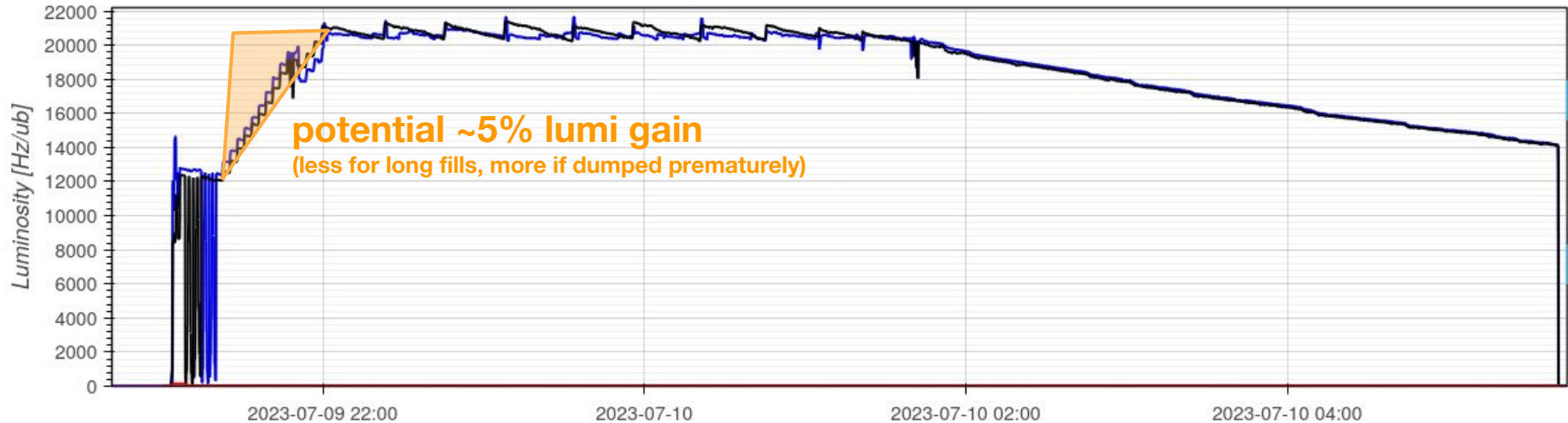


Faster beta* Levelling at the Start of Stable Beams

M. Hostettler

motivation

- the 1.2m \rightarrow 30cm beta* levelling range is tuned for $1.8e11$ ppb
 - not likely we will reach $1.8e11$ ppb in 2023
- beta* levelling can only take one step after the other
 - ~45 min to reach the target pileup
 - time spent in step preparation: **beam process time is only 4-5 min!**

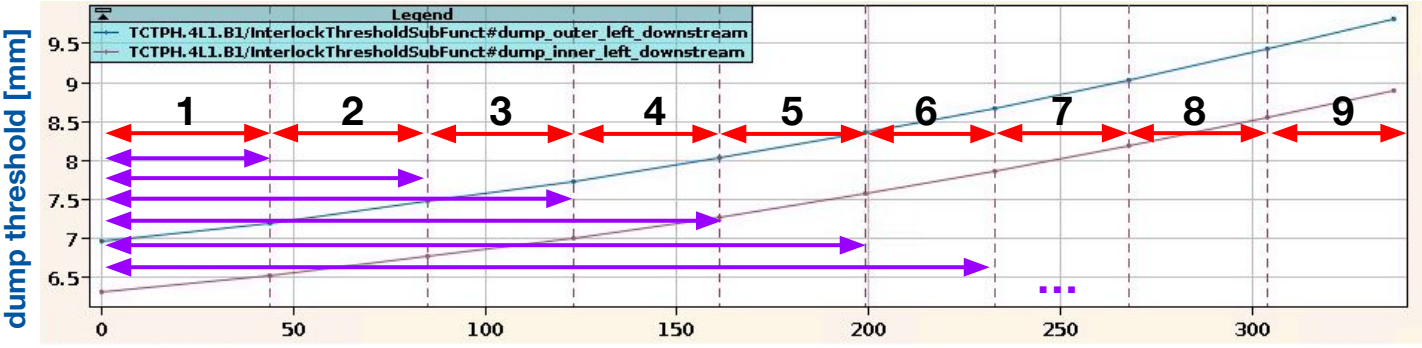


can we "skip" steps?

- **"skipping" steps: still play the full functions, in longer segments**
 - save the 1-2min to prepare all equipment at every step
 - shorten the ramp-up to < 10 min!
- **possible for PCs, OFB, PCInterlock, and TCT/TCL positions**
- **problem for TCT/TCL interlock thresholds**
 - **MCS settings**, segmented functions with signatures per segment
 - "joining" segments **breaks the signatures**
- **used regularly with setup beam in commissioning & MDs**
 - TCT/TCL interlock limits open
 - not an option with high intensity...

