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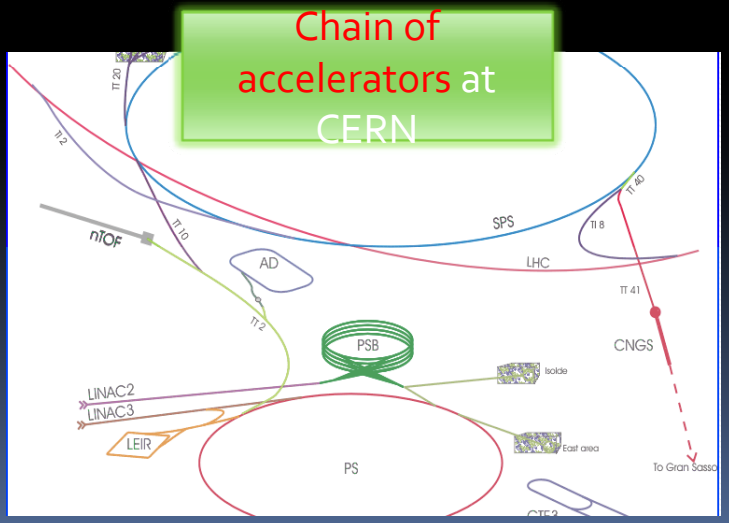
CERN BEAM STUDIES INTO THE EGEE/WLCG ENVIRONMENT

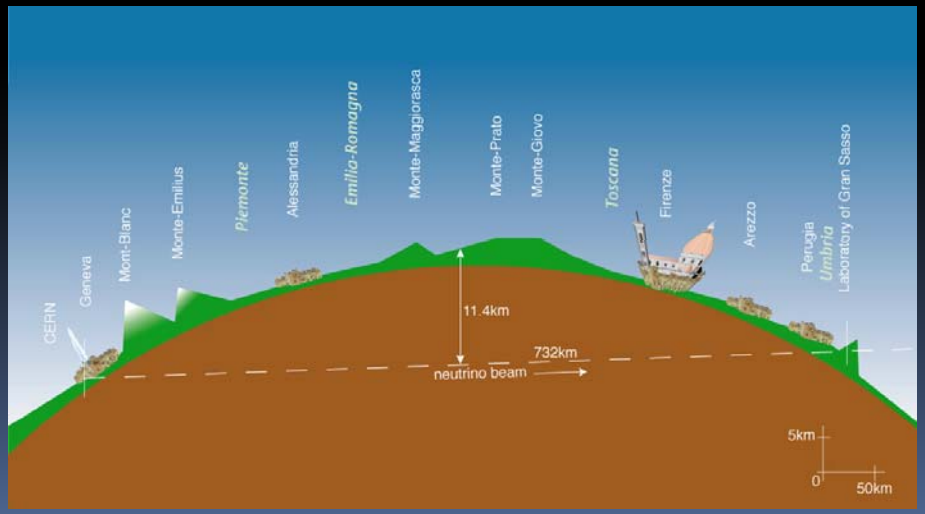
Outlook

- The beam team at CERN have expressed their interest to run two different aplications into the Grid
  - Tracking
  - Collimation
- In these few slides we will present the nature of these applications and the Grid infrastructure we have defined
- Thanks to Andrea Franchi, Thomas Weiler and Frank Schmidt (Beam team at CERN) for their help

1st Application: Tracking

- GOAL of the analysis: Provide the OPERA detector at Gran Sasso (Italy) with large bunches of neutrinos
  - Using bunches of protons hitting a target after being accelerated by the SPS accelerator

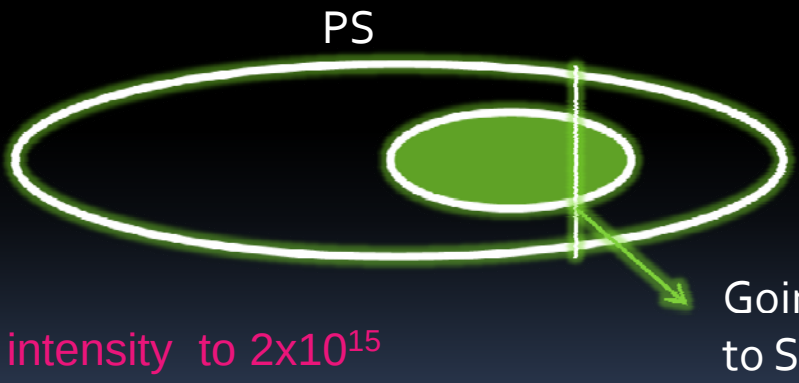




Current extraction procedure

- METHOD: Extraction performed in 5 turns
  - Application of an magnetic field which moves the beam towards a metal blade
  - The beam is shaved and the slice beyond the blade is ejected to wards the SPS

