Parameters and tolerances: focus on aperture (slightly updated figures...)

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Proposed approach to derive phase-dependent tolerances

- The first issue is given by the interdependencies between parameters.
- This implies defining a number of fundamental functions of the target parameters. Some examples:
  - Peak closed-orbit
  - Beta beating
  - Dispersion beating

  } **Linked via mechanical aperture definition**
- Then, appropriate criterion should be defined to compute the change in fundamental functions -> relaxed tolerances on parameters.

Mechanical aperture – I

No margin available under nominal conditions.

During early stages of commissioning, maximum aperture gain ~ 0.5 σ!

Settings during injection (in σ_β, δ=0)

a_{abs}	=	~ 10.0 σ	Active absorbers in IR3 and IR7
a_{sec3}	=	9.3 σ	Secondary collimators IR3 (H)
a_{prim3}	=	8.0 σ	Primary collimators IR3 (H)
a_{ring}	**=**	**7.5 σ**	**Ring cold aperture**
a_{prot}	≥	**7.0 σ**	TCDQ (H) protection element
a_{prot}	=	**6.8 σ**	TDI, TCLI (V) protection elements
a_{sec}	=	**6.7 σ**	Secondary collimators IR7
a_{prim}	=	**5.7 σ**	Primary collimators IR7
a_{TL}	=	**4.5 σ**	Transfer line collimators (ring protection at **6.9 σ**)

Actual cold aperture: 7.7 σ

➔ Tight settings below “canonical” 6/7 σ collimation settings!

Tighter for larger beta beat (smaller cold aperture)!

Mechanical aperture – II

- Present situation:
  - Closed orbit -> 4 mm 2/3
  - 20% beta-beating -> 1 mm 1/6
  - 30% dispersion beating -> 1 mm 1/6
- Two possibilities to gain additional margin (basic principle: easier to correct orbit than beating -> increase beating budget):
  - Re-distribute aperture margin (0.6 mm) to beating components only:
    - **Closed orbit -> 4 mm**
    - **(20+6)% beta-beating -> 1.3 mm**
    - **(30+9)% dispersion beating -> 1.3 mm**
  - Re-distribute aperture margin (0.6 mm) and transfer part of CO budget (1 mm) to beating components only.
    - **Closed orbit -> 3 mm**
    - **(20+16)% beta-beating -> 1.8 mm**
    - **(30+24)% dispersion beating -> 1.8 mm**

