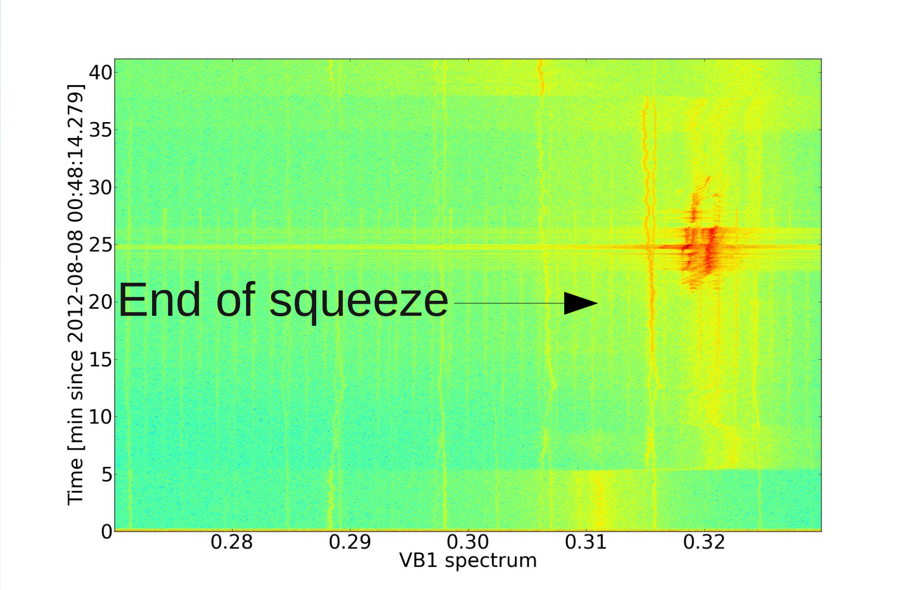
Stability consideration with beam-beam and octupoles

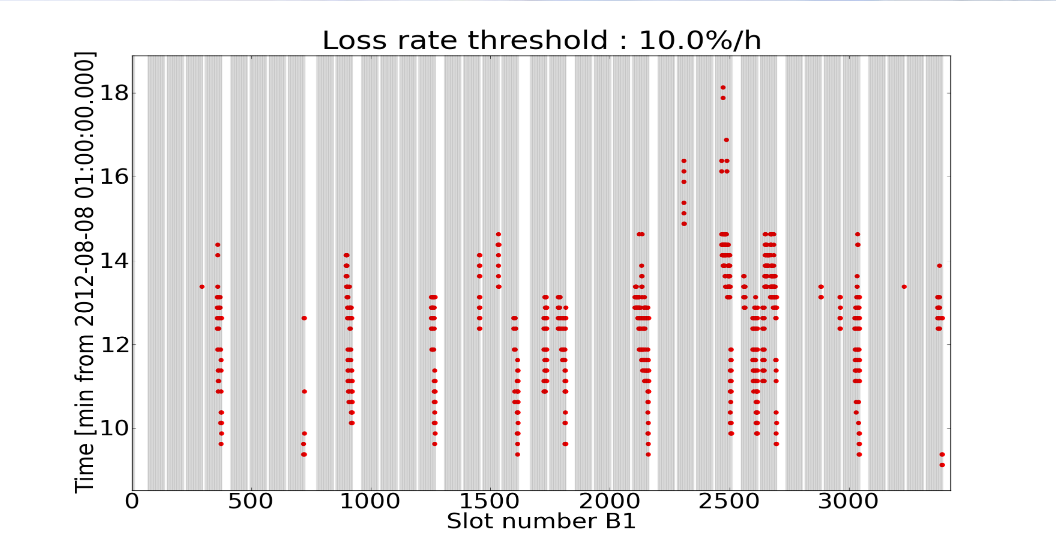
X. Buffat, N. Mounet, T. Pieloni, W. Herr, ...

- Instability observations with new octupole setting
- Numerical evaluation of stability diagrams
  - Before / after the squeeze
  - Collapse of separation

