- Aim of the discussion
  - To review the aperture of the Q4 to assess whether any reduction is possible.
- Aperture evaluation
  - The tolerances (mechanical, alignment, beam-related) are discussed.
    - Linear addition is used for the tolerances on the various parameters, as it was the case for LHC. This is a conservative approach, but is providing some additional safety margin.
    - The emittance used for the aperture evaluation should be nominal one for HL-LHC. This implies re-defining the value of the protected aperture. PLC should look after this step. This has no implications for the aperture requirements.
    - The beam-related tolerances, e.g. beta-beating, are based on Run I experience. They might be reviewed once more experience is gained with ATS optics.
    - The mechanical tolerances for the Q4 are not known to-date and those of the triplets have been assumed. A critical review of these values should be made with the help of vacuum experts.
  - Optics and layout
    - A revised version of the layout is available, taking into account the recent hardware changes for the triplet quadrupoles (nominal gradient and length).
    - A careful analysis of the required orbit knobs has been made in order to make the aperture estimates as realistic as possible. More knobs have been included in the aperture estimate with respect to the past, but this is based on the LHC experience.
  - Aperture situation
    - A detailed table summarising the aperture situation for all IR elements and for four optics (round 15 cm, 20 cm β^*; flat 7.5/30 cm, 10/40 cm β^*) is presented.
    - In future, the missing aperture in millimetres will be also provided to ease the discussion on possible improvements to the aperture by changing mechanical tolerances.
    - It is underlined that the choice of 150 mm for the coil aperture of the triplets turns out to have been a very good one.
    - The aperture of the Q2 and Q3 is below target. However, there are means to improve the situation, i.e., by taking into account the impact of β^* levelling. Of course, this implies that this gymnastics has to work. Any improvement on the mechanical tolerances or on the W thickness does not seem to bring enough in terms of aperture gain individually but they should be investigated It was also noted that the smaller thickness of the W shielding of the beam screen of Q2 and Q3 could allow for improved tolerances.
    - Concerning the Q4 aperture, three options have been considered: nominal (90 mm coil aperture); intermediate (80 mm coil aperture); existing MQY (70 mm coil aperture).
    - The 90 mm coil aperture solution is, of course, not only compatible with the target set by the collimation system, but provides also additional margin.
    - The 80 mm coil aperture solution is marginal in terms of aperture for the case of flat optics.
    - The 70 mm coil aperture solution (MQY) is not conform in terms of aperture for the case of flat optics.
    - It is reminded that flat optics represent back up solution in case of unforeseen difficulties with the crab cavities. Hence, the selected option for the Q4 aperture should be compatible with flat optics. This rules out the 70 mm option (MQY).
    - The acceptable option should have an aperture in the interval 80 mm - 90 mm.

The final value should be decided based on: cost savings considerations; magnetic design considerations for the new two-layer design; need of additional aperture margins to ensure operability of the HL-LHC; review of the mechanical tolerances and optimisation of the beam screen.