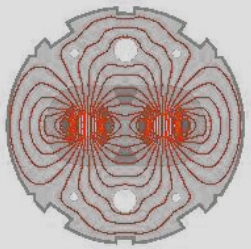
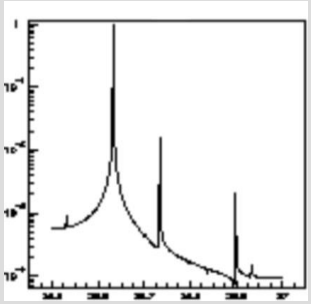
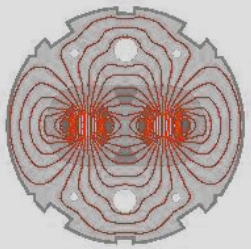


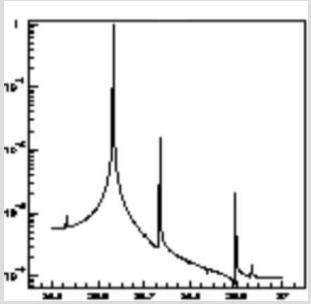
# Plea for an Aperture Kicker for the LHC



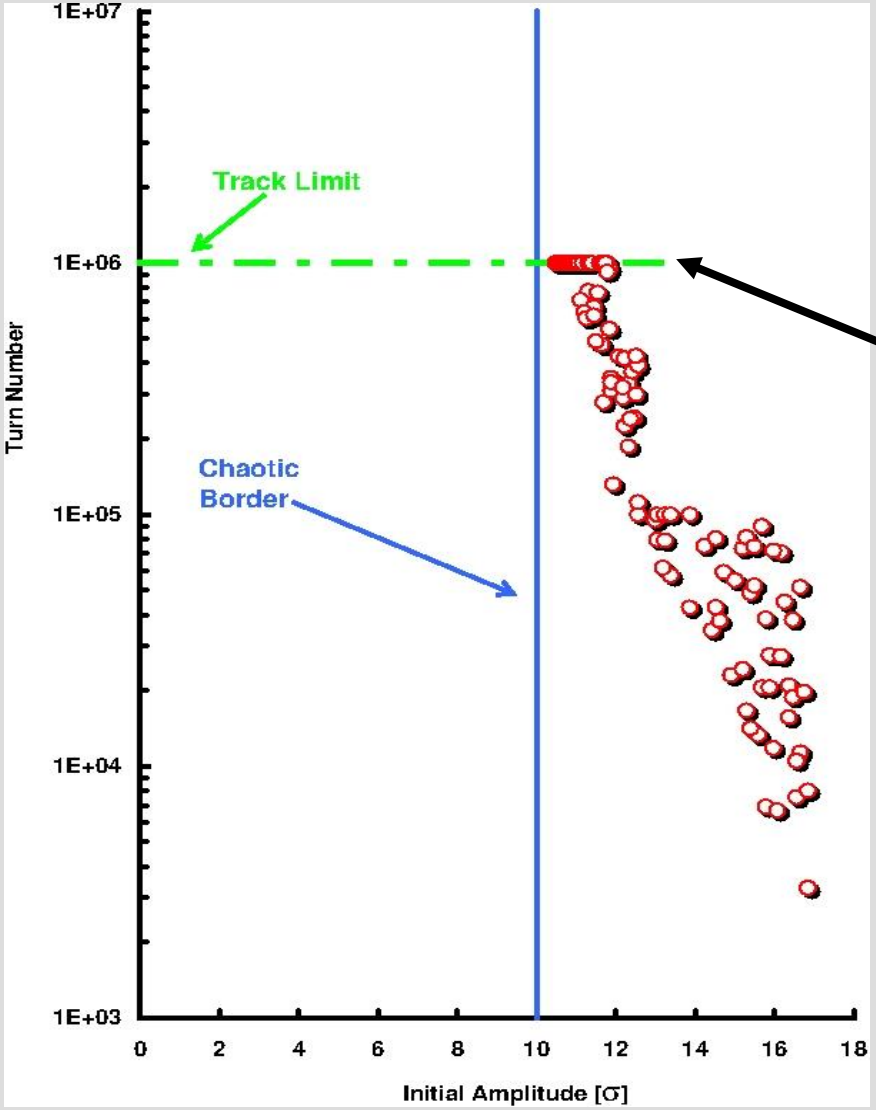
- **Definition of the Dynamic Aperture of an Accelerator**
- **Hollow Beams versus Beam Heating**
- **Motivation for Upgrading to a “real” Aperture Kicker**
- **Safety & Technical Issues**



