# Minutes of the HL-LHC WP2 Task 2.4

# 8th (VIDYO) meeting on Wednesday 26/03/2014 (11:00-12:30, 6/R-018)

**Task 2.4 members**: Alexey Burov (AB), Alessandro Drago (AD), Alessandro Gallo (AG), Andrea Mostacci (AM), Alessandro Vivoli (AV), Benoit Salvant (BS), Bruno Spataro (BrunoS), David Alesini (DA), Deepa Angal-kalinin (DAK), Elias Metral (EM), Elena Shaposhnikova (ES), Fabio Marcellini (FM), Fritz Caspers (FC), Frank Zimmermann (FZ), Gianluigi Arduini (GA), Giovanni Rumolo (GR), Hugo Alistair Day (HAD), John Jowett (JJ), Kevin Li (KL), Luigi Palumbo (LP), Mauro Migliorati (MM), Michel Martini (MM), Mikhail Zobov (MZ), Nicolas Mounet (NM), Nicolo Biancacci (NB), Oliver Boine-Frankenheim (OBF), Olga Zagorodnova (OZ), Oscar Frasciello (OF), Paul Goergen (PG), Rainer Wanzenberg (RW), Uwe Niedermayer (UN), Wolfgang Hofle (WH).

**Present**/Excused: AB, AD, **AG (Vidyo)**, AM, AV, **BS**, BrunoS, DA, DAK, **EM**, **ES**, FM, FC, FZ, **GA**, GR, HAD, JJ, **KL**, LP, MM, MichelM, **MZ (Vidyo)**, **NM**, **NB**, OBF, OZ, **OF**, PG, **RW (Vidyo)**, UN, WH, **Juan Esteban Muller**, **Giovanni de Michele**.

## 1) General information (EliasM):

- Newcomer: Nicolo Biancacci => Fellow (on impedance and related effects for HL-LHC) as of 01/02/2014 with Benoit Salvant as supervisor. Has been added to the mailing list.

- Kevin Li should have been already included in the mailing list => To be checked by KevinL and EliasM.

- WP2 Task leader meeting on 21/03/14 (https://indico.cern.ch/event/307357/material/minutes/minutes.html) => Several actions for us following the Vacuum Technical meeting which took place on Wednesday 5/3/2014 => See Actions below.

- Some news about the 2nd RF system in HEADTAIL by KevinL

  - It has been checked, it is working and it should then be possible to perform detailed beam instabilities studies in the presence of 2 RF systems (400 and 800 MHz, and then 400 and 200 MHz) => Some simulations are ongoing.

  - A first discuss on the results will take place on 09/04/14 (next meeting).

**2) HL-LHC (and LHC) longitudinal collective effects with 1 RF system (400 MHz) or 2 RF systems (400 + 800 or 400 + 200) by Elena Shaposhnikova: https://indico.cern.ch/event/308981/contribution/0/material/slides/2.pdf**

- Reminder: so far double RF system is not necessary for beam stability in the longitudinal plane.

- A double RF system is usually used either in Bunch Lengthening (BL) or Bunch Shortening (BS) mode => Depends on the relative phase between the 2 systems. The synchrotron frequency distribution inside the bunch is then very different.

- Main applications

  1) Modify the line density distribution ("flat" bunches in BL-mode) – can also be achieved in a single RF system but for a limited time (due to IBS, RF noise, SR).

  2) Increase the synchrotron frequency spread for beam stability (BL- or BS- mode).

  3) Increase the bucket size (only BL-mode).

- Comments / recommendations from ElenaS:

  - BL-mode seems much more fragile for beam stability than BS-mode (due to the non-monotonic behaviour of the synchrotron frequency distribution and the possible loss of landau damping when the derivative of the distribution is 0) except if we use very short bunches.

  - If a High Harmonic (HH) RF system is to be used for beam stability, use the BS-mode in $2^{nd}$ harmonic.

  - If we want to have only bunches more flat do not use a $2^{nd}$ RF system as it is maybe too expensive and we have other means (except if we cannot keep it).

- A HH RF system in the LHC has been considered in the past (since 2002) for several reasons => Short bunches, flat long bunches, beam stability, beam-induced RF heating, IBS and pile-up density.

  - A preliminary cavity design of 800 MHz exists (L. Ficcadenti et al.).

  - MDs done in 2012 with a "flat" bunch distribution in a single RF system => To study RF heating.

- Low Harmonic (LH) RF system in the LHC as a fundamental RF: motivations

  - Longer bunches for reduction of pile-up density.

- Together with existing 400 MHz RF can be used for luminosity leveling.

- Push up the limitation to injected intensity from power limit in SPS 200 MHz RF system (after upgrade).

- Improve IBS, beam induced heating and e-cloud effect (R. Tomas Garcia et al., RLIUP).

- Beneficial for ions and momentum slip-stacking scheme in the SPS (J. Jowett, RLIUP).

- New proposal for compact SC cavity design (R. Calaga).

