Report from the LHC Run-III Configuration Working Group

G. Arduini, M. Barnes, H. Bartosik, K. Brodzinski, X. Buffat, F. Cerutti, **S. Fartoukh**, B. Goddard, G. Iadarola, **N. Karastathis**, S. Le Naour, A. Lechner, J. Maestre Heredia, A. Mereghetti, E. Metral, D. Missiaen, N. Mounet, F.X. Nuiri, S. Papadopoulou, Y. Papaphilippou, B. Petersen, C. Schwick, G. Rumolo, B. Salvant, M. Solfaroli Camillocci, G. Sterbini, H. Timko, R. Tomas Garcia, J. Uythoven, J. Wenninger

9th LHC Operations Evian Workshop
01/02/2019

CERN

LHC Run-III Configuration Working Group

LCR3 WG Mandate

Prepare **LHC operational scenarios** for the third exploitation period of the LHC and assess them in terms of **performance reach**, expected **limitations** & **action plan to overcome them**.
The working group reports to the LHC Machine Committee.

Contributors

Collaborative effort between many colleagues from:
BE-ABP, BE-RF, BE-OP, EN-SMM, EN-STI,
LPC, TE-ABT, TE-CRG, TE-MPE, TE-MSC
& many more
Thank you!

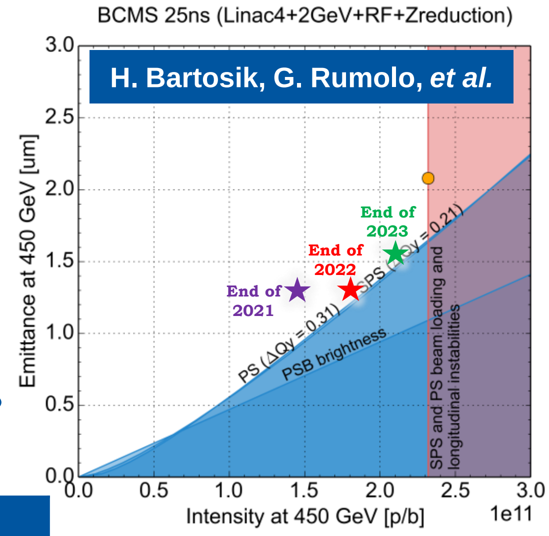
Indico Agendas: https://indico.cern.ch/category/10387/

Deliverables & Equipment Group Constraints

- Very clear forecast from LIU for the commissioning plan:
  - Gradual intensity ramp up over Run-III.

	2021	2022	2023*	Comment
# bunches	Up to 2748 (BCMS)			
ϵ_n $[\mu m]$	1.3	1.3	1.3 → 1.55	Intensity Ramp Up
N_b $[10^{11}p]$	0 →1.4	1.4 →1.8	1.8 → 2.1	Max intensity at the end of each year

** Not including 2024 when the LHC is in shutdown but the injectors are fully operational.*



At the LHC, can we inject, accelerate, collide and safely dump such a beam?

System	1.7e11	1.8e11	Comment
MKI	OK	OK	One new MKI prototype to be installed in 2022/2023 in IR8. 1.8×10^{11}ppb should be within reach with 1.3ns ➔ Studies are on-going for 1.2
RF	OK	OK	Klystron power limitation at INJ: 1.8×10^{11}ppb ➔ out of reach with Q22, ok for Q20 with >1.2ns in RAMP.
Alignment	NA	NA	Vertical realignment of LSS5 (Q10-Q10) by up to -3 mm
Cryogenics	OK	OK	Total heat load measured at 306W → $L_{peak} = 2.05 \times 10^{34}$ Hz/cm^2 at 7.0 TeV. Impact of running the triplet at the cryo limit is marginal (<2%) on the cooling capacity of the beam screen in the adjacent arcs.

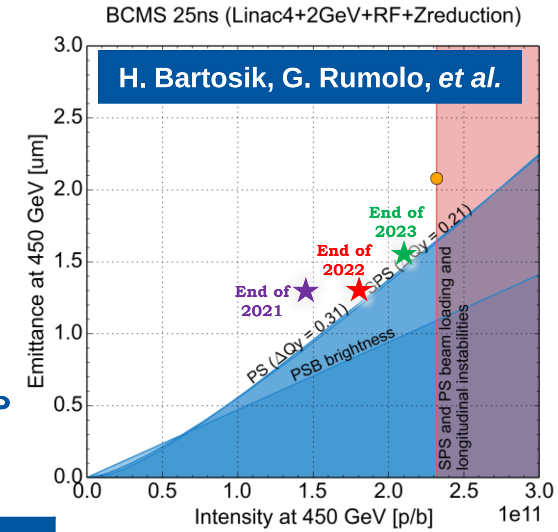
M. Barnes, K. Brodzinski, B. Goddard, A. Lechner, J. Maestre Heredia, A. Mereghetti, D. Missiaen, F.X. Nuiri, B. Salvant, H. Timko, J. Uythoven, J. Wenninger, *et al.*

Deliverables & Equipment Group Constraints

- Very clear forecast from LIU for the commissioning plan:
  - Gradual intensity ramp up over Run-III.

	2021	2022	2023*	Comment
# bunches	Up to 2748 (BCMS)			
ϵ_n [μm]	1.3	1.3	1.3 → 1.55	Intensity Ramp Up
N_b [10^{11}p]	0 →1.4	1.4 →1.8	1.8 → 2.1	Max intensity at the end of each year

* Not including 2024 when the LHC is in shutdown but the injectors are fully operational.



At the LHC, can we inject, accelerate, collide and safely dump such a beam?

System	1.7e11	1.8e11	Comment
TCDQ	OK	OK	For 2.5mm gap and $N_b = 1.7 \times 10^{11}$ppb safety factor up to 2.5. Studies on-going for other gap values (2.0mm). TCDQ leveling MD successful!
TCDS	OK	?	Already designed for $N_b = 1.7 \times 10^{11}$ppb, but in plastic deformation already ➔ Studies on-going.
TDE	?	?	New downstream window installed in LS2. Not sufficient margin for the upstream window ➔ YETS 2021/2022. Material re-characterization needed for the body at 2500ºC . Study on-going.
Collimation	OK	OK	No issue on finding suitable settings for Run-III (with the help of partial upgrade in Run-III and thanks to dedicated telescopic optics).

The LHC should be available to accept **a <u>max</u> bunch population of**

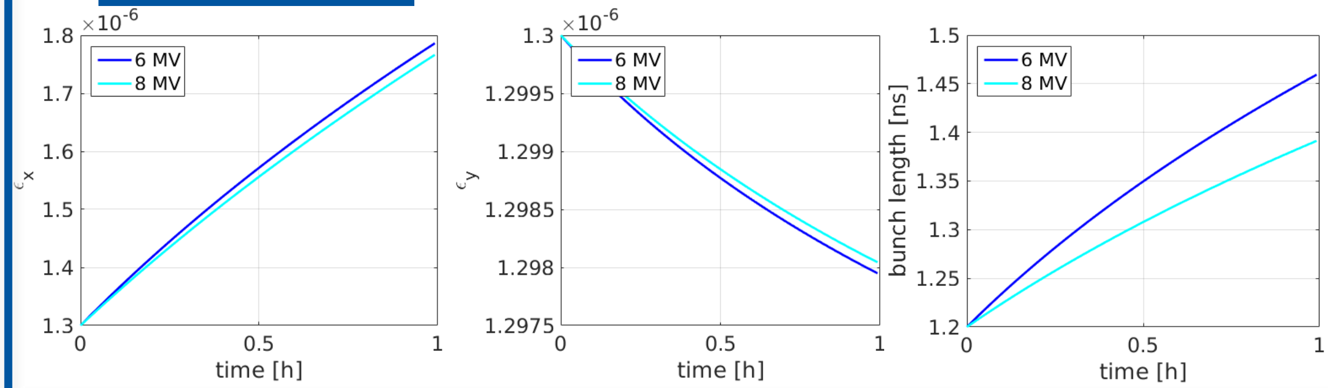
$$\mathbf{N_b = 1.8 \times 10^{11} ppb}$$

Especially, after the TDE downstream window upgrade.

