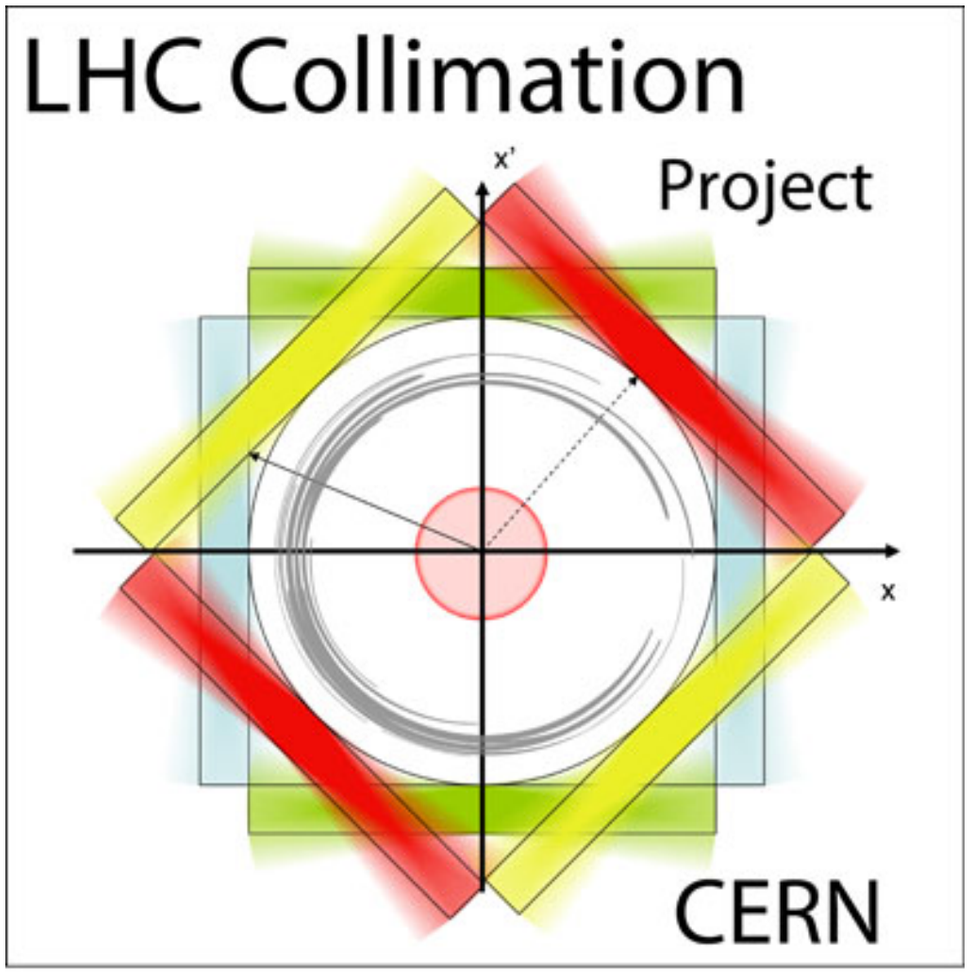
Collimation Qualification Needs



B.Salvachua, A.Mereghetti, D.Mirarchi,
S.Redaelli and G.Valentino

C.Bracco and J.Uythoven

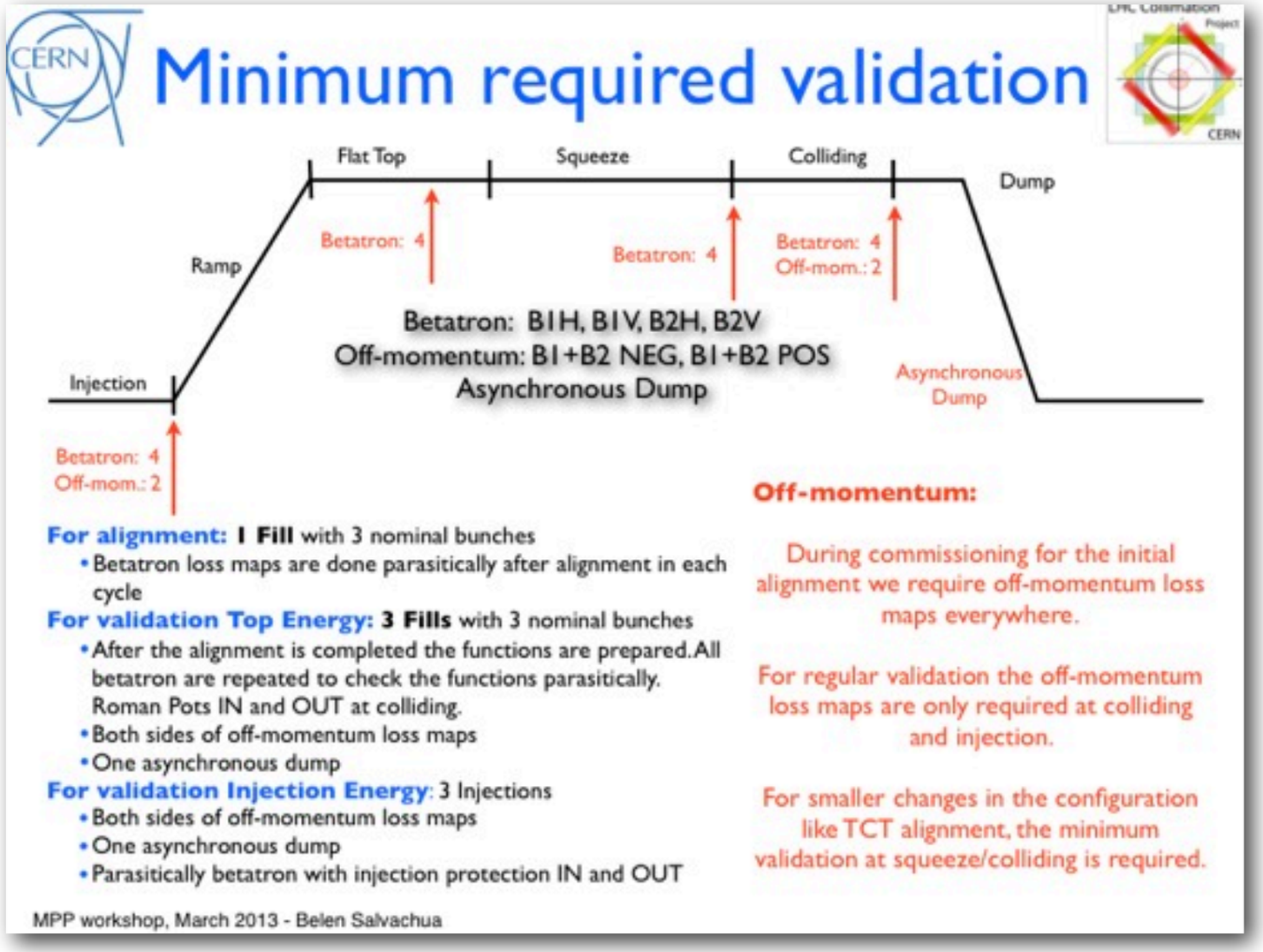
Outline

- **Introduction**
- **Betatron loss maps:**
  procedure and validation
- **Off-momentum loss maps:**
  procedure, validation and new technique
- **Validation results**
- **Requirements for after TS2**