MCS revisited once again

- currently: functions split in segments + 1 signature per segment
- possible extension: "cumulative" signature table from start to any point



TCTPH.4L1.B1/InterlockThresholdSubFunc#sub_signatures	#
	1 705e7c321ea5785faba506c31099dbd23ce6b86117a7c322b1944828a65d9383546a92865ab1e21d773c99d91b702da9
	2 6dc4916cd0d1bbf610441c383b55eaf3cb2bcae67c126ffeed5f85ae2adcd03239023cf450dbaf0391bcdcb79b907afe03a
	3 1269abad2f46409d69b22e9a38fa8a6564c0b10f4b1c22234fcc7fd309db61bdc428b273f6ff2b28e362212d701ea540073
	4 0a7631700028ed32b8d45217660d044481c2e1e89a951b45595a8f585e8aeb2835fea6216927e8c4433c7578a85402abe
	5 0f4282e2e1227e2b045e759d0e566629732f740000e5f5e709777046f1e2775421b2b0790eb37d0e920e20f47b0

TCTPH.4L1.B1/InterlockThresholdSubFunc#sub_signatures_cumulative	#
	1 705e7c321ea5785faba506c31099dbd23ce6b86117a7c322b1944828a65d9383546a92865ab1e21d773c99d91b702da9
	2 762924f264ba98773e05bdb7a98ee16db2587a30e4b0eafc368f05e89ab452af4630c0504a47de479deef7313e0fcdf0
	3 17fc670029f1c2a2d38a738032c10d51a4d4db6ee30f320b82356238d164bf630618c2c28486b1d8720b928172cbb6d4335
	4 06f1930fbf342770f739e0c9d3cf08f049e48a4255413427c08e54f928cf0391923ad7cfe346257435871b0611ea2df54e37f
	5 5b85f9c05bf139ed54befad3e2e6e789e5ce984ec491bdb2bcab0ad37e6df3e58a5c5c281ad4553dae6ee94a9198980d

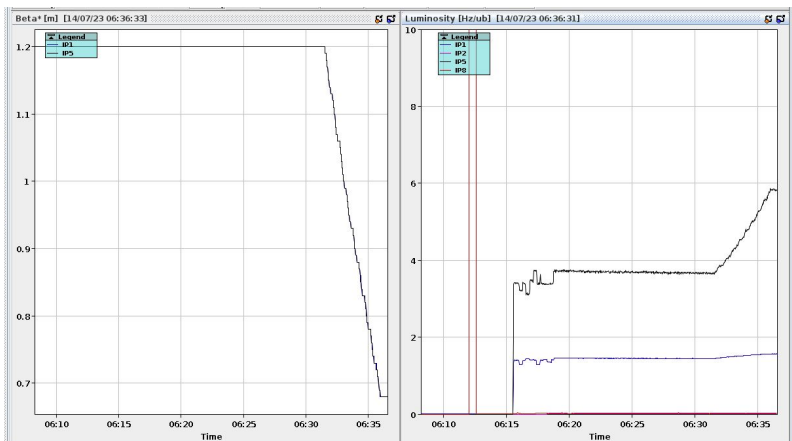
proposal & implications

- **add an MCS "cumulative" signature table**
 - allow jumping **from 120cm** to any beta* levelling step
 - starting from any later step: single steps only
 - no arbitrary jumps, no de-squeeze
- **in physics fills: jump from 120cm to ~68cm**
 - 1-2 steps below the experiment's pile-up target
 - to be fine-tuned with intensity
- **risk: jumping too far from the start**
 - overshoot of pile-up (experiments) and lumi (cryo)
 - risk to lose IT cryo conditions and saturate experiments
 - possible mitigation: remove cumulative signatures beyond 60cm?
 - prevent jumping beyond 60cm