M. Barnes, K. Brodzinski, B. Goddard, A. Lechner, J. Maestre Heredia, A. Mereghetti, D. Missiaen, F.X. Nuiri, B. Salvant, H. Timko, J. Uythoven, J. Wenninger, *et al.*

When the protons are in the LHC (I)

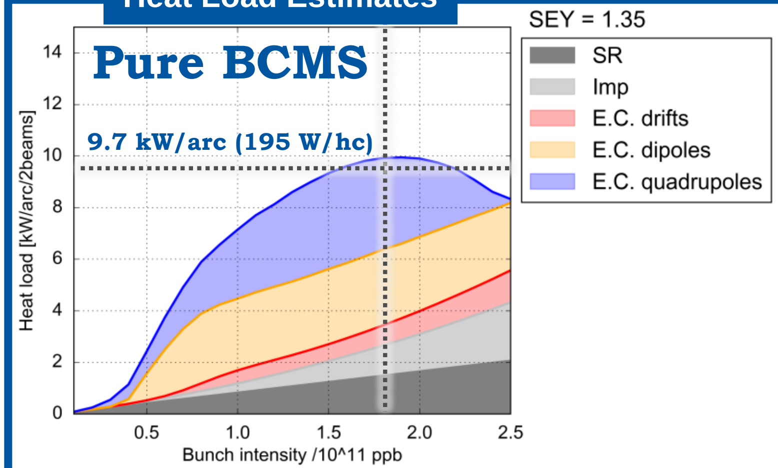
IBS+SR Estimates



- $N_b = 1.8 \times 10^{11}$ ppb, $\epsilon_n^{inj} = 1.3$ μm & $\sigma_L = 1.2$ ns
- Horizontal Emittance Growth @ FB: $\approx 0.5 \mu m/h$ (additional effects, e.g. e-cloud, not considered here)
- Two scenarios considered at Start SB: **1.8 μm** & **2.5 μm**

S. Papadopoulou, Y. Papaphilippou *et al.*

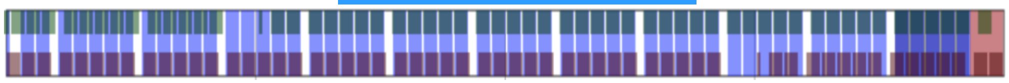
Heat Load Estimates



- BCMS: extra margin than the 25ns standard.
- Almost within the capacity for 1.8×10^{11} ppb.
- Assuming no degradation during LS2!

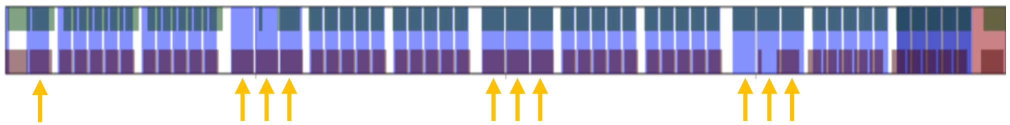
G. Iadarola, M. Solfaroli Camillocci, J. Wenninger *et al.*

Baseline: Pure BCMS



5x48 bpi, 2736 collisions in ATLAS/CMS, **2250/2376 in Alice/LHCb**

Backup: Mixed BCMS with 8b+4e (56b) inserts



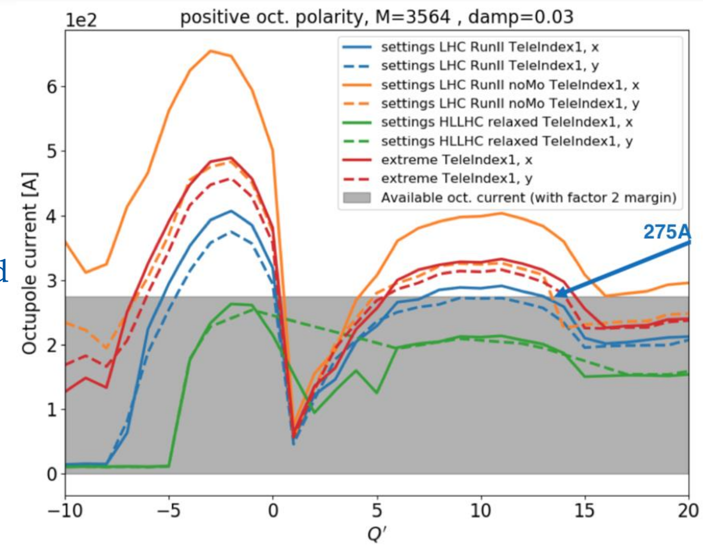
- Required for the **25% missing cryo-cooling capacity**.
- **9.2% less collisions at IP1/5** compared to pure BCMS scheme
- Operationally viable under the two beam (**INTR/NOM**) injection scheme, but could require some overhead until fully automatized.

* 25ns_2492b_2484_1949_2131_240bpi_13inj_800ns_bs200n_run3study

When the protons are in the LHC (II)

Stability Concerns

- Without BBLR there is some stability margin due to the **collimator upgrade**.
- The operational **polarity** of the octupoles has not been decided yet.
  - The critical point for $I_{MO}>0$: end of ramp ➔ Stability guaranteed even in the most demanding configuration.
  - The critical point for $I_{MO}<0$: end of squeeze ➔ can create issues in ADJUST and/or with offset leveling mode ➔ we need ≈300A of octupole current at a tele-index of 2.5 to allow for any long-range separation.
- The **telescopic index needs to be applied already in the RAMP** to increase the effectiveness of the octupoles → CRDS MD successful!
- The **TMCI threshold** is pushed further away (4.7×10^{11}ppb) compared to Run-II.



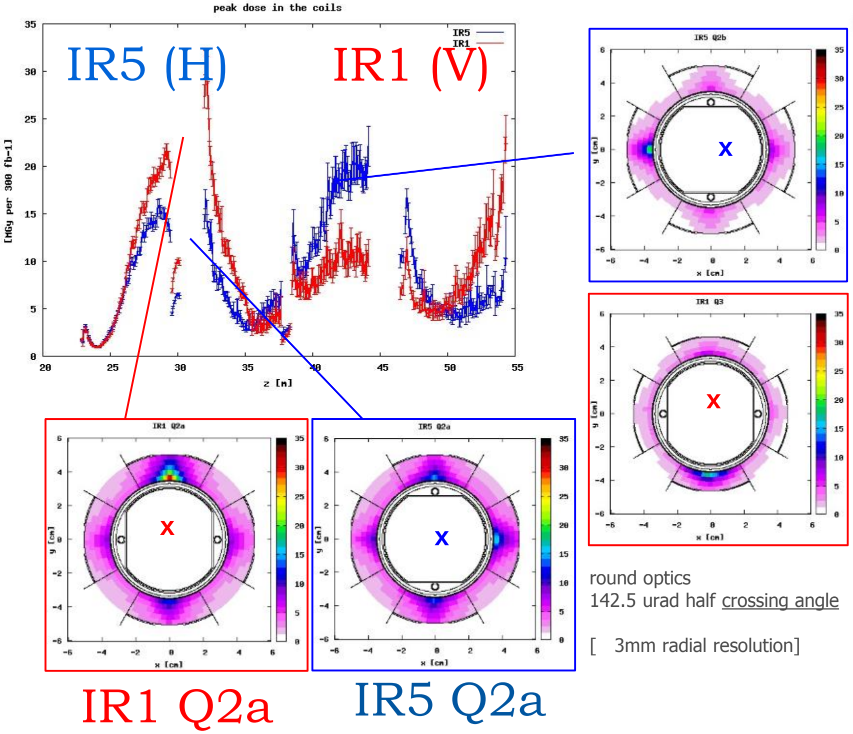
X. Buffat, E. Metral, N. Mounet, *et al.*

