“Collimation Update” talk at the LHC Performance Workshop, Chamonix 2018 — update on IR7 cleaning —

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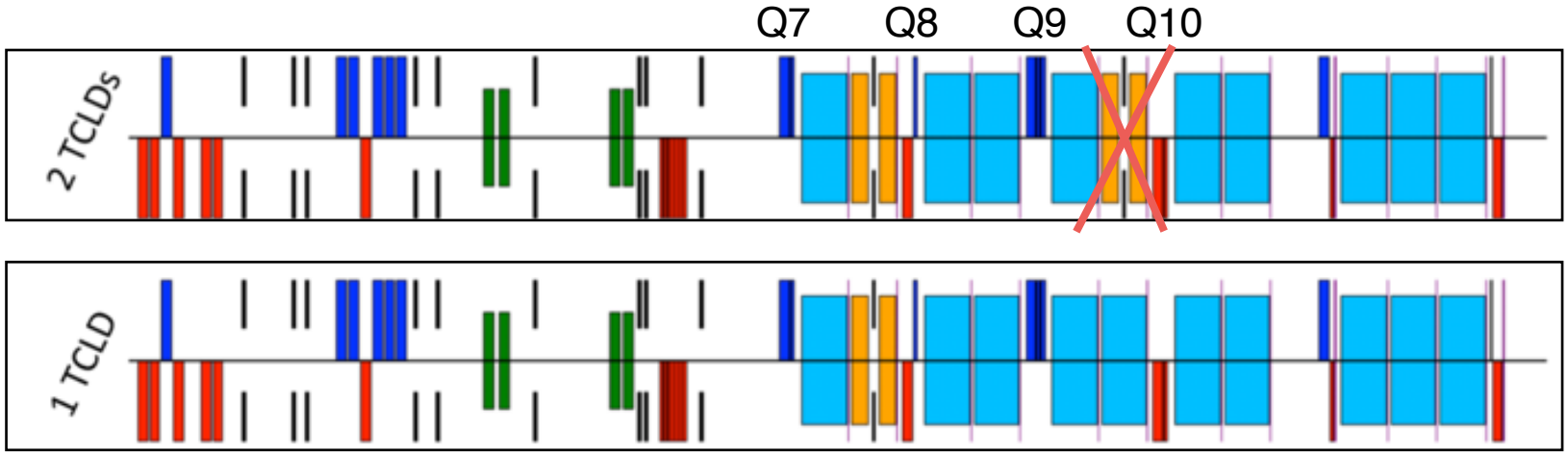
25/01/2018

Basic recap of layouts

- "Historical" layout with 2 TCLDs, optimum for performance, was re-scoped to a 1-TCLD layout (C&S review 2016)
  - ↦ *Cost saving and resources drove the decision.*
  - ↦ *Cannot demonstrate that HL-LHC cannot operate without it. Certainly, no severe performance limitations immediately in Run IV.*
  - ↦ *Launched mitigation measurements (new layouts, new settings, crystals, …)*
- Timeline: remained LS2, as main issues are related to ion operations.



Sketch of DS right of IR7 ↦ dipole MBB.8 is the one that we will change.

Beam quench tests - latest news

Performed 3 important controlled quench tests in 2015

- *"Collimation quench test":*
  1. *with proton beams at 6.5 TeV;*
  2. *with Pb ion beams at 6.37 Z TeV.*
- *"Luminosity quench test": steer the collision products into DS magnet*
  3. *with Pb ion beams at 6.37 Z TeV (around IR5, to mimic the IR2 operations)*

Important to repeat these tests in 2018, last chance before LS2!

Clearly, synergy with results on cables from magnet team.

Quoted losses are estimated from simulations (see later slide)!

	Beam	Beam energy* [Z TeV]	Beam loss [kW]	Losses in coil [mW/cm^3]	Quench
IR7	protons	6.50	~ 600	~20	**NO**
IR7	Pb ions	6.37	~ 15	~25-30	**YES**
IR5	Pb ions	6.37	0.053+	~ 20	**YES**

Still no quenches for proton losses; quenches with low-ish peak power with ions!
Both quenches occurred at MB magnets.