Observations

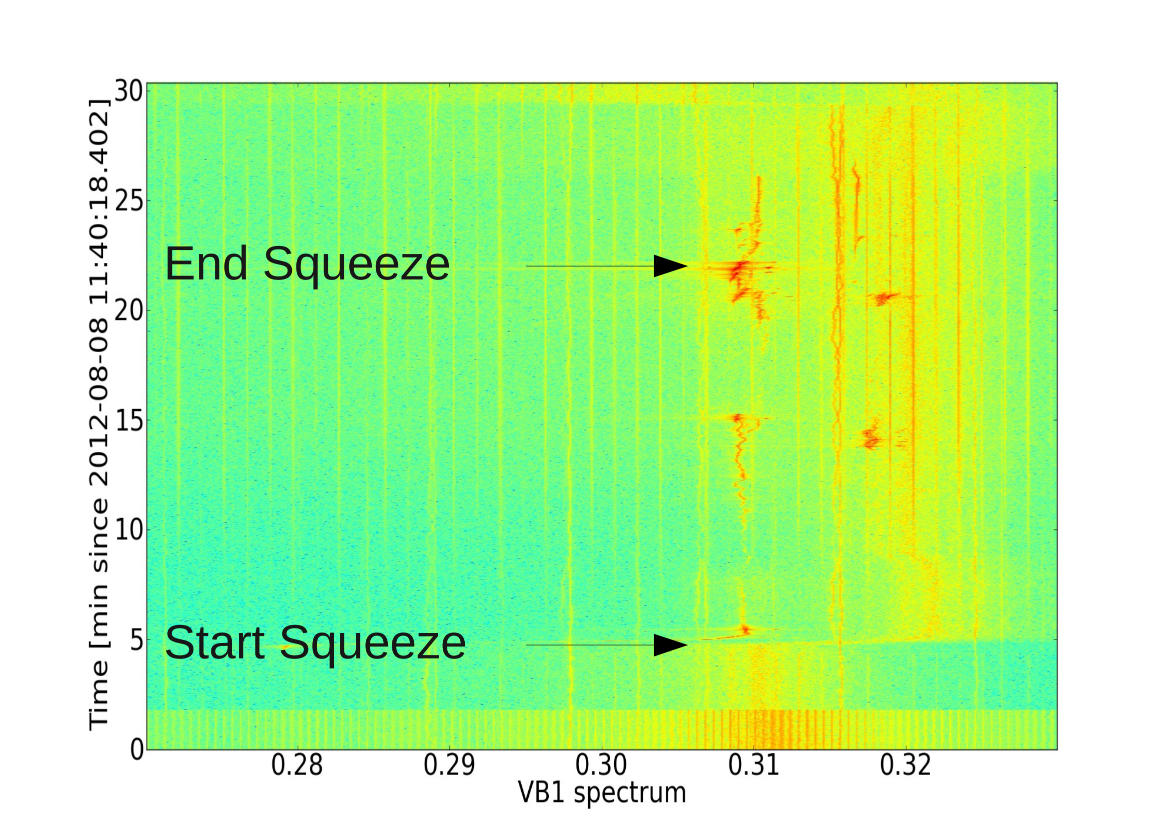
- End of squeeze
  - Fill 2927,2928
- Vertical plan
- End of trains are going unstable





Observations

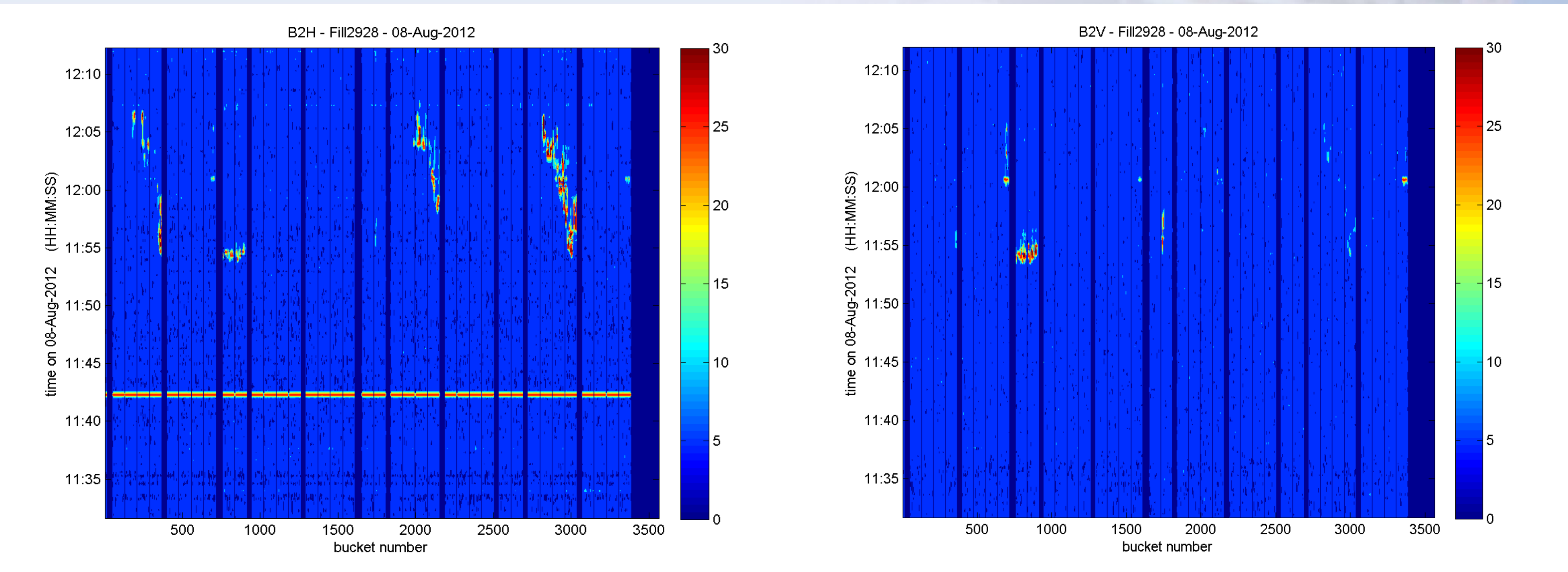
- Flat top / during the squeeze
  - Fills 2928, 2932
- Both vertical and horizontal