Introduction

MPP workshop 2013

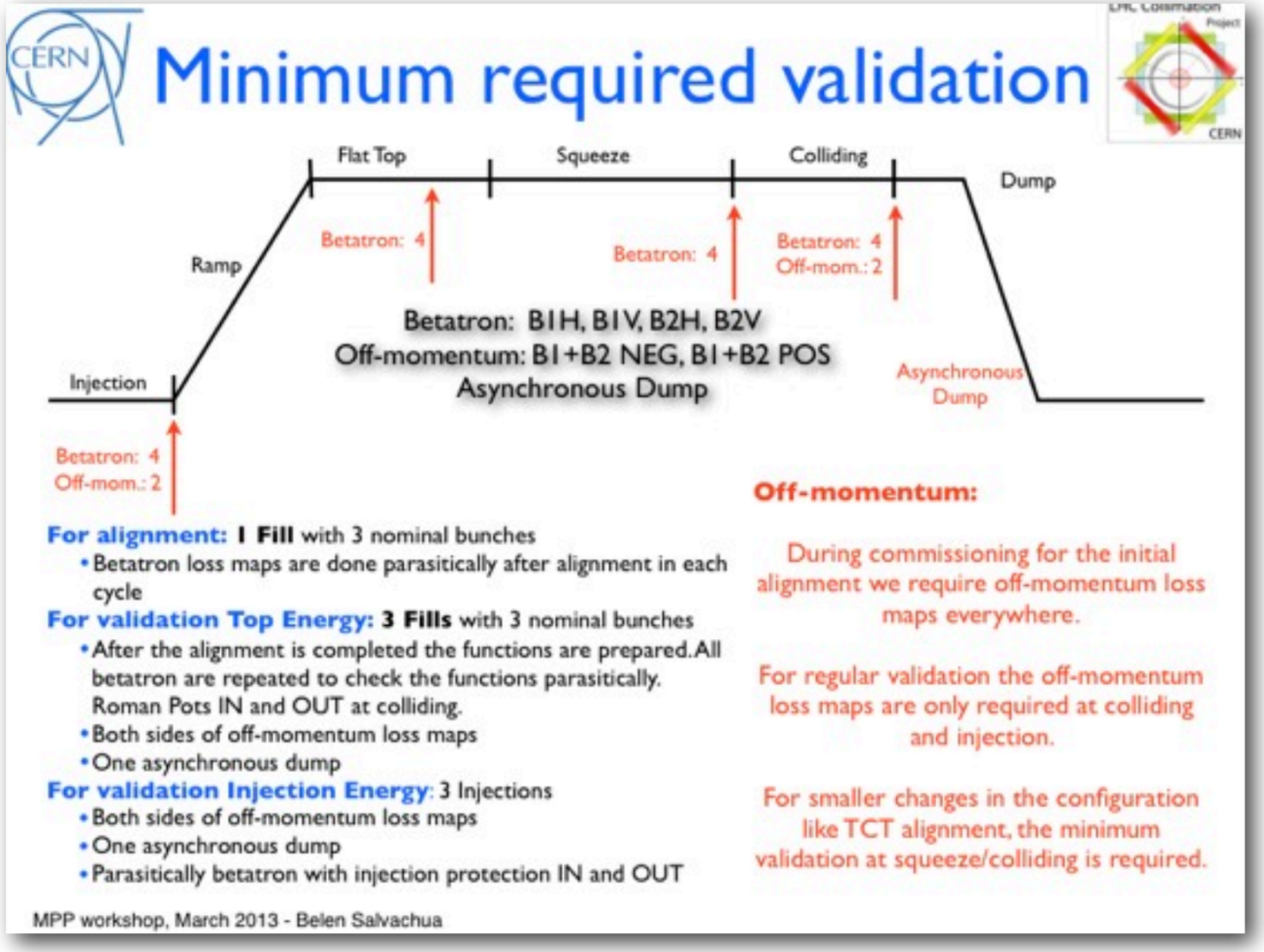
- **Required Validation in Run I**



Introduction

- **Required Validation in Run I**
- **3 fills at each validation step**

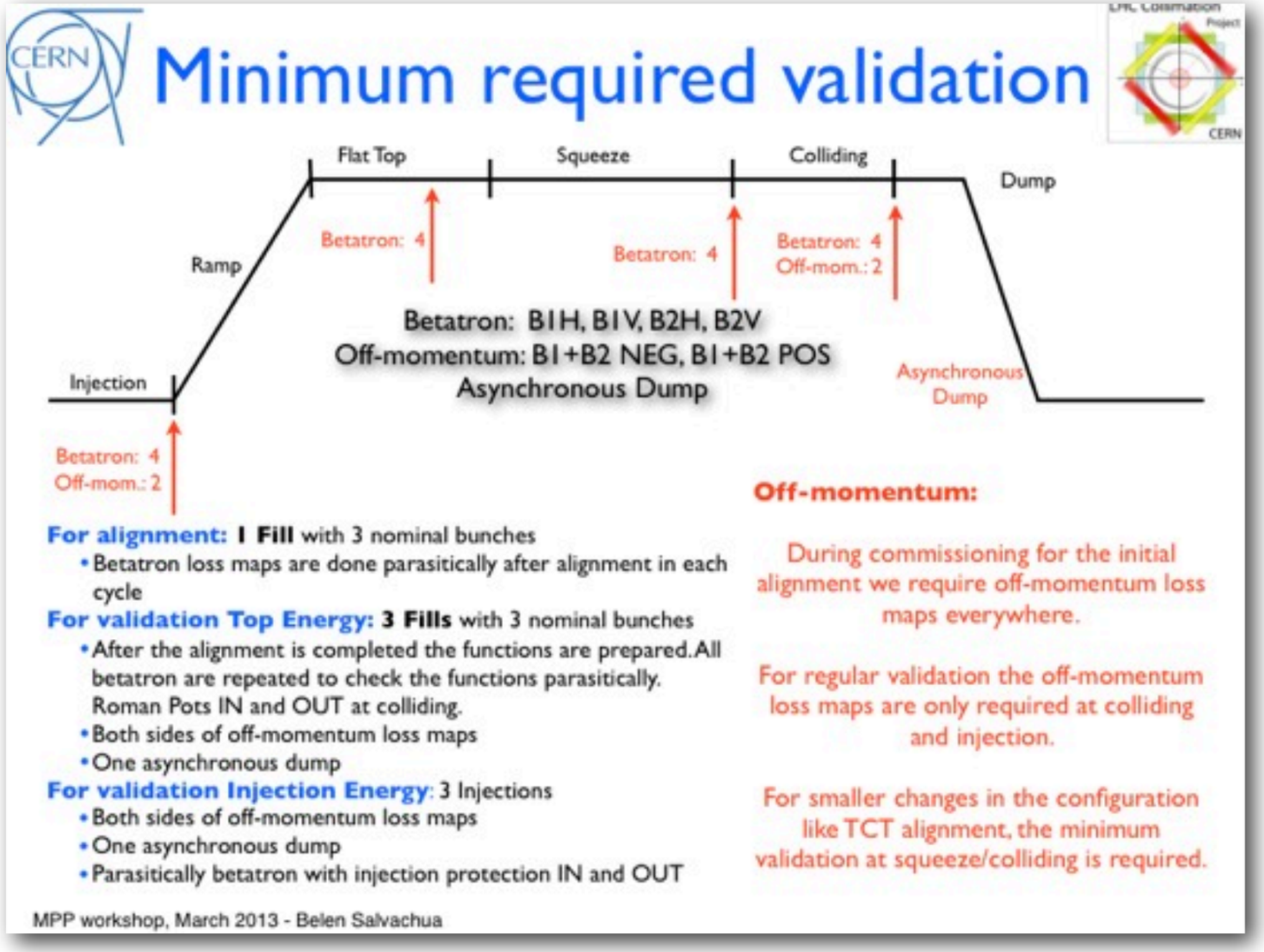
MPP workshop 2013



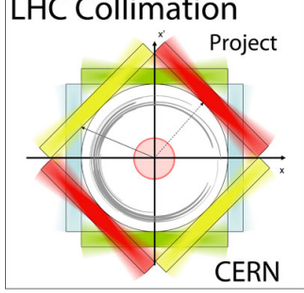
Introduction

- **Required Validation in Run I**
- **3 fills at each validation step**
- **Could it be reduced?**

MPP workshop 2013



Betatron Loss maps



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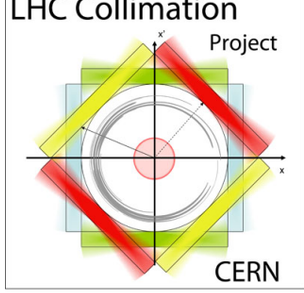

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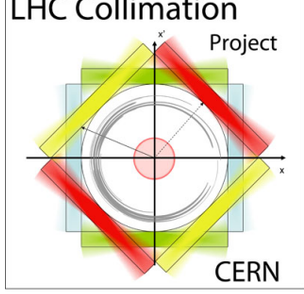

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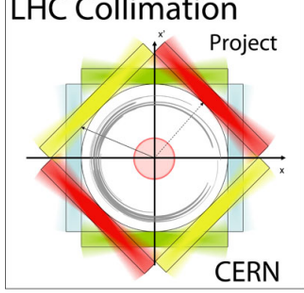

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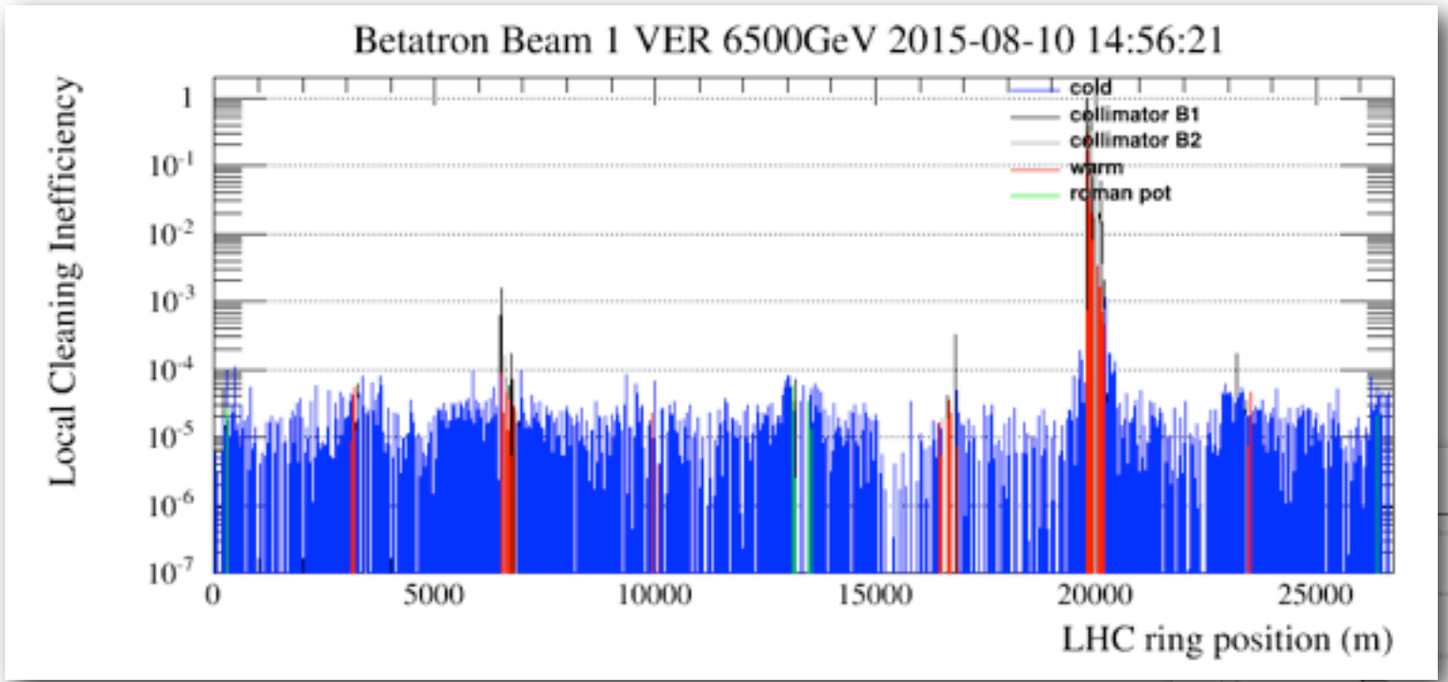
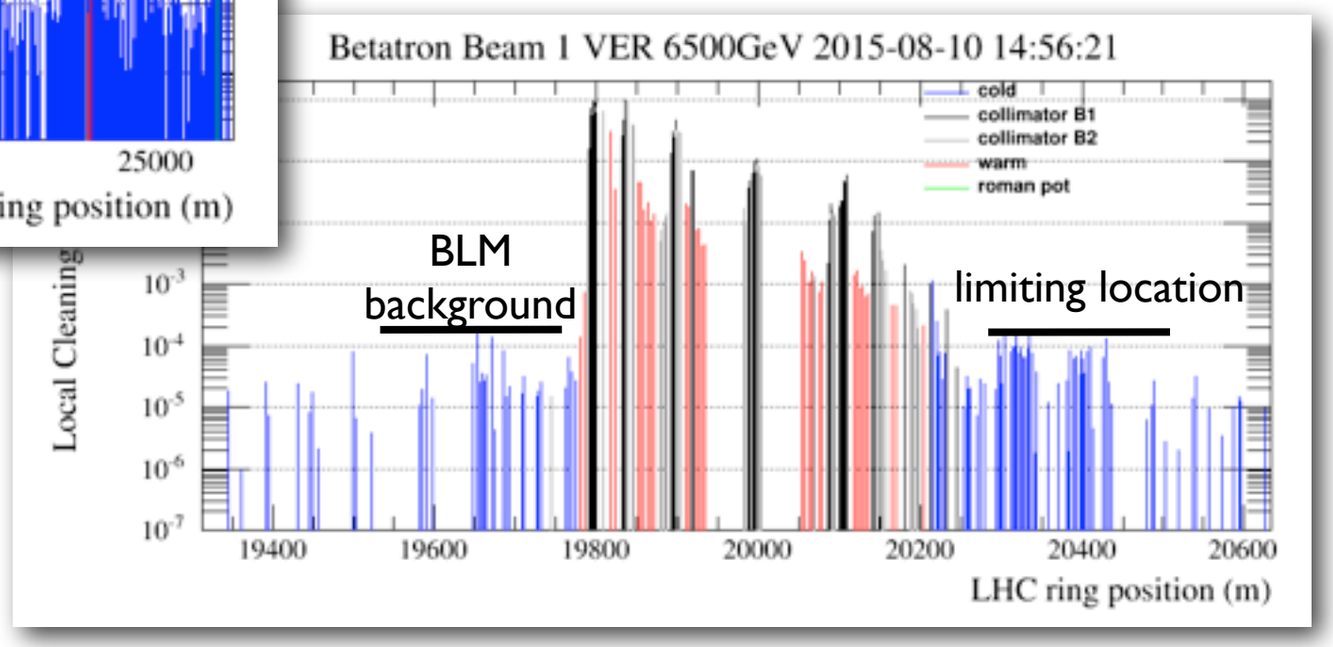