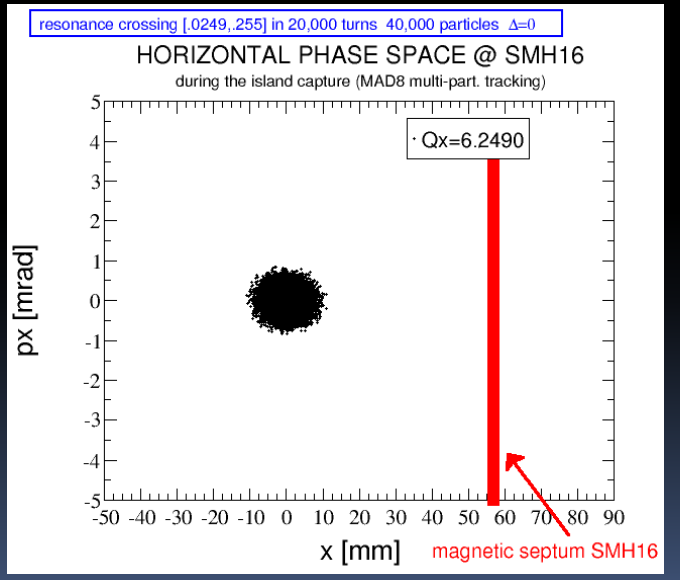
- PROBLEM: High beam loss and radiation of the beam touching the metal blade
  - Proton intensity limited
    - $3x10^{15}$ protons per cycle are required
    - This beam loss decreases the intensity to $2x10^{15}$
  - This limit can be technically overcome, but operational and also legal issues prevent it



New extraction procedure

- Basic Idea: Separation of the beam in 5 beamlets by using octupole magnets
  - A field of $V=kx^4$ and a horizontal tune value of Qx = 6.25 creates 5 islands (4 beamlest + core)
  - Variating the Qx until 6.258

  the islands are separated until 3cm
    - Separation achieved at 100,000 turns
    - Fast magnetic field then applied to move the island out of the PS without touching the metal blade



