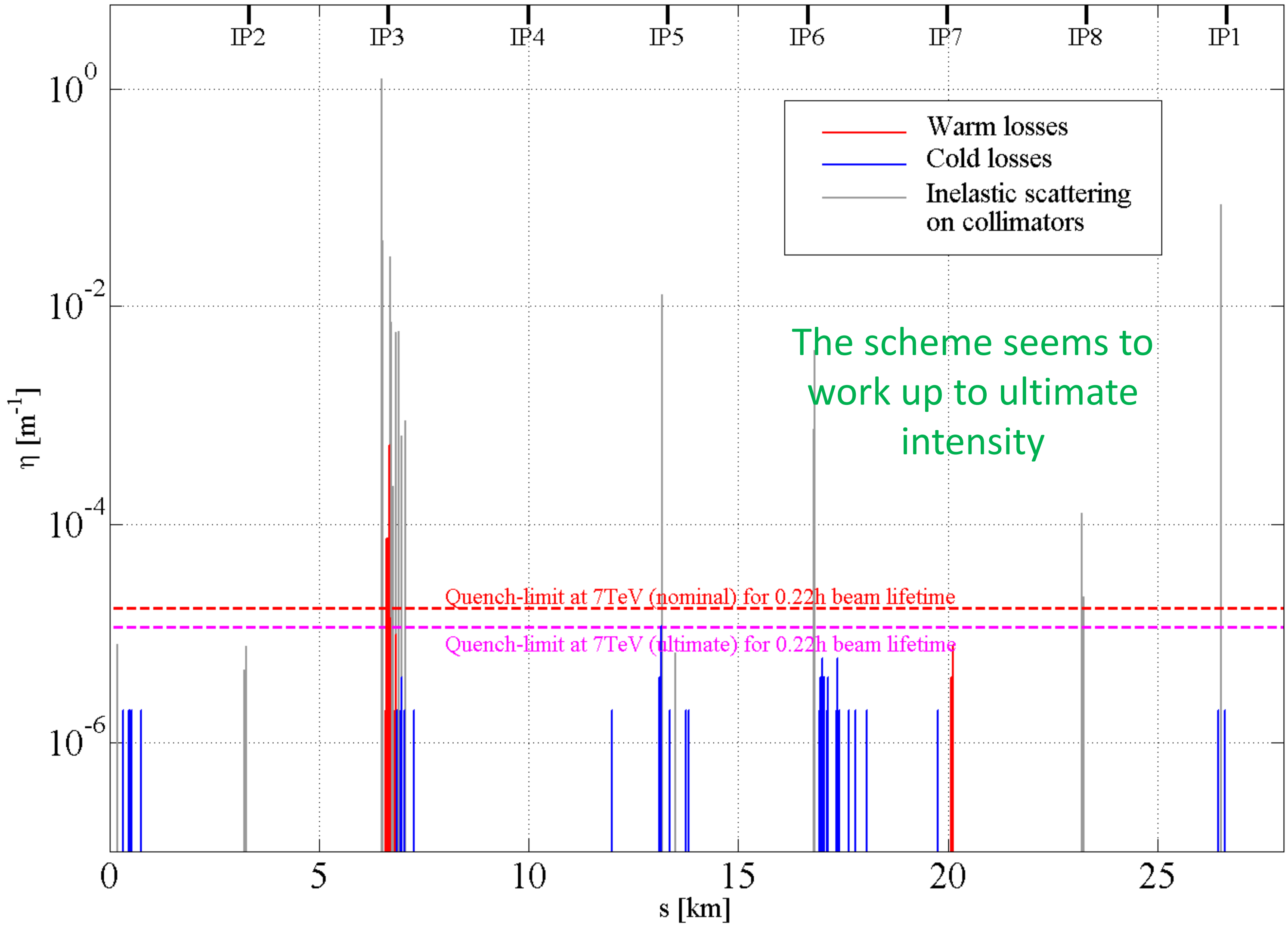

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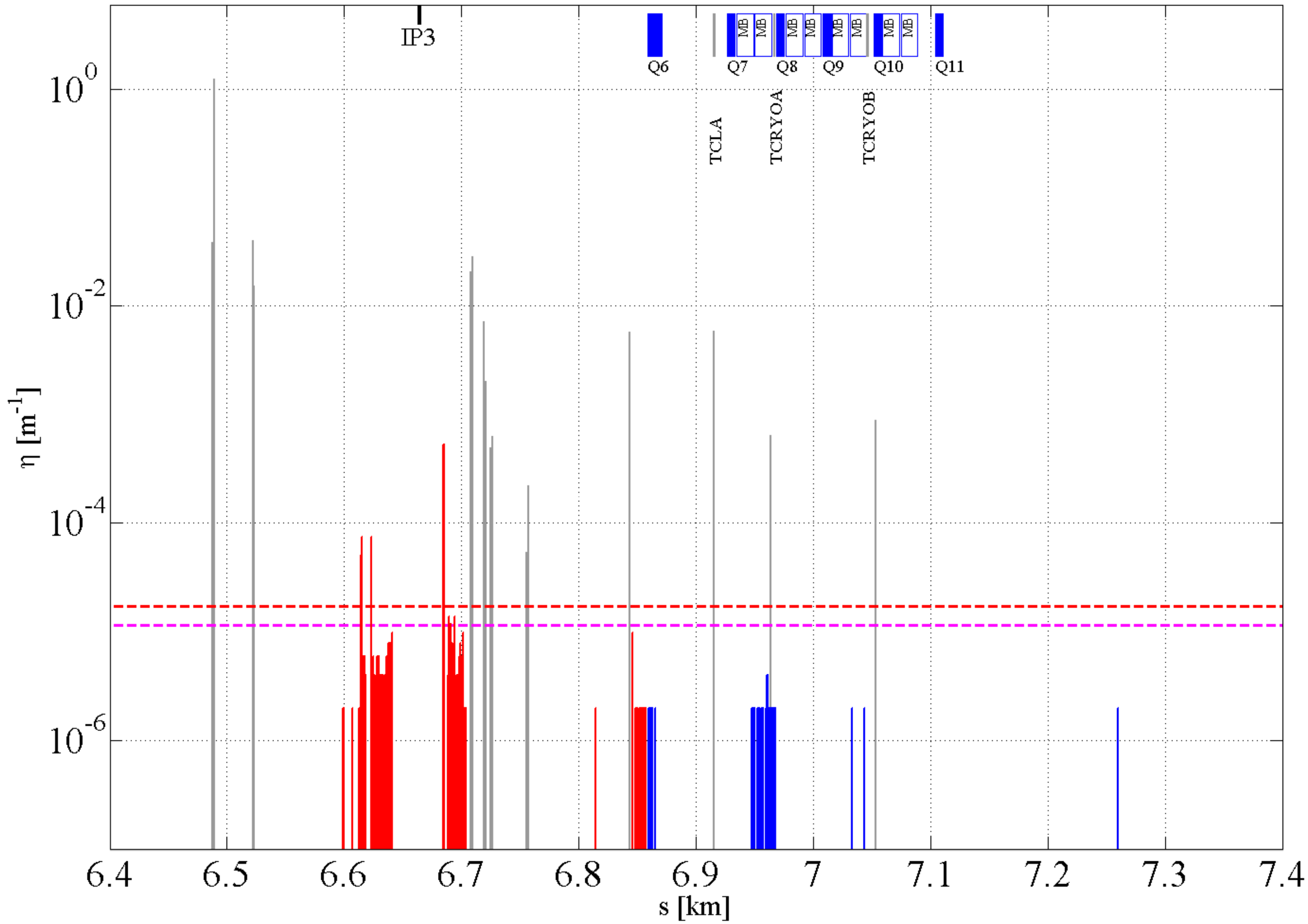
