




HL-LHC WP2 Actions for HSC section (as of 14/08/2020)

E. Métral

(with BenoitS, CarloZ, GianniI, LottaM, NicolasM, NicoloB and XavierB
+ DOCT/FELL/PJAS => Many thanks to/for all!)

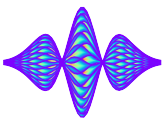
=> See: <https://espace.cern.ch/HiLumi/WP2/Wiki/Team%20Discussions.aspx#InplviewHashb2a491d2-3a67-4ac3-92de-118f681bffb=FilterField1%3DStatus-FilterValue1%3DIn%2520Progress>

 Impedance police	...	<input type="checkbox"/> Elias Metral	In Progress	(2) Normal	31/12/2020
 Beam-beam strong strong actions	...	<input type="checkbox"/> Elias Metral	In Progress	(2) Normal	31/12/2020
 Actions on transverse stability	...	<input type="checkbox"/> Elias Metral	In Progress	(2) Normal	31/12/2020

 Electron cloud effects - coherent and incoherent effects	...	<input type="checkbox"/> Giovanni Iadarola	In Progress	(2) Normal	31/12/2020
 Electron cloud build-up	...	<input type="checkbox"/> Giovanni Iadarola	In Progress	(2) Normal	31/12/2020



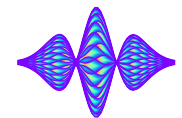
Questions from GA



- ◆ Make a plan for addressing them
- ◆ Look also at the pending actions for the other WPs to see if we have a complete list of the points for which we need input



Impedance (BS&NB&CZ et al.)



1. Y chambers in 1/2/5/8:

- a. Obtain the drawings of the 'as installed' Y-chambers in 2-8 and re-evaluate their impedance.

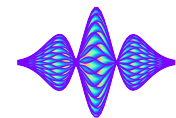
Presented at WP2 meeting on 2/4/2019 (<https://indico.cern.ch/event/804347/>).

IR2 and IR8 Y chambers (from meeting on 10/3/2020 - <https://indico.cern.ch/event/881273/>): Convergence not yet found. Remain to be added to the impedance model though the impedance is expected to be small.

=> Will be added by end of this year. Low priority though, since low impact: Y chambers in IR1 and 5 have already a very small impact in transverse (a few kOhm/m) and beta functions smaller in IR2 & 8



Impedance (BS&NB&CZ et al.)



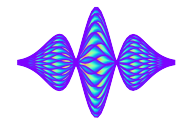
2. Triplet BPMs:

- a. Design is now finalized as presented at the HL-TC on 21/9/2017: [https://indico.cern.ch/event/666310/contributions/2722980/attachments/1527764/2389507/BI Hilumi TCC 21st Sept 2017 IRBPM.pptx](https://indico.cern.ch/event/666310/contributions/2722980/attachments/1527764/2389507/BI_Hilumi_TCC_21st_Sept_2017_IRBPM.pptx) . Need to update the impedance estimates including possible coating of the BPMs
This should be done by end of February 2019. 3D models were being simulated at WP2 meeting on 2/4/2019. Action Gianluigi to verify the status with R. Jones. E-mail to Rhodri on 18/10/2019: drawings passed to B. Salvant and N. Biancacci. **No additional information at the WP2 meeting on 10/3/2020** (<https://indico.cern.ch/event/881273/>). **Status**

=> Discussion in April 2020 on the tapering angle, design not finalized and will be provided to us (by mid-October). Deadline Spring 2021 (if needed we could do it before, putting less priorities on other items)



Impedance (BS&NB&CZ et al.)



3. Special BPMs:

- a. EO-BPM for crabbing
- b. QPU for emittance meas.
- c. Cherenkov Monitor for Longitudinal Meas

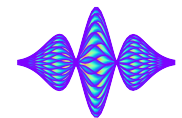
will be installed between Q5 and Q6 in iP4 (see presentation at WP2 meeting on 11/6/2019 - <https://indico.cern.ch/event/823530/>)

The impedance of these objects should be studied. No additional news during meeting on 10/3/2020 (<https://indico.cern.ch/event/881273/>).