Observations

- Different bunches going unstable in either vertical or horizontal

B. Salvant

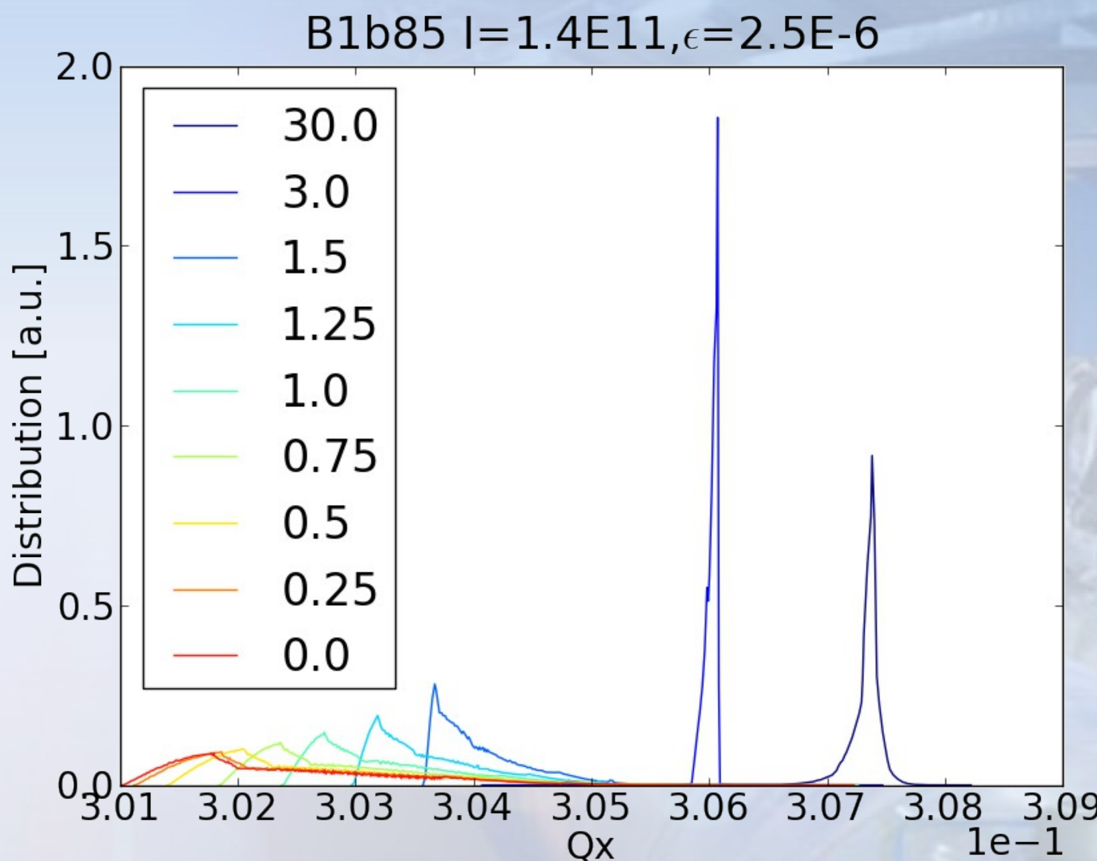


Summary of changes

- Vertical instabilities are now also observed
- Different bunches are affected (fewer LRs)
- Instabilties are now also observed at the begining and during the squeeze
- No instability observed during PHYSICS beam process

Motivation

- Need to understand stability of BB with octupoles
- Tune distribution gives a first hint on the stability diagrams
  - Already presented@LMC by E. Metral (13-06-2012 and 02-08-2012)