example of squeeze 80cm were the TCT are hardly seen and the cleaning inefficiency is IP7 is barely above the BLM background



In this case the cleaning inefficiency is maximum 1.9e-4 or better, which is just ok to validate the cleaning.

Betatron

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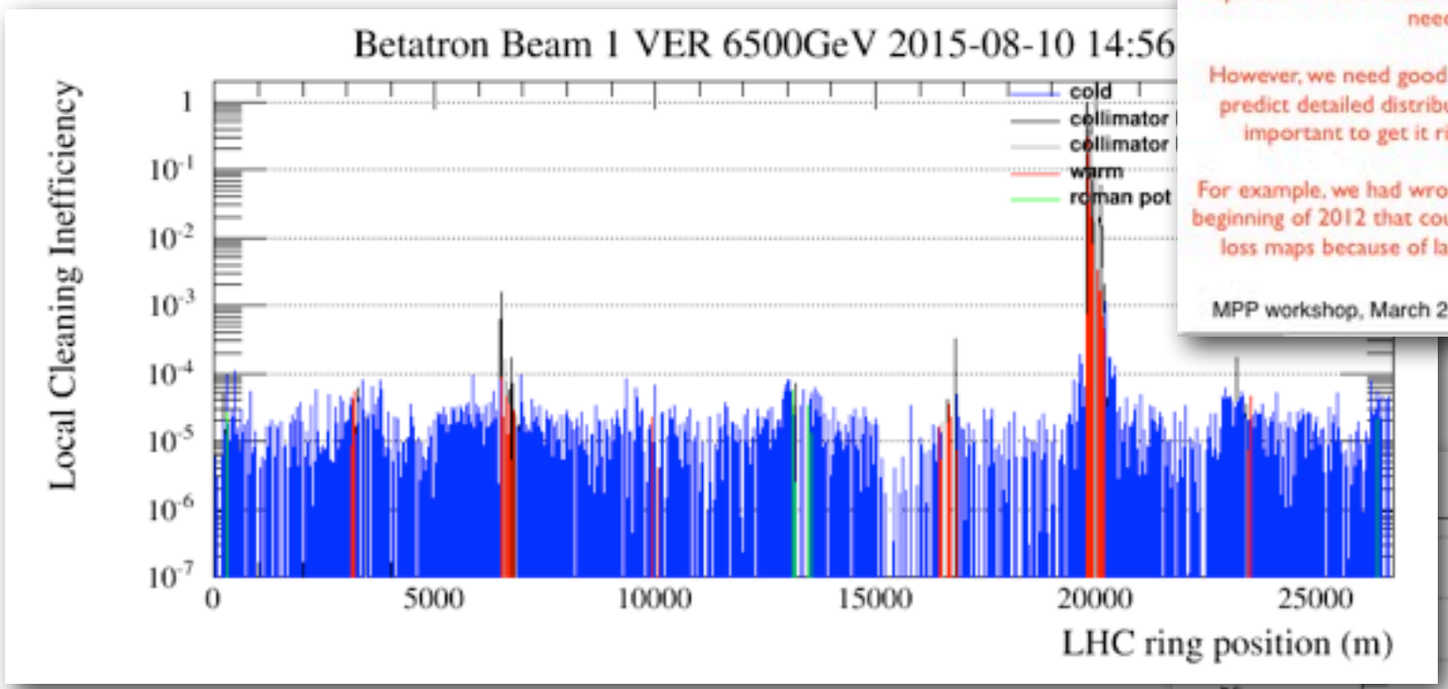
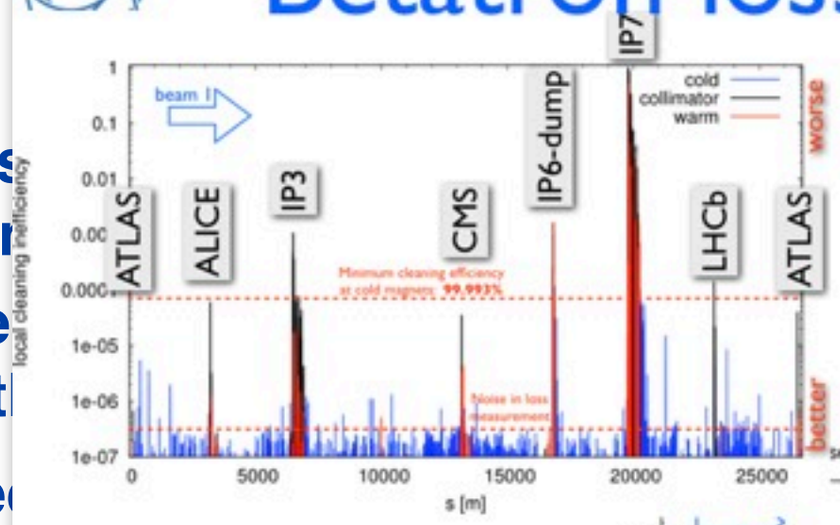


Betatron loss maps



2012 case

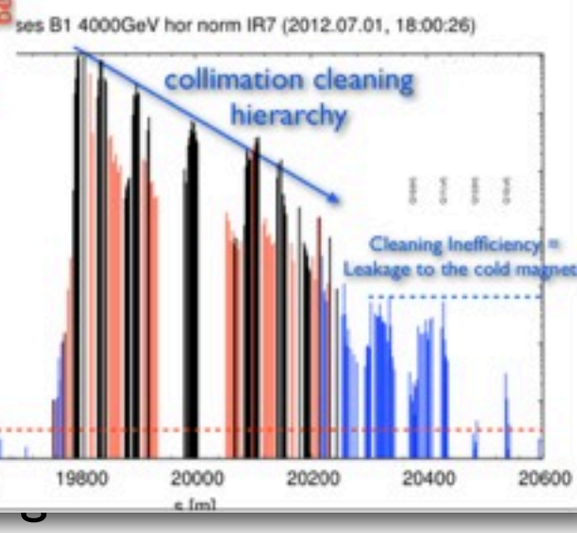
IR7 and the leakage into the DS in IR7
(cleaning inefficiency in Q8).

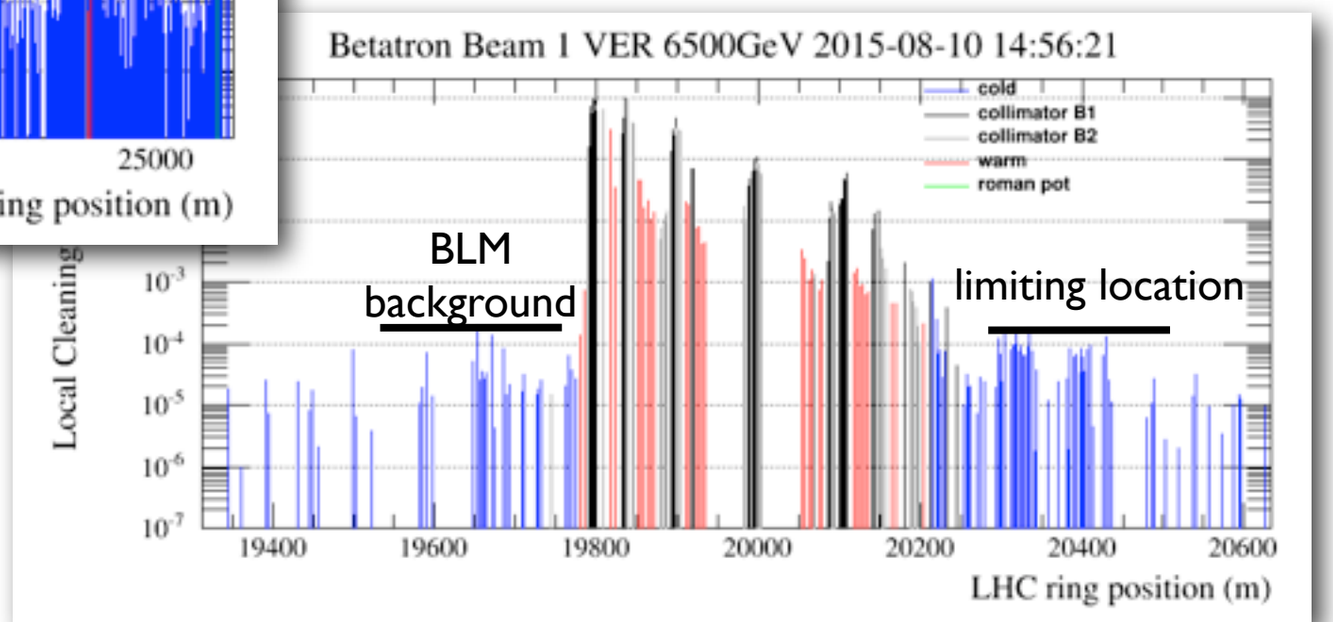
If there is something suspicious we ask for new los
maps and in some cases we repeat the alignment i
needed.