	2021	2022	2023	Comment
Beam Energy [TeV]	7.0			7.0 TeV is being re-discussed for Run-III
Collisions at IP1/5	2736 / 2736 (2484 / 2484)			() = Mixed filling scheme for possible heat load limitation
Collisions at IP2/8	2250 / 2376 (1949 / 2131)			() = Mixed filling scheme for possible heat load limitation
Bunch Length [ns]	1.2			Favorable for MKI and RF emittance blow-up
Normalized Emittance [μm]	1.8 (2.5)			() = Pessimistic emittance preservation
Bunch Charge [10^{11} ppb]	0 → 1.4	1.4 → 1.8	1.8 *	Assuming marginal losses in the ramp (~ 1%) * A priori the LHC cannot take more than 1.8×10^{11}ppb during Run-III
L_{level} [Hz/cm^2]	$2 \cdot 10^{34}$, $1.3 - 1.4 \cdot 10^{31}$, $2 \cdot 10^{33}$			For IP1/IP5 , IP2, IP8 respectively.

Optics Flavors & Triplet Lifetime (I)

- The **triplet lifetime** shall extend until LS3, but should **not be an obstacle to the luminosity production** in Run-III ➔ Run-I/II: Optics can affect IT lifetime.
- Two optics flavors to exploit during Run-III
  - **Round** ($\beta_X^* = \beta_{||}^* = \beta_{round}^*$) ➔ Swapping the vertical crossing polarity ➔ H, +V, -V
    ➔ **Choice for 2021**

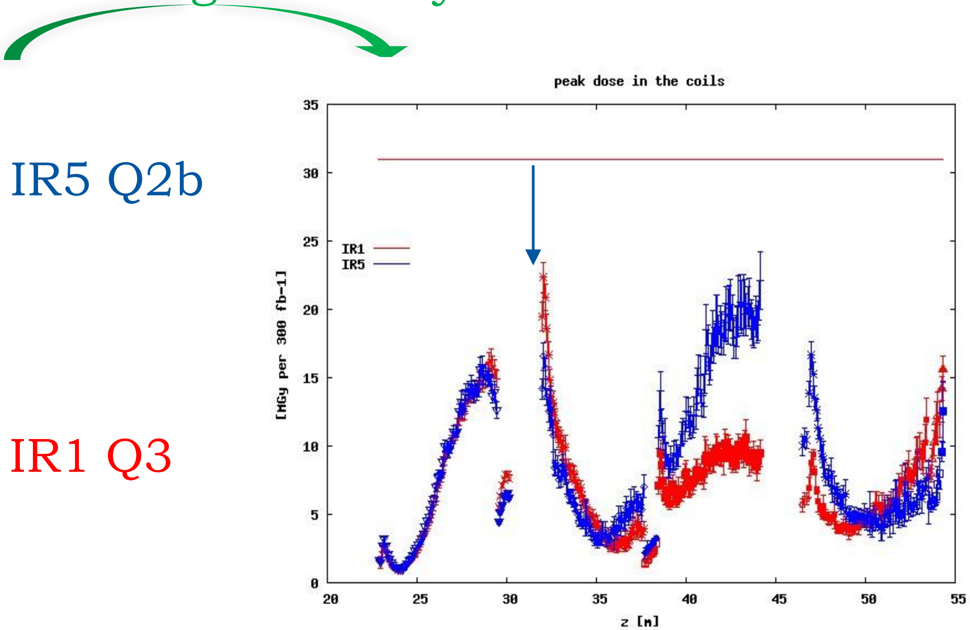
Triplet dose limit: 30 MGy



round optics
142.5 urad half crossing angle

[3mm radial resolution]

Reversing V Polarity



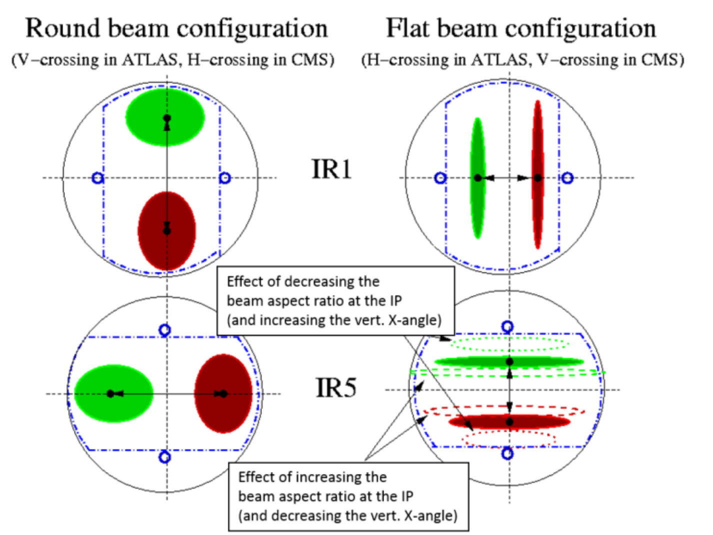
r=30% decrease ➔ 40% increase in integrated luminosity

F. Cerutti, *et al.*

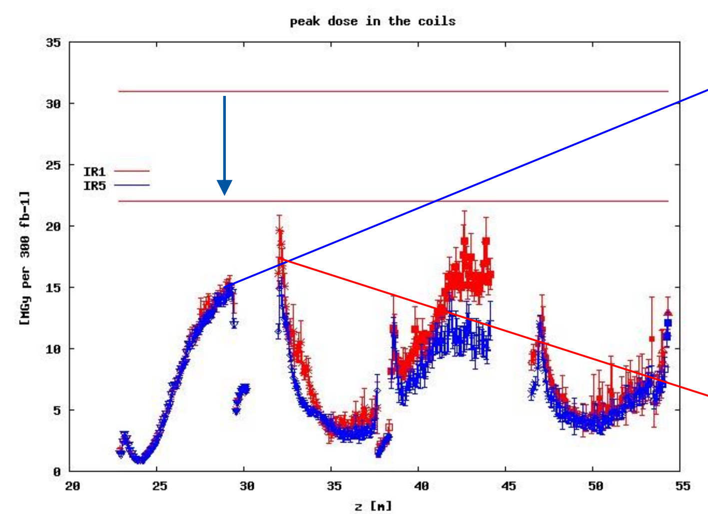
Optics Flavors & Triplet Lifetime (II)

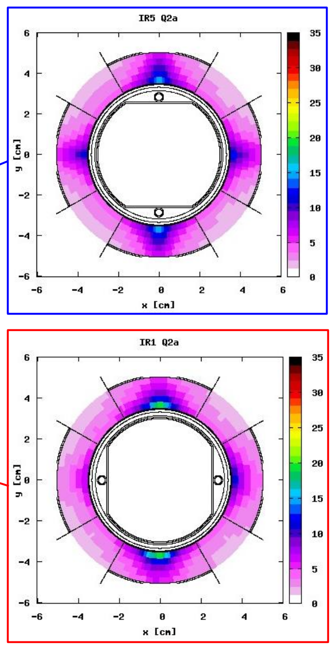
- The **triplet lifetime** shall extend until LS3, but should **not be an obstacle to the luminosity production** in Run-III.
- Two optics flavors to exploit during Run-III
  - **Round Optics** $(\beta^*_X = \beta^*_{||} = \beta^*_{round})$ ➔ Swapping the vertical crossing polarity ➔ H, +V, -V
  - **Flat Optics** $(\beta^*_X > \beta^*_{round} > \beta^*_{||}, \sqrt{\beta^*_X \beta^*_{||}} \approx \beta^*_{round}$ at cst lumi$)$ ➔ H, +V, -V