Estimated losses in SC coils

- Simulation assumptions/input
  - 0.2 h lifetime (pessimistic according to present operational experience)
  - Produces about 988kW losses at HL: 2760b of 2.3e11p
  - Usual simulation chain: tracking + energy deposition
  - New, tighter, IR7 setting baseline for beta* = 15 cm
- We need to add a **factor 3** to these numbers, to take into account the observed loss underestimation in the DS during quench tests.
- Aside
  - Important recent developments: SixTrack/FLUKA extended to the full chain of simulations for ions

TCLD position	PROTONS					IONS				
	Cell 8/9			Cell 11		Cell 8/9			Cell 11	
	MB	*MQ*	*11T*	*MB*	*MQ*	*MB*	*MQ*	*11T*	*MB*	*MQ*
No TCLD	**6.3**	3.0	-	3.6	3.8	**19.4**	8.9	-	**19.4**	12.1
MBB.8	2.0	2.4	3.2	2.6	**3.8**	1.8	4.9	7.1	**11.8**	11.2

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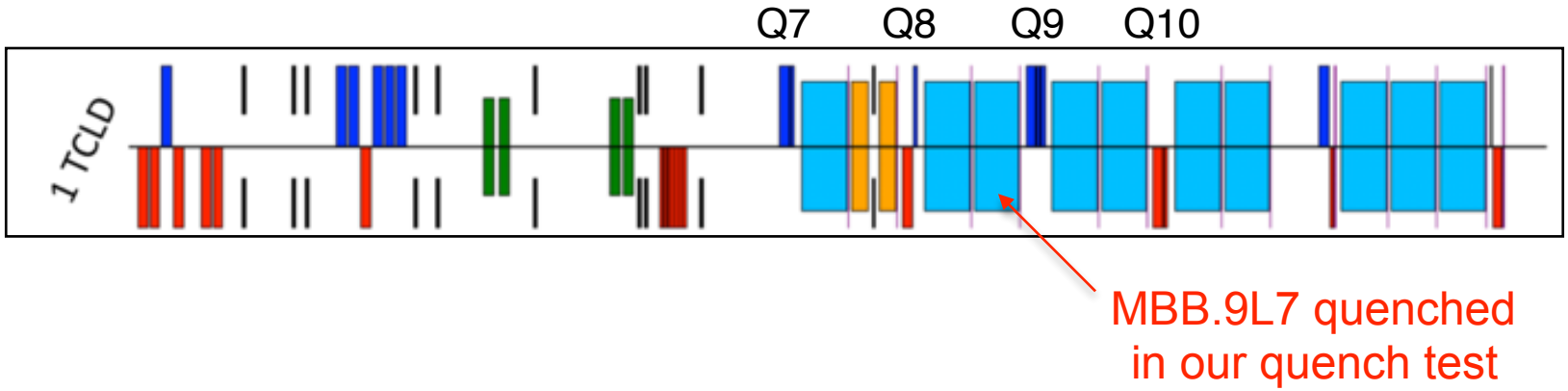
Study of alternative layouts