commissioning

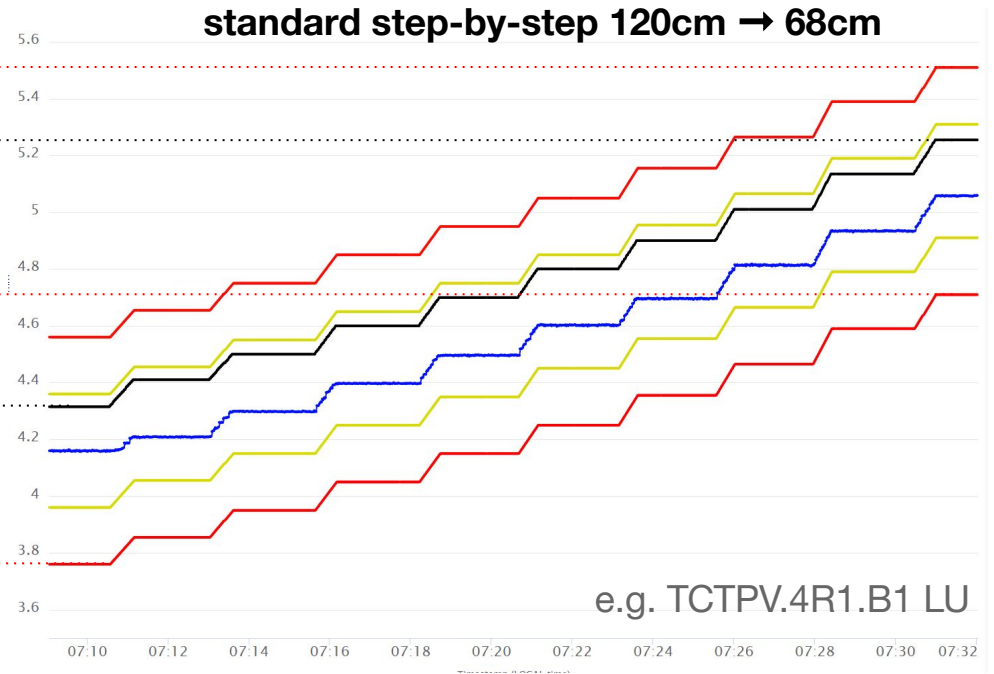
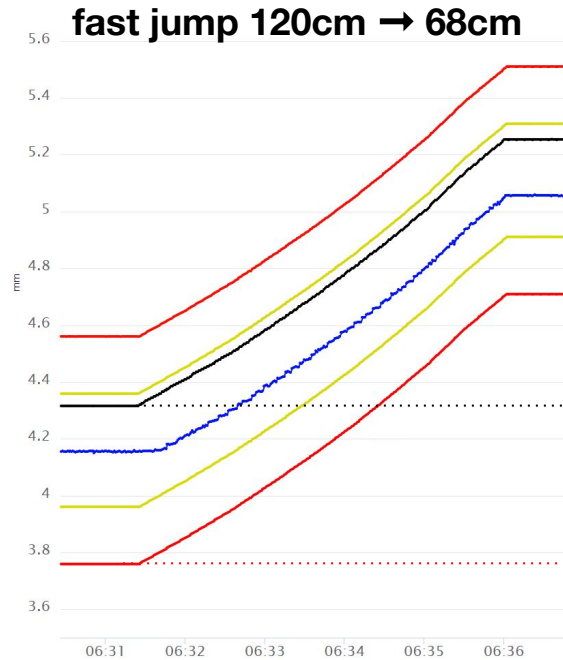
- **test with setup beam (2x2 bunches) done**

- yesterday night, in the shadow of the CMS magnet downtime
- good opportunity: taking physics time would have nullified the gain
- test successful: jump to 68cm then continue levelling step-by-step



```
TCTPV.4L1.B1: 0 -> 277 using cumulative limit function (index 0 -> 8)!  
TCTPH.4L1.B1: 0 -> 277 using cumulative limit function (index 0 -> 8)!  
TCTPV.4L2.B1: 0 -> 277 using cumulative limit function (index 0 -> 8)!  
TCTPH.4L2.B1: 0 -> 277 using cumulative limit function (index 0 -> 8)!  
TCTPV.4L5.B1: 0 -> 277 using cumulative limit function (index 0 -> 8)!  
TCTPH.4L5.B1: 0 -> 277 using cumulative limit function (index 0 -> 8)!  
TCTPV.4L8.B1: 0 -> 277 using cumulative limit function (index 0 -> 8)!  
TCTPH.4L8.B1: 0 -> 277 using cumulative limit function (index 0 -> 8)!  
TCTPV.4R1.B2: 0 -> 277 using cumulative limit function (index 0 -> 8)!  
TCTPH.4R1.B2: 0 -> 277 using cumulative limit function (index 0 -> 8)!  
TCTPV.4R2.B2: 0 -> 277 using cumulative limit function (index 0 -> 8)!  
TCTPH.4R2.B2: 0 -> 277 using cumulative limit function (index 0 -> 8)!  
TCTPV.4R5.B2: 0 -> 277 using cumulative limit function (index 0 -> 8)!  
TCTPH.4R5.B2: 0 -> 277 using cumulative limit function (index 0 -> 8)!  
TCTPV.4R8.B2: 0 -> 277 using cumulative limit function (index 0 -> 8)!  
TCTPH.4R8.B2: 0 -> 277 using cumulative limit function (index 0 -> 8)!
```

commissioning



→ **proposal: start with small jumps in physics**

- e.g. first fill, jump 2 steps, then 4, 6, ...

conclusions

- **faster beta* levelling ramp-up could gain ~5% integrated luminosity**
- **segmented collimation limits (MCS) do not allow skipping steps**
- **add MCS signatures for "cumulative" limit functions**
 - allow going from 120cm to any point in the squeeze
 - limit signatures to $\geq 60\text{cm}$?
- **software ready, test cycle with setup beam done**
- **proposal: start using the jump in physics**
 - start with small jumps, increase fill by fill
 - final goal: go to target minus ~5%
 - ~68cm, depending on bunch intensity

spares

commissioning

- **the software changes are ready, but not yet released**
- **introducing such a change with 2400b is not ideal**
 - but similar mechanics used during commissioning / MDs
- **integrated luminosity gain would be lost by dedicated test fill(s)**
- **proposal:**
 - **dry run during the next access day**
 - PCs in simulation, collimators & limits moving
 - **parasitic test at the next opportunity?**
 - e.g. MD cycle, no trains available from injectors, ...
 - ideally 3x3 nominal bunches, collisions in all IPs
 - **start with small jumps in physics**
 - e.g. first fill, jump 2 steps, then 4, 6, ...