Triplet dose limit: 30 MGy



The crossing angle is rotated by 90deg and deployed in the plane of highest β to minimize the loss factor.*





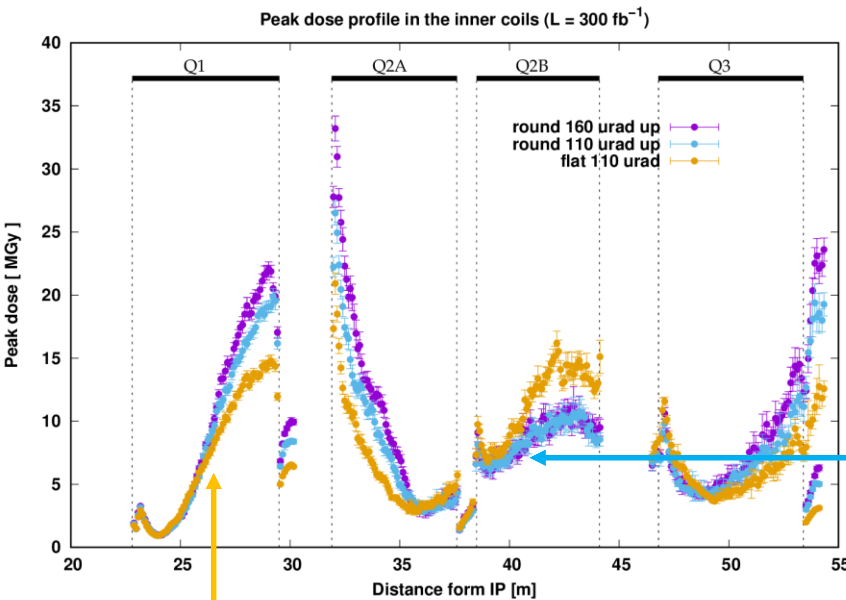
r=35% decrease ➔ 50% increase in integrated luminosity

F. Cerutti, *et al.*

Optics Flavors & Triplet Lifetime (III)

- The **triplet lifetime** shall extend until LS3, but should **not be an obstacle to the luminosity production** in Run-III.
- Two optics flavors to exploit during Run-III
  - **Round Optics** ($\beta_X^* = \beta_{||}^* = \beta_{round}^*$) ➔ Swapping the vertical crossing polarity ➔ H, +V, -V
  - **Flat Optics** ($\beta_X^* > \beta_{round}^* > \beta_{||}^*, \sqrt{\beta_X^*\beta_{||}^*} \approx \beta_{round}^*$ at cst lumi) ➔ H, +V, -V

Triplet dose limit: 30 MGy



F. Cerutti, *et al.*

	Run-I	2015	2016	2017	2018	Total
Energy [TeV]	3.5 / 4	6.5				
L_{int} $[fb^{-1}]$	30	5	40	50	65	190
Lumi averaged half crossing angle [μrad]	- 145	- 205	- 180	+135	+ 144	
IR1Q2a up [MGy]	0.5	0.2	1.7	4.5	6.1	13
IR1Q2a down [MGy]	1.0	0.6	4.3	2.1	2.7	11
IR5Q2b in [MGy]	0.7	0.4*	3.0*	2.8	3.9	11

* Crossing angle dependence in IR5 not fully studied yet

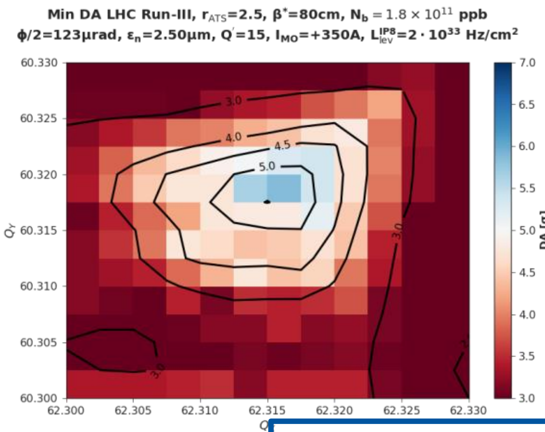
The target of any operational scenario would be to **keep the crossing-angle as small as possible** for as long as possible, without sacrificing performance. ➔ ***"Safely operating just above the BB limit" !***

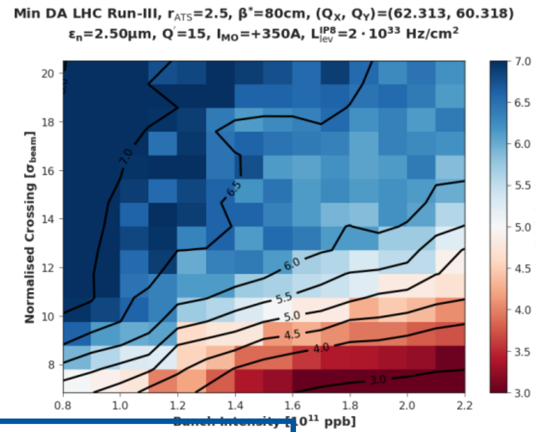
Flat optics is an appealing option on reducing the peak dose

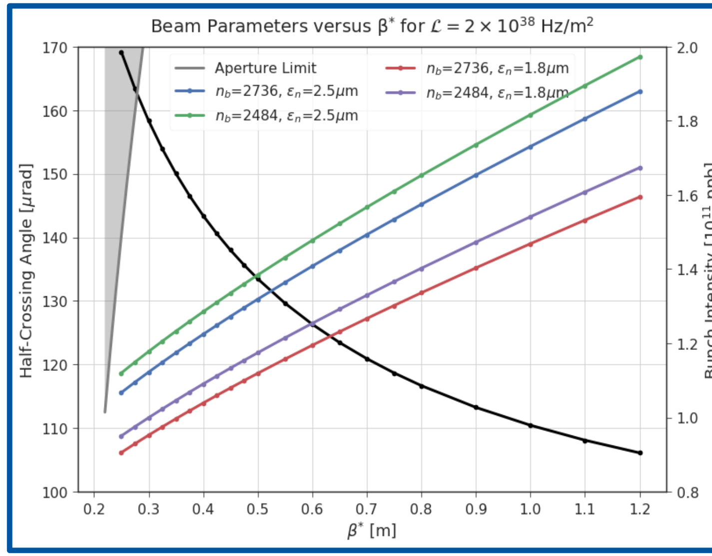
In terms of triplet lifetime, cryogenics and experiments (pileup) there is no foreseen constraint in **constantly operating at a luminosity of 2.0×10^{34} Hz/cm^2**

Running Scenarios under the guidance of Beam-Beam simulations

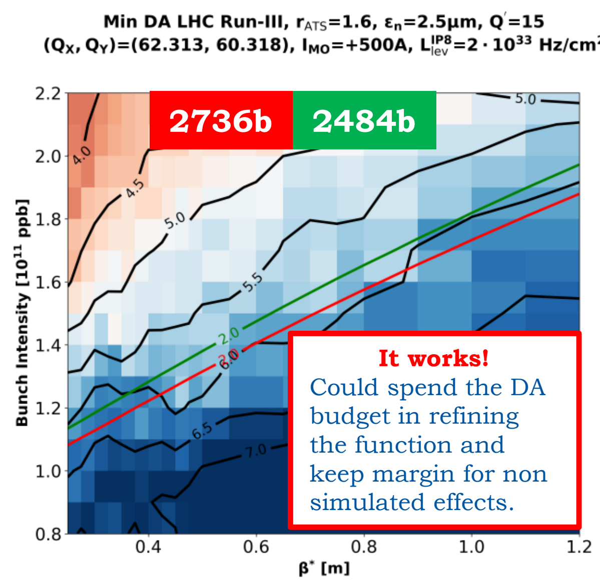
- We use **Dynamic Aperture** beam-beam simulations to estimate the beam lifetime.
  - DA simulations were proved to be a helpful “tool” to guide the **LHC operation** during Run-II (tune optimizations, anti-leveling, etc).
- Based on our experience, we set a **target DA for LHC >5.0σ**