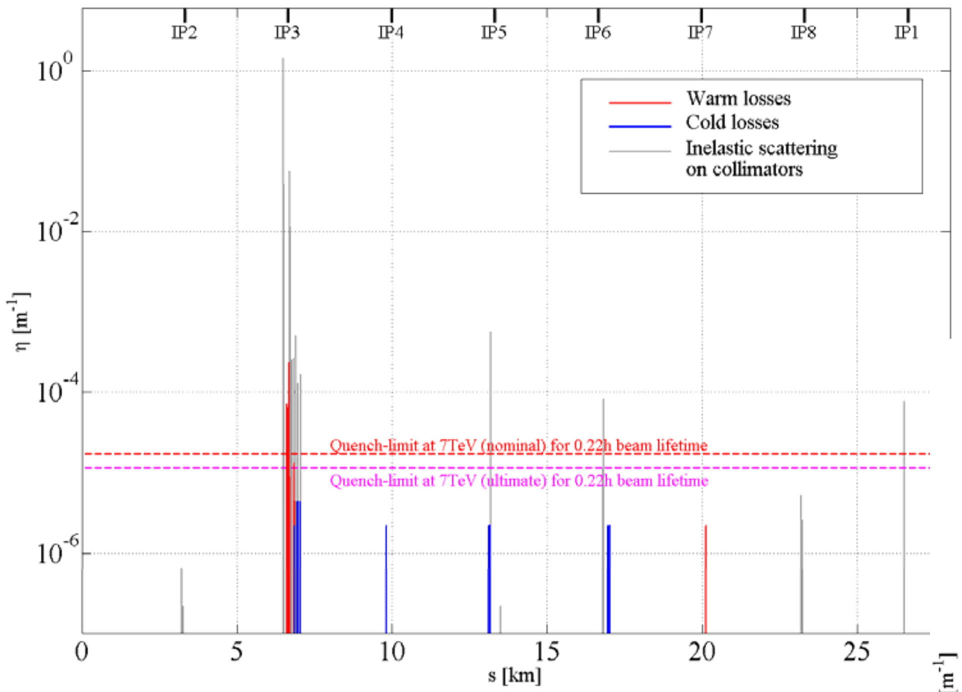


IR3 combined cleaning

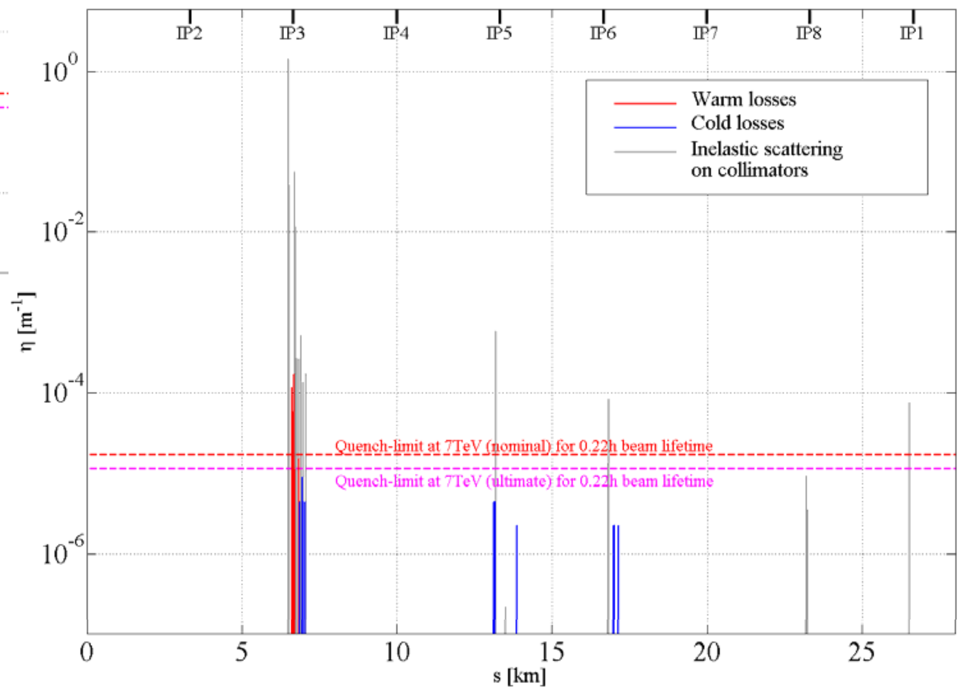
Beam 1 - horizontal halo @ 6.003σ ± 0.0015σ

