Review of BI specs for TT21/22/23/24/25

F.M. Velotti, V. Kain, Y. Dutheil, M. Fraser

Previous documents and specs

- Initial specifications for TT20 and other primary lines covered already a large part of the new instrumentation needed
- After 2021 startup, and in the context of the review of the issues had, it was decided to review our requests
  - Original request: https://edms.cern.ch/document/2113420/0.1
  - This document was discussed already in the context of the SLAWG with BI colleagues – proposed changes included already feedback on what could be done and to not explode in terms of cost
- We are now summarising all the changes that **ideally** we would do to these lines

Beam parameters assumed

- For the specification we have used the assumptions in the tables on the side
- It was agreed in the NA meetings that clear numbers taking into account also possible future projects, should be provided – **they are not these ones!**
- Brennan and Gianluigi will follow this up

Parameter	Value	Unit	Comment
Particle type	protons		
Nominal pulse intensity	~ 3 - 4 × 10^{13}	p/spill	Typical operational intensity
Set-up pulse intensity	~ 2 × 10^{12}	p/spill	Low intensity used for beam set-up
Extraction rate fluctuations(1)	3x average nominal rate		Detector should be resilient to short spikes in rate (~20 ms) at start and end of spill.
Pulse (spill) length	1 - 10	s	BDF and MD spills can be as short as 1 s spill, but up to 10 s should remain possible for NA
Pulse structure(2)	D.C.	-	Baseline is a DC beam: there may be future scenarios with bunched extraction (200 MHz)
Repetition period	> 7.2	s	Minimum cycle length with a 1.2 s flat-top
Integrated extracted intensity (POT)	< 5 × 10^{19}	p/year	Maximum annual flux foreseen with BDF operation
Circulating beam size (rms)	~ 1 × 1 [H × V]	mm	Along LSS2: Gaussian distribution
Extracted beam size at electrostatic septa (ZS) (total)	~ 10 – 20 [H]	mm	H: non-Gaussian distribution, V: beam size same as circulating beam

Parameter	Value	Unit	Comment
Particle type	$^{208}Pb_{82}$		Xe also used
Pulse intensity	~ 4 × 10^{8}	charges/spill	
Pulse length	< 10	s	
Pulse structure	D.C.	-	Baseline is a DC beam
Repetition period	16.8 – 25.2	s	

Changes already in place

- The different monitors in the TT20 lines are now PPM
- We access to data on the different BSPs, BSGs and BSIs in time along the spill with sampling rate of 20 ms
- Six additional BLMs have been installed along TT20 during YETS 17/18
- Two new diamond BLMs have been installed in LSS2 and start of TT20, although they have not been commissioned yet
- A longitudinal BLM has been installed (refurbished) but it is not been commissioned yet

Requests for new instrumentation - position

- Available BSPs in TT20 lines are very difficult to use for any optics measurements
  - Position measurement becomes unreliable as soon too far off from center
  - Not reliable for non-symmetric distribution
- Requests to have devices to measure accurately position at all locations of BSPs => replace BSPs with BPMs or BSGs or equivalent
  - Are BPMs an option? 200 MHz and 40 kHz still present in the first part of the extraction – could this be used for BPM?
  - We could define an operational scenario with RF on, like move to amplitude extraction to be able to extract bunched beams with not too high losses
  - Exhange should be performed in TT21/22/23/24/25
  - Higher priority for TT22/23/24/25

Line	Number or BSPs
TT21	19
TT22	3
TT23	4
TT24	4
TT25	5

Requests for new instrumentation – beam size

- Large coverage with BSG provided already in vertical, but quite a few key locations missing in horizontal
- We need to increase the horizontal coverage especially after the splitters and before the targets
  - **Request to have at least 3 BSG per plane per line** (see table for what is missing)
- Replace 3 BSPs with BSGs as in specification document (see also here) for TT21
- Refurbish BTVs in 2116 (~ 20 m upstream first MSSB), 2117 (~20 m downstream first MSSB) and 2204 (~20 m upstream of second MSSB) and provide resolution of 1-2 mm
- Single-shot beam profiles before and after the extraction septa (ZS, MST, MSE) are requested with a resolution approaching 0.1 – 0.2 mm
- If possible, add FISKs in the line for accurate beam profile measurements and time-resolved

