Proposal for change of the reference emittance for the estimate of apertures, DA, etc.

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Status

- Normalized emittance of 3.5 μm used for:
    - Aperture calculations for protons and ions
    - DA estimates without beam-beam

- Proton nominal emittance of 2.5 μm used for:
    - DA aperture in the presence of beam-beam
    - Normalized beam-beam separation

Proposal

- Move to a single unit for all the simulations to avoid confusion

- Appropriate scaling of the parameters in sigma so to keep the same "apertures" in mm (defined by the collimation system) is needed

- It is a change of unit like moving from the imperial system to the metric system or the other way round

- Use the sigma corresponding to the nominal normalized r.m.s. transverse emittance of 2.5 μm as unit.

Implications

- **Minimum Physical Aperture** (after subtraction of tolerances):
    - See note: CERN-ACC-2014-0044 for tolerances used in collision.
    - Note under preparation for injection summarizing based on presentations at WP2/5/14 joint meetings and presented at HL-LHC annual meeting:
        - 47th HiLumi WP2 (5/8/14) Task Leader Meeting, Friday, 17 April 2015 (R. Bruce and F. Velotti)
        - F. Velotti, Aperture and protection tolerance for the injection into LHC, 5th Joint HiLumi LHC-LARP Annual Meeting 2015, CERN, 26-30 October 2015

	Old (ε_n=3.5 μm)	New (ε_n=2.5 μm)
Injection	9	10.6
Collision	12(*)/17	14.2 (*)/20.1

(*) When protected by nearby TCT

Implications

- Collimator settings at injection:

	Old (ε_n=3.5 μm)	New (ε_n=2.5 μm)
TCP (LSS7)	5.7	6.7
TCSG (LSS7)	6.7	7.9
TCSTCDQ (LSS6)	7.5	8.9
TCDQ (LSS6)	8.0	9.5
TCLD (LSS7)	13.0 (tbc)	15.4 (tbc)
TCLA (LSS7)	10.0	11.8
TCT (LSS1/5)	13.0	15.4
TCP (LSS3)	8.0	9.5
TCSG (LSS3)	9.3	11.0
TCLA (LSS3)	10.0	11.8
TCT (LSS2/8)	13.0	15.4
TDI (LSS2/8)	6.8	8.0
TCLI (LSS2/8)	6.8	8.0

Implications

- Collimator settings in collision:

	Old (ε_n=3.5 μm)	New (ε_n=2.5 μm)
TCP (LSS7)	5.7	6.7
TCSG (LSS7)	7.7	9.1
TCSTCDQ (LSS6)	8.5	10.1
TCDQ (LSS6)	9	10.6
TCLD (LSS7)	10	11.8
TCLA (LSS7)	10	11.8
TCT (LSS1/5)	10.5	12.4
TCL (LSS1/5)	12	14.2
TCP (LSS3)	15	17.7
TCSG (LSS3)	18	21.3
TCLA (LSS3)	20	23.7
TCT (LSS2/8)	30	35.5

Implications

- **Minimum Dynamic Aperture** (no beam-beam):

	Old (ε_n=3.5 μm)	New (ε_n=2.5 μm)
Injection	10	11.8
Collision	10	11.8

- **Minimum Dynamic Aperture*** (with beam-beam):

	Old (ε_n=2.5 μm)	New (ε_n=2.5 μm)
Collision	6	6

No Change

(*) At injection and in the other phases before collision we assume that beam-beam is negligible. Should we quantify better this request?

Long range beam-beam separation

- Minimum normalized long range beam-beam separation

	Old (ε_n=2.5 μm)	New (ε_n=2.5 μm)
Collision	12.5	12.5

No Change

To note

- The above parameters are acceptable also for:
    - Scrubbing at injection when larger emittances are expected (ε_n=3.75 μm)
    - Ion operation (ε_n=1.5 μm) having the same physical emittance of a proton beam with ε_n=3.75 μm for equivalent magnetic field in the magnets.

Questions / Comments

- Question form Yannis: Is our target of 6 sigma dynamic aperture (minimum value achieved at minimum β^*) consistent with our TCP opening of 6.7 σ?

- Comment from Stefano: We should round the numbers for the target values (granularity of 0.5 σ?)