Ideal machine = without imperfections



W-TCRYO

Cu-TCRYO



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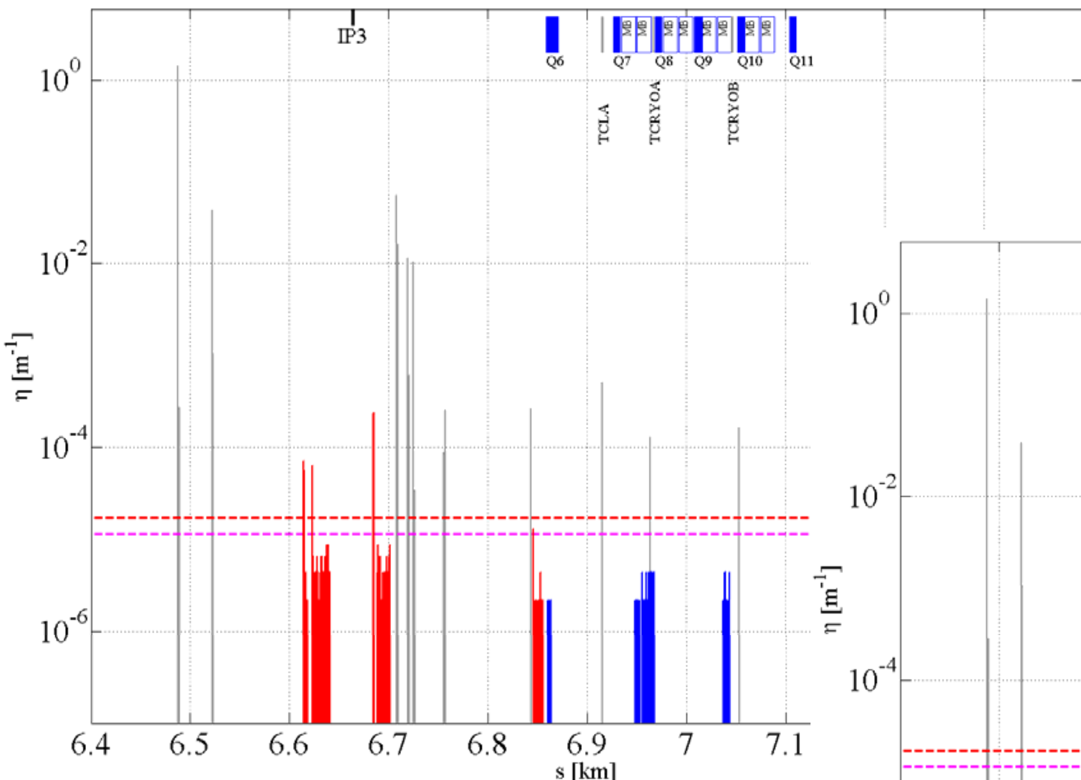
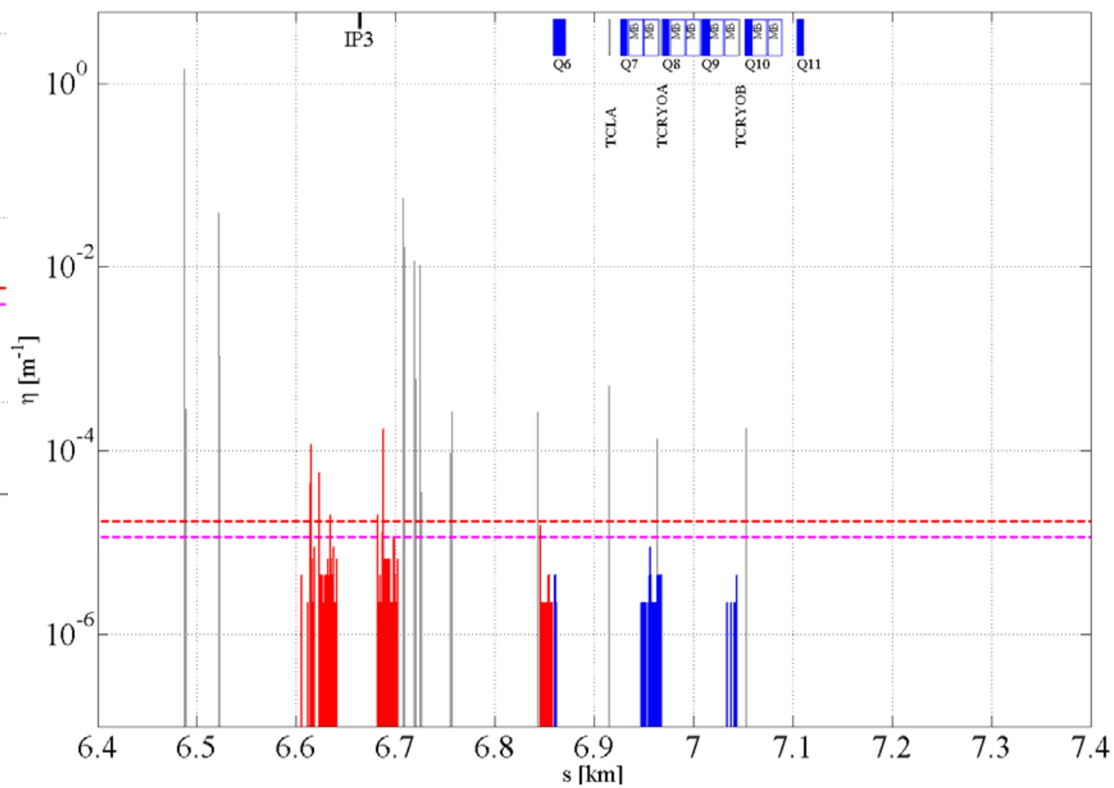