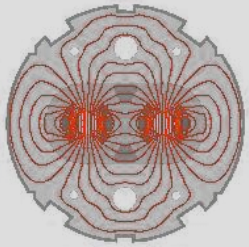
# Survival Plot

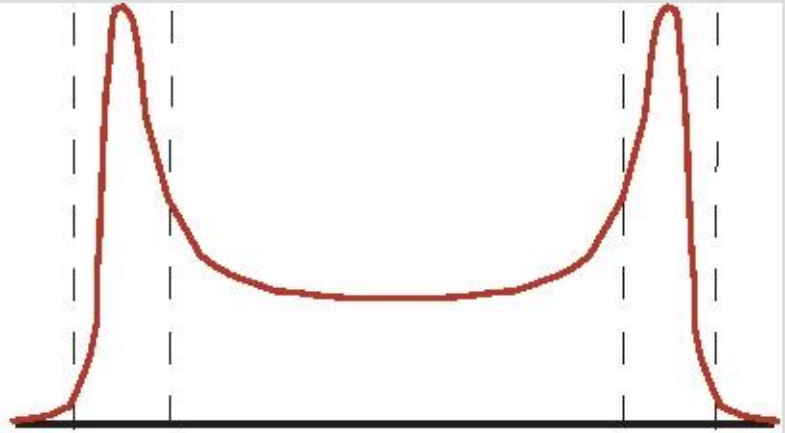


The Dynamic Aperture in an Accelerator is defined as the smallest amplitude at which particle loss takes place before the end of a time interval of interest.