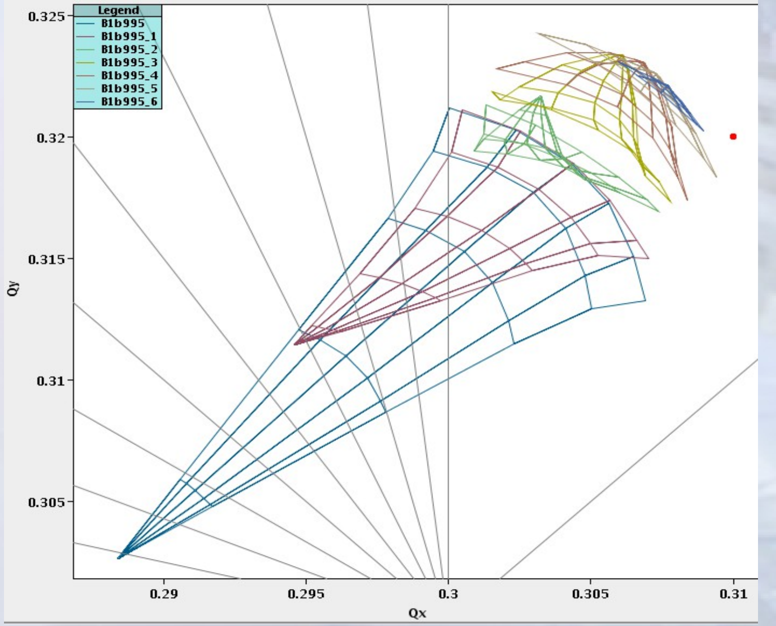


- Still not a stability diagram...

Numerical evaluation of stability diagrams

- Dispersion integral : $$\frac{-1}{\Delta Q} = \iint \frac{J_x \frac{\partial \Psi}{\partial J_x} dJ_x dJ_y}{Q_0 - Q_x(J_x, J_y)}$$
- Octupoles only : $Q_x(J_x,J_y) = Q_{x,0} + a_x J_x + a_y J_y$
- With BB :

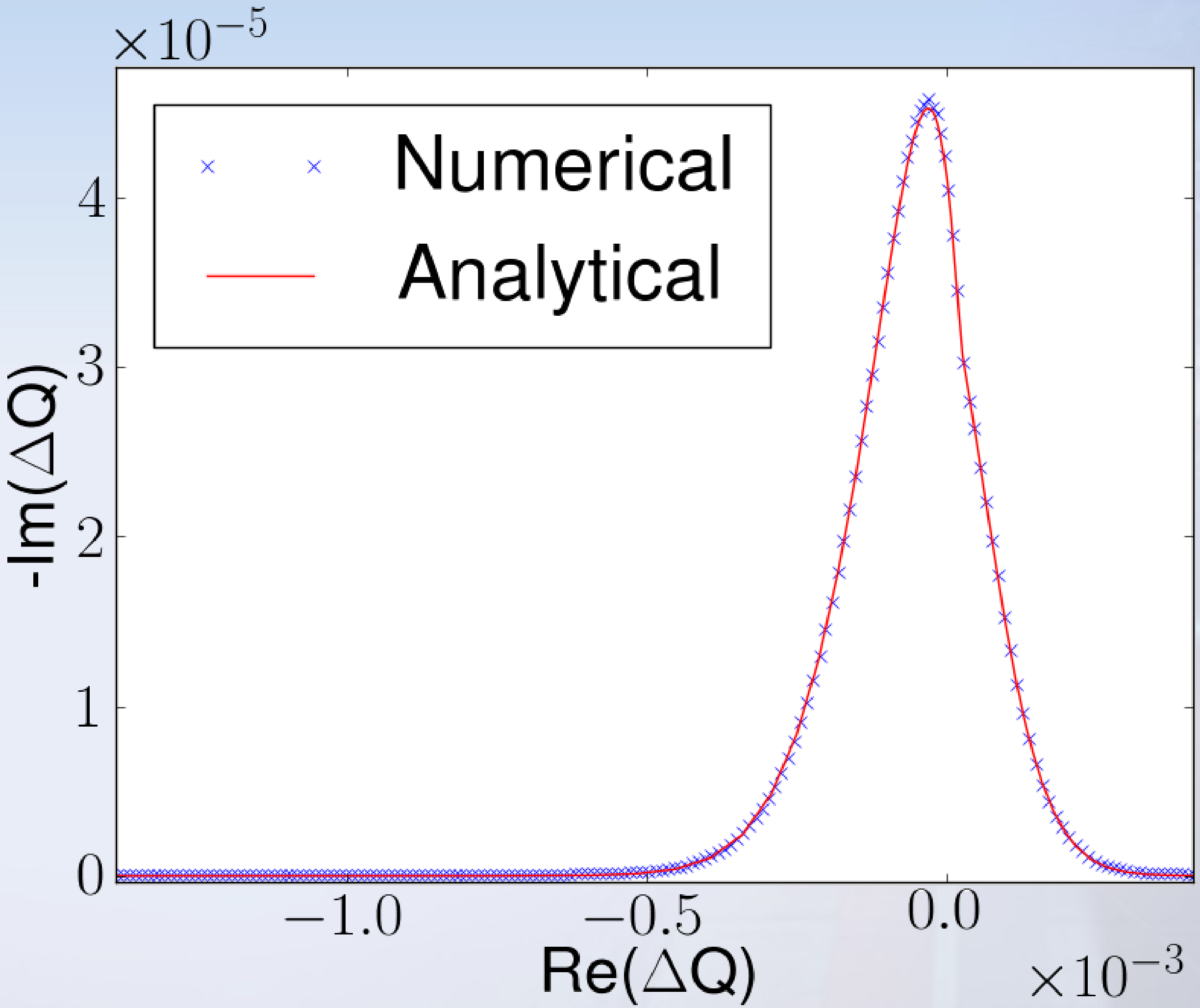
  → Tune spread from tracking simulation (MAD-X)