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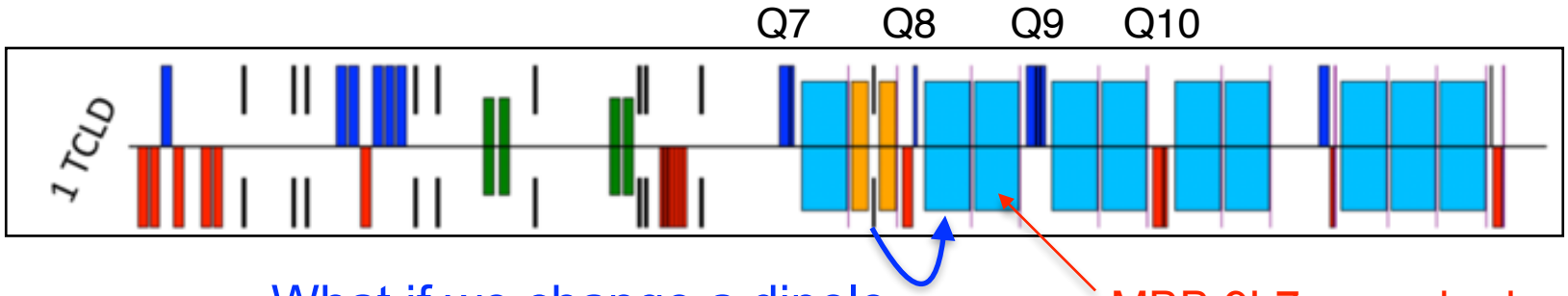
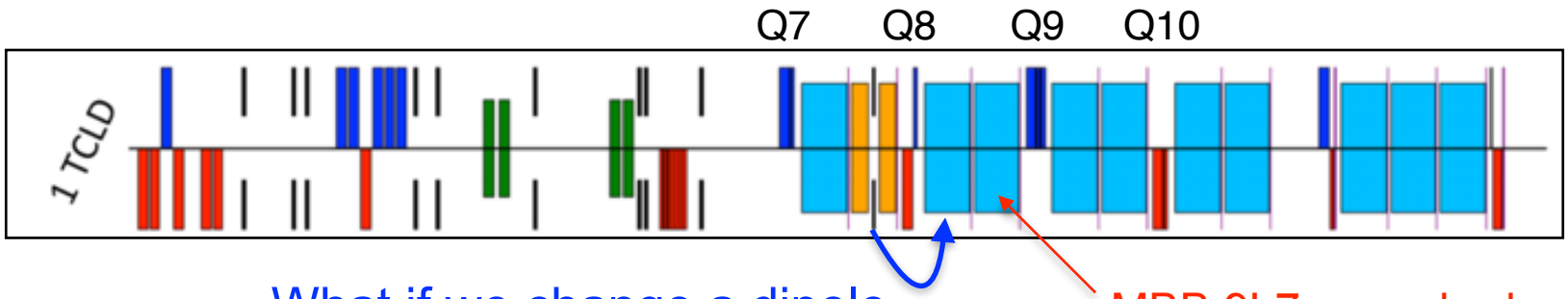


What if we change a dipole further downstream?

MBB.9L7 quenched in our quench test

Study of alternative layouts



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MBA.9	1.8	2.4	**14.2**	<0.1	<0.1	2	1.2	**11.2**	<0.001	<0.001

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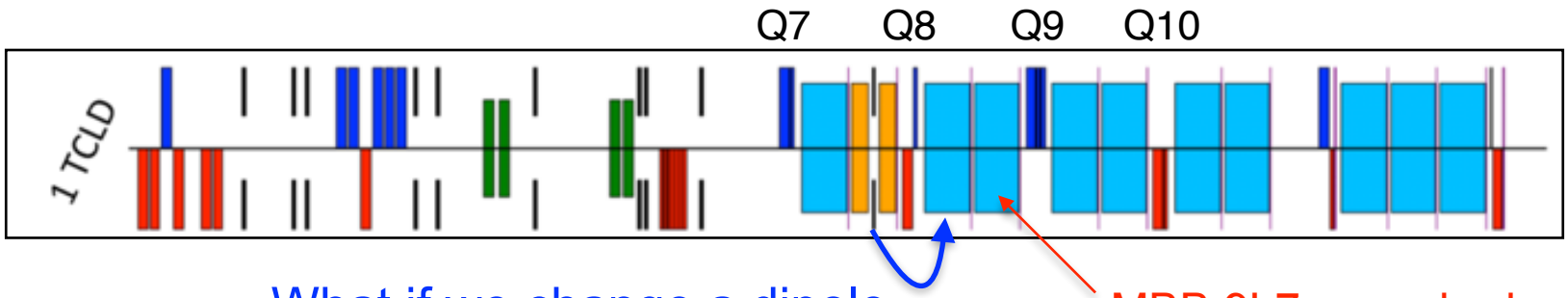