However, we need good references, it is hard to predict detailed distribution of the losses, it is important to get it right at the beginning.

For example, we had wrong TCT settings in IR2 at beginning of 2012 that could not be spotted on th loss maps because of lack of good references.

MPP workshop, March 2013 - Belen Salvachua





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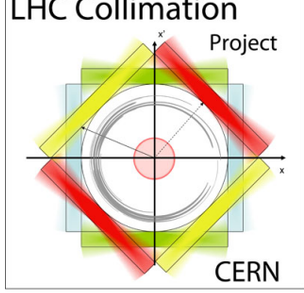
Off-momentum Loss maps



- **Off-momentum loss maps require 1 fill per side (+/-500Hz RF freq shift)**

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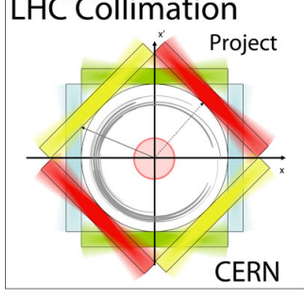

- **Off-momentum loss maps require 1 fill per side (+/-500Hz RF freq shift)**
- **New techniques in collaboration with RF *(Ph. Baudrenghien, M.Jaussi, H.Timko*) are being explored. Three paths that could be combined are being explored:**
  - blow-up the bunches longitudinally before doing the loss map so that a smaller frequency shift can be done.
  - add an RF noise so that you push the particles from the core to the off-momentum up to the separatrix, filling the buckets.
  - feedback based on BLM signals to control of the optimal frequency is being prepared.

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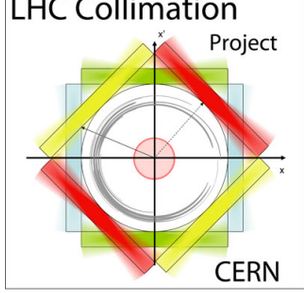

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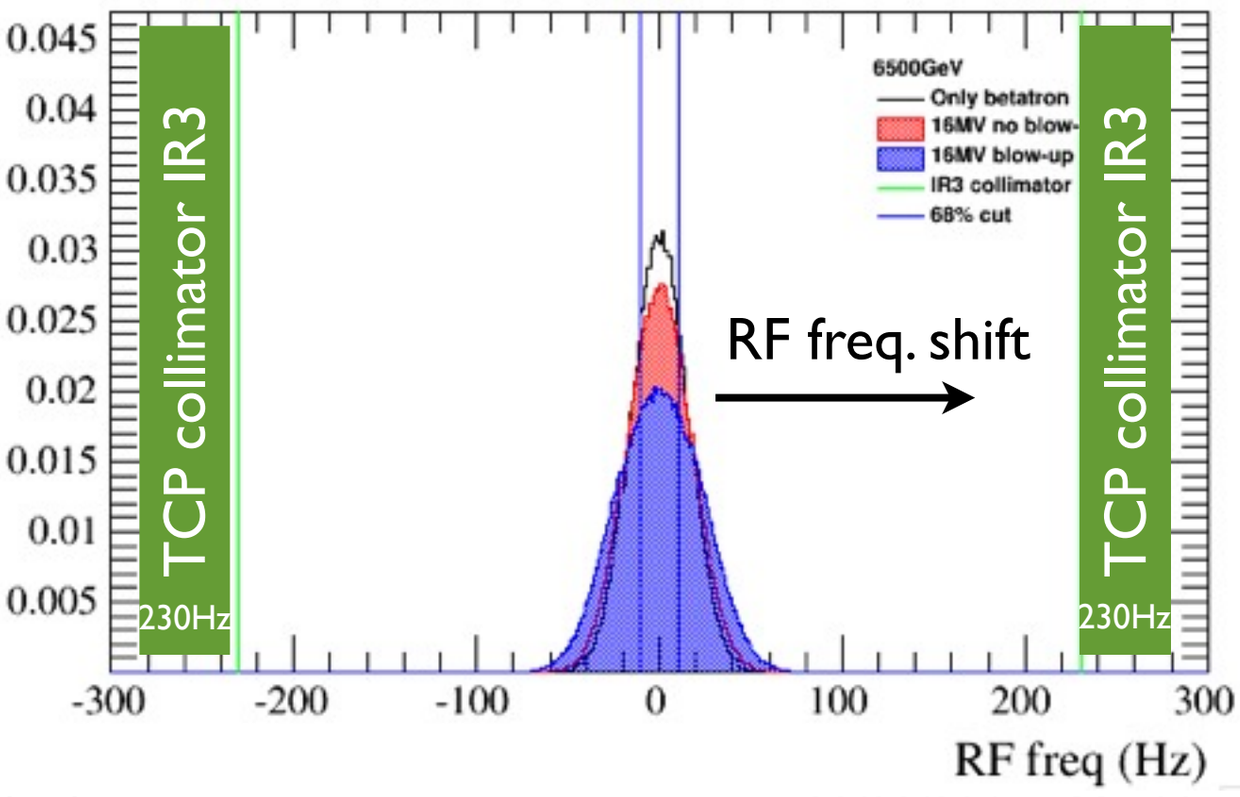
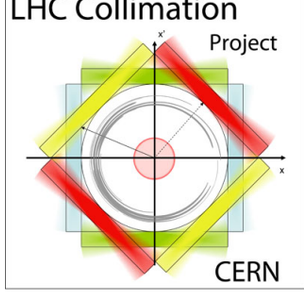


Increasing RF voltage from 12MV to 16MV and adding noise to fill the bucket. The effects due to the dispersion wider beam

Off-momentum Loss maps



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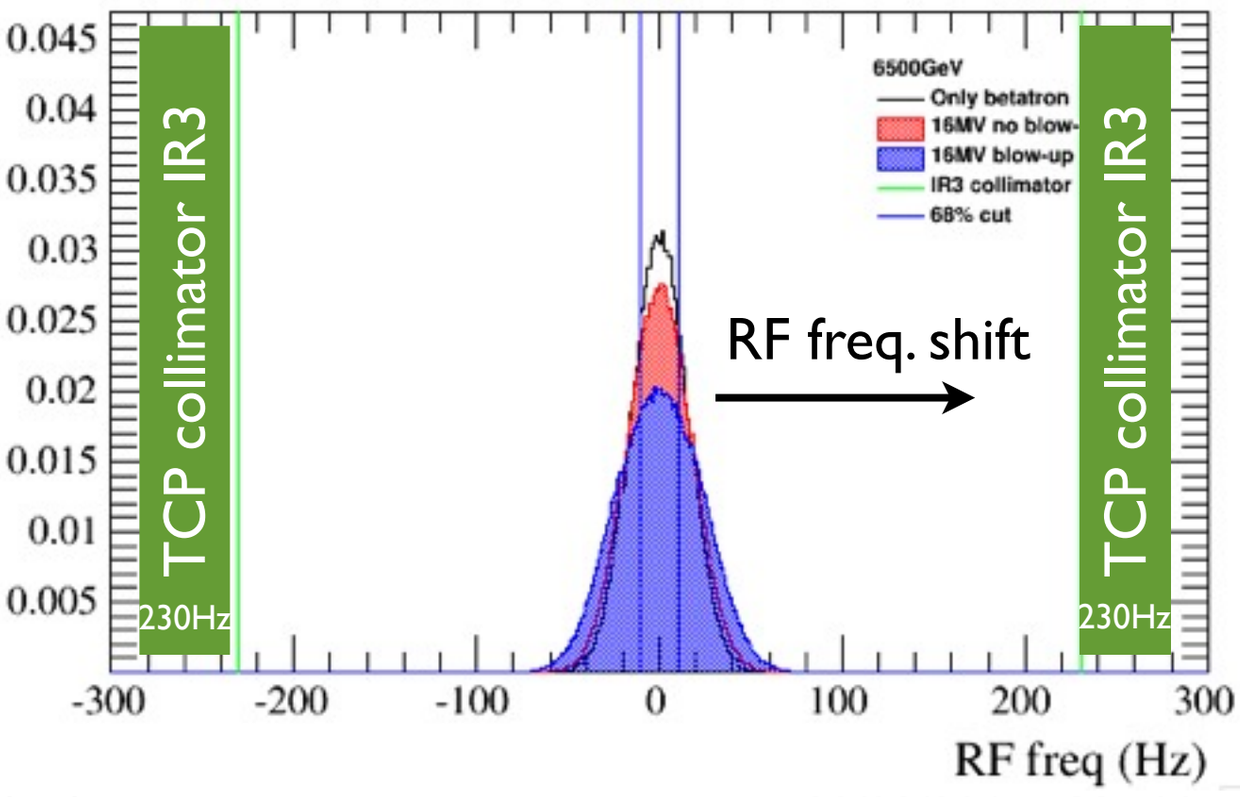
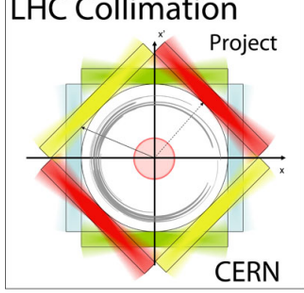


Increasing RF voltage from 12MV to 16MV and adding noise to fill the bucket. The effects due to the dispersion wider beam

This technique combined with a fast controlled RF trim could potentially be used to gain 1-2 fills per beam mode validated.



Off-momentum loss maps

- In addition to the RF blow up we are setting up a feedback based on the BLM RS07 fast acquisition to stop the RF freq trim before the dump when losses are adequate for the validation.