Some after-LHCCWG meeting developments - I

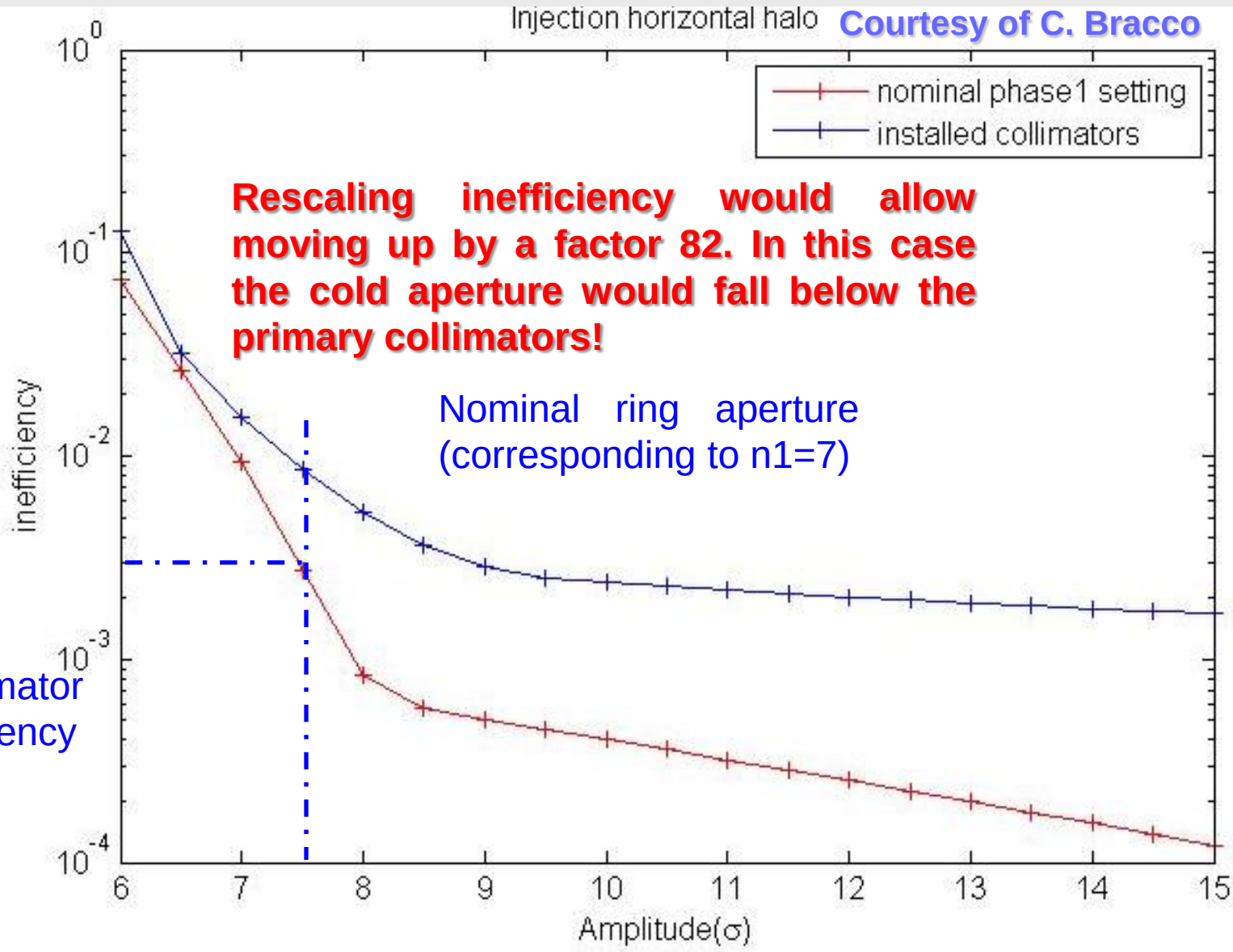
- Stage-dependent tolerances for closed orbit, beta and dispersion beating can be based on collimation system inefficiency.
- This assumes that the machine protection function of the TDI, TCLIs, and TCDQ can be relaxed/skipped.
- The actual position of the protection devices can be kept fixed to the nominal one (see p. 3), but it is considered acceptable that the cold ring aperture goes below 6.8-7 sigmas.
- The underlying principle is that with reduced intensity an increased inefficiency can be tolerated, which corresponds to reducing the effective cold machine aperture according to:

With:

- N_{tot}: total beam intensity
- η: collimation system inefficiency
- A: cold machine aperture in sigmas

$$\frac{N_{tot,nom}}{N_{tot,comm}} = \frac{\tilde{\eta}(A_{comm})}{\tilde{\eta}(A_{nom})}$$

Some after-LHCCWG meeting developments - II



Some after-LHCCWG meeting developments - III

Injection	Stage I 43 bunches	Stage I 156 bunches	Stage II 75 ns
$N_{tot,nom}$/ $N_{tot,comm}$	82	10	3.75
ΔA (σ)	1.5	1.3	0.9
Aperture gain (mm)	1.7	1.6	1.1
New CO (mm)	4	4	4
New beta-beating (%)	20+17	20+16	20+11
New disp-beating (%)	30+26	30+24	30+17
New CO (mm)	3	3	3
New beta-beating (%)	20+28	20+27	20+21
New disp-beating (%)	30+41	30+39	30+32

Unsafe beams

The nominal intensity used is indeed that for the Stage III, i.e. 5 10^{10} p/b and 1.4 10^{14} p/beam.

General consensus on relaxing tolerances with safe beam, only.

Hence, for Stage I up to Phase A.4 (included).