- Numerical evaluation of the integral

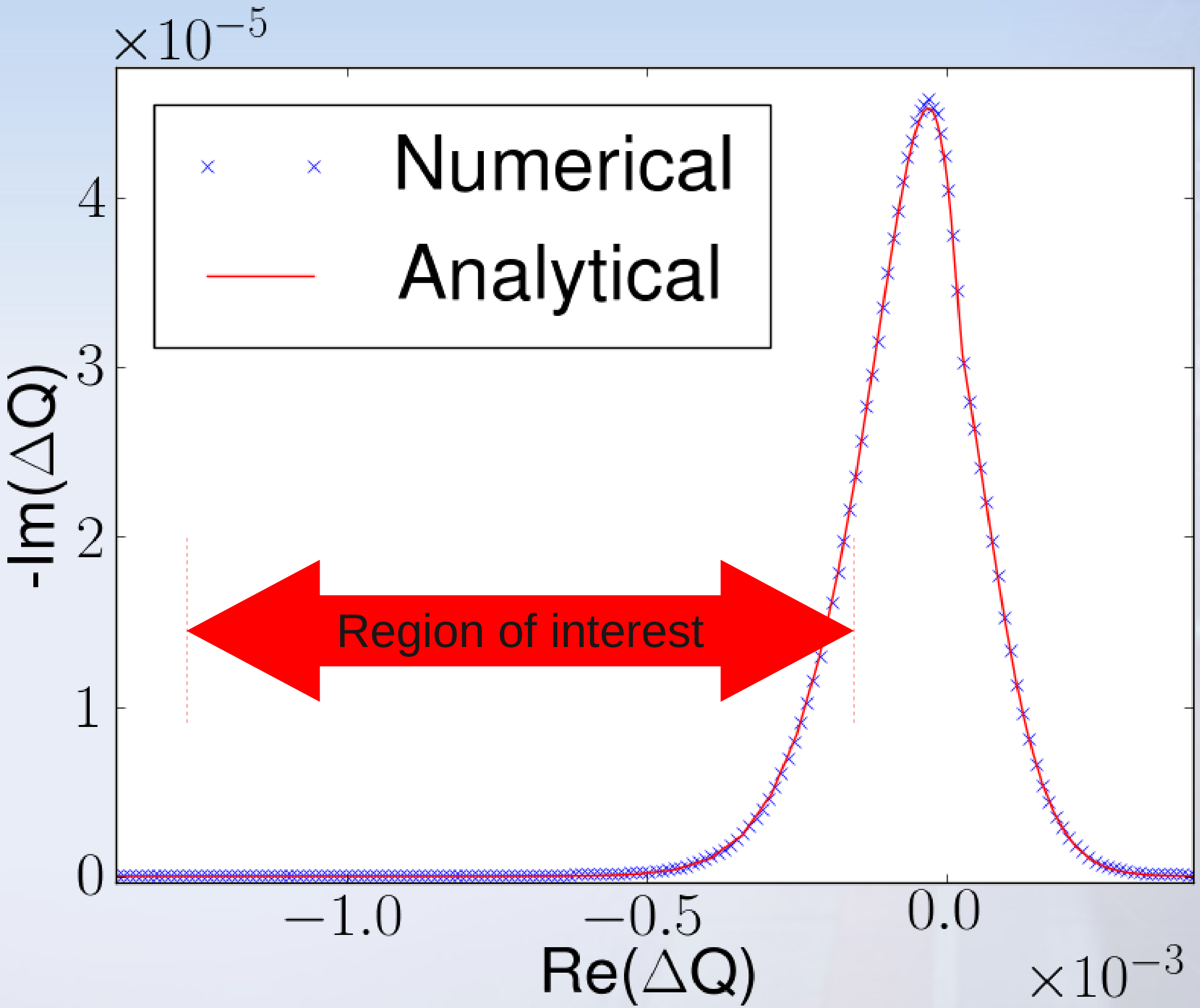
- W. Herr and L. Vos, *Tune distributions and effective tune spread from beam-beam interactions and the consequences for Landau damping in the LHC,* LHC Project Note 316, 2003