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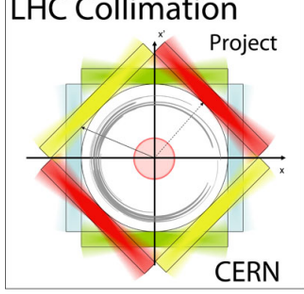

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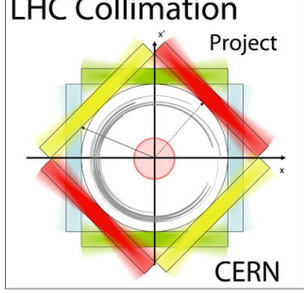

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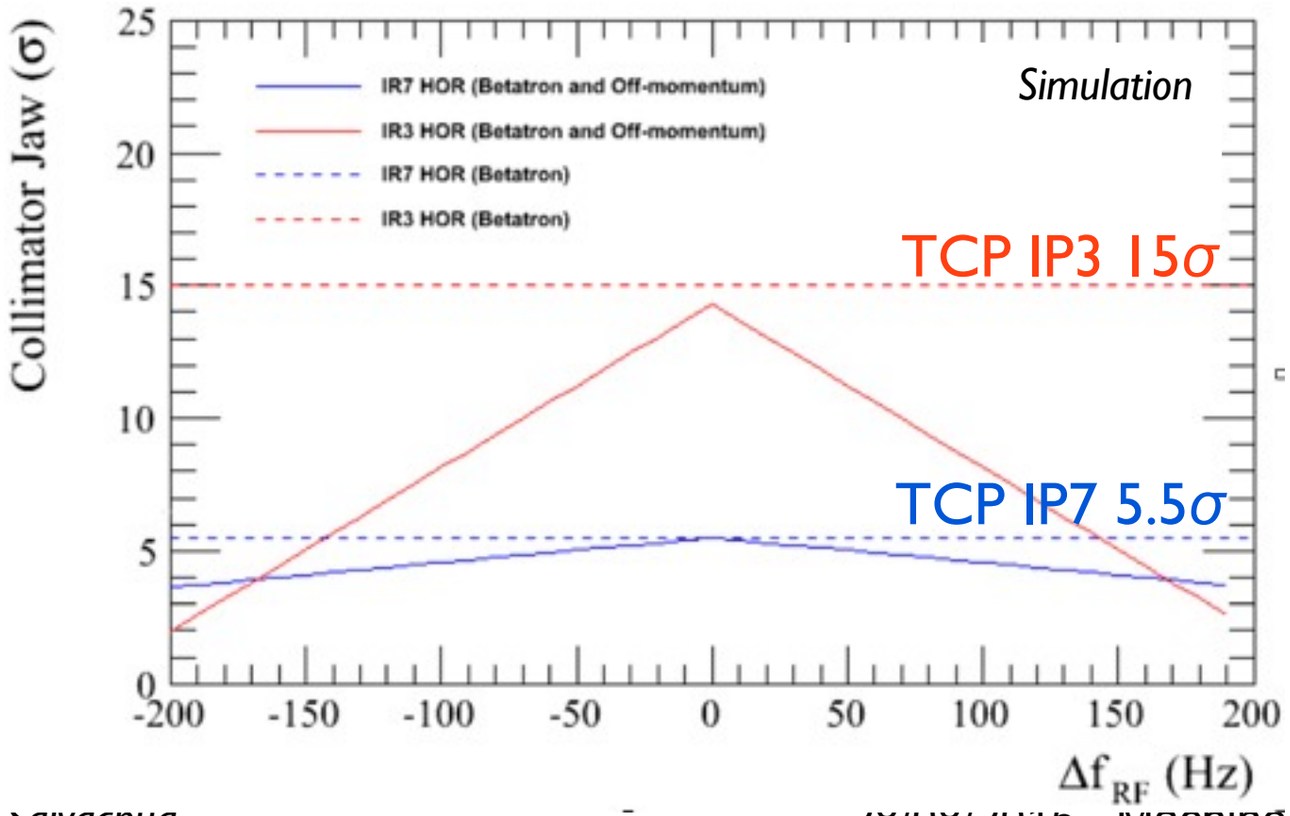
Shifting the RF frequency is equivalent to move the beam towards the collimators, but since the dispersion is higher in IR3, for the same Δf_{RF} the beam the shift is higher in IR3. Between 150Hz and 200Hz shift IR3 losses would dominate.



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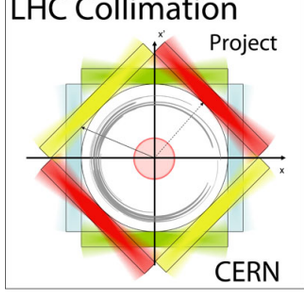

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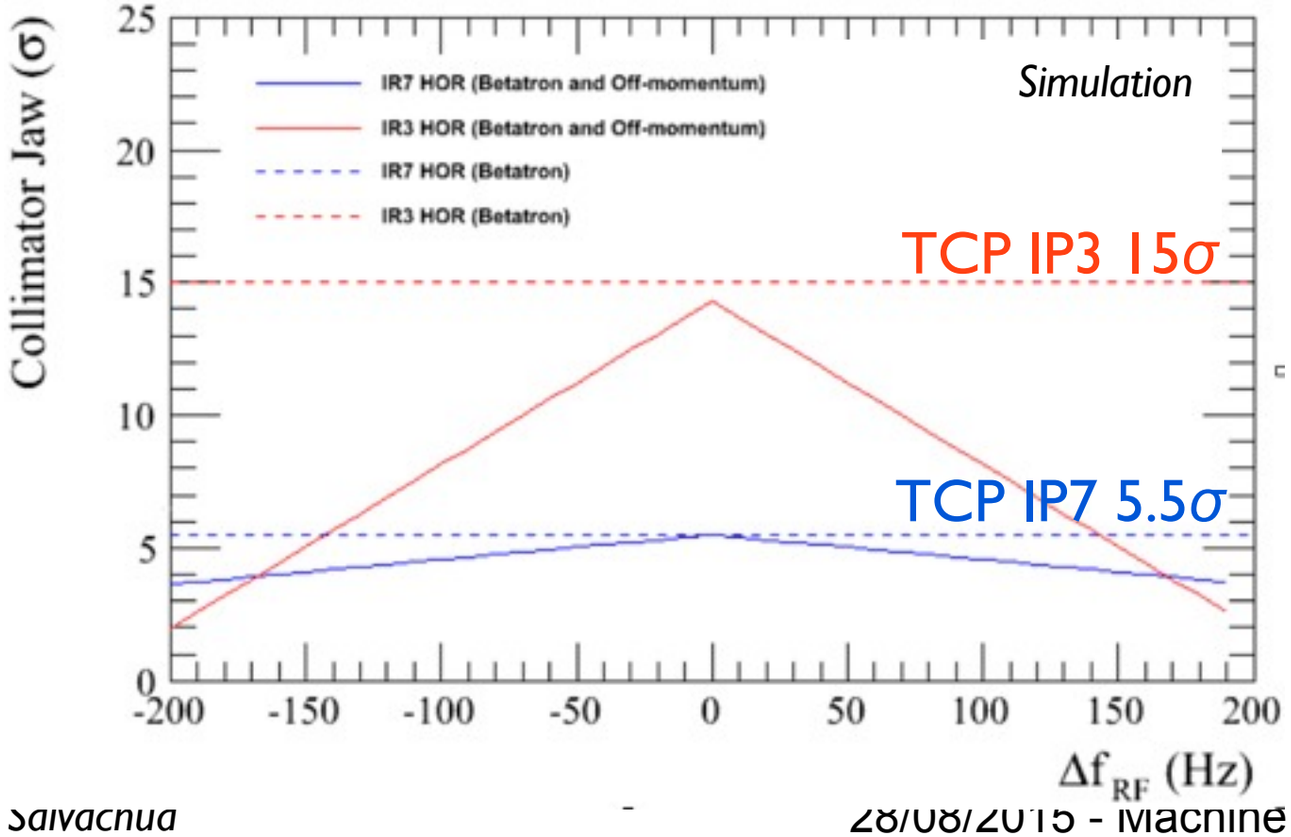
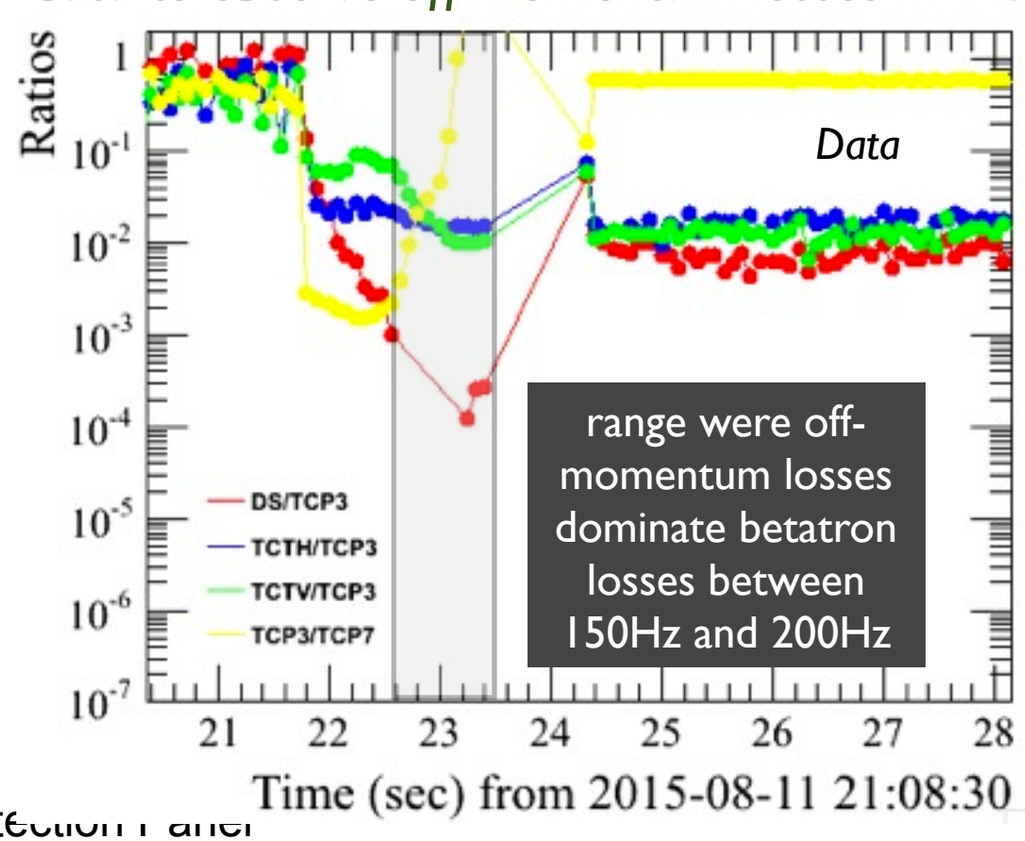


With the fast BLM data (80ms) we monitor the ration IR3/IR7 and the losses in DS and TCTs during the off-momentum loss maps. This gives the input to the feedback. The same range of 150Hz to 200Hz is found from the measured data to observe off-momentum losses in IR3.