W-TCRYO

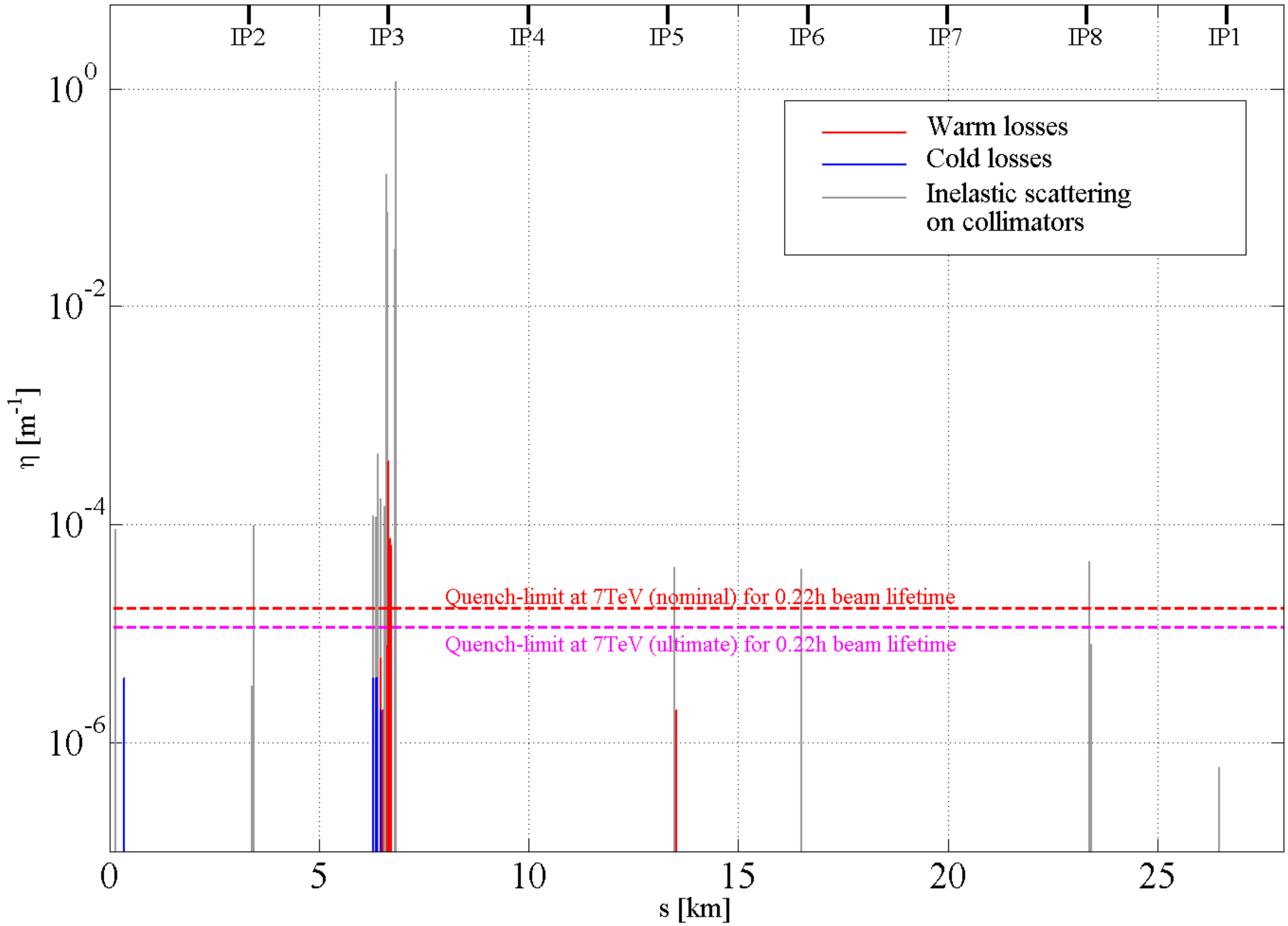
Cu-TCRYO



IR3 combined cleaning + W-TCRYO

Beam 2 – horizontal sheet beam @ TCP.6R3.B1 (0.5μm impact parameter)

Ideal machine = without imperfections



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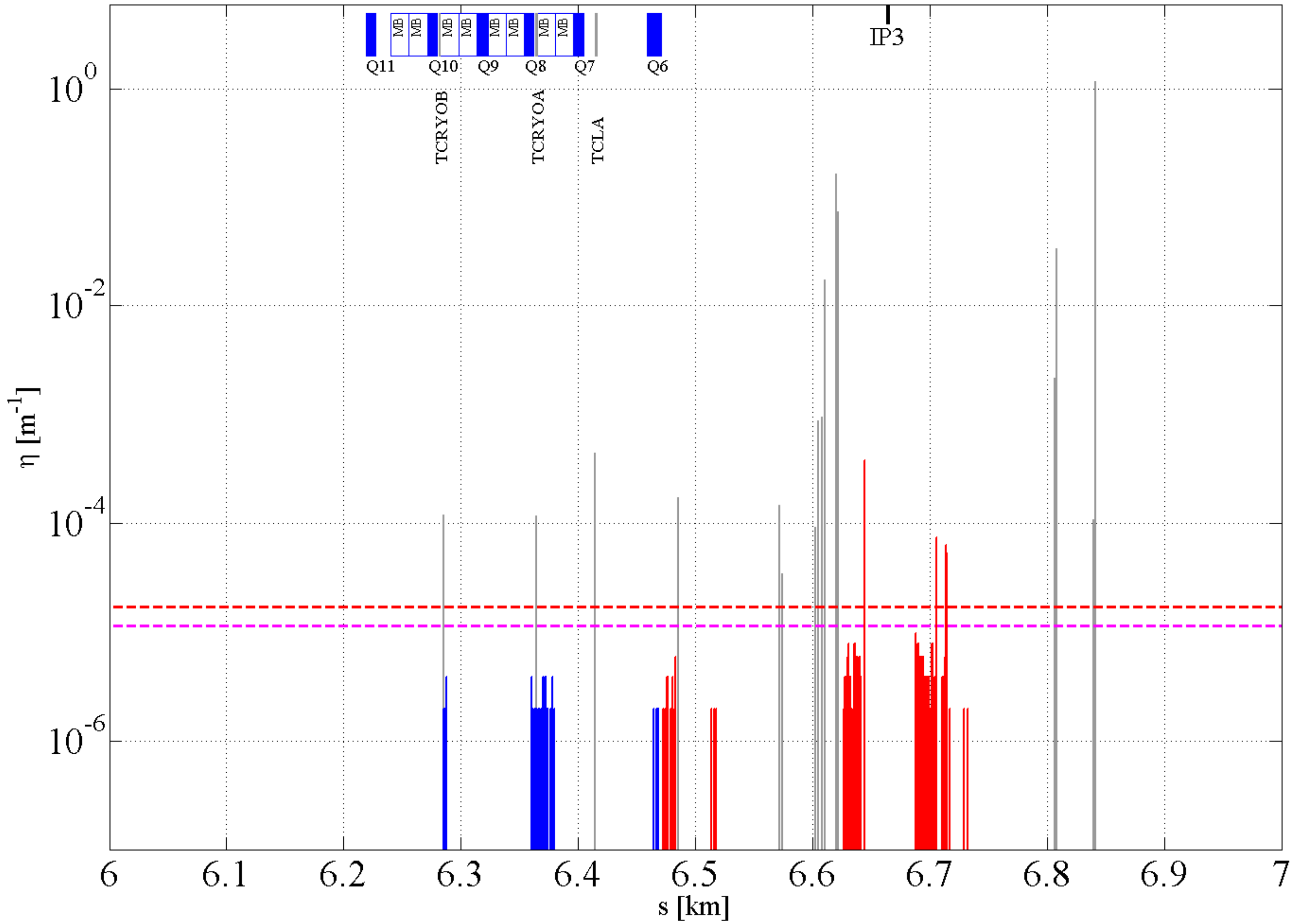
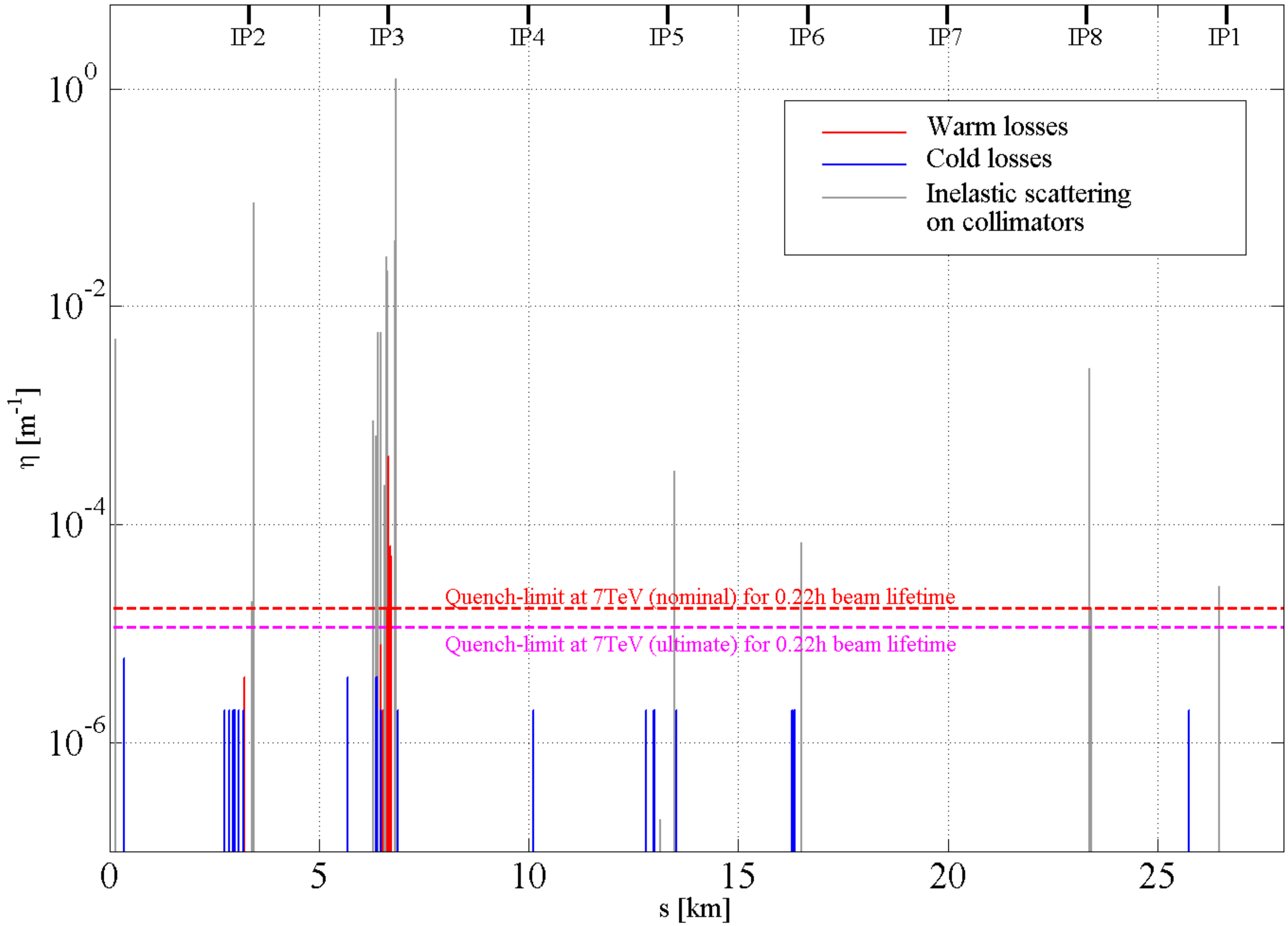