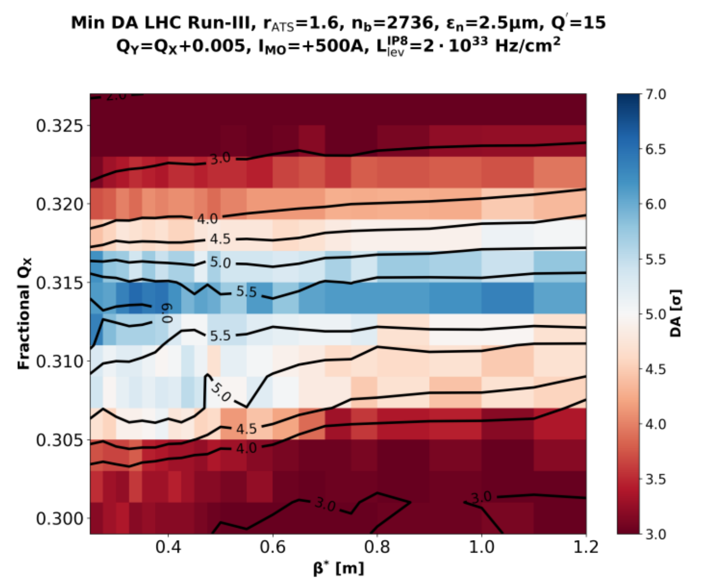




In the regime of **optimal tune**, the **crossing angle** is (almost) a linear function of the **bunch charge**.



It works!
Could spend the DA budget in refining the function and keep margin for non simulated effects.



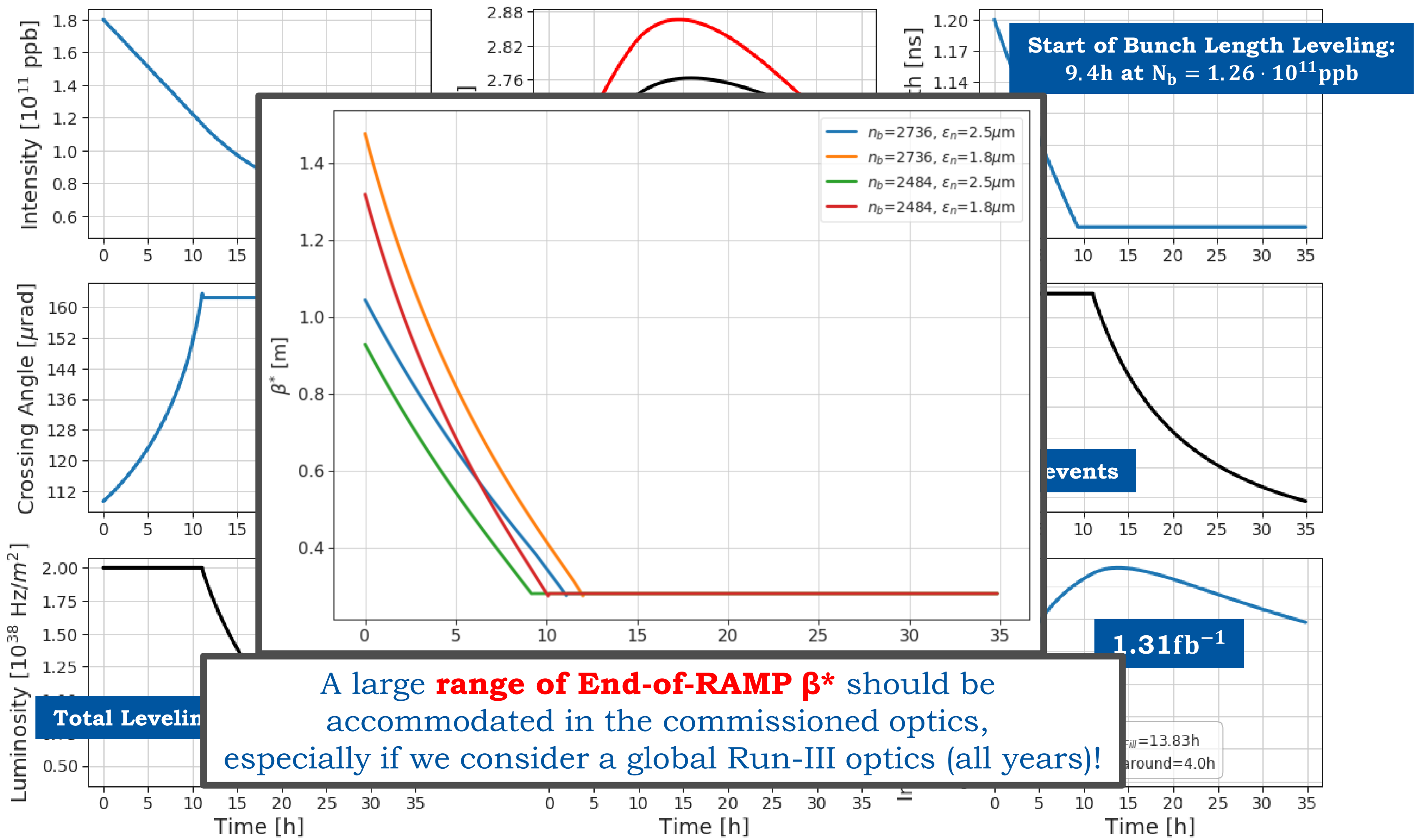
I. **Large dynamic range of β*:** 20% in 2018 ➔ up to 500% in 2023
II. Not all the luminosity shall be produced **at the maximum crossing angle** (IT lifetime)
III. De facto **parametric variation of the crossing angle with β*** shall be established.

STABLE BEAMS (in 2023)

* Contribution of IR8 included.
Not Including major losses beyond expectation.

IBS+SR+Extra Growth H = 0.05 μm/h & V = 0.10 μm/h | Leveling at $2.0\times10^{38} Hz/m^2$

