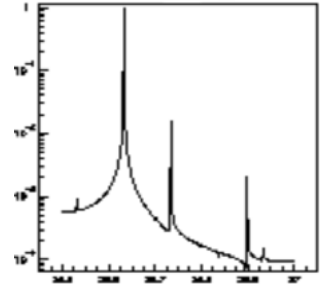
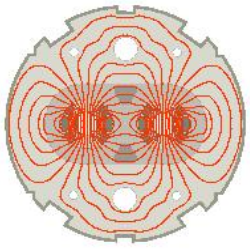


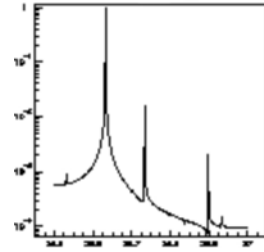
# Non-Linear MAD-X Model of the LHC



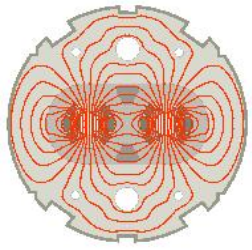
- What do we have?
- What will we need?
- Some examples



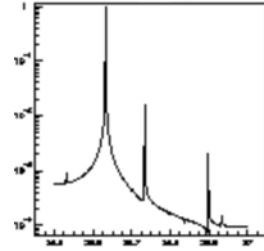
# What do we have



- Mad-X well debugged
- Mad-X fully adapted to handle LHC including two-beam treatment
- Higher order terms now available via PTC
- Elaborate matching techniques
- Very elaborate error treatment
- Two-beam closed orbit routines



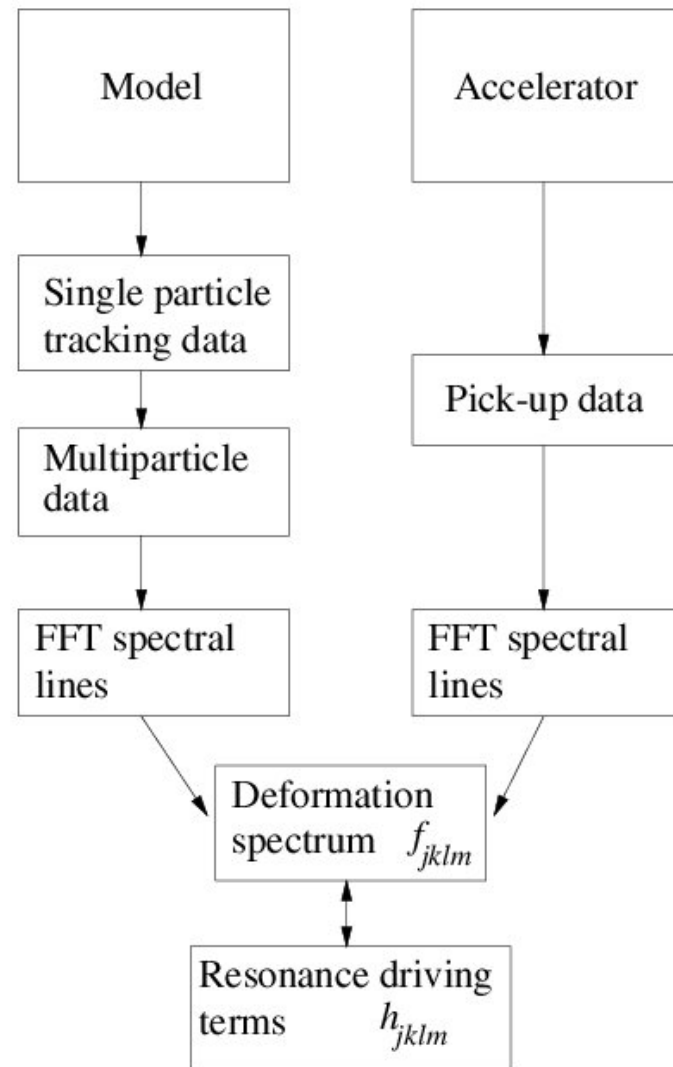
# What will we need

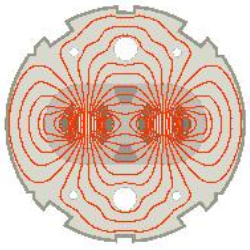


- Full link to the database of the magnet designers
- Feed-back from the machine
  1. What do we want to measure and control?
  2. Which data can be obtained?
  3. For which machine condition?
  4. How can we define a beam-based database?
- Link to beam-based database
- Answers in real-time (during shift!)