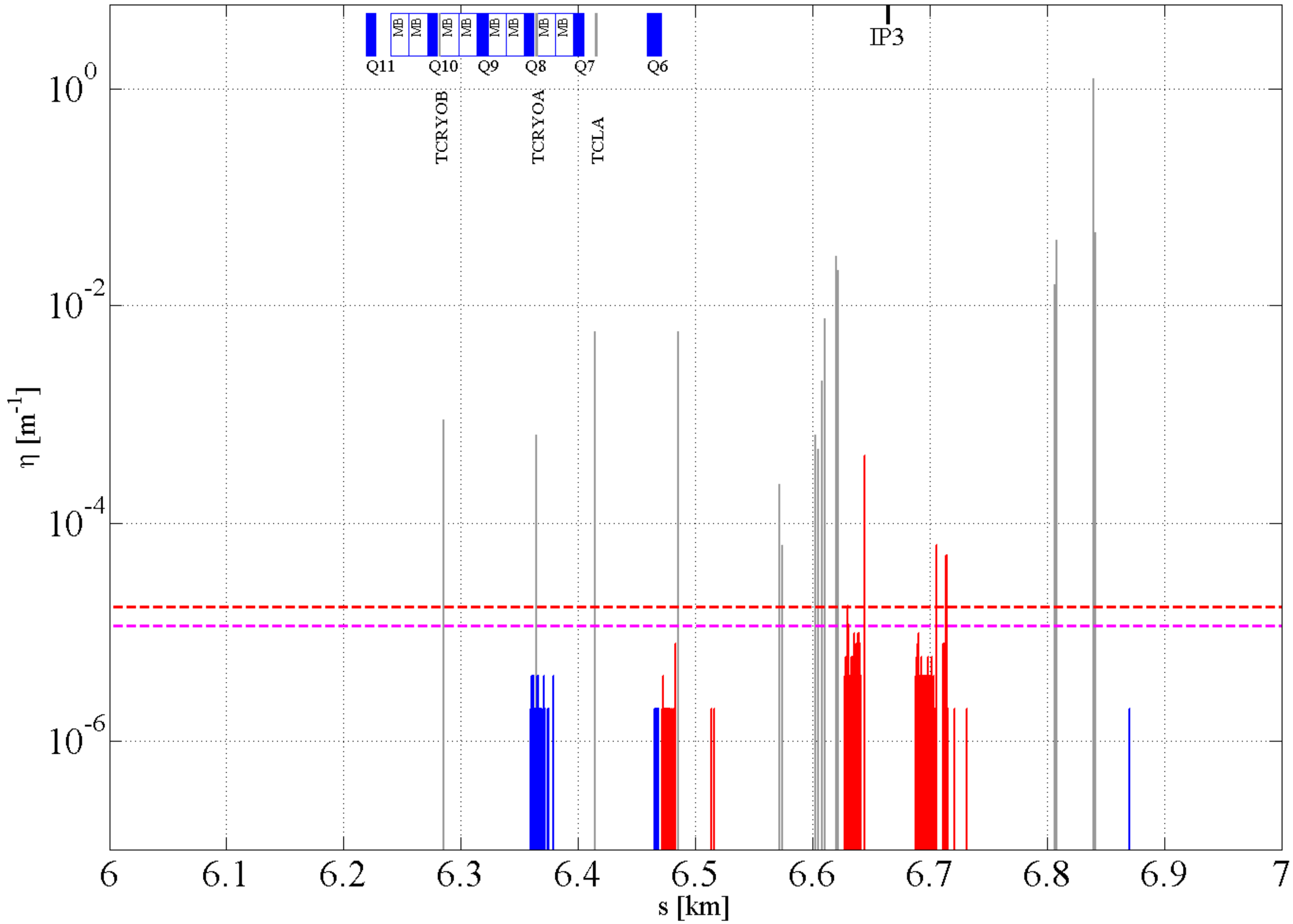
IR3 combined cleaning + W-TCRYO
Beam 2 – vertical sheet beam @ TCP.A6R3.B1 (0.5μm impact parameter)