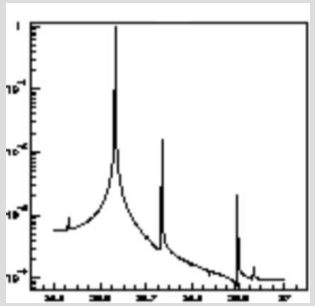



1E6 turns are 89s in the LHC





Wirescan

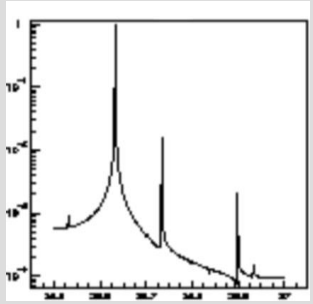


Decoherence

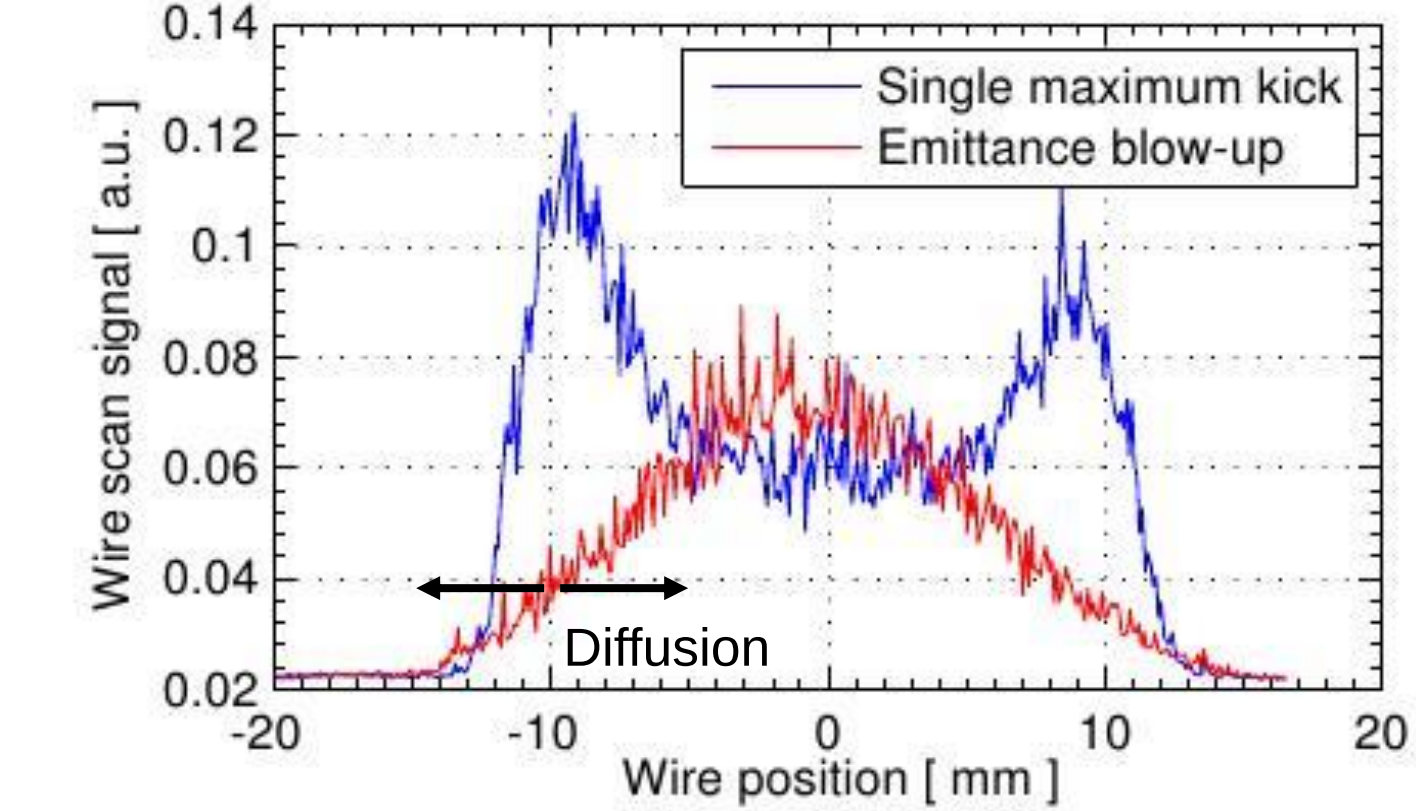


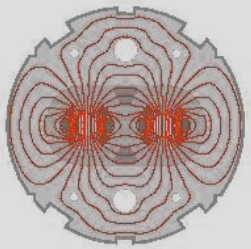

**Hollow Beam via a Single Kick**

# LHC Hollow Beam and Beam Heating

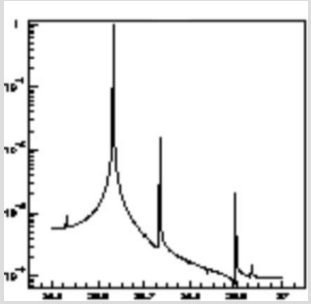


LHC APERTURE MEASUREMENTS, C. Alabau Pons, M. Giovannozzi, G. Müller, S. Redaelli, F. Schmidt, R. Tomás, J. Wenninger, Proceedings of IPAC'10, Kyoto, Japan

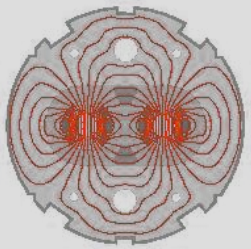




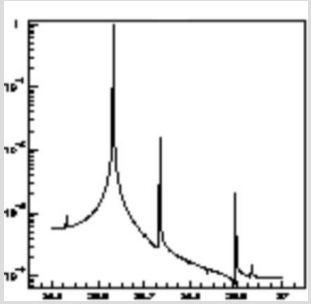
# Hollow Beams versus Beam Heating



- **The DA is a Single Particle Effect.**
- **Ideally we would like to push a single particle to large amplitudes and study its behavior.**
- **For a real accelerator we have study instead a low emittance, low intensity bunch.**
- **A single kick of these bunches with the aperture kicker is the best approximation we have!**
- **Heating the beam is leaving the main bulk of the particles at low amplitudes and the results are highly dependent on the details of the beam distribution and the diffusion model.**

