

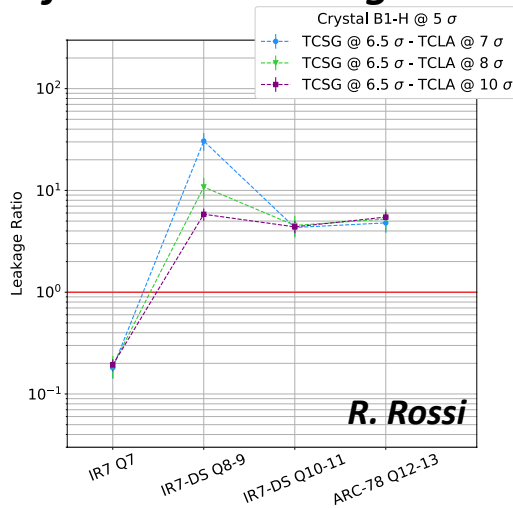
Crystal Collimation Tests with Pb Ion Beams

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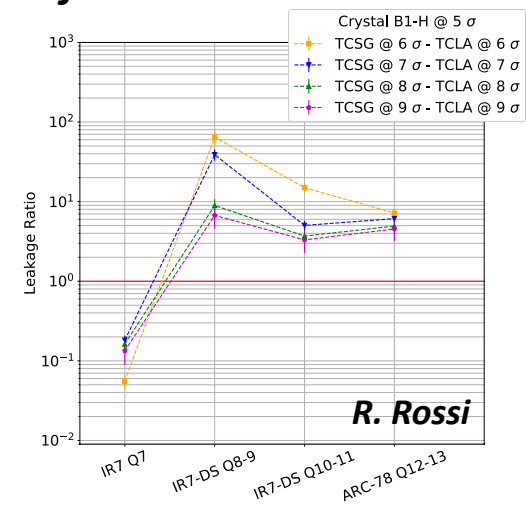
On behalf of the LHC Collimation team

- **Crystal collimation tests** carried out in **2015 and 2016 with Pb** beam, in **2017 with Xe** beams
 - **Puzzling results obtained with Pb beams**
 - **Improved collimator settings deployed with Xe beams**
- ➔ **Excellent results achieved and significant cleaning improvement demonstrated!**

Absorption of debris from TCSGs using TCLAs



Cleaning efficiency as a function of TCSG-TCLA clearance



Improved cleaning performance in the range of 3-60 achieved with crystals!
Very important to confirm these results with Pb beams!

- **MD can be structured in two main blocks:**
 1. Low intensity fill focused on optimized crystal collimation cleaning
 2. High intensity fill focused on operational test

- **Main goals of low intensity fill:**

1. Crystal characterization by means of angular and linear scans
2. Cleaning efficiency as a function of collimator settings

Usual measurements performed from 2015 with p, Pb and Xe beams

- **Possible timeline:**

- ✓ Preparatory checks at injection energy ~ 2 h
- ✓ Prepare and perform energy ramp ~ 1 h
- ✓ Crystal scans, collimator scans and loss maps at flat top energy ~ 6 h
(complete list of loss maps required in backup)

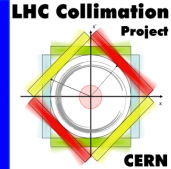
Usual beams and filling scheme as in the previous MDs

Time required per MD [h]	9
Beams required [1, 2, 1&2]	1 & 2
Beam energy [GeV Z]	450 & 6370
Optics (injection, squeezed, special)	Injection and flat top optics
Bunch intensity [#ions]	<1.8E10 at 450GeV, <1.8E10 charges at 6.5TeV
Number of bunches	30 b (total intensity <3e11 charges) Filling scheme: "Crystal_MD_XE_2017", 3 bunches spaced by 2 μ s, each group of 3 spaced by 3 μ s
Transv. emittance [m rad]	>1.5 μ m
Bunch length [ns @ 4s]	1
Optics change [yes/no]	No
Orbit change [yes/no]	No
Collimation change [yes/no]	Yes: TCPs and selected TCSGs collimators in IR7 (upstream crystals)
RF system change [yes/no]	no
Feedback changes [yes/no]	no
What else will be changed?	Crystals moved into the beam and set as primary collimators.
Are parallel studies possible?	No
Other info/requests	No

- **If all the tests with low intensity beams successfully performed in 9h**
 - ✓ Possibility to perform a second ramp for operational tests
- **Linear and angular crystal positions validated** during commissioning: LM and ASD
- **Preliminary tests performed** on 19th Nov. as **EoF with 648 bunches** (std coll. system in place)
 1. Crystal inserted to intermediate position (TCP's shadow) using sequence
 2. Manual insertion to final physics positions in 5 μ m steps
 3. No sign of temperature increase observed
 4. 3 out of 4 crystals kept in stable channeling for about 2-3h
(B2V goniometer required a reboot and reference channeling angle lost)
- **Possible plan of the fill with high intensity beams:**
 1. At least 300 bunches injected in the machine (using operational filling scheme)
 2. Automated movement using sequence until intermediate position
 3. Manual insertion to final physics positions with new reference channeling angle for B2V found during low intensity fill
 4. All the 4 crystals inserted in channeling at flat top and standard cycle played until collisions to observe if channeling is kept during dynamic phases

- **Very important to confirm results obtained with Xe using with Pb beams in view of HL-LHC**
 - ✓ Complete characterization of crystal collimation performance with low intensity beams

- **If all the tests with low intensity beams successfully performed in 9h**
 - ✓ Possibility to perform a **second ramp for operational tests:**
 - STD coll. System in place and crystal inserted of 0.25σ w.r.t. TCPs at flat top
 - Standard cycle played until collisions to observe if channeling is kept during dynamic phases
 - Promising results obtained with 25 and 648 bunches in collisions



BACKUP



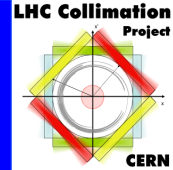
Loss maps crystal collimation Pb



Config.	TCP [σ]	TCSG (up) [σ]	Cry [σ]	TCSG (down) [σ]	TCLA [σ]
1	OUT	OUT	5.0	6.5	10.0
2	OUT	OUT	5.0	6.5	9.0
3	OUT	OUT	5.0	6.5	8.0
4	OUT	OUT	5.0	6.5	7.0
5	OUT	OUT	5.0	6.0	6.0
6	OUT	OUT	5.0	7.0	7.0
7	OUT	OUT	5.0	8.0	8.0
8	OUT	OUT	5.0	9.0	9.0



Reference loss maps Pb



Config.	TCP [σ]	TCSG (up) [σ]	Cry [σ]	TCSG (down) [σ]	TCLA [σ]
1	5.0	6.5	OUT	6.5	10.0
2	5.0	6.5	OUT	6.5	9.0
3	5.0	6.5	OUT	6.5	8.0
4	5.0	6.5	OUT	6.5	7.0
5	5.0	6.0	OUT	6.0	6.0
6	5.0	7.0	OUT	7.0	7.0
7	5.0	8.0	OUT	8.0	8.0
8	5.0	9.0	OUT	9.0	9.0