

# **LHC Instabilities: needs for tests with** **Octupole order polarity**

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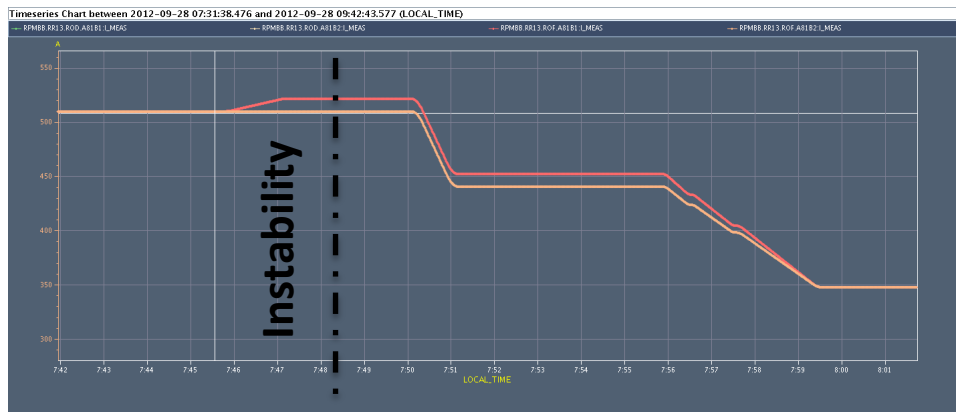
# Instabilities:

Started beginning of the year...

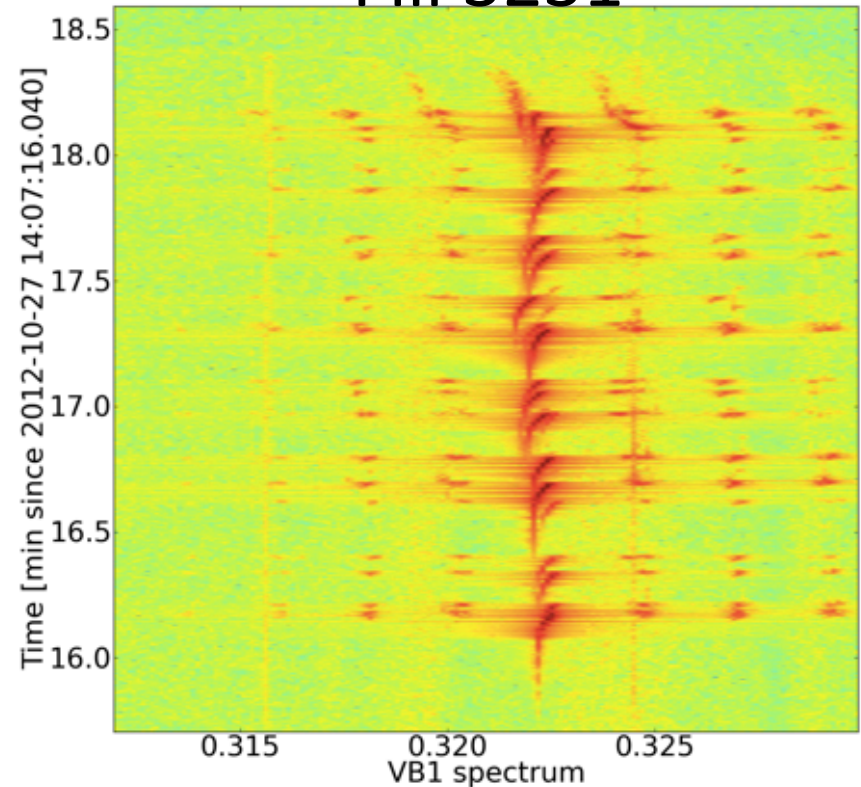
Many fills damped but many without any instability, varying a lot...

...many changes and understandings (Q', Oct, Damper,...)...

...still present in every fill at end of squeeze, very reproducible!