=> No news (waiting for info from ThibautL)



Impedance (BS&NB&CZ et al.)



4. **New deformable RF fingers:**

- a. No pending points remaining

5. **ALICE vacuum chamber:**

- a. No issue expected for HL-LHC

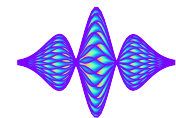
6. **VELO**

- a. No pending point remaining

=> SMOG2 RF fingers buckling issue to be assessed. BenoitS brought it to the TREX meeting where MikeL mentioned that vacuum should follow this up closely. Will this stay after LS3? What will replace SMOG2?



Impedance (BS&NB&CZ et al.)



7. MKI:

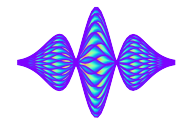
Further discussion on the subject in WP2 meeting on 10/3/2020 (<https://indico.cern.ch/event/881273/>). From the point of view of the design the new MKI is OK for HL-LHC still cost benefit not estimated → **passed it to the TCC.**

8. CMS vacuum chamber:

a. None



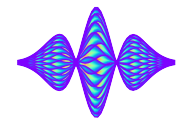
Impedance (BS&NB&CZ et al.)



9. HL-LHC Crab Cavities:

- a. From WP2 meeting on 29/1/2019 (<https://indico.cern.ch/event/788818/>): **Analysis of the stability and heat load in the presence of the crab cavity HOM should be repeated also for the 8b4e beam and possibly for hybrid schemes.**

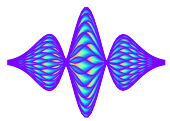
=> Will be done with the new tables that will be provided by James. Latest RFD table received but they are still working on the DQW one (not known when we will receive it). Transverse beam stability analysis done for 25 ns (most critical case). Deadline end of the year (for what we received). What about the other updates which might be needed in the future?



10. Collimators:

- a. Study scenario of operation with asymmetric opening of the collimators (secondaries). **This is still interesting for the collimation team. Impedance estimate should be done for the configuration proposed by the collimation team (see proposal made at ColUSM on (<https://indico.cern.ch/event/736735/>)). WE should also determine the sensitivity matrix of impedance reduction (relative reduction of the octupole current) per mm asymmetric opening of one of the jaw for the various primary and secondary collimators.**
- b. From WP2 meeting on 10/3/2020 (<https://indico.cern.ch/event/881273/>). Impacted graphite collimators (at HiRadMat) have been measured (cavity measurement) both for Cu and Mo coating (coating done at CERN). Resistivity is approximately 70 nOhm.m for both Mo and Cu coated non-impacted surfaces and it increases to 140 (Mo) and 160 (Cu) nOhm.m in the impacted areas. The intensity of the beam impacting the collimator jaws should be specified and the measurements of the jaws impacted with lower intensities should be performed too. (**Action: Benoit**)
- c. Measurements of the coated irradiated (at GSI) samples should be performed with a new RF cavity. **Action: Nicolo**

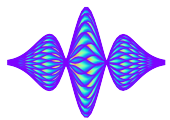
a) => The study of Dimitr Kodjaandreev (master student of Alessio Mereghetti in 2018) should be reviewed (it was not presented at the WP2). David Amorim implemented in the LHC model the possibility to put asymmetric settings, but a large scale study of the impact on the octupole threshold still needs to be done, and both implementation and impact study remains to be done for HL-LHC. This is a long-term effort (manpower not assigned yet) and one issue is that Alessio is now gone. What is the priority to assign to it for HL-LHC? Reminder: it is currently an important aspect which needs to be checked for LHC



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b) => Very important action and BenoitS et al. will do their best, but 2 pbs here: 1) activation and 2) what are we allowed to do to the collimators (since collimation team wants to keep them as spares)? Proposed deadline: end 2021



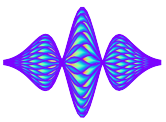
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- c. Measurements of the coated irradiated (at GSI) samples should be performed with a new RF cavity. **Action: Nicolo**

c) => Ongoing. Both BNL and GSI types of samples have been measured without irradiation. Next: GSI samples have been already irradiated and the measurements will be performed before the end of the month. BNL measurements are being planned for 2021



Impedance (BS&NB&CZ et al.)