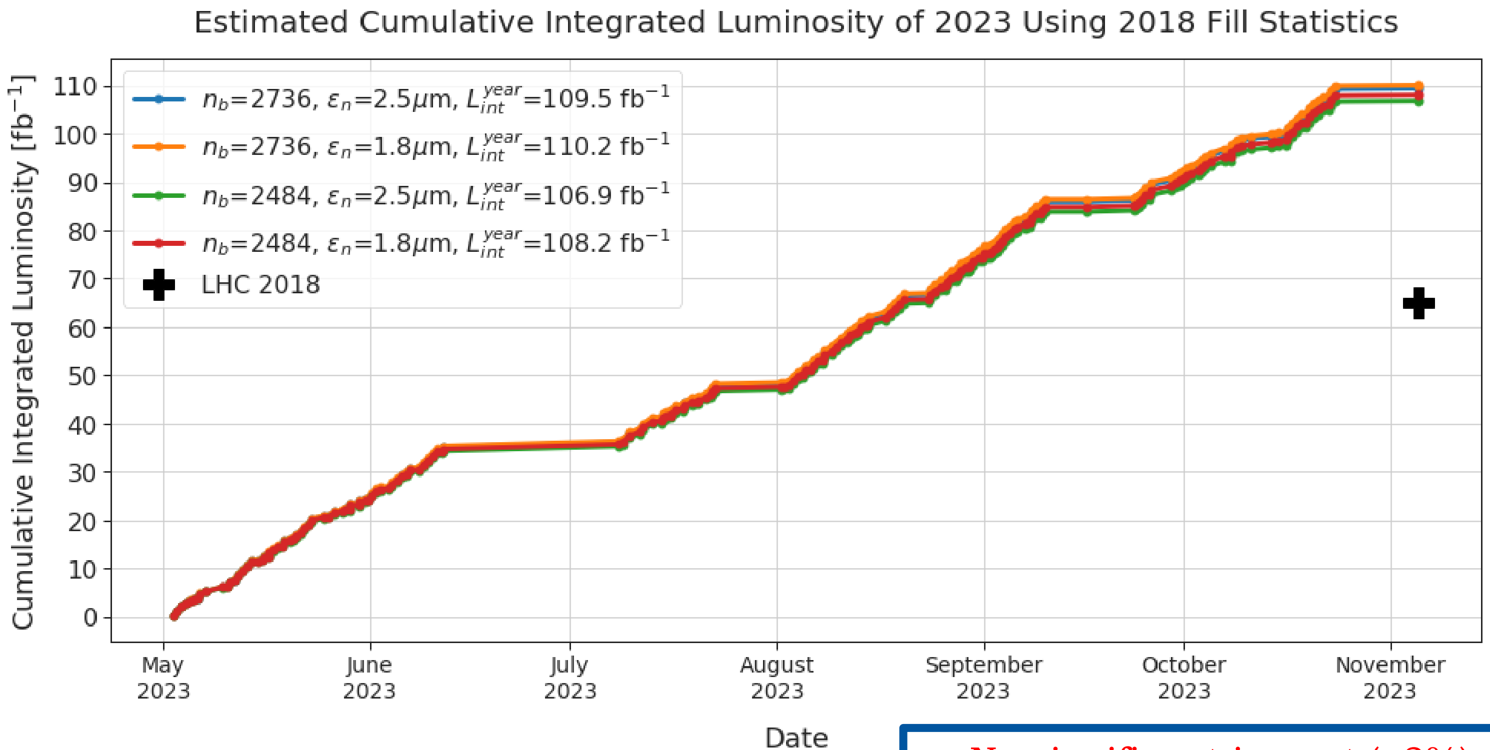
$N_{1,2} = 1.80\times10^{11}$ pbb, $\phi/2 = 109\ \mu$rad, nb = 2736, $\beta_0^* = 1.0$ m, $\varepsilon_n^{x,y} = 2.5\ \mu$m, σ_{bOff}* = 110 mb, σ_{inel} = 81 mb



A large **range of End-of-RAMP β*** should be accommodated in the commissioned optics, especially if we consider a global Run-III optics (all years)!

Looking into our crystal ball

- Using the above (ideal) scenario and the 2018 fill statistics
- Possible impact of larger intensity and higher energy on the machine availability is not considered.

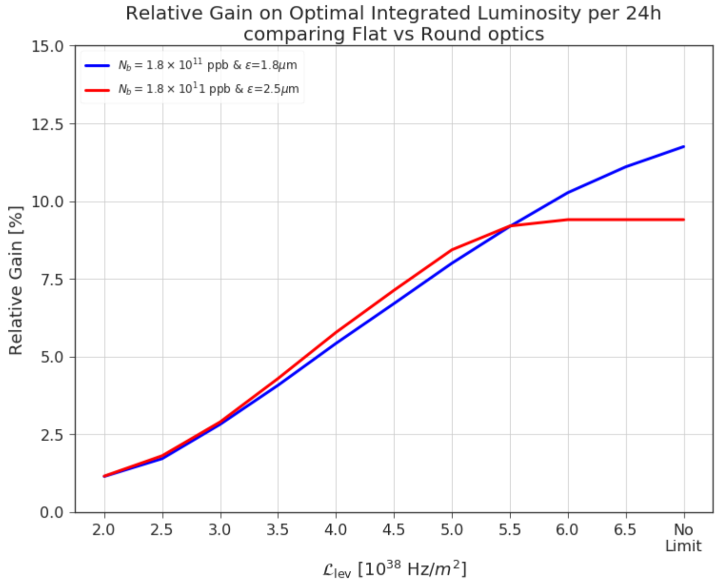


- Integrated performance of ≈ 108fb^{-1}
- Average (stat.) half-crossing angle 122.0 μrad
- Average value of β* at the time of dump 55 cm

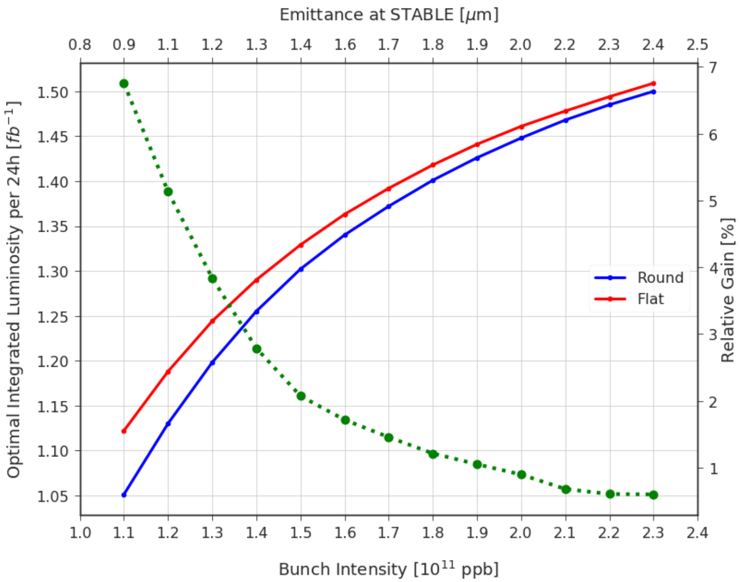
- No significant impact (<2%) on the performance, from the number of bunches or emittance preservation due to leveling (assuming no other losses).

What about flat optics?

- The potential of the flat optics is limited by the **levelled luminosity** of $2 \times 10^{34} Hz/cm^2$.
- Could be an interesting alternative for boosting performance in the **low-intensity regime**.



Levelling at 2.0×10^{34} Hz/cm^2



- On the other hand, to **ease the LHC commissioning**, for **2021** there is a preference to stick to the well-known **round optics**.

- For the operation of 2022/2023 the decision on optics is **postponed for EYETS-2021/2022**.
  - based on **MDs** and re-evaluation of the **need** (with refined forecast of **Run-III performance**, confirmation of the **CERN master schedule**, etc.)

- However, some information is **already available**!

Triplet Lifetime Forecast

Run-III PROSPECTS	up to now	2021	2022	2023	up to triplet replacement
beam energy [TeV]		7			
integrated lumi [fb^{-1}]	**190**	25	90	120	**425**
ROUND OPTICS				* crossing angle dependence in IR5 not properly studied yet	
lumi averaged half cross. angle [urad]		-162	-148 **(-162)**	**+134** **(+162)**	
IR1 Q2a up [MGy]	**13**	1.2	4.2	11.9 **(13.4)**	**30 (32)**
IR1 Q2a down [MGy]	**11**	2.8	9.5 **(10.0)**	5.6	**29 (29)**
IR5 Q2b inward [MGy]	**11**	1.9*	6.2* **(6.8*)**	7.5* **(9.1*)**	**27 (29)**
FLAT OPTICS				** assuming IR5 polarity inversion in 2023	
lumi averaged half cross. angle [urad]		130	130	130	
IR1 Q2a up [MGy]	**13**	1.7	6.0	8.0	**29**
IR1 Q2a down [MGy]	**11**	1.7	6.0	8.0	**27**
IR5 Q2b inward [MGy]	**11**	1.0	3.6	4.8	**** 20**

F. Cerutti, *et al.*

With the help of crossing angle polarity inversion, 235 fb^{-1} could be added at 14 TeV c.m. before reaching the 30MGy limit.