## Fill 3231

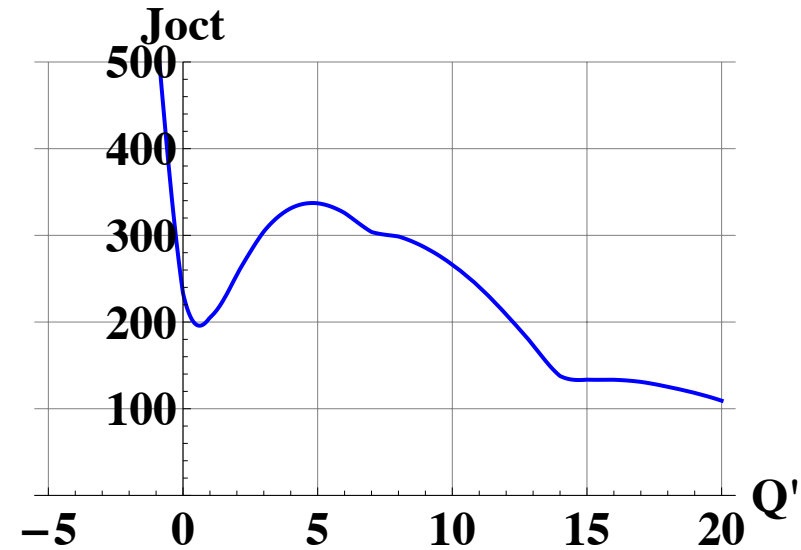


Some data analysis shown at:

- LBOC 17<sup>th</sup> April 2012
- LBOC 8<sup>th</sup> May 2012
- LBOC 31<sup>st</sup> July 2012
- LMC 29<sup>th</sup> August
- ABP/ICE meetings

# Single beam stability: reproducibility

gain=> 400 turns, MO-



- Old machine sittings on very **“sensitive” area**

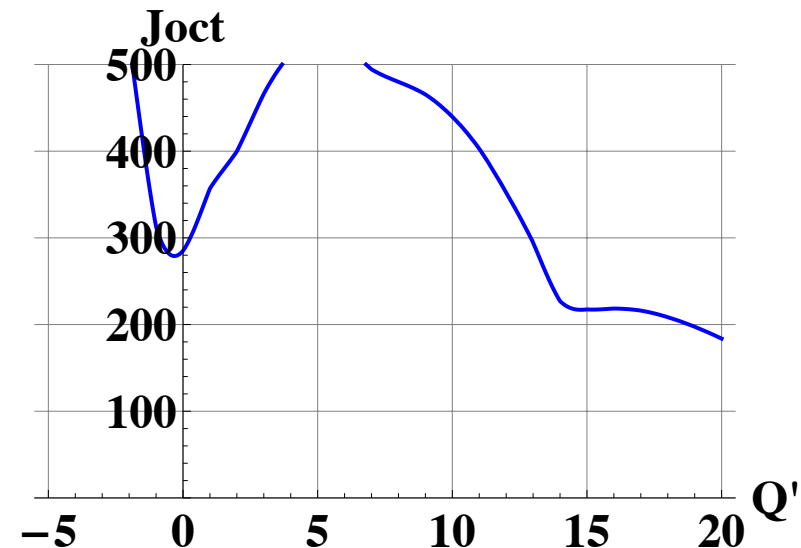
Fill to fill variations could be explained by stability area:

**instability changes significantly f2f**

(change 1 unit  $Q'$  could change significantly the Oct threshold)