=> Double RF system should be used for short bunches.

- Low Harmonic (LH) RF system in the LHC as a fundamental RF: possible issues (to be studied)

- Need to be used together with the 400 MHz RF to preserve beam stability (for the same longitudinal emittance stability threshold ~ $h^2$ => 4 times lower).

- In a double RF system (BL-mode): limit on the bunch length (3.4 ns) to avoid loss of Landau damping.

- Full-detuning scheme most probably would also be needed => tilted bunches (if required bunch positions are not the same) and reduced beam stabilization.

- Crab cavities at 200 MHz (?)

- Transverse beam stability in a double RF system => Ongoing studies by KevinL, which will be discussed during the next meeting.

- Question from MikhailZ: do we continue to work on the design of the 800 MHz? Answer from ElenaS => Yes. We need first the results on transverse beam stability from KevinL (see next meeting). Furthermore, ElenaS said that 800 MHz would be the best option to be ready in case of a problem.

**3) Test simulations of TT2-111R lossy dispersive material properties by Oscar Frasciello: https://indico.cern.ch/event/308981/contribution/3/material/slides/0.pdf**

- In the new LHC secondary collimator design with BPM, the (transverse) RF fingers have been replaced by TT2-111R ferrite blocks => In order to accurately estimate the impedance of the new collimators, the dispersive properties of the ferrite have to be correctly managed by FDTD electromagnetic codes.

- OscarF et al. implemented the TT2-111R measured magnetic permeability

into the GdfidL code, by means of a two-resonances Lorentz function fit.

- As a 1st check / benchmark, they performed a simple coaxial cable measurement simulation to compare the computed S-parameters to analytical formulas from transmission lines theory. As a 2nd check / benchmark, they also performed the same type of test with the FD code, HFSS.

=> A perfect agreement (for S11) was obtained.

- The code was then used to simulate the wakes and impedances of the new BPM-collimator. It was found that the TT2-111R provides quite a strong damping of HF modes, while some modes still lie in the LF range (up to ~ 100 MHz).

- This mode (~ 100 MHz) was already discussed a bit in the past and it was nevertheless accepted to install the new BPM-collimators as the impact of this mode should be rather small (https://espace.cern.ch/project-TCTPcollimators-MechanicalDesign/MaterialProcurement/TCTP%20Prototyping%20%20Manufacturing%20Meetings/24th%20TCTP%20Prototyping%20and%20Manufacturing%20Meeting/24th%20TCTP%20PM%20Meeting.docx).

- Next step: full understanding of LF damping(?) properties of the ferrite. The issue with the LF modes could come from the rough mesh and the fact that all the ferrite properties were not implemented (eps etc.)

- BenoitS commented that there is a request from EN-MME to help in the design of new tapers for collimators.

- BenoitS commented that the good agreement obtained in the benchmark (case with S11) does not mean that it will be OK for the wakefield solver. Giovanni de Michele mentioned that he checked this in the past during his PHD and he found that the implementation was fine but that there were some issues with the wakefield solver => To be followed up.

**4) Actions**

**- Action 1 (GiovanniR)**: Follow-up of electron cloud effects => Proposed deadline: Joint HiLumi LHC-LARP Annual Meeting in KEK in November 2014

- The question was raised whether electron cloud build-up could occur in the crab cavities and for which value of the SEY.

- A margin of 150 W has been provided for heat load due electron cloud in the triplets in IR1 and IR5.

- Simulations for the heat load due to electron cloud should be performed in the triplets in IR2 and 8 (so far an extrapolation form measurements has been done) and for all the new elements of the IR1/5 matching section. Sensitivity to orbit (e.g. when the beams are separated should be studied).

- The electron cloud instability threshold resulting by electron cloud in the triplet/matching sections in IR1 and 5 should be estimated.

**- Action 2 (NicolasM)**: Follow-up of impedance effects => Proposed deadline: End of April

- The impedance of the beam screen should be reviewed in light of its operation at 50 K. The effect of magneto-resistance should be included. Some simulations should be performed at 20K, 30K, 40K, 50 K, 60K and 70K since the sensitivity of copper resistivity is very sensitive in this region. The baseline temperature of operation of the beam screen needs to be defined (Action: V. Baglin, who said already that it should be between 30K and 70K).

- Beam position monitors at the triplet are still providing an important contribution to the impedance. The design of the BPMs should be reviewed in collaboration with BI. One could ask the sensitivity of the accuracy and impedance as a function of aperture.

**5) Next meeting**

- The next (9th) VIDYO meeting will take place on Wednesday 09/04/2014 from 11:00 to 12:30 in the room 6/R-018 for the CERN people. The agenda is

1) General information (EliasM)

2) Transverse beam stability studies in the presence of 2 RF systems (Kevin Li)

3) HL-LHC (and LHC) longitudinal collective effects with 1 RF system (Juan Esteban Muller)

4) AOB (EliasM)

*Minutes by EliasM, 31/03/2014.*