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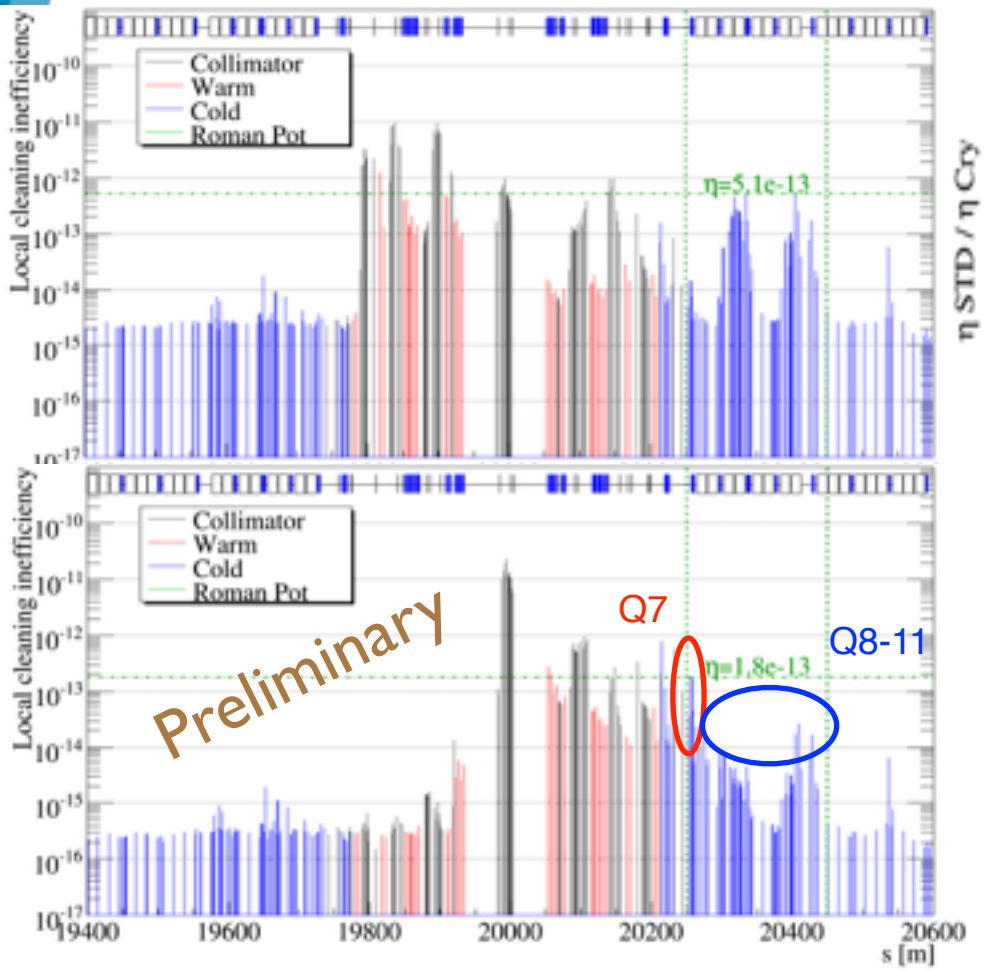
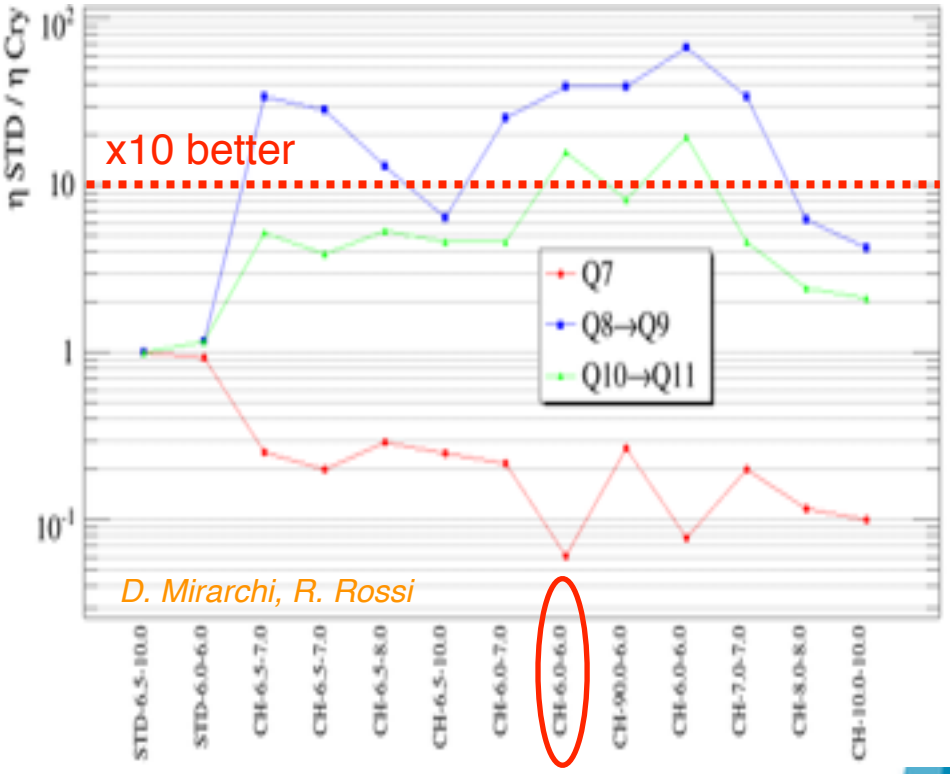
Losses in 11T dipole become higher. Only an option if 11T dipoles had guaranteed quench limits well above ~50mW/cm^3. New results: end of Feb. Kept the baseline as this could not be guaranteed.