Nested Head-Tail model

gain=> 400 turns, MO+



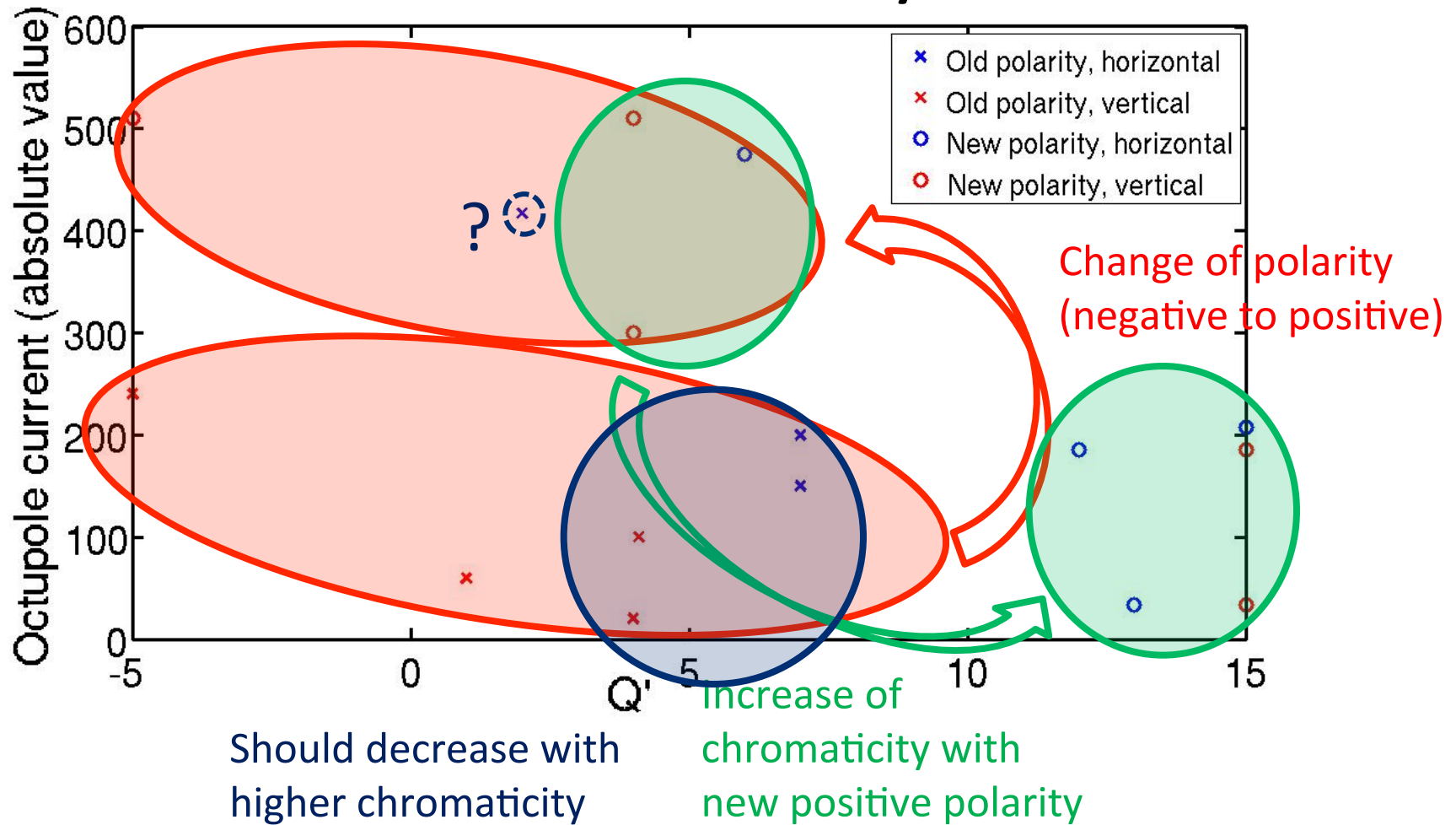
- New machine sitting on **plateau of parameters**

**Instability extremely reproducible**

every fill minute 16 of Squeeze BP

(variations of chroma not detrimental)

# Single-beam and flat top instabilities observed this year

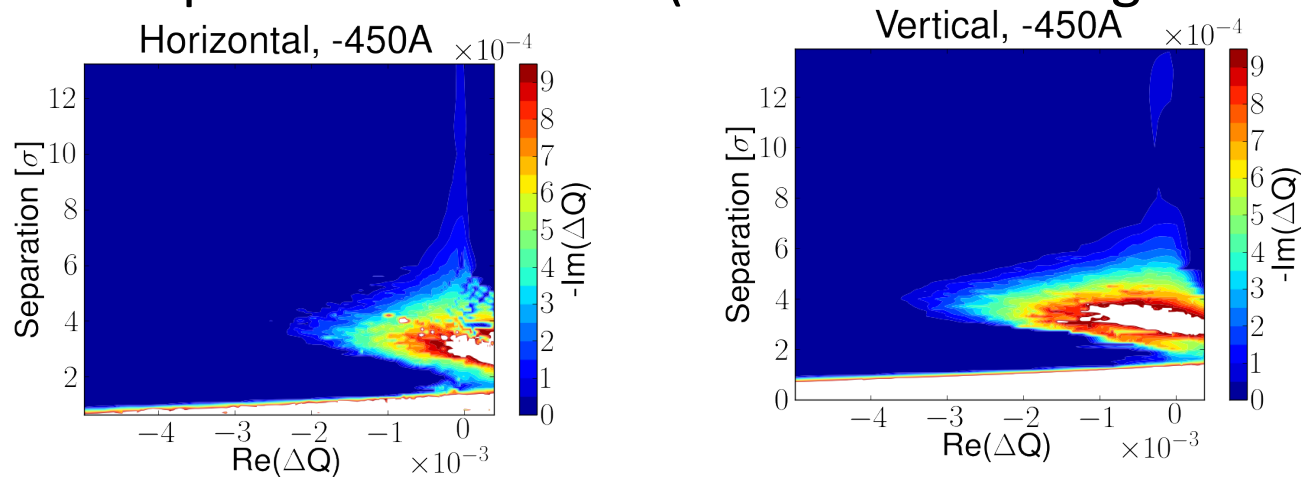


Note: beam and machine parameters are sometimes slightly different between these measurements.