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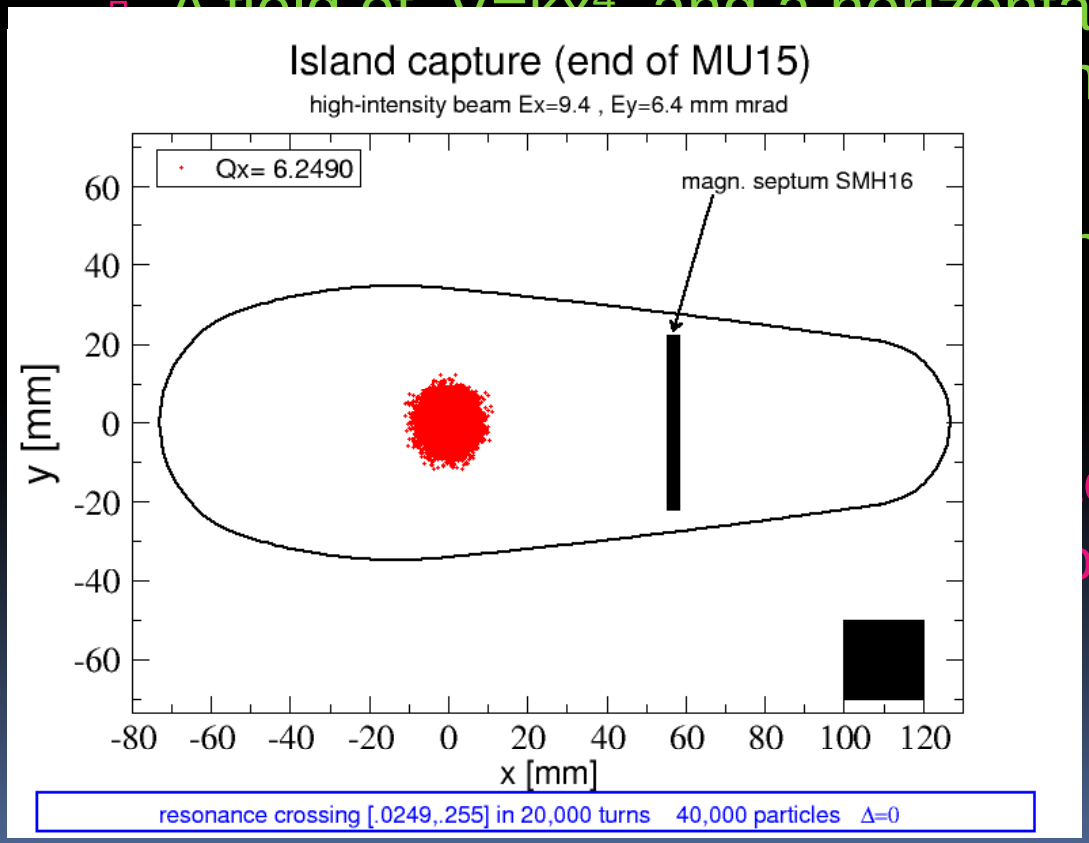
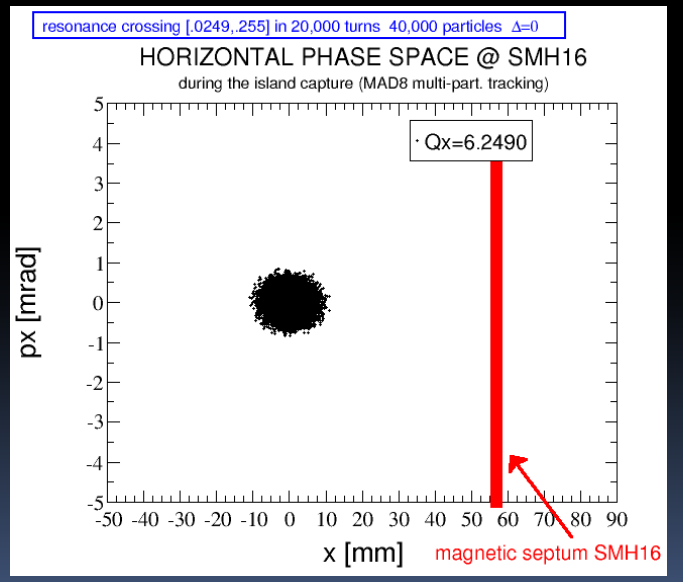




Numerical issues (I)

- Number of particles per island
  - Equal sharing of particles (20%) among islands is required
    - Large diferences among islands would induce electromagnetic resonant fields in the SPS which can deteriorate the beam quality
  - Highly depending on the turns used to separate the islands: higher number of turns => better sharing
  - The octupole setting has to be optimized in order to ensure 20% of protons per island
- Conclusion
  - It is neccessary to perform realistic simulations over 100,000 turns to optimize the octupole setup

Numerical issues (II)

- Height of each island
  - The octupoles induce a small coupling with the vertical plane increasing the height of the islands
  - Not measurable in the PS, it can produce beam losses in the extraction channel
  - It is impossible to figure out from the beam losses whether they are placed in the horizontal or vertical planes
- Conclusion
  - Full 2D simulations required
  - Higher computational load compared to the 1D case

Numerical issues (III)

- Value of the fast magnetic field
  - Magnetic field rise time of 350 ns
  - In the PS the bunches of particles have a separation of 210 ns
  - At least the last bunch will touch the metal blade
    - The radiation losses must be estimated
- Conclusion
  - Simulations with large number of particles (~1E6) are required