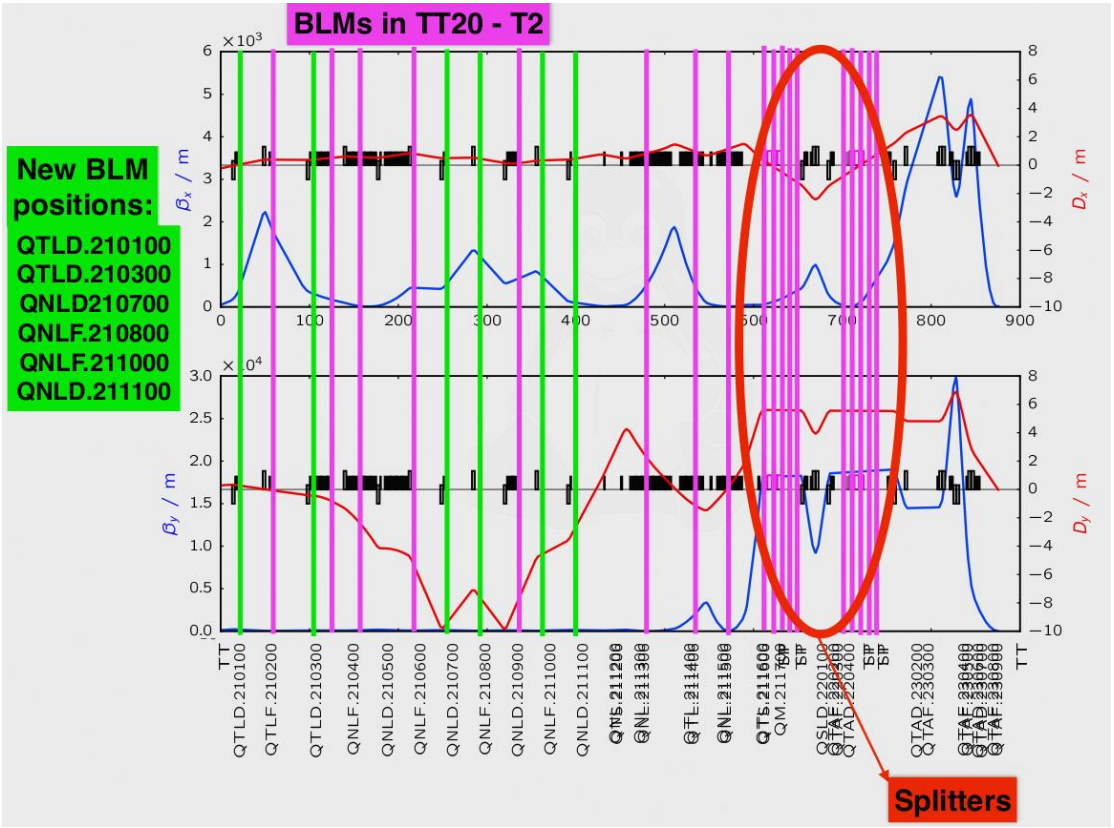
Line	Number of BSGHs to add	Number of BSGVs to add
TT22	2	-
TT23	2	-
TT24	2	1
TT25	-	-

Requests for new instrumentation – intensity

- BCT exploiting remanent harmonics in spill? Or again exploit special operation mode to allow extraction of bunched beam for calibration
- High-bandwidth spill monitor needed to assess harmonic content of extracted spill
  - It is needed to be able to resolve 43 kHz (revolution frequency) and twice that (86 kHz as 2 batches)
  - Up to 200 MHz (RF frequency) would be ideal for accurate measurements of spill quality
  - Ensure low noise first BSI in TT20 for accurate noise compensation (high BW not needed for this)
  - Future experiments are requesting knowledge of the beam harmonics up to 10 GHz
  - Spill monitor should be sensitive enough to allow measurements with ions too
- For long term prospects (post-LS3), it was proposed to investigate a possibility to measure beam intensity at %-level
- For now, working on procedure to calibrate BSIs in TT20

Requests for new instrumentation – losses

- **<u>TT23/24/25 not equipped with BLMs: request to add 1 BLM per quadrupole in these 3 lines (lines from splitters to primary targets)</u>**
- LHC BLMs available in LSS2, but in non-PPM mode: request to have them in the SPS timing system to be able to simplify readings and integrate with standard tools



Summary

- Specification for primary line to NA completed with all unrestrained desires
- ASAP:
  - High BW spill monitor and low noise spill monitor
- Highest priority items:
  - Add BSGs in TT22/23/24 to achieve at least 3 BSG per plane per line
  - Replace all BSPs with BPMs/BSGs or any other position device to improve measurement quality and range
  - Refurbish BTVs at splitter location for real beam size measurements
  - Add 1 BLM per quadrupole in TT23/24/25