Validation of numerical solver



- Only octupoles
  - -100A
  - 2E-6 μm

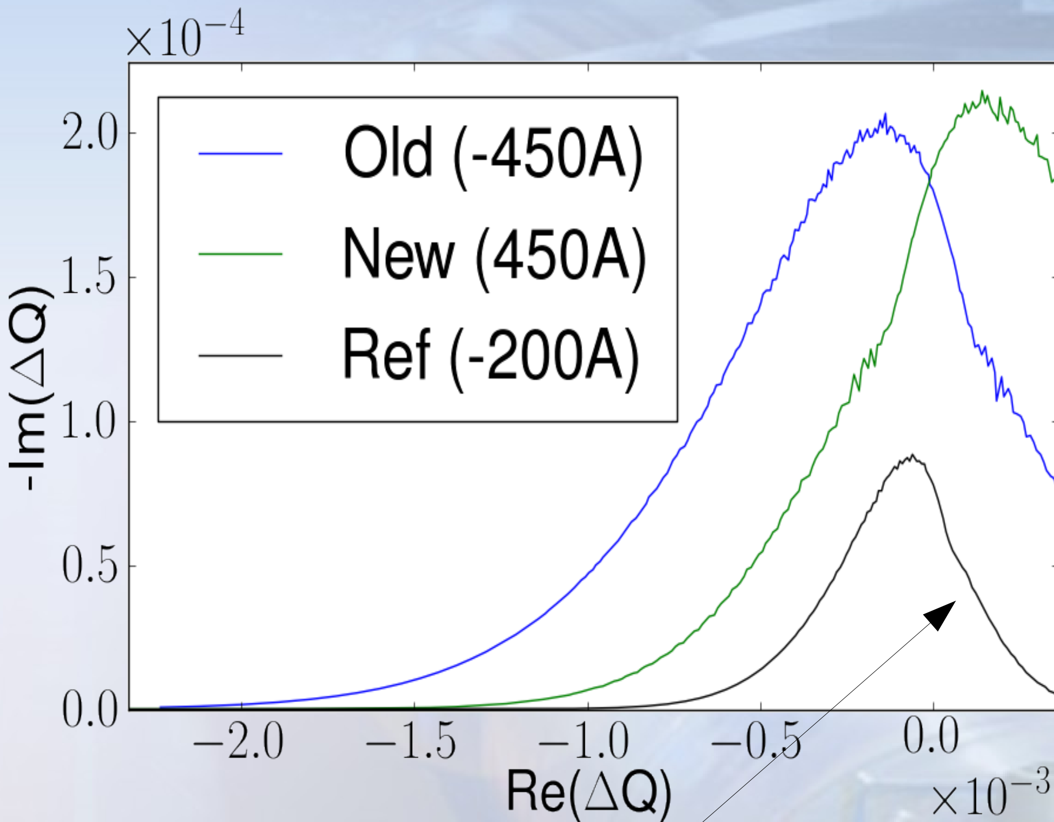
REMINDER
(of some Nicolas' talk)