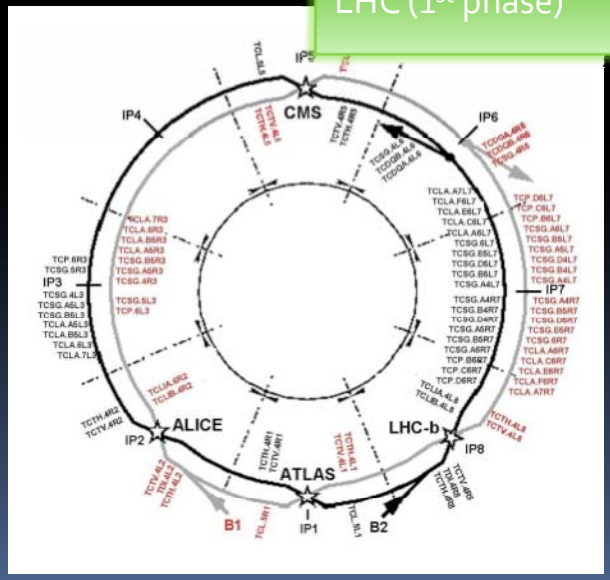
Tracking jobs into the Grid

- Large-scale Simulation
  - Realistic number of turns : 100,000
  - Large number of particles: 1,000,000 to be split into a large number of GRID nodes to speed up simulation
- Thanks to the GRID setup, optimization studies (Octupole gradient and tune variation) can be carried out to minimize and estimate beam loss

2nd Application: Collimation

- GOAL of the application: Clean up of the beam losses at the LHC in a controlled way
  - Losses driven by dynamical processes and also by operational inestabilities or machine failures
- About 40 collimators around the LHC ring for the 1st phase of the experiment
- Planned to duplicate the number of collimators for the 2nd phase

Collimators distribution at the LHC (1st phase)



Loss Rates at the LHC

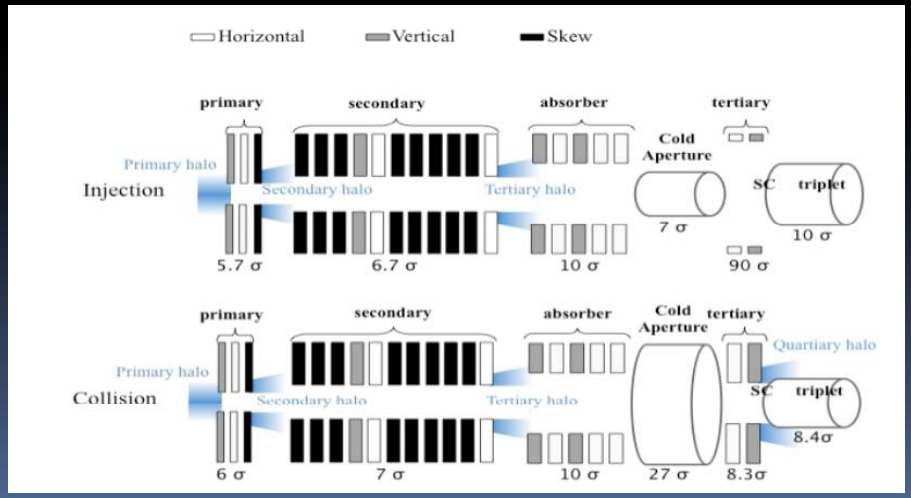
- Summary of the specified maximum loss rates for safe operation of the LHC machine and its collimation system
  - At the nominal LHC operation (7 TeV) the beam life is 20h

Mode	T [s]	τ [h]	R_{loss} [p/s]	P_{loss} [kW]
Injection	cont.	1.0	0.8×10^{11}	6
	10	0.1	8.6×10^{11}	63
Ramp	1	0.0006	1.5×10^{13}	1098
Collision	cont.	1.0	0.8×10^{11}	97
	10	0.2	4.3×10^{11}	487

Numerical Issues

- Each collimation job includes:
  - Generation the halo particles hitting the primary collimator
    - About 3200 particles per job and up to 1600 jobs for each system setup
  - Simulation of

the cleaning procedure for the generated particles



Setup on the Grid

- New VO fully approved by EGEE: vo.sixt.cern.ch
  - Grid infrastructure in terms of services provided at CERN
  - Access to the queues, definition of a dedicated software area and storage space is required for the rest of the sites
- Tracking requirements
  - High picks of production followed by thorough analysis periods
  - During the active circles, the VO foresees 800 jobs per day with an average duration of 12h
  - Small output files
- Collimation requirements
  - Intended to run during the whole LHC life
  - About 1200 daily jobs of 12h of duration each
  - Small output files
- Storage requirements
  - Master copy of output files stored at CASTOR@CERN
  - Secondary copies planned to be stored in some other sites
- Current Status
  - Both analysis are being merged into the Grid using the Ganga UI for job submission and tracking