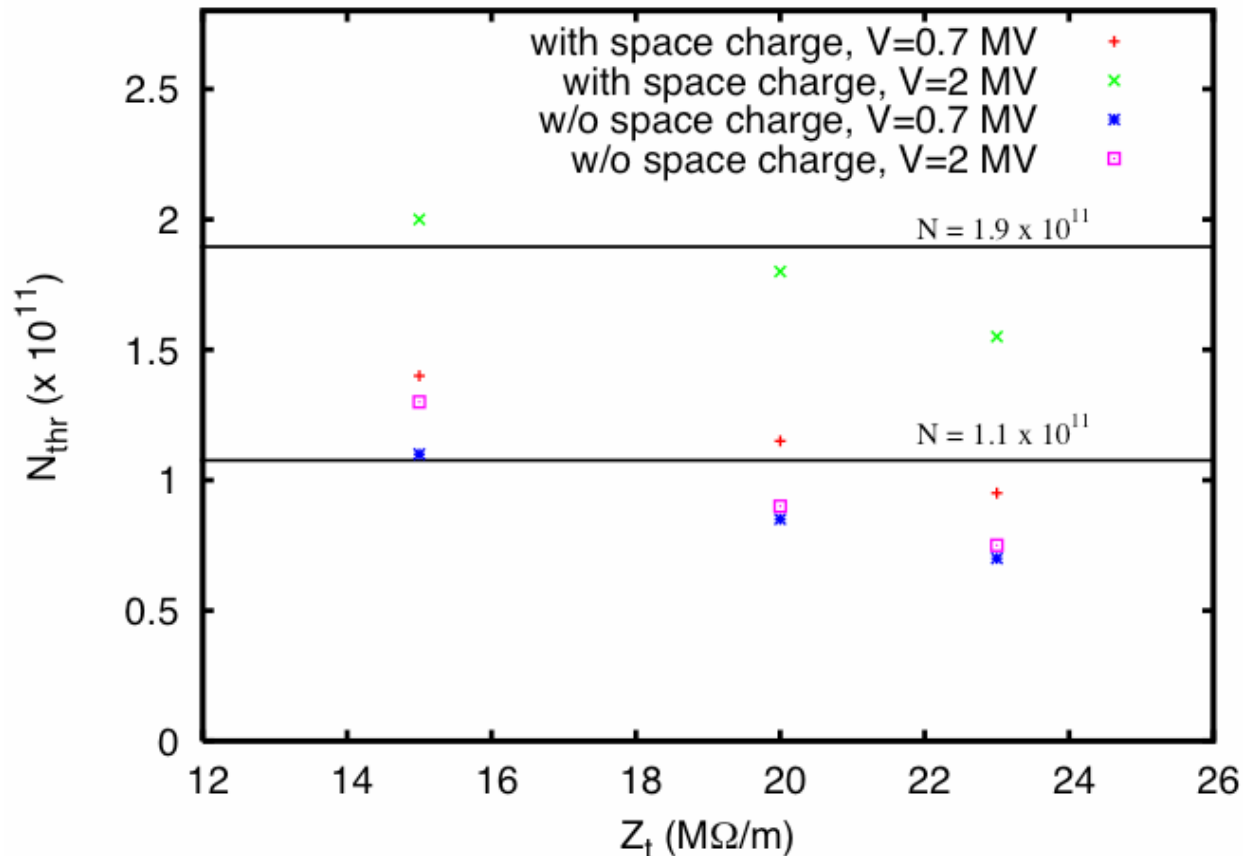


# Higher injection energy in the SPS (Effects on TMCI)

G. Rumolo in RLC-LHC Meeting (11/11/2005)

- Parameters
- Study of **TMCI** threshold with **HEADTAIL** simulations
- Conclusions

Study of TMCI threshold at 26 GeV/c for different impedances and rf voltages. Neither of the two considered voltages was a matched value.



## Main assumptions for this analysis:

- Nominal (LHC) beam parameters at injection:
  - Longitudinal emittance  $0.35 \text{ eVs}$  - unchanged
  - Normalised transverse emittances:  $\sim 3.0 \mu\text{m}$
- Injection at  $26$ ,  $40$  and  $60 \text{ GeV}/c$
- Bunches are always **matched** to their buckets
- The chamber is assumed to be **flat** (dipole wakes weighed by Yokoya coefficients + quadrupole wakes)
- **Space charge** optionally included
- Broad band impedance with  $R_s = 20 \text{ M}\Omega/\text{m}$ ,  
 $\omega_r = 1.3 \text{ GHz}$ ,  $Q = 1$

Main **implications** of the chosen set of parameters  
(reference is the parameter set at 26 GeV/c):

- Longitudinal emittance **0.35 eVs**:
  - \* Bunch length is kept constant (0.3m) and momentum spread  $\delta p/p_0$  is scaled by  $27.7/\gamma$  for 40 and 60 GeV/c
  - \* Matched voltage, which scales like  $\eta/\gamma$ , is re-adjusted for each set of simulations
- Normalised transverse emittances:  **$\sim 3.0 \mu\text{m}$** :
  - \* Transverse beam sizes are scaled by  $\sqrt{27.7/\gamma}$   
so the net improvement on the space charge tune shift is like  $(27.7/\gamma)^2$

$N$  is the number of protons/bunch

	26 GeV/c	40 GeV/c	60 GeV/c
Threshold $N$ without space charge ( $\times 10^{11}$ )	0.7	1.5	1.9
Threshold $N$ with space charge ( $\times 10^{11}$ )	0.9	1.8	2.2

Without space charge, **the threshold increases like  $\eta$** , which is confirmed by Elias' formula and by the fact that the threshold still stays at around 1.9 at 450 GeV/c

# Conclusion

- The **threshold of TMCI significantly increases** raising the injection energy (but, when keeping the longitudinal emittance constant, like  $\eta$  and not like  $\gamma$ , as one might expect) and at 40 GeV/c it becomes higher than the threshold at 26 GeV/c including space charge.
- Higher injection energy in the SPS is certainly **beneficial** against TMCI!