→ Additional 15fb^{-1} can be gained thanks to the parametric crossing angle variation (bare minimum gain without pushing down the average crossing angle)

Flat optics remain an interesting configuration for 2022/2023:
- →It would provide a **small additional margin in IR1**,
- →Preserve to **a sizeable extend the CMS triplets**, to serve as IR8 spare magnets for the HL-LHC era

Conceptual Design of Run-III optics

- The strategy on STABLE works **conceptually** → need to complete the picture with the full LHC Cycle

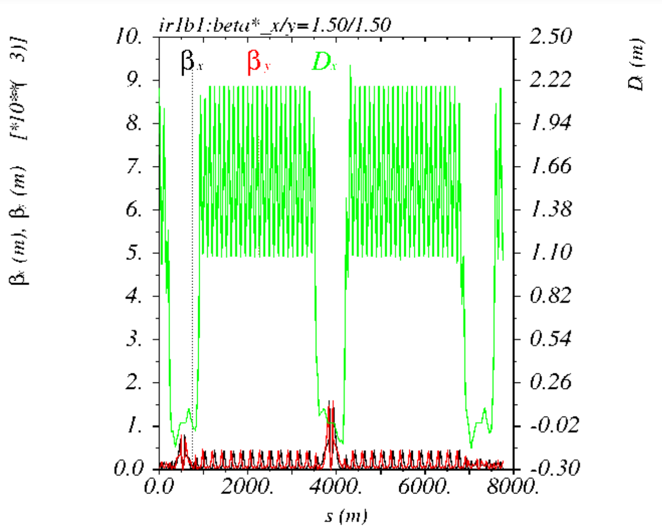
INJPHYS → Optics are a priori unchanged with respect to 2017/2018

RAMP → Telescope needs to be deployed to increase the efficiency of octupoles for Landau damping

~~**SQUEEZE**~~ → No SQUEEZE BP

STABLE
- → Collide & Squeeze → Large range of Start SB β^* & Tele-index of 2-3
- → Preference from FP to squeeze in tele-mode: keeping a constant R-matrix from the IP to the Roman Pots.
- → ATLAS/CMS : β^* leveling with adapting the crossing angle simultaneously
- → LHCb : Offset leveling & H crossing angle (V?) : $L \leq 2 \times 10^{33} \mathrm{Hz/cm^2}$ & $\beta^* = 1.5$ m
- → ALICE : Prepared for luminosity $L \leq 1.3 - 1.4 \times 10^{31} \mathrm{Hz/cm^2}$ (Ions disconnected ... ysics)

ROUND: β^* leveling from 1.5 m to 24 cm



Considering in addition, the allowed range of [1/4, 4] for the tele-index for match-ability, the only possible approach is to start the β^* leveling from an **anti-telescope**, **cross the 1/1** tele-index and continue in **telescopic SQUEEZE**.

Combined Ramp and Anti-Telescopic Squeeze (CRATS)

Concerning the anti-telescope

- Starting from an **anti-telescope configuration** we get:

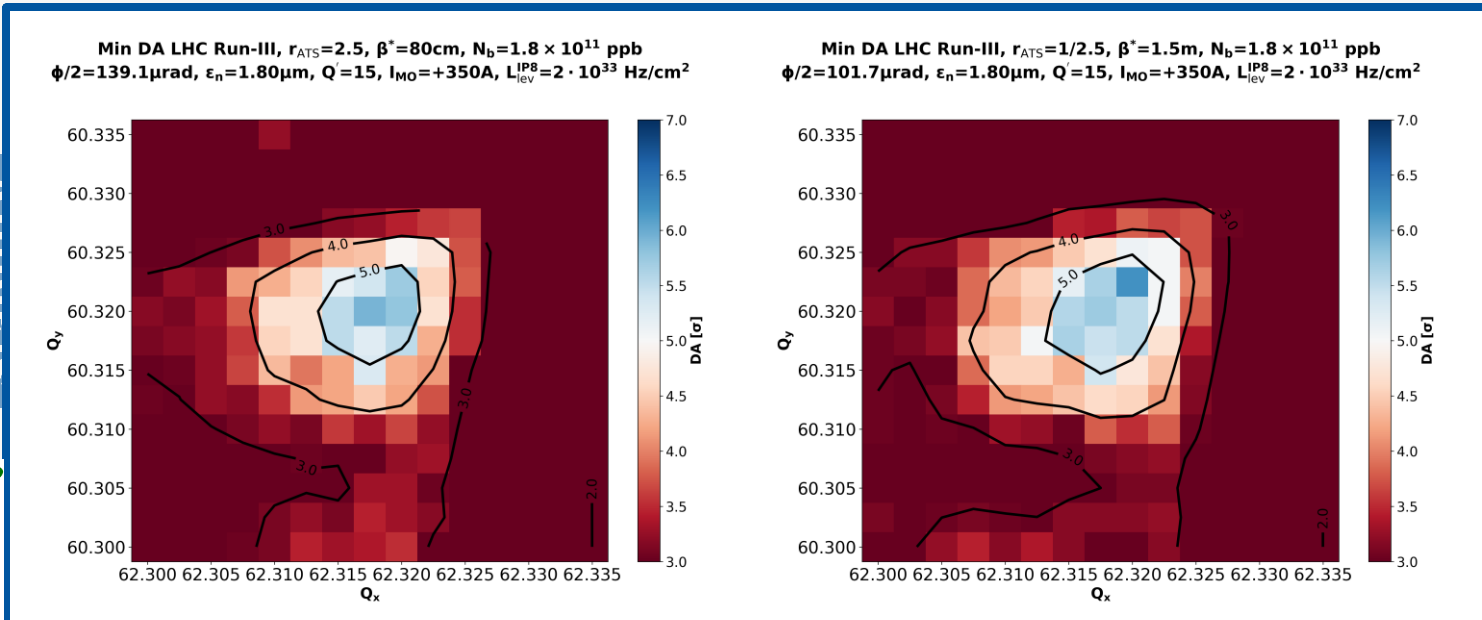
Predicted MO thresholds @ FT and benefits from (anti-)telescopic optics

MO thresholds [A] @ 7 TeV (I_{MO}>0) * Including factor 2.0 margin	2021 (1.4/1.8 brightness)	2022/2023 (1.8/1.8 brightness)
Tele index of 1 (standard)	430	550
Tele-index of 2.5 (telescopic)	275	350
Tele-index of 1.8 (telescopic)	350	455
Tele-index of 1/1.8 (anti-telescopic)	**350**	500
Tele-index of 1/2.5 (anti-telescopic)	305	**350**

** The ramp will a priori change from 2021 to 2022, unless good news in the MO measured thresholds.*

Choice of EoR telescopic parameters	2021	2022	2023
EoR β* [m] at IP1 & IP5	1.1	1.5	
EoR pre-squeezed β* [m]	0.6		
Tele-index (anti-telescopic)	0.6/1.1 = 1/1.8	0.6/1.5 = 1/2.5	

Beam-Beam



Beam Parameters at End of RAMP

	2021	2022	2023	Comment
Beam energy [TeV]	7.0			7 TeV is being re-discussed for Run III
Collisions at IP1/5 & IP2/IP8	2736/2736 & 2250/2376			Possible heat-load limitation not included
Bunch length [ns]	1.2	1.2	1.2	1.0 ns after ~10 h of SB, then kept constant
Normalized emittance [μm]	2.5	2.5	2.5	Huge margin taken (could be as small as 1.8 μm)
Bunch charge [10^{11} ppb]	0 → 1.4	1.4 → 1.8	1.8	Intensity ramp up within each year