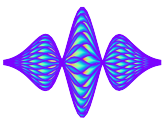
11. Hollow electron lens:

- a. From meeting on 10/3/2020 (<https://indico.cern.ch/event/881273/>): no design change so far. Update in September 2020?

=> There was a recent update. Still not a final design, especially the instrumentation (BGC). A new non-standard stripline monitor was included and the results were presented at the HSC section meeting on 28/09/2020. Regarding the “impedance of the electron beam itself”, the situation should be reviewed by the end of the year



Impedance (BS&NB&CZ et al.)



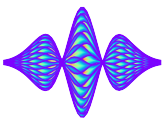
12. Crystal collimator

- a. Studies ongoing but no solution found yet for a design without replacement chamber. Status?

=> For protons there will be a replacement chamber. For ions, the work was already done in the longitudinal plane by the collaborators from La Sapienza. What is missing is the transverse part: will be done by BenoitS et al. by the end of the year (as it is requested for this date)



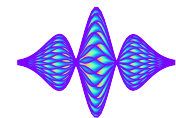
Impedance (BS&NB&CZ et al.)



- 13. Beam Screen:**
 - a. None



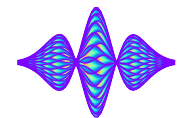
Impedance (BS&NB&CZ et al.)



14. Other LHC BPMs:

- a. From WP2 meeting on 03/09/2019 (<https://indico.cern.ch/event/840137/>): Impedance Simulation of possible modes for shorted BPMs should be performed

=> Study performed by a student from BenoitS and CarloZ (Otto Ellonen), see report on CDS: <https://cds.cern.ch/record/2687361>. Some future work could be done (studying in detail the transverse dipolar and quadrupolar contributions, etc.). Which priority should we put on this (proposed low priority)?



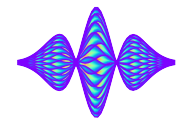
15. General:

- a. Impedance model updated and presented at the meeting on 10/3/2020 (<https://indico.cern.ch/event/936313/>) and on 28/7/2020 (). Missing elements to be included in the model:
 - i. Hollow electron lens => Not estimated yet
 - ii. Crystal collimators => Just a tube for protons
 - iii. Y chambers IR2/8 => Still to be done
 - iv. MKI (added?) => Already in since 10/03/2020
 - v. Update the model to consider the more realistic resonant frequency of 5 GHz instead of 50 GHz for the broad band impedance contribution

=> It is for the longitudinal plane and it will be done by TheoA, as agreed with RamaC



Impedance (BS&NB&CZ et al.)



16. BGVs

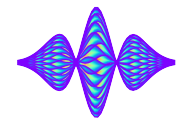
- Study just started and BI would like to write the TDR by end of 2021
- BGV demonstrator does not work (and it is not known yet why), and will not be used in Run 3 => Should it be removed?
- Reminder: 1 BGV needed per beam in IR4 (beta function should be 200 m to 300 m)

17. BGIs

- Study not started yet, as they are still working on devices for PS, then SPS (which should be compatible with LHC). It should come in January 2021

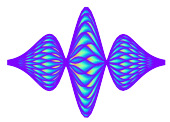


Transverse beam stability (NM&XB et al.)



1. From WP2 meeting on 16/4/2019 (<https://indico.cern.ch/event/804350/>): continue the studies to determine the dependence of the stability limits on the longitudinal distribution at low chromaticity (**Action: Elias**) – **Q4 2020**

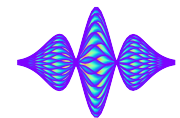
=> Done by XavierB and presented during the HSC section meeting of 10/08/2020. Discussion between XavierB and AdrianO (who studied this also with PyHT in the past) to document their nice studies in PRAB for ~ Spring 2021



Transverse beam stability (NM&XB et al.)