Ideal machine = without imperfections

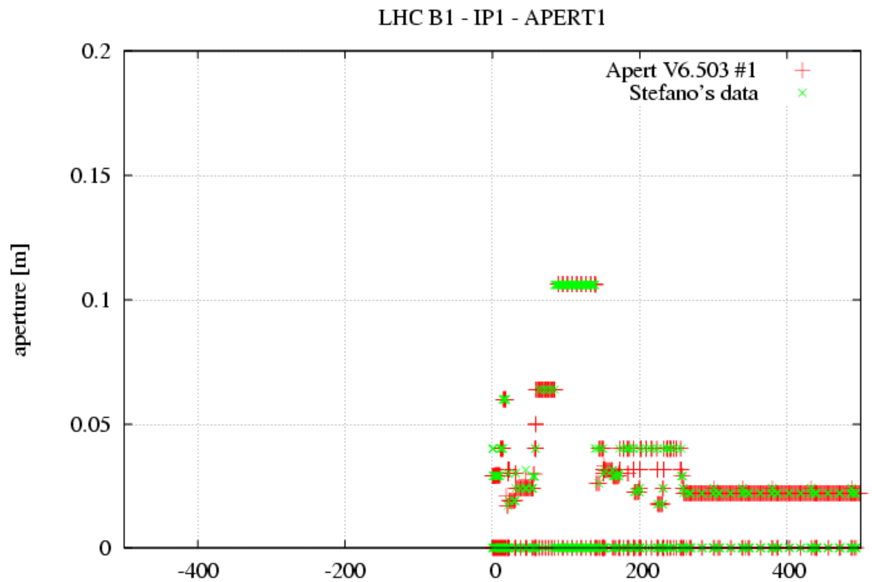


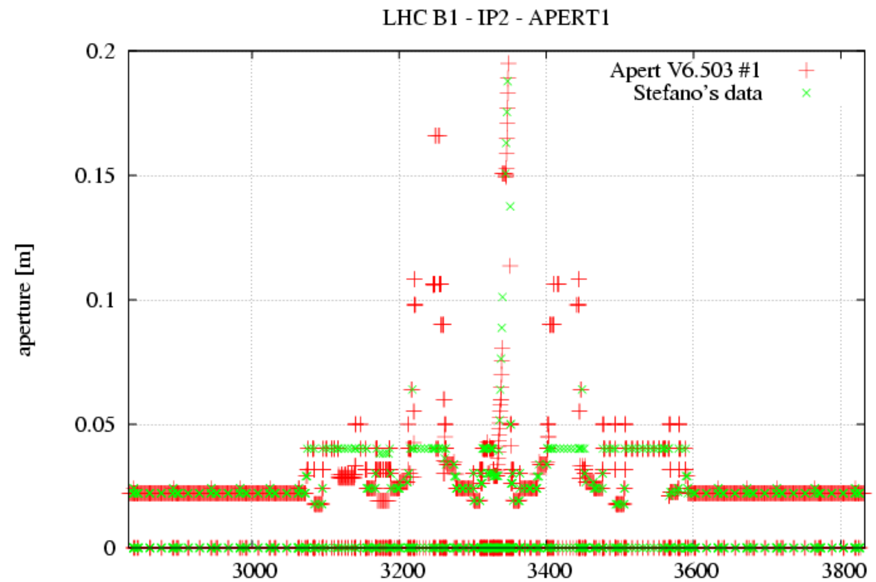
Beam 2 – vertical sheet beam @ TCP.A6R3.B1 (0.5μm impact parameter)