OPTICS PARAMETERS @ Beginning of SB				
β^* [m] at IP1/5	**1.1**	**1.5**	**1.5**	**Anti-telescopic optics**
β^* [m] at IP2/IP8	**10.0/1.5**	**10.0/1.5**	**10.0/1.5**	**β^* @ IP2/8 is kept constant over the full Run**
Half X-angle [μrad] at IP1/5	108	102	102	V/H (resp. H/V) for round (resp. flat) optics levelling
Half X-angle [σ_{beam}] at IP1/5	12.4	13.6	13.6	Calculated with γε=2.5 μm
Peak lumi [10^{34} $cm^{-2}s^{-1}$] @ IP1/5	**0 → 1.55**	**1.19 → 1.98**	**1.98**	**Calculated with γε=1.8 μm (best lumi conditions)**
Half X-angle [μrad] at IP2/8	200/250	200/250	200/250	V/H at IP2/8 (V-Xing in IR8 under discussion)
Half ǁ sep. @ IP2 [σ_{coll}]	0 → 1.79	1.79 → 1.89	1.89	For $1.3 \times 10^{31} \mathrm{Hz/cm^2}$ & 200-70=130 μrad Xing
Half ǁ sep. @ IP8 [σ_{coll}]	0 → 0.76	0.76 → 0.97	0.97	For $2.0 \times 10^{33} \mathrm{Hz/cm^2}$ & 250+135=385 μrad Xing (worst case)

Beam Parameters at End of STABLE (Round Case)

ROUND OPTICS	2021	2022	2023	Comment
Beam energy [TeV]	7.0			7 TeV is being re-discussed for Run III
Collisions at IP1/5 & IP2/IP8	2736/2736 & 2250/2376			Possible heat-load limitation not included
Bunch length [ns]	1.0			1.0 ns after ~10 h of SB, then kept constant
Normalized emittance [μm]	2.5			
β* [m] at IP1/5	0.28			Telescopic optics
Half X-angle [mrad] at IP1/5	162 (9.4 σ_{beam})			V/H
Levelling time @ $2 \times 10^{34} Hz/cm^2$ [h]	**0.0 → 5.0**	**5.0 → 11.9**	**11.9**	**Burn off calculated with 110 mb (IR8 included)**
Optimal fill length [h]	-- → 9.8	9.8 → 14.6	14.6	Assuming a turn around time of 4 h
Bunch charge [10^{11} ppb]	0 → 0.89	0.89 → 0.97	0.97	
β* [m] at IP2/IP8	10.0/1.5	10.0/1.5	10.0/1.5	β* @ IP2/8 is kept constant over the full Run
Half X-angle [mrad] at IP2/8	200/250	200/250	200/250	V/H at IP2/8 (V-Xing in IR8 under discussion)
Half || sep. @ IP2 [σ_{coll}]	0 → 1.60(1)	1.60 → 1.64	1.64	For $1.3 \times 10^{31} \mathrm{Hz/cm^2}$ & 200-70=130 μrad Xing
Half || sep. @ IP8 [σ_{coll}]	0 → 0.13(2)	0.13 → 0.38	0.38	For $2.0 \times 10^{33} \mathrm{Hz/cm^2}$ & 250+135=385 rad Xing (worst case)

(1) **Lumi levelling at $1.3 \times 10^{31} \mathrm{Hz/cm^2}$ in Alice over the full fill length** is granted when the intensity ramp up reaches ~2×10^{10} ppb with 2250 collisions/turn

(2) **Lumi levelling at $2.0 \times 10^{33} \mathrm{Hz}/cm^2$ in LHCb over the full fill length** will be granted towards the end of 2021 @ 1.4×10^{11} ppb for negative LHCb polarity assuming 2376 collisions/turn [and earlier for positive polarity, with 115 μrad internal crossing, when the intensity ramp up reaches 1.15×10^{11} ppb].

A Performance Forecast

Experiment	Target for Run-III
ATLAS & CMS	As much as possible! (pileup < 60 events)
Alice	200 pb^{-1}
LHCb	> 15 fb^{-1} (50 fb^{-1} by LS4)

Theoretical maximum estimates, assuming

- **160 OP** days & **4h turnaround** time
- **Machine Efficiency:** 20% in 2021 and 50% later
- **Intensity ramp-up:** linear within a year
- **Peak Luminosity:** IP1/5: $2.0 \times 10^{34} Hz/cm^2$, IP2: $1.3 \times 10^{31} Hz/cm^2$, IP8: $2.0 \times 10^{33} Hz/cm^2$
- **Effective cross-section:** 110mb

	2021	2022	2023
Intensity ramp up [10^{11} ppb]	0 → 1.4	1.4 → 1.8	1.8
Round optics (Flat optics)			
Optimal fill length [h]	-- → 9.8 (10.8)	9.8 (10.8) → 14.6 (16.4)	14.6 (16.4)
β* [m] at IP1/5	0.28 (0.50/0.15)		
Integrated lumi in IR1/5 [fb^{-1}]	**18 (19)**	**97 (102)**	**106 (110)**
β* [m] at IP2	10.0		
Integrated lumi in IR2 [pb^{-1}]	36(1)	90	90
β* [m] at IP8	1.5		
Integrated lumi in IR8 [fb^{-1}]	**~ 3(2)**	**14**	**14**

→ 411 (421)

Exceeds target

(1) **Lumi levelling at $1.3 \times 10^{31} Hz/cm^2$ in Alice over the full fill length** is granted when the bunch population reaches ~2×10^{10} p/b with 2250 collisions/turn

(2) **Lumi levelling at $2.0 \times 10^{33} Hz/cm^2$ in LHCb over the full fill length** is granted when the intensity ramp up reaches 1.4×10^{11} ppb (resp. 1.15×10^{11} ppb) with 2376 collisions/turn for negative (resp. positive) LHCb polarity. A performance reduction factor of 50% has been applied accordingly in 2021.

Summary

- Pending the confirmation & possible updates of various equipment systems (MKI, RF, TCDS, TDE etc.), **the maximum bunch intensity accepted in the LHC is capped at 1.8×10^{11} ppb for Run-III**.
- The main guideline for Run-III scenarios must be the **preservation of triplet lifetime**
  ➔ Crossing angle as small as possible (eventually flat optics in 2022/2023).
- **"Simultaneously" adapting of β* (in tele-mode) and crossing angle** is the leveling strategy of choice for IP1/5 (offset leveling for IP2/8)
  ➔ **Beam-beam validation of the conceptual leveling**.
- Large dynamic range of EoR β* values & need for telescope in the RAMP ➔ **CRATS**
- **The SQUEEZE BP is skipped** ➔ Collide & Squeeze to reach $2.0 \times 10^{34} \mathrm{Hz/cm^2}$ as fast as possible following by β* leveling in tele-mode only (FP experiments).
- Restart in **2021** with **round optics**, decision for round/flat for 2022/2023 after the MD period of 2021.
- **Very preliminary performance estimates** (with many assumptions) show an integrated performance of **~110 $\mathrm{fb^{-1}}$ (2023) for IP1/IP5**, with >400 being within reach until LS3.

Short-time plan of the WG

- **Finalize the studies & consolidate the maximum intensity of 1.8×10^{11} ppb.**
- Test the validity of injection optics in terms of beam-beam
- Prepare the complete set of optics for the Run-III operation (Q2 2019)
- Validate the optics in terms of collimation, stability, beam-beam, estimated performance, etc.

➔ **1st report to the LMC : 6th of March**

Thank you for your attention!