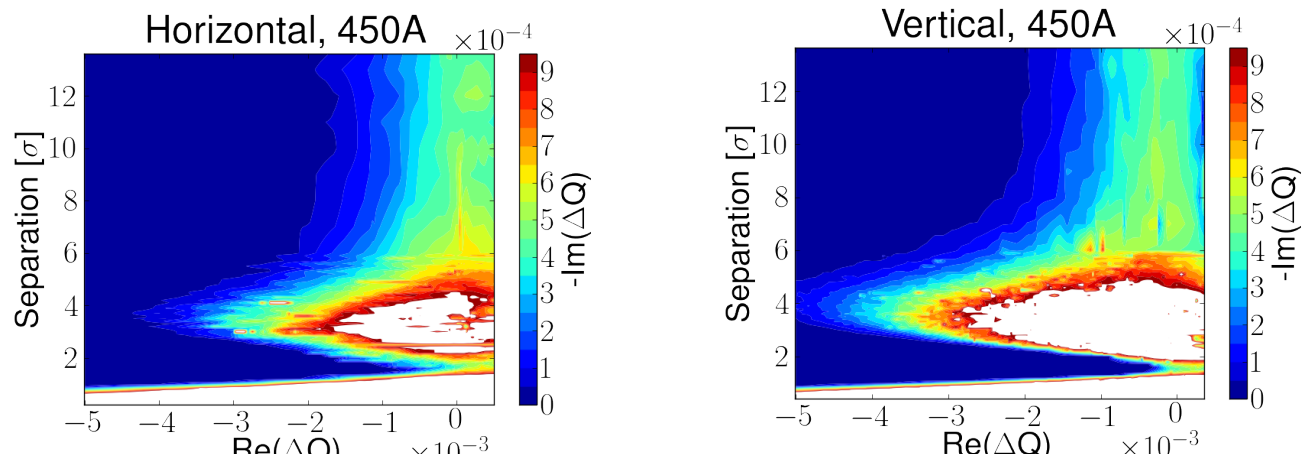
# Two beams models:

- Chromaticity and damper gain not optimum (tiny changes of chroma could lead to complete unstable scenario) this could explain old polarity fill to fill variations
- Tune spread cannot explain what we see (LMC talk 29<sup>th</sup> August 2012)

**Old polarity**



**New polarity**



# What do we know?

## Old polarity

- Machine settings (Q', Oct, damper) **not optimum!**
- Instabilities **not very reproducible** from f2f
- **Needs time to develop** (end of squeeze, plateau during old Adjust)
- **Ramp-Flat-top more stable** less losses
- Allows more **margin** for single beam and better lifetime



## New polarity

- Machine settings measured and **optimized** (Q', Oct, damper)
- Instabilities extremely **reproducible**
- **Needs time to develop** (end of squeeze, plateau during old Adjust)
- **Ramp-Flat-top less stable**
- **No margin!**

**Data analysis points to older polarity**

# Summary:

- New Oct polarity provides better stability at end of squeeze, but worse at beginning...but **instability still present!**
- Instability needs time to develop: during collapse of separation we always go through minimum... **faster is better!**
- **Instability before/during/after squeeze cannot be explained by change of tune spread due to LRs** (especially with new polarity of the octupoles), picture is far more complicated!
  - A. We need to **understand the source** of instability: **working on it** (New models developed, MD requests and test during fills when possible)!
  - B. Possible solution to stabilize: **collide&squeeze feasibility OK!**
  - C. Plan B: if any, **points to old polarity** (more margin single beams and speeding up process to avoid dead-time)!
- From data for options **B&C older polarity would be our choice** but....

....we need to **test experimentally the adjust BP with old polarity and optimum settings...**

# Plan: Test old polarity

- Chroma measurement (probe)
- Find minimum Oct current in the “plateau” area as we are now (just change of polarity and reduce current)
- Apply new Adjust beam-process (to go fast in collision)
- If no detrimental effects seen in adjust then go for physics fills

2 shifts needed rMPP suggestions :

Intensity ramp up:

- 1 fill 3 bunches (check settings, measure&correct chroma)
- 1 fill 480 bunches  $1.5e11$  ppb at inj (go in collision check stability) ...
- Full beam
- **Proposal from LPC to test in MD4 then few fills before 25 ns**

**After analysis we could have few physics fills for statistics and have all the data to conclude for after LS1 run!**