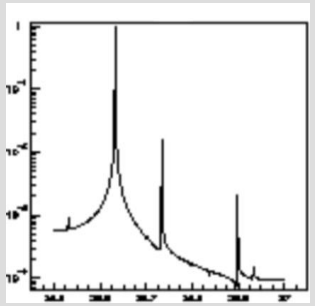


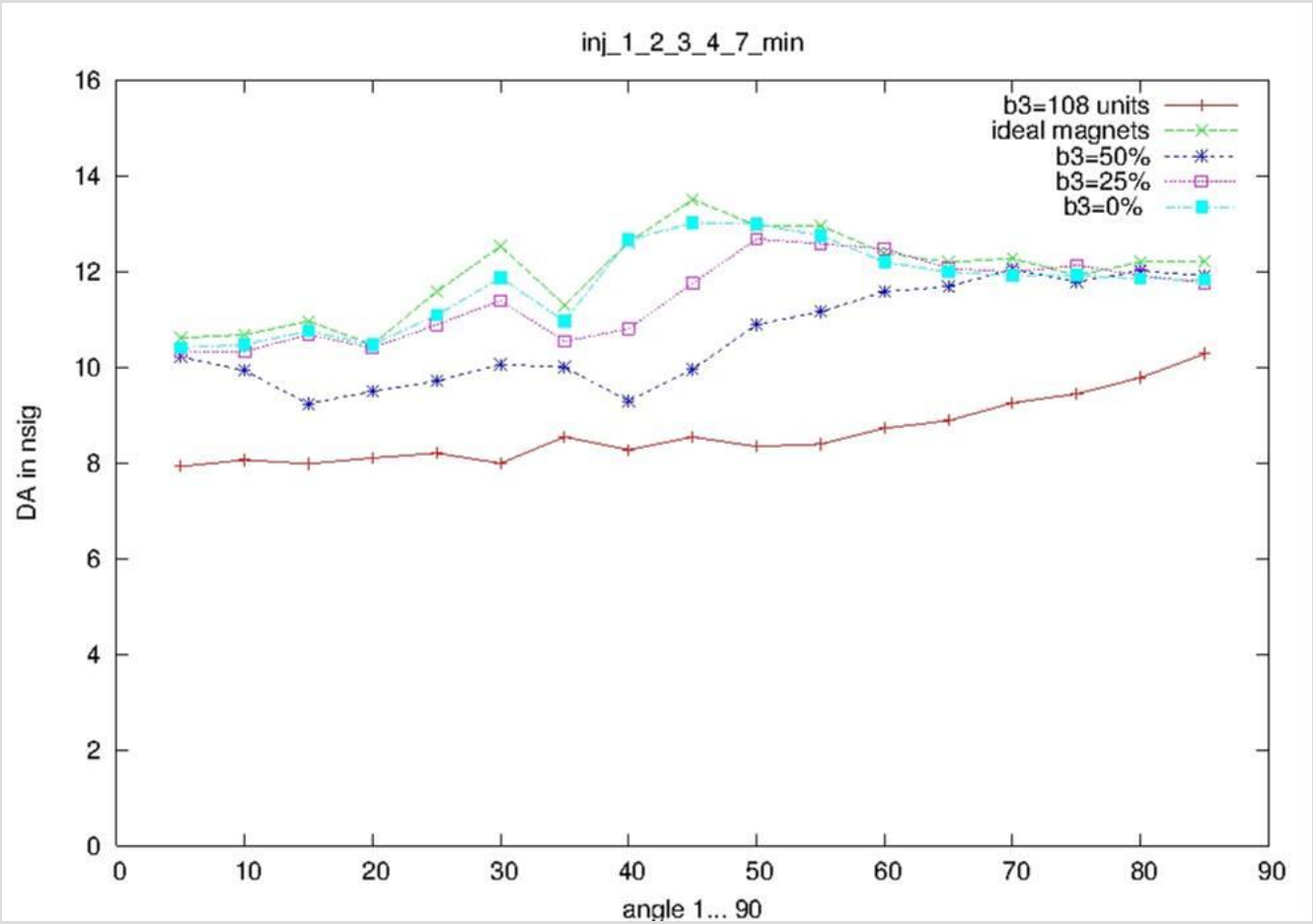
# Motivation for Upgrading to a "real" Aperture Kicker