- Not all the tune spread is useful

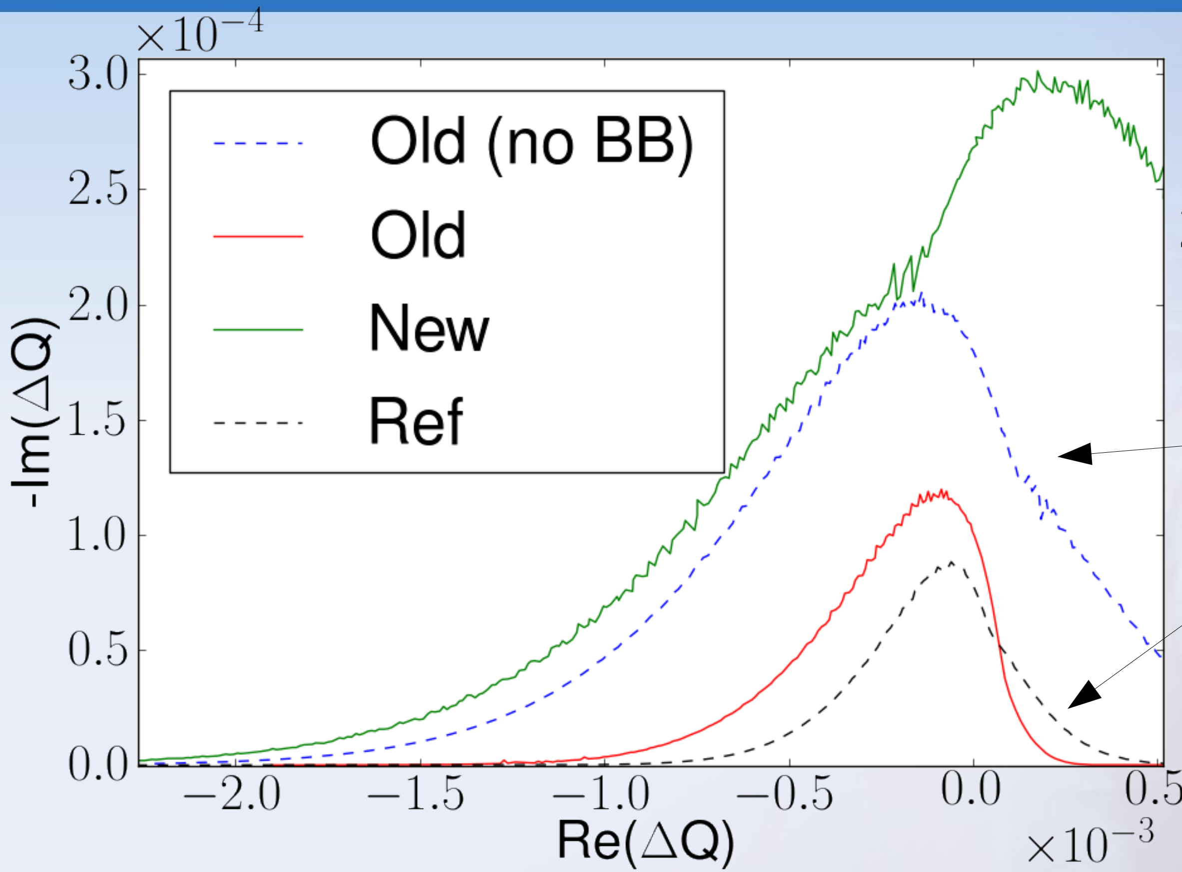
Before the squeeze

- Stability diagram smaller than with old polarity
  - As already mention by the impedance team
- Not enough to explain the instability



Stable during MD with one Beam

After the squeeze



Beam 1, bunch 85
1.4E11
2E-6 µm
±450A

Stable before the squeeze

Stable during MD with one Beam

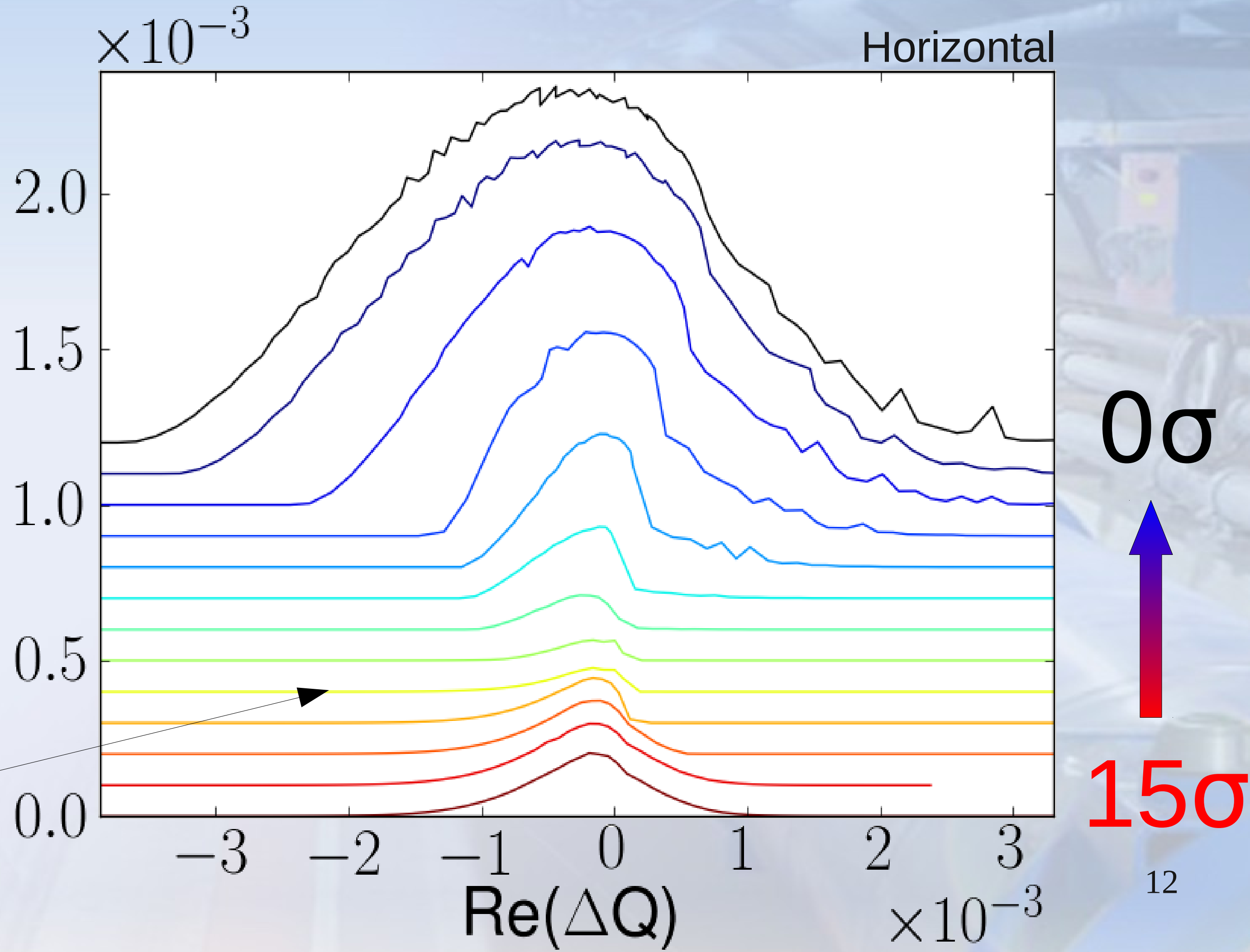
- The compensation of LR and octupole tune spread is not sufficient to explain the instability
- The situation now should be much better