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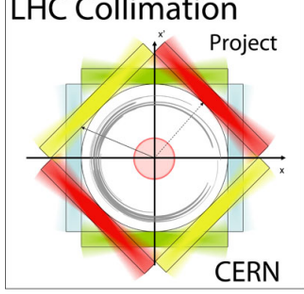

- We had the possibility to try the RF blow up and the feedback at injection and at top energy.
- In particular at injection it proved to be effective.
- At top energy the longitudinal blow-up seems not strong enough, BUT the feedback would be very advantageous.
- Last validation for the VdM was done with the feedback (no RF blow up) both off-momentum loss maps in the same fill.

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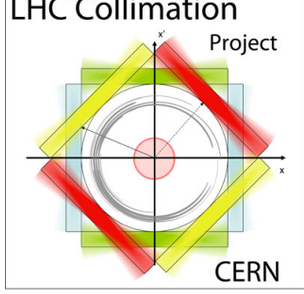

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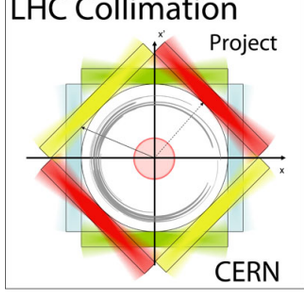

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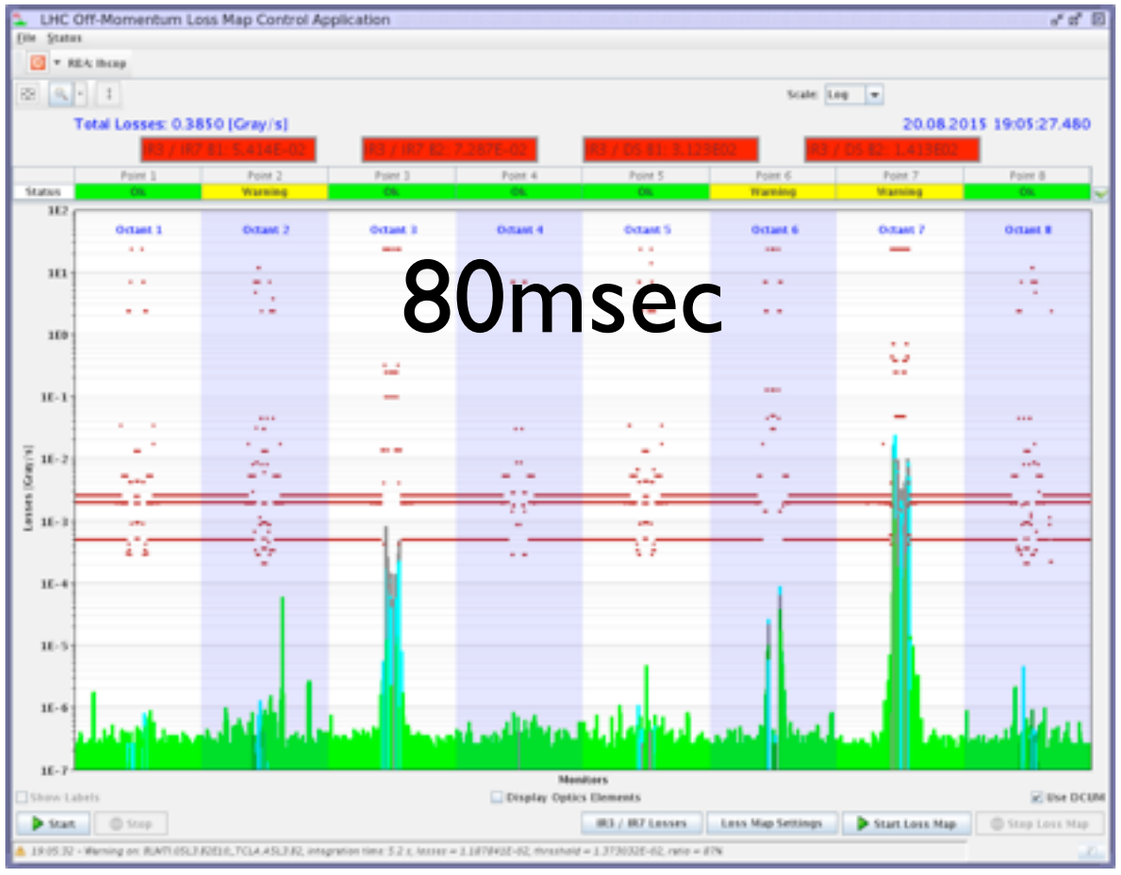
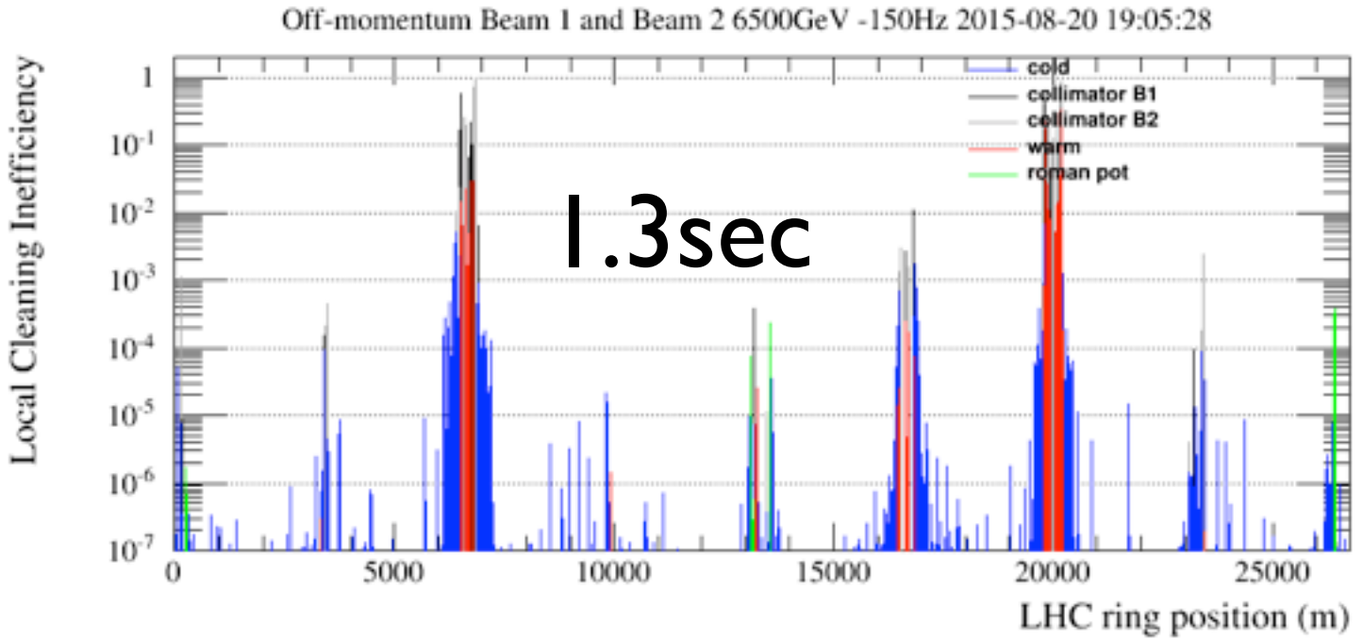
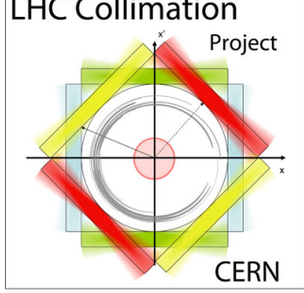
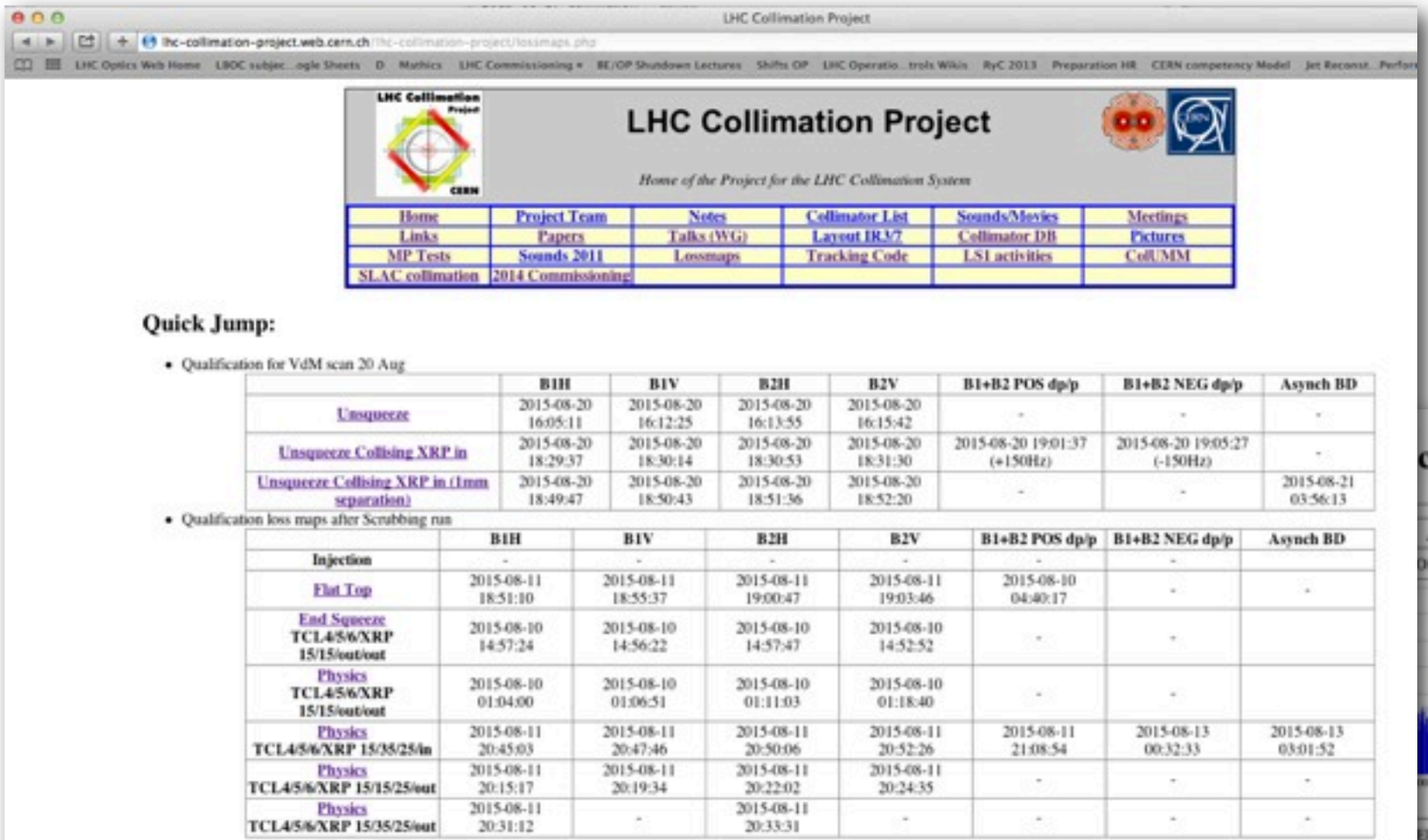




