TCT and TCLI IN THE LHC

A. Grudiev, E. Métral and F. Ruggiero

- **Logics of our analysis ⇒ For a reasonable and comprehensive answer to the Collimation team**

SUMMARY (1/2)

- Per beam, there are
  - 1 TCTH and 1 TCTV at each interaction point $\Rightarrow$ 4 TCTH and 4 TCTV
  - The 4 TCTH are all of the same type (1-beam pipe)
  - 2 TCTV at D2 (i.e. where the 2 beams are well separated $\Rightarrow$ 1-beam pipe) at points 1 and 5
  - 2 TCTV at D1 (i.e. where the 2 beams are not separated $\Rightarrow$ 2-beam pipe and large cavity created) at points 2 and 8
  - In addition there is also 1 TCLI (TCLIA.4R2.B1) used only at injection (1-beam pipe) and 1 TCLI (TCLIB.6R2) used also only at injection (but 2-beam pipe)

- The 4 TCTH, the 2 TCTV at D2 and the TCLIA.4R2.B1 are all (the 7) of the same type (= 1-beam TCS-type device), and of the same type of the collimator prototype used in the SPS in 2004. For this we have measurements of the trapped modes by FC and TK, and simulations by AG. Conclusion: All this is known and OK

SUMMARY (2/2)

- The new result is for the 2 TCTV at D1 and for the TCLIB.6R2 (2-beam devices), which are currently under study by AG. And this is for this 3 devices (2 used at top energy and 1 used at injection) that the Broad-Band impedance is quite high. For the trapped modes we think we will be able to damp them with ferrites (opening the RF bypass for the ferrite to be effective or keeping the RF bypass but creating a small cavity to put the ferrite) but this still has to be demonstrated by simulations, which AG will perform once RA will tell him which gap is OK

STRATEGY FOR THE 2 TCTV AT D1 (1/2)

- **In the minutes of the last RLC meeting (17/03/06) we said that "a (full) gap of 12 mm is needed for 2 devices and 30 mm in case of more than 2 devices"**

Broad Band impedance of the TCTV/TCLI for different gap size

BB transverse impedance of a cylindrical taper, Yokoya 1988, CERN SL/90-88

$$Z_T^{(1)} = -\frac{iZ_0}{2\pi} 2I_1;$$

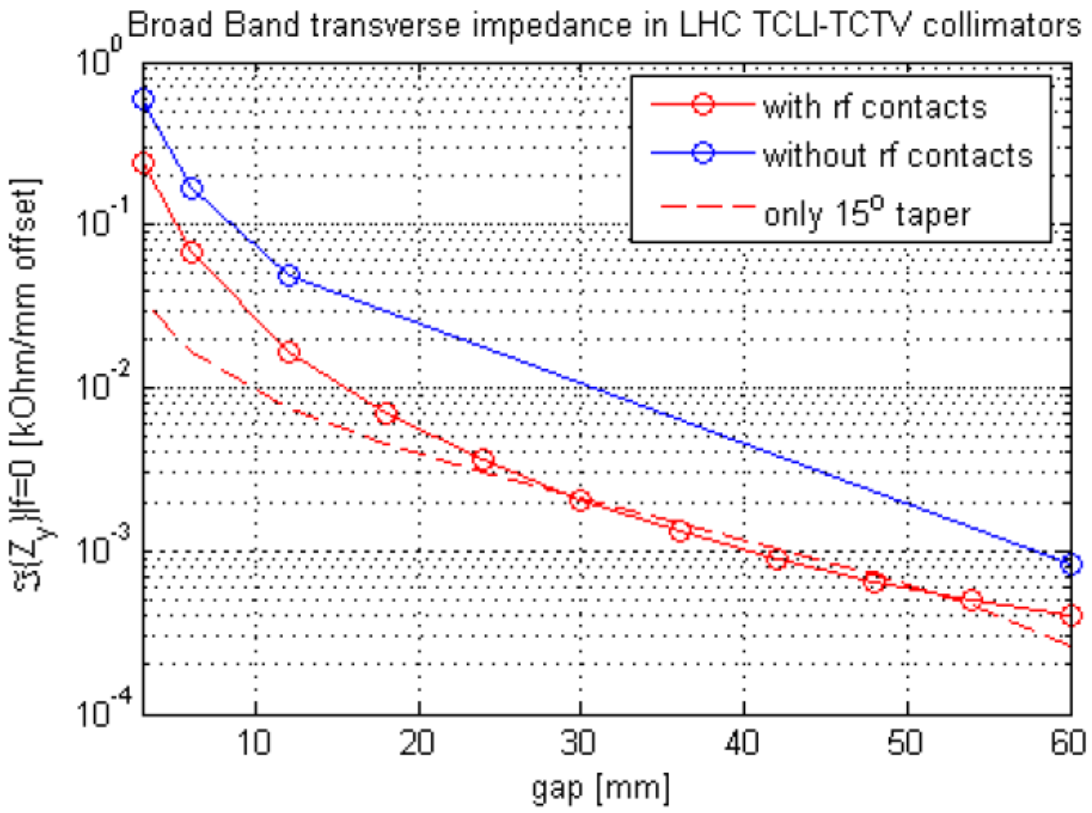
$$I_1 = \theta\left(\frac{1}{a} - \frac{1}{b}\right);$$

$$\theta = 15^o;$$

$$a = 3\,mm;$$

$$b = 70mm;$$

$$Z_T^{(1)} = 20\,k\Omega/m$$



For parallel plate geometry: $Z_y^{(1)} = Z_T^{(1)} \times 1.64 = 35\,k\Omega/m$

STRATEGY FOR THE 2 TCTV AT D1 (2/2)

- ⇒ 12 mm is chosen to have a BB impedance per device which is about 1% of the total BB impedance of the design report (*j* 2.67 MΩ/m at top energy), i.e. ~ *j* 0.02 MΩ/m in the previous plot

- However this result is obtained for the nominal case where $\beta \approx \beta_{av}$ (~ 70 m)

- If, as discussed with RA yesterday, the beam is squeezed in 2 and 8, the β function will increase to ~ 660 m, i.e. by a factor 10

  ⇒ In this case, the impedance will increase by a factor 10

  ⇒ The impedance has to be reduced by a factor 10

  ⇒ The full gap has to be increased from 12 mm to 30 mm (see previous plot). In this case the BB impedance is similar to the 1-beam TCS-type device, and the TCTV is useless*

* Reminder: The TCTV primary function is shadowing the triplet, which half aperture is ~ 10 mm ⇒ It should be at ~ 8 mm (half gap) maximum to play is role

STRATEGY FOR TCLIB.6R2

- It is used only at injection and to protect the arc
  - The TDI alone protects until ~ 50% of the nominal intensity
  - For higher intensities, the TCLI (graphite) is absolutely needed

- A full gap of 12 mm is also chosen for the TCLIB.6R2 to have a BB impedance which is the same percentage of the total BB impedance of the design report (j 1.34 MΩ/m at injection) as for the 2 TCTV at D1 at top energy

$$\frac{2 \times 0.02}{2.67} = \frac{0.02}{1.34}$$

NEXT WORK

- **Include the BB impedance of all the collimators in our stability analysis**