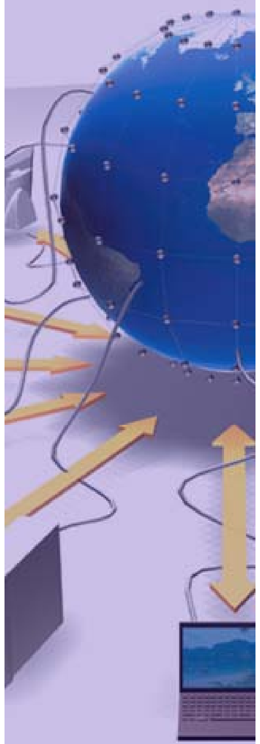
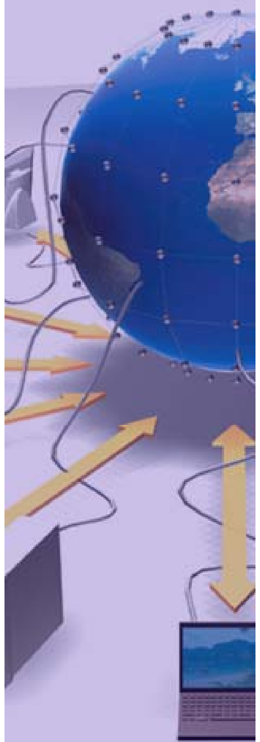


Towards the 5th LHC VO: The LHC beam studies in the WLCG environment

CHEP 2009, Monday 23rd March 2009 (Prague)

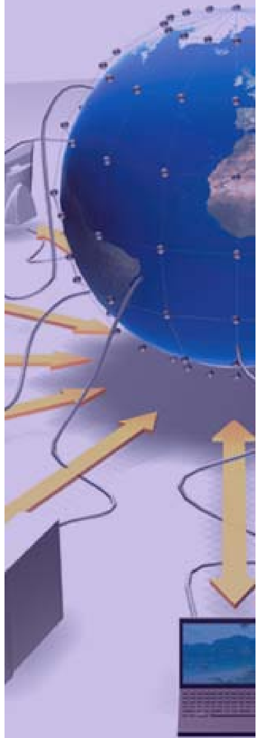
Patricia Méndez Lorenzo (CERN, IT/GS)
Jakub Moscicki (CERN, IT/GS)
together with
Frank Schmidt, Thomas Weiler and Andrea Franchi from the beam team at CERN