Promising results from crystal collimation

Horizontal cleaning, 6.5 Z TeV, Xe beams



Observed an improvement of
> 10 in DS magnets (only B1-h).
Q7 possibly affected by showers.



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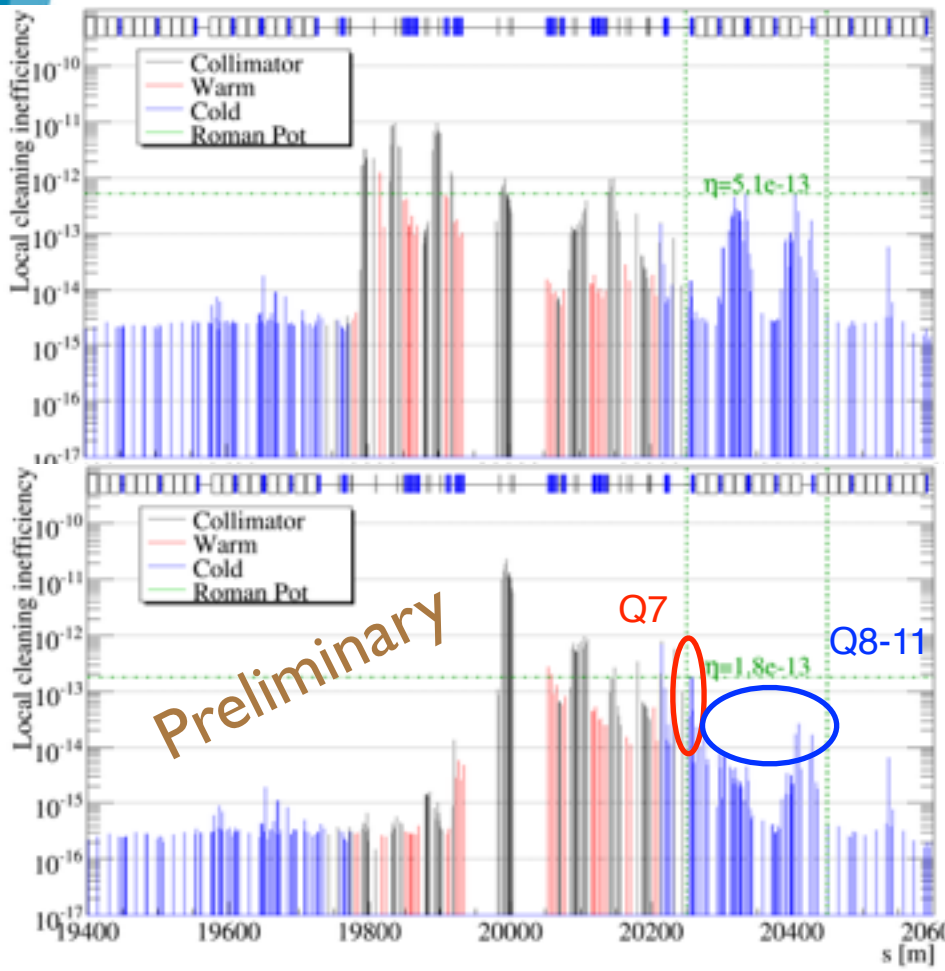