Validation results



- **The track of the loss maps validation is still done on the Collimation Project web page but it should be more automatic, this will allow faster comparison with previous loss maps.**


LHC Collimation Project

lhc-collimation-project.web.cern.ch/lhc-collimation-project/lossmaps.php

LHC Collimation Project

Home of the Project for the LHC Collimation System

Home	Project Team	Notes	Collimator List	Sounds/Movies	Meetings
Links	Papers	Talks (WG)	Layout IR3/7	Collimator DB	Pictures
MP Tests	Sounds 2011	Lossmaps	Tracking Code	LS1 activities	CollUMM
SLAC collimation	2014 Commissioning				

Quick Jump:

- Qualification for VdM scan 20 Aug

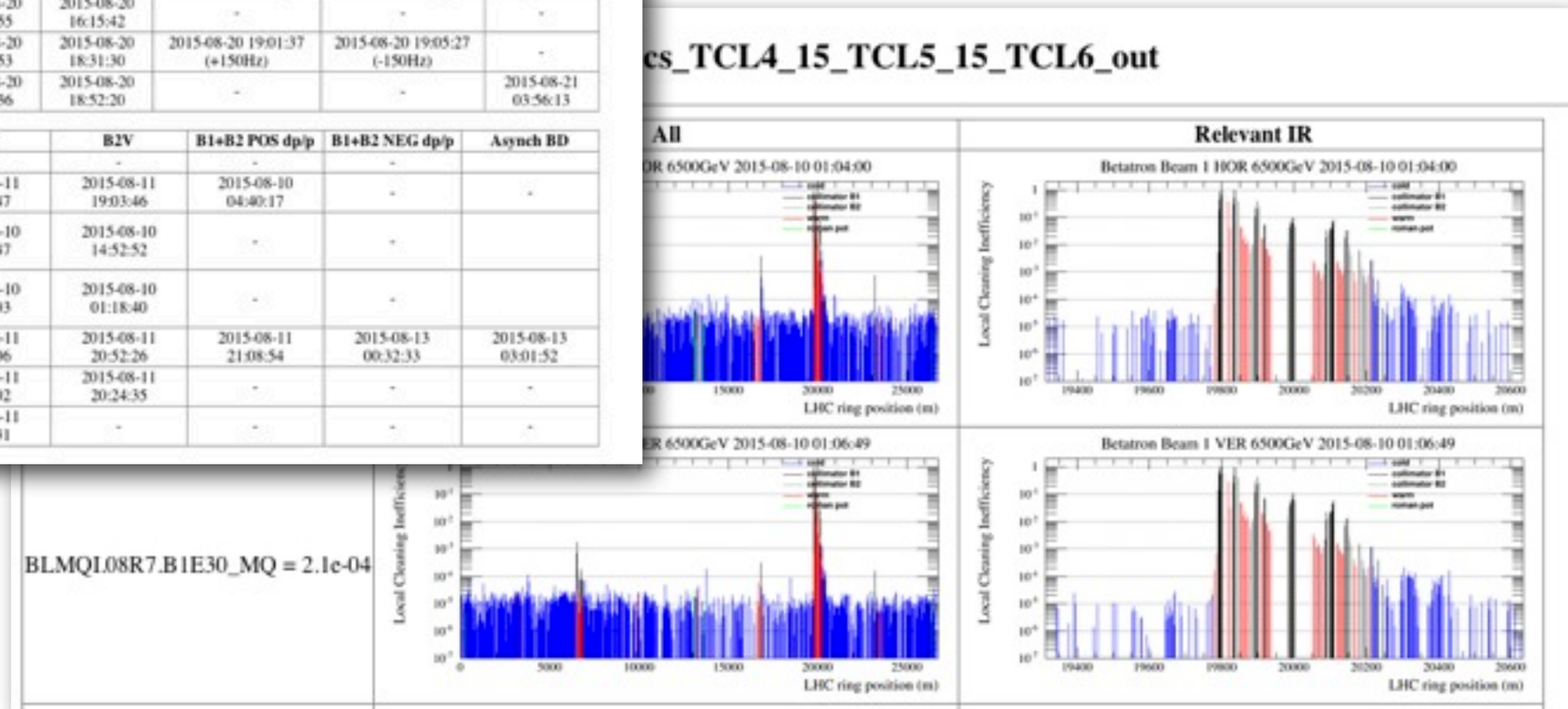
	B1H	B1V	B2H	B2V	B1+B2 POS dp/p	B1+B2 NEG dp/p	Asynch BD
Unsqueeze	2015-08-20 16:05:11	2015-08-20 16:12:25	2015-08-20 16:13:55	2015-08-20 16:15:42	-	-	-
Unsqueeze Collising XRP in	2015-08-20 18:29:37	2015-08-20 18:30:14	2015-08-20 18:30:53	2015-08-20 18:31:30	2015-08-20 19:01:37 (+150Hz)	2015-08-20 19:05:27 (-150Hz)	-
Unsqueeze Collising XRP in (1mm separation)	2015-08-20 18:49:47	2015-08-20 18:50:43	2015-08-20 18:51:36	2015-08-20 18:52:20	-	-	2015-08-21 03:56:13

- Qualification loss maps after Scrabbing run

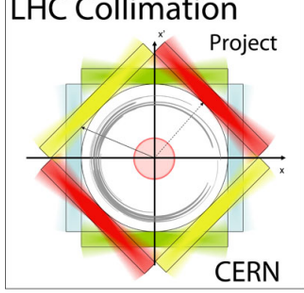
	B1H	B1V	B2H	B2V	B1+B2 POS dp/p	B1+B2 NEG dp/p	Asynch BD
Injection	-	-	-	-	-	-	
Flat Top	2015-08-11 18:51:10	2015-08-11 18:55:37	2015-08-11 19:00:47	2015-08-11 19:03:46	2015-08-10 04:40:17	-	-
End Squeeze TCL4/5/6/XRP 15/15/out/out	2015-08-10 14:57:24	2015-08-10 14:56:22	2015-08-10 14:57:47	2015-08-10 14:52:52	-	-	
Physics TCL4/5/6/XRP 15/15/out/out	2015-08-10 01:04:00	2015-08-10 01:06:51	2015-08-10 01:11:03	2015-08-10 01:18:40	-	-	
Physics TCL4/5/6/XRP 15/35/25/in	2015-08-11 20:45:03	2015-08-11 20:47:46	2015-08-11 20:50:06	2015-08-11 20:52:26	2015-08-11 21:08:54	2015-08-13 00:32:33	2015-08-13 03:01:52
Physics TCL4/5/6/XRP 15/15/25/out	2015-08-11 20:15:17	2015-08-11 20:19:34	2015-08-11 20:22:02	2015-08-11 20:24:35	-	-	-
Physics TCL4/5/6/XRP 15/35/25/out	2015-08-11 20:31:12	-	2015-08-11 20:33:31	-	-	-	-

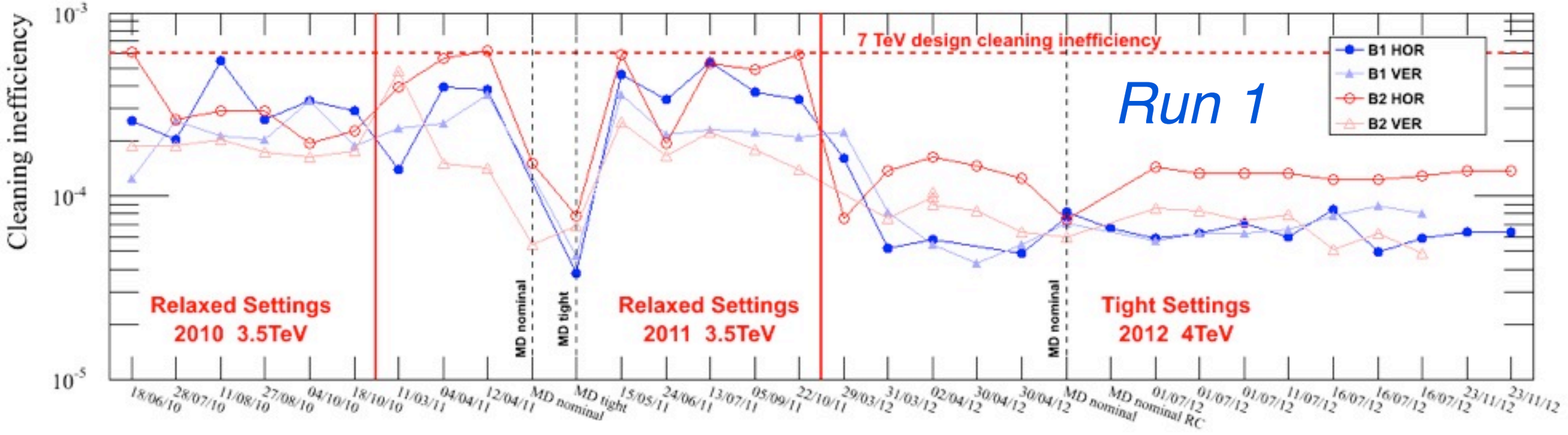
Tables showing what was done and what is missing