2. From WP2 meeting on 9/7/2019 (<https://indico.cern.ch/event/831847/>):
 - a. Examine whether the growth rates of the observed instabilities are consistent with models. G. Mazzacano compared the measured and modelled growth rates for an MD in 2017 and XavierB presented the results at Evian 2017. No significant discrepancy was found. To be repeated for 2018 MDs. Q1 2020
 - b. From WP2 meeting on 10/3/2020 (<https://indico.cern.ch/event/936313/>). Some significant changes in the measurements performed on collimators cannot be explained yet:
 - i. TCP.C6L7.B1 was replaced by a collimator equipped with BPM between two measurements. An analysis should be done to see whether the change of HW can explain the observed difference. **Action: Nicolas**
 - ii. Change of resistivity due to irradiation could be a possibility. It is definitely important improve the precision of the measurements of the variation of the resistivity of the MoGr and Mo coated MoGr as a function of the radiation dose. **Action: Nicolo to proceed with measurements with smaller RF cavity.**

a) => This exercise was not redone in 2018 but it was done in detail for 2017 (in the instability table generated): rise-time seems too low (even if the peak of the distribution was “about right without Landau damping”...). Next: try and study new experimental methods to validate the modelled growth rate (end 2021)

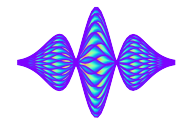


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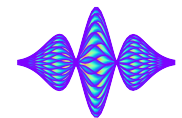
b.i.) => Done (WP2 meeting of 29/09/2020)

b.ii) => Ongoing (see point 10.c))



3. From WP2 meeting on 02/06/2020 (<https://indico.cern.ch/event/920529/>):
 - a. Estimate impact on required octupole current to stabilize the beam from expected collimator misalignments. **Action: Nicolas, Roderik**

=> Proposed deadline end of 2021. Furthermore, we will try to measure it with beam during Run 3

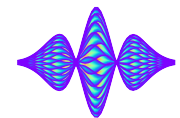


4. From WP2 meeting on 28/7/2020 (<https://indico.cern.ch/event/934794/>):
 - a. Assess possible limit on amplitude noise from crab cavities resulting from instability latency considerations. **Action: Xavier**

=> Half done (simulations done) and the plan is to extend the study with damper and chroma: proposed deadline ~ Spring 2021



Beam-beam strong-strong (XB)

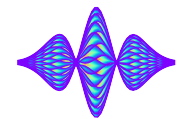


1) Finalize note on Strategy for Landau Damping of head-tail instabilities at top energy in the HL-LHC

=> After another iteration with GA and RT, XB sent the new version of the 28-page note on 16/09/20 (<https://cernbox.cern.ch/index.php/s/JPM3ER2w4ktdCJI>). No news since then



Beam-beam strong-strong (XB)

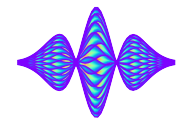


- 2) From WP2 Meeting on 08/05/2018 (<https://indico.cern.ch/event/726041/>): PACMAN bunches having different orbits might feature different separations during the collision process and cross minimum of stability at different timings. **Action: Xavier to verify. Not urgent but should be done.**

=> The statement is correct but it doesn't really impact the strategy since the speed of the collapse is such that the separation from 2 to 0 sigma is done in less than a second



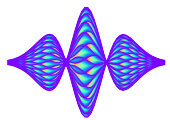
Beam-beam strong-strong (XB)



- 3) Studies to be performed for back-up/alternative scenarios:
 - a) Evaluate the dynamic effects (tune, orbit, chromaticity) when going in collision for:
 - i) Flat optics. **Not urgent**

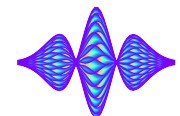
=> Nothing done yet (as it is a big work). Next year seems from us to be the right year to do it

Beam-beam strong-strong (XB)