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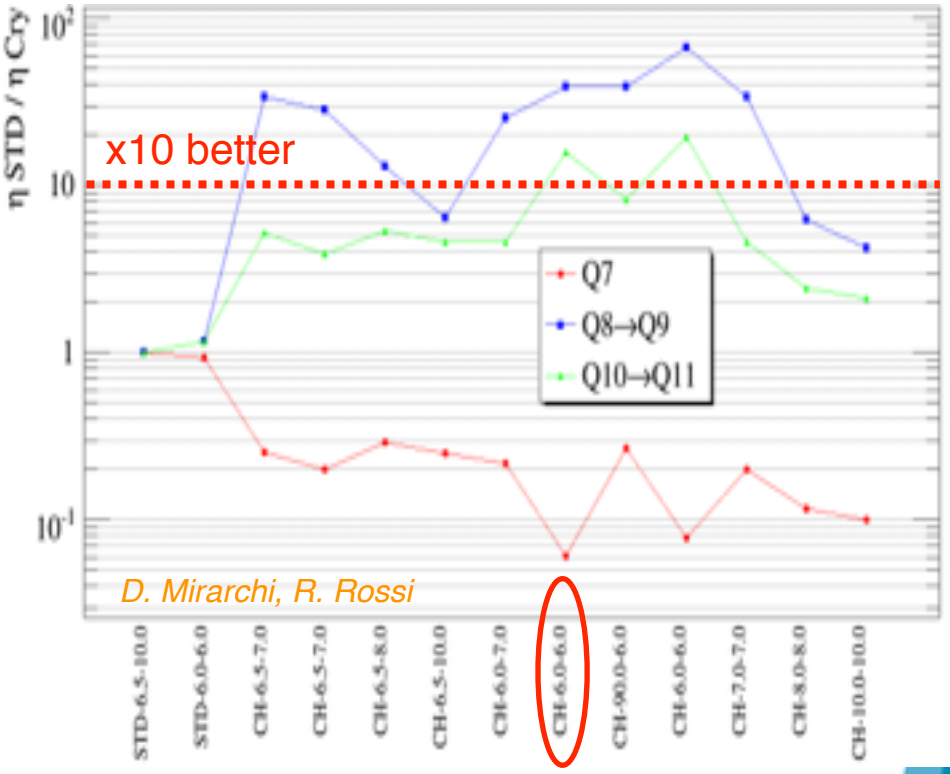

Priority for 2018 is to confirm these results for Pb beams and study more solid integration of the crystals into IR7.