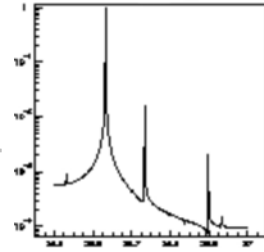
## Technique overview

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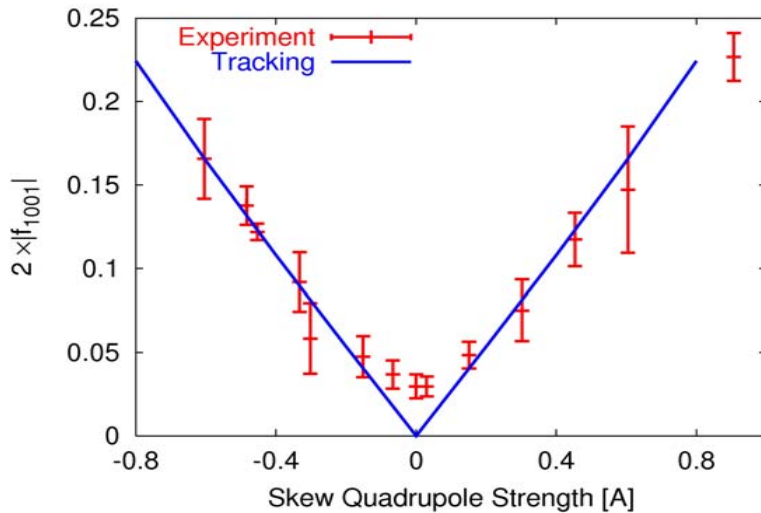


# Linear Coupling Compensation



## Linear Coupling in SPS (2001)

The coupling term  $|f_{1001}|$  is plotted as function of the strength of the skew quadrupoles:

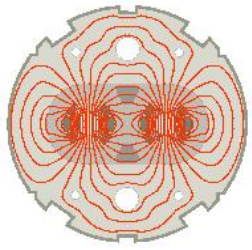


PS Booster

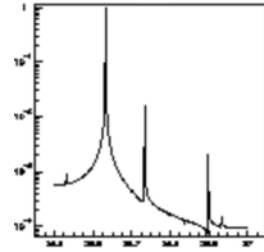


⇒ Model and experiment are in excellent agreement.

⇒ This shows that SPS is decoupled in this particular case.



# Sextupole Resonances



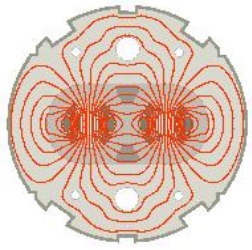
- SPS

- Polarity Problem
- Sextupole Failure
- Measure Coefficient

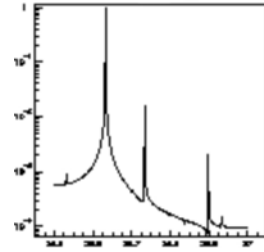





- PS Booster

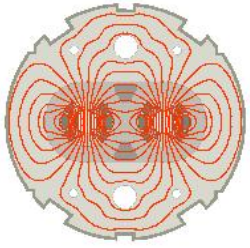




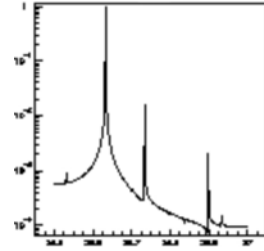
# Exotic Applications



- Single  $4\sigma$  Kick does everything!! 
- AC-Dipole idea great  lacks proof of applicability!!
- Chromaticity Measurement (sign also!)  
In simulation works with simultaneous transverse and longitudinal kick  experiment remains sketchy



# Commissioning of the LHC



- Polarity Checks & Correction Steering both **Beam-based**
- Mostly for Injection and  $b_3$  Spool Piece Correction
- Higher Orders and Top Energy *not* excluded
- Need turn-by-turn BPM System on *Day 1*, which means low Failure Rate for all BPMs each Turn!!