- 4) Possibility to suppress the installation of MS in Q10 in IR1 and 5: **limit for beta* is > 21 cm without MS10 upgrade**. Update presented on 10/9/2019: <https://indico.cern.ch/event/844767/> and key parameters for the various solutions summarized and circulated. Another presentation on WP2 meeting on 25/2/2020 (<https://indico.cern.ch/event/886762/>). **So far the most appealing solution appears the No MS10 solution with phase advance optimization. Feedback from BB WS simulation studies to be provided with new operational scenario.** Review of the situation without MS10 at the beginning of collisions and at the end of the leveling with the right intensity and crossing angle for positive octupole polarity. Optimization of the phase advance with beam-beam effects included checking also interactions with pacman effects. **(Action: Sofia, Xavier)**

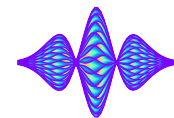
=> From the point of view of PACMAN effects, we saw that even the worst phases advance can be tolerated, so the only actions remaining concerns DA (for round optics). For flat optics: proposition to study this next year



- 5) From WP2 presentation on 21/4/2020 by Xavier (<https://indico.cern.ch/event/903324/>). The possibility of introducing a separation in the crossing plane could help to reduce the strength of the octupoles required to stabilize the beam. **Action: Xavier to study and confirm this. See presentation on 28/7/2020 (<https://indico.cern.ch/event/934794/>).** Further investigations are required as a new type of mode coupling instabilities has been revealed.

=> XavierB ran COMBI with the full 6D lens in some cases and he could not reproduce the instability predicted by BimBim. In some sense, it is good news as it suggests that it is Landau damped. On the other hand, it could also be a bug/numerical artefact in one or the other code. XavierB has implemented a linearized 6D lens in COMBI to investigate in more details, simulations are now running. Recent news: simulations more difficult than expected (6D lens very time consuming) => Proposed deadline: ~ Summer 2021

Master plan (as of 25/09/2020)



	Transverse impedance and beam stability limits		Longitudinal impedance and Beam induced heating		Electron cloud effects		Noise levels, accuracy, precision, resolution	
	Input	Date	Input	Date	Input	Date	Input	Date
	WP4							
Acceleration cavities and RF systems								
RF Crab cavities in SPS LSS6		Completed		Completed				
RF Crab Cavities in LHC IR1 and IR5		Completed		Completed		31.12.21		31.12.23
RF 400 MHz								
Transverse damper								31.12.23
WP5								
Collimation								
TCSPM IR7		Completed		Completed		Completed		
TCLD IR7		Completed		Completed		Completed		
TCLM IR1/5		31.12.22		31.12.22		Completed		
TCL IR1/5		31.12.22		31.12.22		31.12.22		
TC TPM IR1/5		31.12.22		31.12.22		31.12.22		
HEL		31.12.22		31.12.22		31.12.22		31.12.22
Crystals		31.12.20		31.12.20		31.12.20		
WP6B								
Warm powering								
Main dipoles and quadrupoles								31.12.24
WP9								
Cryogenics								
IP1/5 Triplets				Completed		31.12.20		
IP1/5 RF Crab Cavities				Completed		31.12.21		
IP1/5 Matching section				Completed		31.12.20		
IP2/8 Triplets				Completed		Completed		
IP2/8 Matching section				Completed		Completed		
Other IRs				Completed		Completed		
Arcs				Completed		Completed		
WP12								
Beam vacuum								
IR1/5 vacuum components and layout		31.12.23		31.12.23		31.12.23		
IR2/8 vacuum components and layout		Completed		Completed		Completed		
Exp.Vacuum chambers IP1/5 and VAXes		Completed		Completed		Completed		
WP13								
Beam diagnostics								
BPMs		31.12.24		31.12.24		Completed		31.12.21
Crab Cavity related instrumentation		31.12.24		31.12.24		31.12.24		Completed
Beam Profile monitors		31.12.24		31.12.24		31.12.24		31.12.25
BBLR Compensator test		Completed		Completed				