Collapse of separation

A simple example

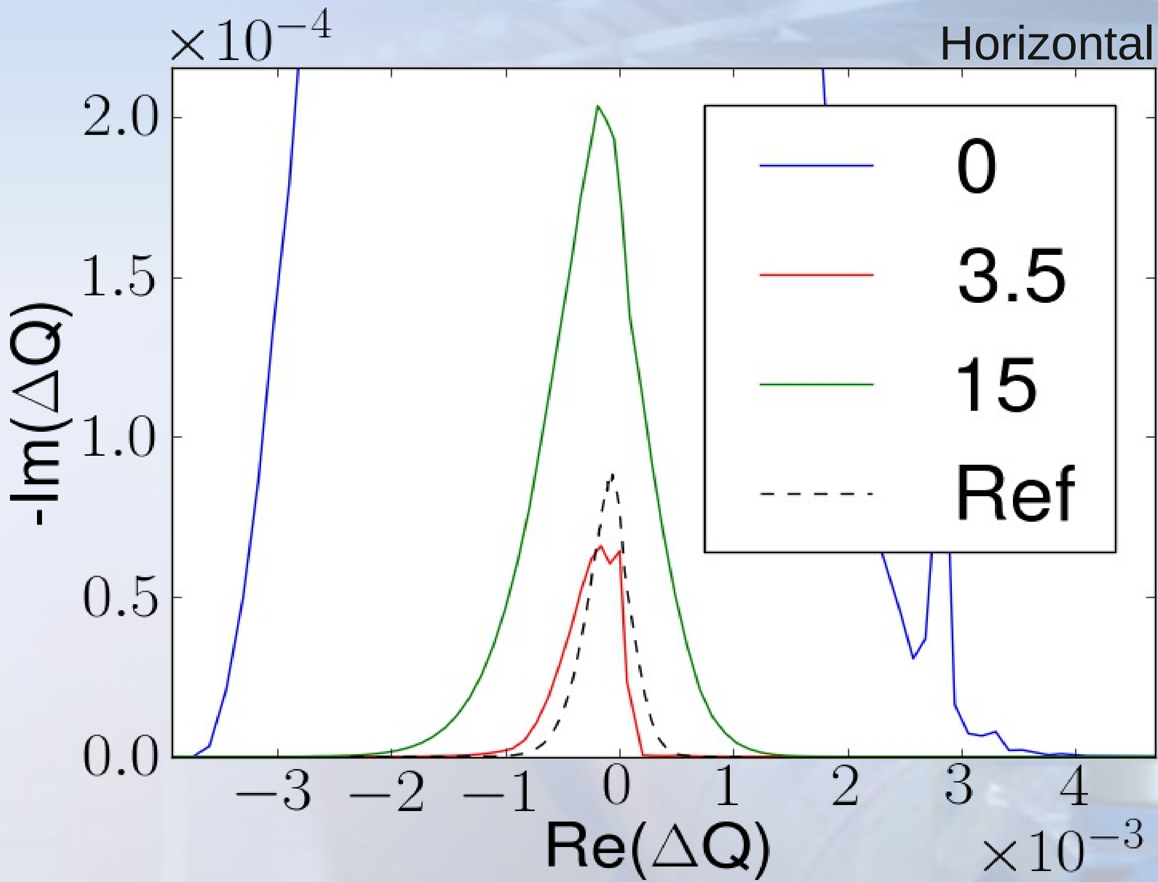
- Single bunch, one Head-on
  - 1.5E11
  - 2E-6 µm
- -450 A
- Vertical separation

Minimum ~3.5σ



Minimum of stability

- There is a minimum of stability
  - Is it sufficient to explain the observations ?
  - Can we avoid it ?



Minimum of stability

- The minimum depends on many parameter
  - Collision schedule
  - Intensity
  - Emittance
  - Octupole setting
  - Transverse offsets at the IPs

Scanning this large parameter space is on going

- Note : we have been going through this minimum all last year ! Only faster...
- 220s instead 56s because of IP8 tilting

→ One could do IP8 tilting after colliding in IP1 and 5

Conclusion

- New octupole polarity provides a better stability at the end of the squeeze, but worse at the beginning
- Instability before / during / after the squeeze cannot be explained by the reduction of tune spread due to LRs (especially with +450A in the octupole)
  - The source of the instability must be undertsood
  - Note : Stability region due to head-on is huge
- The instability during the collapse of the separtion is under study
  - It has not been seen since the polarity change
  - If it would happen again, one may avoid it by going faster through the process

BACKUP
collapse of separation