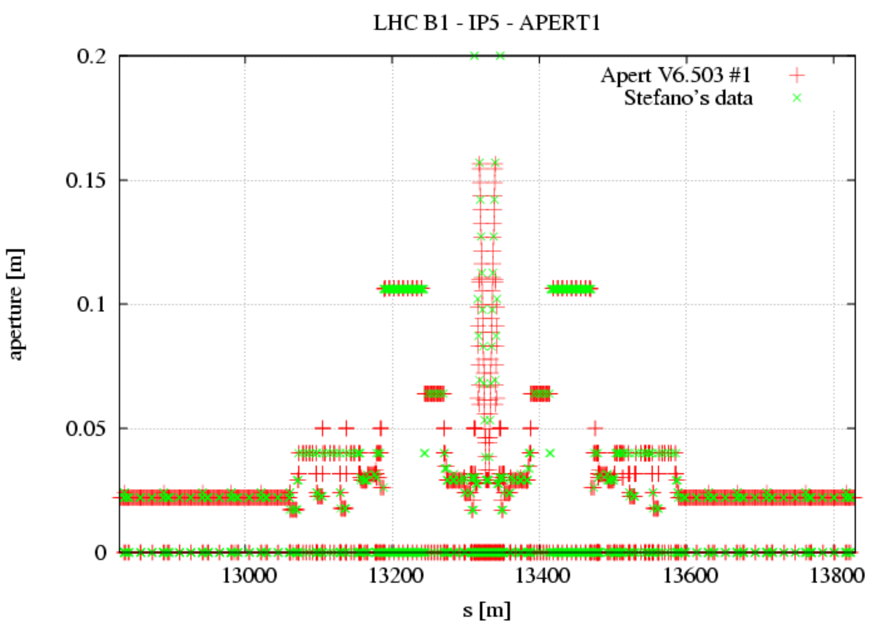
Ideal machine = without imperfections

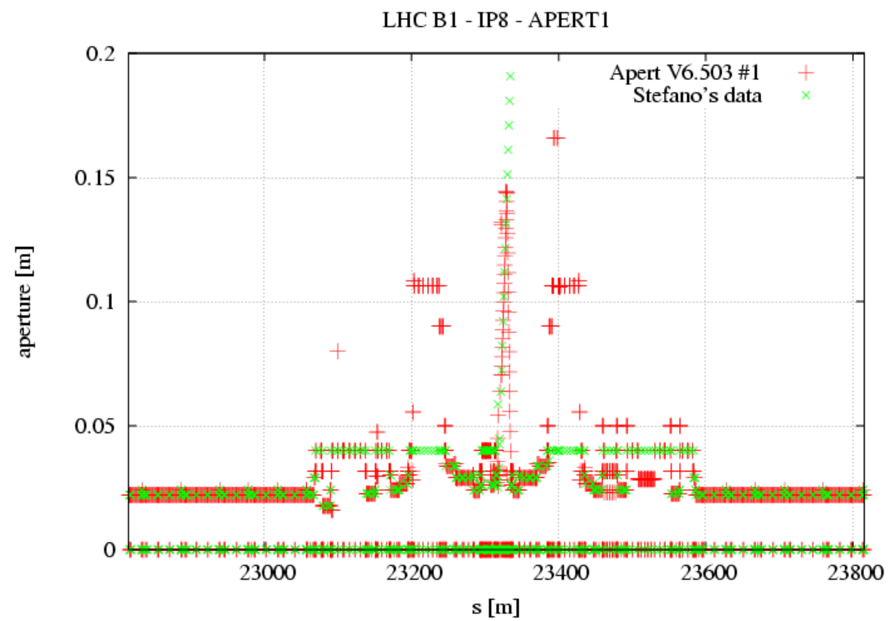


Updated aperture model









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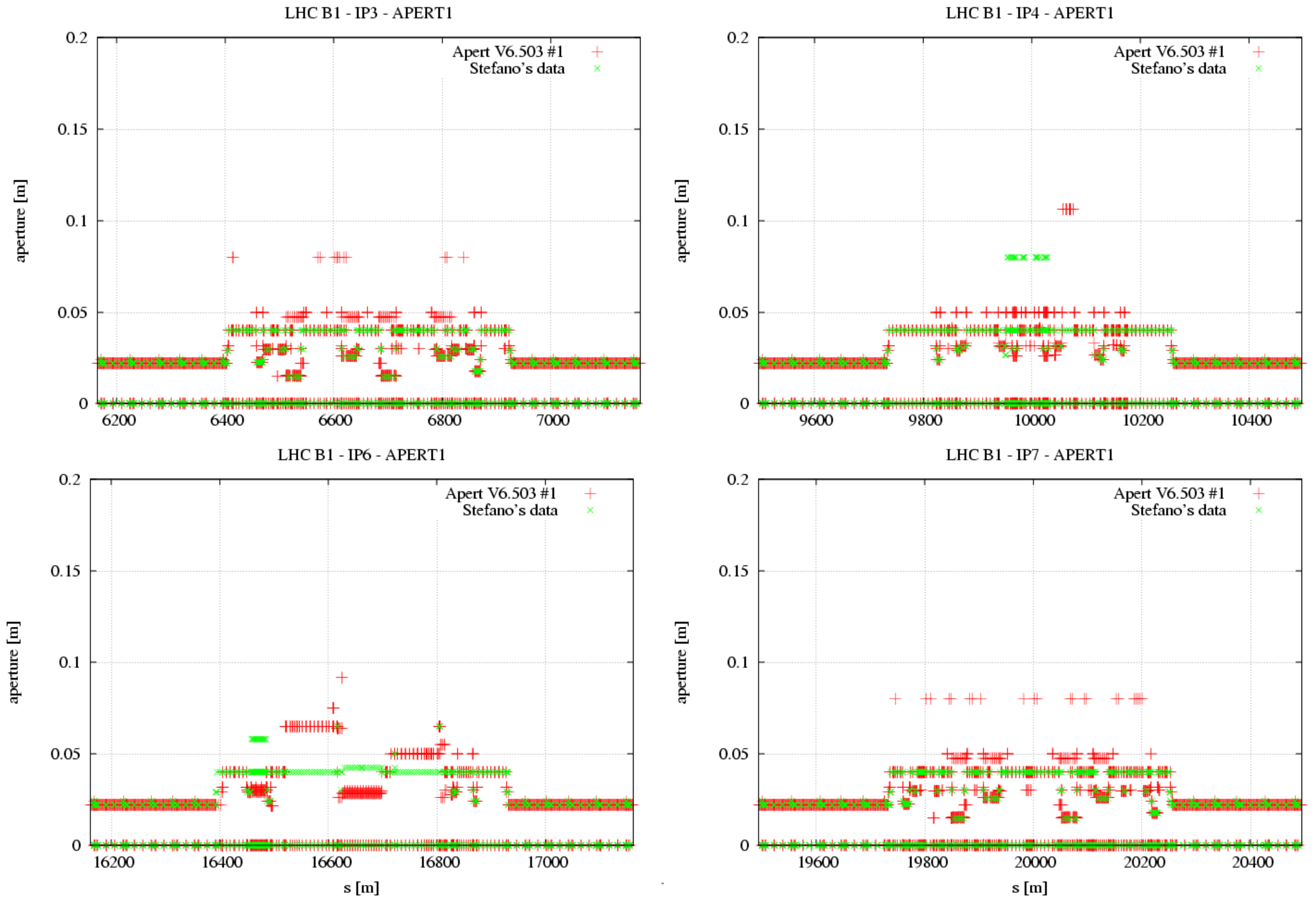

IR3 combined cleaning + W-TCRYO
Beam 1 – horizontal sheet beam @ TCP.6L3.B1 (0.5μm impact parameter)