- **It has been common belief that tracking simulations cannot predict reliable the DA of a real accelerator.**
- **Experience from the TEVATRON, HERA and RHIC made it necessary to apply a safety factor of 2 with respect to the tracking results.**
- **For the LHC more care has been applied for both the tracking studies as well as systematic and precise measurements of all harmonics for all magnets.**
- **The DA is predicted to be ~11 $\sigma$ and a single kick with the aperture kicker to 6 $\sigma$ resulted in no losses whatsoever. Therefore, our predictions are definitely much better than a factor of 2.**
- **Most importantly is the fact, that a true measurement of the DA is not mainly of academic interest but will have a large impact for the validity of tracking studies and in particular for the HL-LHC!**

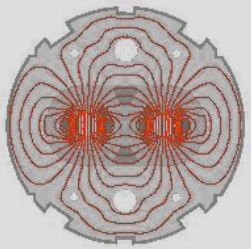
# Typical HL-LHC DA studies



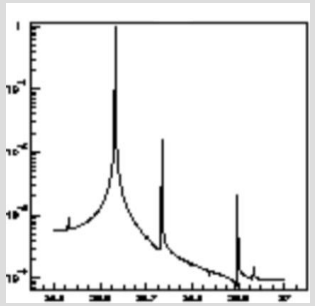



Study for the HL-LHC by Bernhard Holzer:

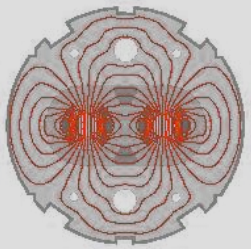
8 $Nb_3Sn$ dipoles with large $b_3$ component



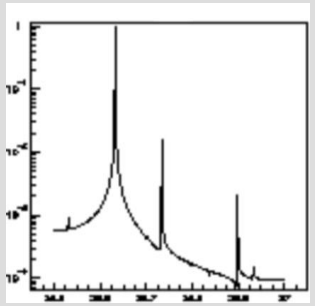
# Safety Issues



- Our present goal is to determine the DA at injection only, obviously much more strength would be needed at higher energies. On the other hand experiments would take very long since we would need a full ramp cycle for each kick!
- For these studies we aim at pilot buches with 3E9 protons, $\varepsilon_n$ = 1.5 $\mu$m and the amplitudes are increased in small steps to avoid full losses.
- Although this intensity it not supposed to do any damage we want to avoid a quench by all means!!!
- The physical aperture has been measured by Stefano et al. to
  - H = 12 $\sigma$
  - V = 13 $\sigma$
- From our tracking studies we expect that the DA of ~11 $\sigma$ is just inside the physical aperture. Moreover, we have first indications that at large amplitudes slow losses take place. Therefore, it is likely that we can actually measure the DA.
- A maximum kick strength between 10 – 11 $\sigma$ is therefore highly desirable!



# Technical Issues



- What needs to be done on the hardware side to achieve kicks 10 - 11 $\sigma$?
- How long will these modifications take?
- For reference: the sigma values are taken at the normalized emittance $\varepsilon_n$ = 3.75 $\mu$m.
- Is the present strength of the aperture kicker 6 $\sigma$?
- Rüdiger has requested that the more powerful generator is exchanged at each Dynamic Aperture MD which will make an access necessary for each usage. Is this truly required?
- It is mandatory, that the present generator is switched back to allow at least the 6 $\sigma$ kick for other less demanding MDs!