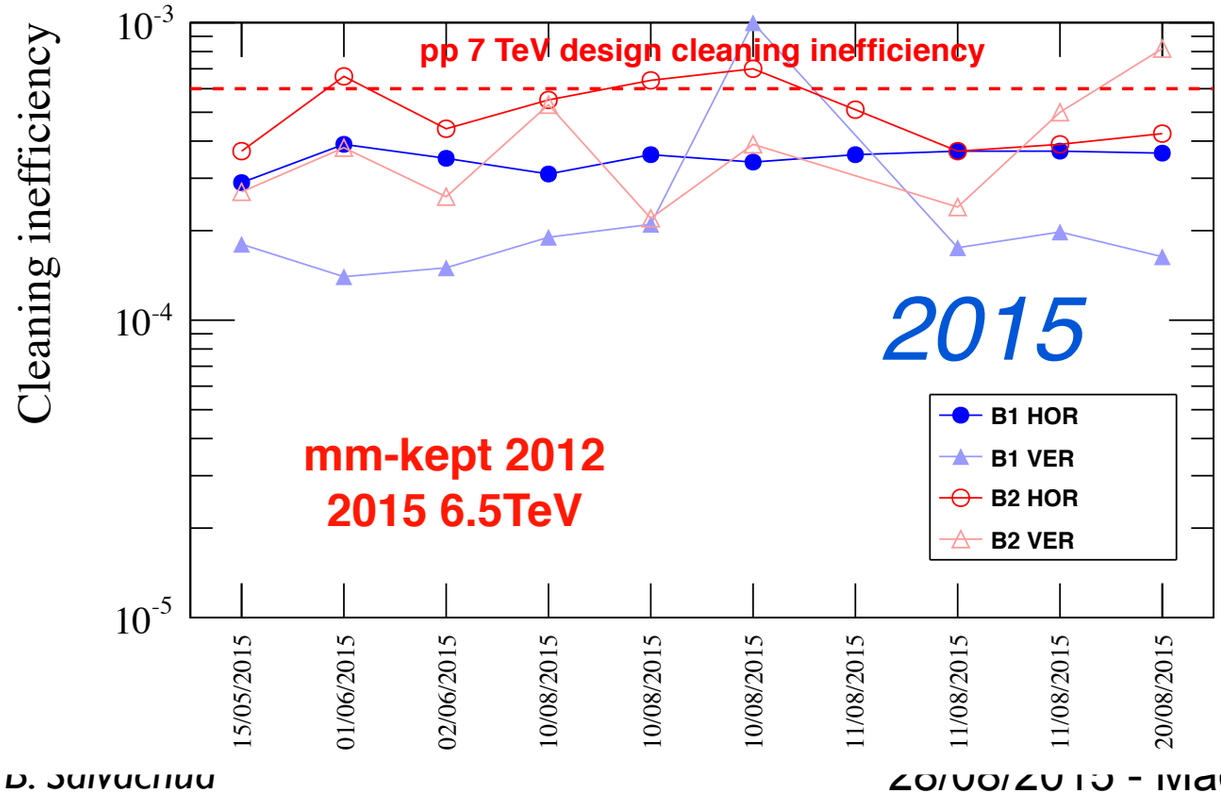
Still one can get the loss maps for different cases and the cleaning inefficiency.



Collimation cleaning

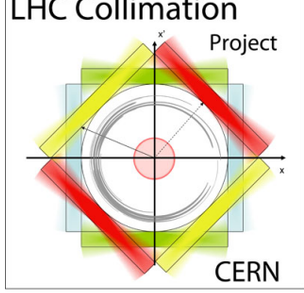






Cleaning in 2015 is stable, similarly to 2012 run. The few outliers correspond to cases were the excitation was not strong enough to distinguish losses from BLM background. Those cases are validated with another loss map.

Requirements after TS2

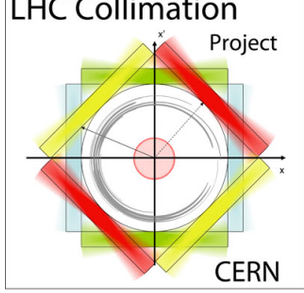


- **If no changes in the machine configuration**

	Betatron Lossmaps	POSITIVE off-momentum	NEGATIVE off-momentum	Asynchronous Dump	Fills
INJECTION	YES	YES	YES	YES	3
FLAT TOP	YES	ALTERNATE SIDE	ALTERNATE SIDE	Cancelled?	1
SQUEEZE	YES	ALTERNATE SIDE	ALTERNATE SIDE	Recommend to keep it	2-3
COLLISIONS	YES	YES	YES	YES	3

Injection: we do the FULL validation

Requirements after TS2



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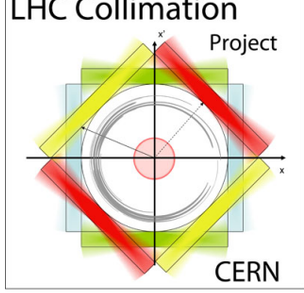
	Betatron Lossmaps	POSITIVE off-momentum	NEGATIVE off-momentum	Asynchronous Dump	Fills
INJECTION	YES	YES	YES	YES	3
FLAT TOP	YES	ALTERNATE SIDE	ALTERNATE SIDE	Cancelled?	1
SQUEEZE	YES	ALTERNATE SIDE	ALTERNATE SIDE	Recommend to keep it	2-3
COLLISIONS	YES	YES	YES	YES	3

Injection: we do the FULL validation

Flat Top: the cleaning betatron/off-mom. is stable, the settings are different in the IRs but is not the limiting location. We request betatron loss maps (because we can do them in the same fill) and one off-momentum side each validation. Asynchronous beam dump is the candidate to be cancelled.

Requirements after TS2



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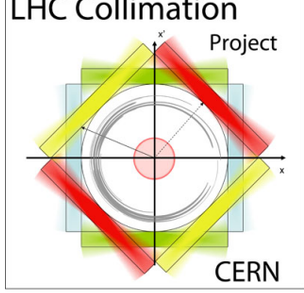
	Betatron Lossmaps	POSITIVE off-momentum	NEGATIVE off-momentum	Asynchronous Dump	Fills
INJECTION	YES	YES	YES	YES	3
FLAT TOP	YES	ALTERNATE SIDE	ALTERNATE SIDE	Cancelled?	1
SQUEEZE	YES	ALTERNATE SIDE	ALTERNATE SIDE	Recommend to keep it	2-3
COLLISIONS	YES	YES	YES	YES	3

Injection: we do the FULL validation

Flat Top: the cleaning betatron/off-mom. is stable, the settings are different in the IRs but is not the limiting location. We request betatron loss maps (because we can do them in the same fill) and one off-momentum side each validation. Asynchronous beam dump is the candidate to be cancelled.

Squeeze: is partially covered by the collisions case, however even though the TCTs are at the same Nsigma setting the orbit has the separation knob which could be more limiting in some cases. We request the betatron and one off-momentum side each time. For the asynchronous beam dump it is worth doing it.

Requirements after TS2



- **If no changes in the machine configuration**

	Betatron Lossmaps	POSITIVE off-momentum	NEGATIVE off-momentum	Asynchronous Dump	Fills
INJECTION	YES	YES	YES	YES	3
FLAT TOP	YES	ALTERNATE SIDE	ALTERNATE SIDE	Cancelled?	1
SQUEEZE	YES	ALTERNATE SIDE	ALTERNATE SIDE	Recommend to keep it	2-3
COLLISIONS	YES	YES	YES	YES	3

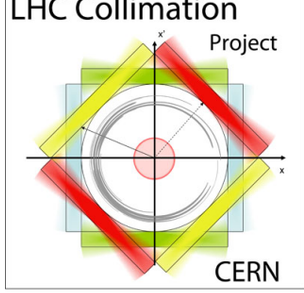
Injection: we do the FULL validation

Flat Top: the cleaning betatron/off-mom. is stable, the settings are different in the IRs but is not the limiting location. We request betatron loss maps (because we can do them in the same fill) and one off-momentum side each validation. Asynchronous beam dump is the candidate to be cancelled.

Squeeze: is partially covered by the collisions case, however even though the TCTs are at the same Nsigma setting the orbit has the separation knob which could be more limiting in some cases. We request the betatron and one off-momentum side each time. For the asynchronous beam dump it is worth doing it.

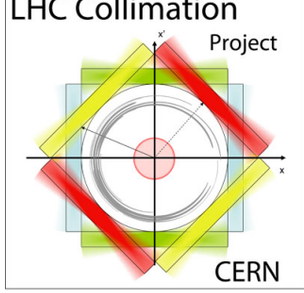
Collisions: we do the FULL validation. It is the most restrictive case and we spend most of the time.

Summary



- **Several activities on going to reduce the time spent in validation:**
  - RF longitudinal blow-up, feedback to trim the RF frequency.
- **The new technique of off-momentum loss maps is almost operational, we have gain already a couple of fills by using it, but it should be improved.**
- **Betatron loss maps are systematically done without losing the fill but the blow-up should be a bit more effective. A documented procedure with example on when to stop the blow up will be done for after TS2.**
- **Proposal for the revalidation after TS2:**
  - 1 off-momentum at flat top and at squeeze (unless they can be done in the same fill)
  - 1 asynchronous beam dump at flat top

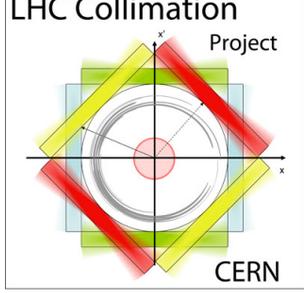
Collimator settings



- **Recap of collimator settings for start of 2015**

		450 GeV	6500TeV
IP7	TCP/TCSG/TCLA	**5.6/6.7/10**	**5.5/8.0/14.0**
IP3	TCP/TCSG/TCLA	**8.0/9.3/12.0**	**15.0/18.0/20.0**
IP6	TCSG/TCDQ	**7.5/8.0**	**9.1/9.1**
IP1 and IP5	TCTP	**13.0**	**13.7**
IP2	TCTP	**13.0**	**37.0**
IP8	TCTP	**13.0**	**15.0**
IP1 and IP5	TCL4/TCL5/TCL6	**out/out/out**	**15.0/15.0/out**

Requirements after TS2



- **If step on beta-star from 80cm to 60cm**

	Betatron Lossmaps	POSITIVE off-momentum	NEGATIVE off-momentum	Asynchronous Dump
INJECTION	YES	YES	YES	YES
FLAT TOP	YES	ALTERNATE SIDE	ALTERNATE SIDE	Cancelled?
SQUEEZE	YES	YES	YES	YES
COLLISIONS	YES	YES	YES	YES