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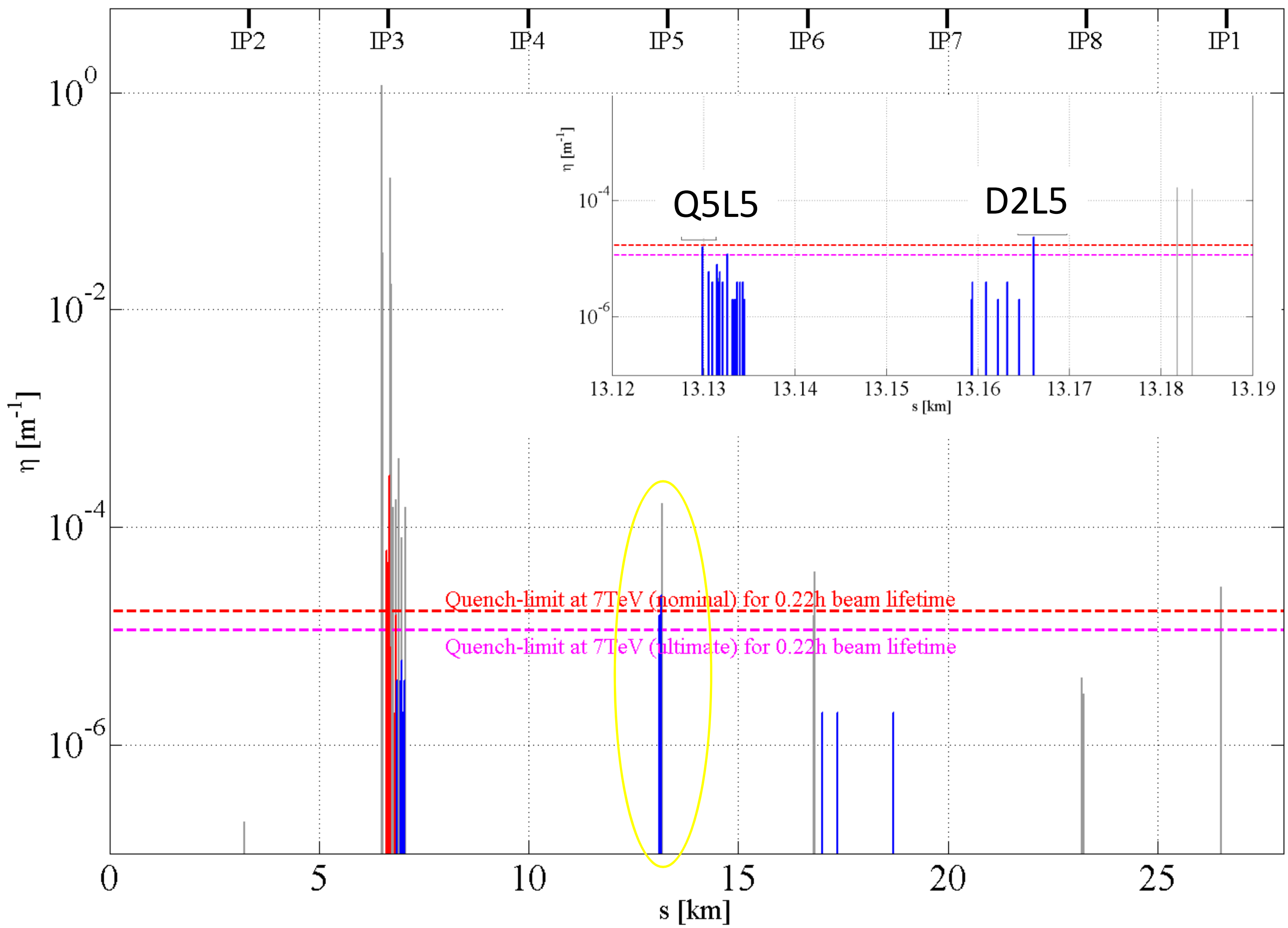

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Beam 1 – vertical sheet beam @ TCP.A6L3.B1 (0.5μm impact parameter)

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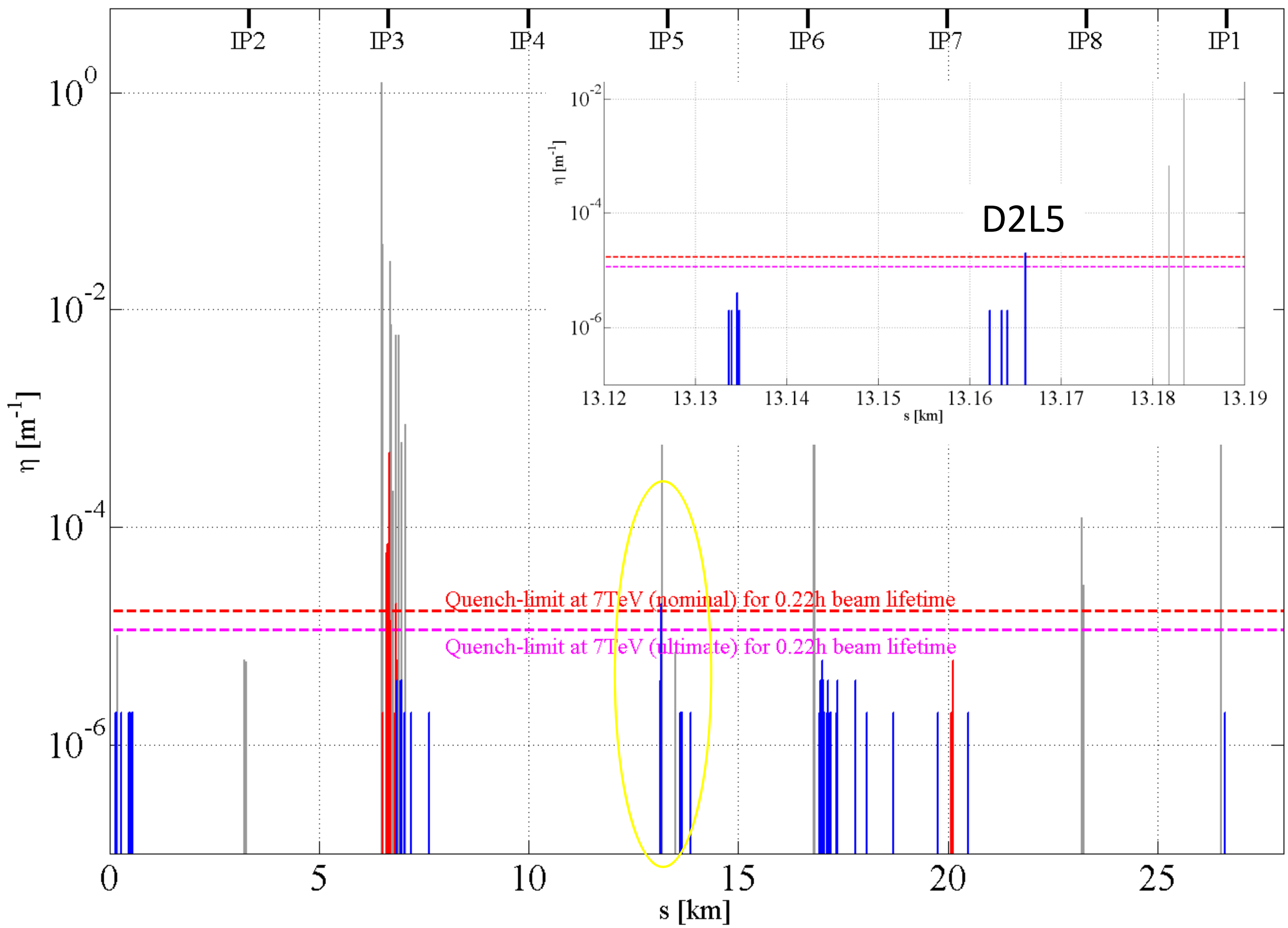

Summary and conclusions

- IR3 combined momentum/betatron cleaning has been studied for the ideal machine: the scheme seems to work up to ultimate beam intensity.
- Effect of aperture model has to be further investigated.
- Due to the lower efficiency as compared to the ‘standard’ collimation scheme, higher background noise to the experiments is expected.