Outlook

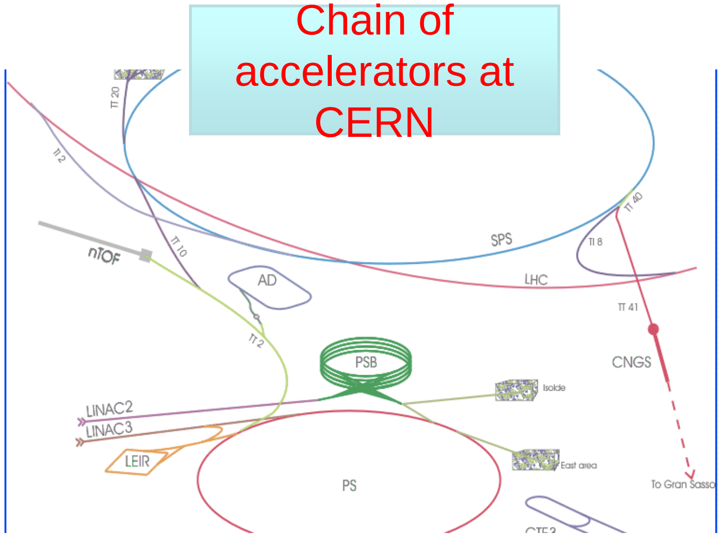


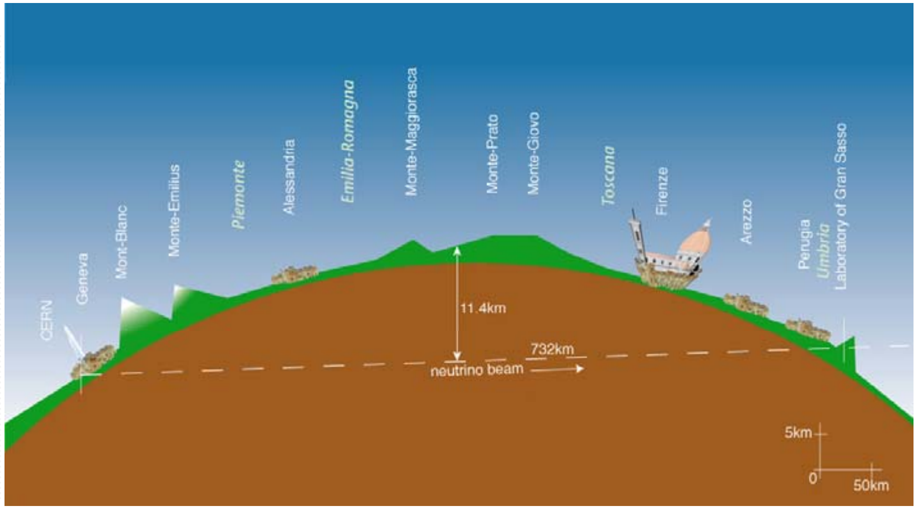
- In Summer 2008 the beam team at CERN expressed their interest to run two different applications into the Grid
  - Tracking
  - Collimation
- This presentation will concentrate on three fundamental aspects:
  - Nature of these applications
  - Grid infrastructure provided to the beam team
  - Potential for other scientific communities such as Fusion studies at ITER
- Thanks to Frank Schmidt, Thomas Weiler and Andrea Franchi from the beam team at CERN

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





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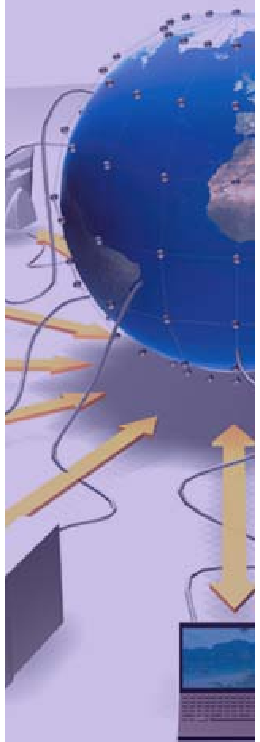
Scope of the tracking analysis



- The tracking studies concentrate on the extraction method of the protons from the PS to the SPS
  - METHOD: splitting the PS beam in 5 beamlets which are introduced into the SPS
    - Using octopole magnets
    - Applying fast magnetic fields which move the beamlets fto the SPS
  - GOAL: decrease as much as possible the energy losses which could compromise the required multiplicity
  - STUDIES ONTO THE GRID: Simulation of all factors which can cause the energy losses

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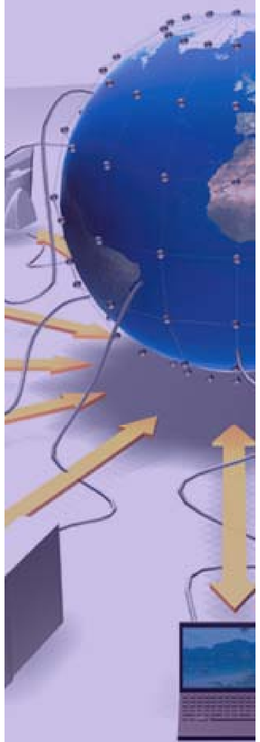
Numerical issues

- Number of particles per beamlet
  - Equal sharing of particles (20%) among beamlets is required
  - It is neccessary to perform realistic simulations to optimize the octupole setup
- Height of each beamlet
  - The octupoles induce a small coupling with the vertical plane increasing the height of the beamlet
  - Full 2D simulations required
- Value of the magnetic field applied to move the beamlets out of the PS
  - Differences between the magnetic field rise time and the bunches separation at the PS can indude some energy losses
  - Simulations with large number of particles (~1e^6) are required



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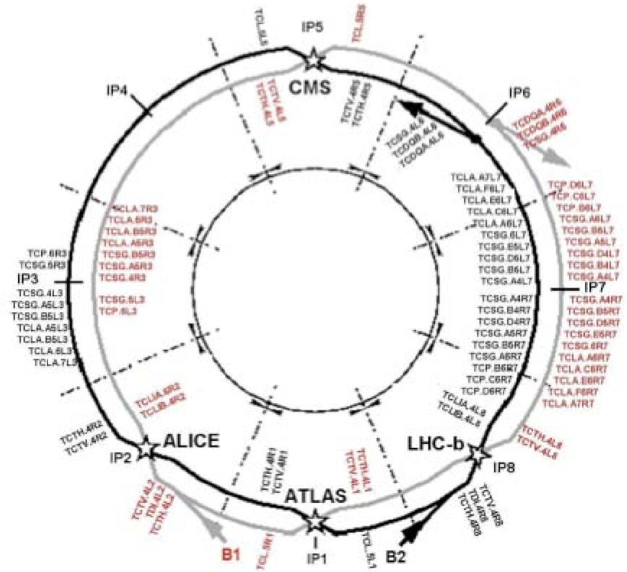
2nd Application: Collimation

- 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)



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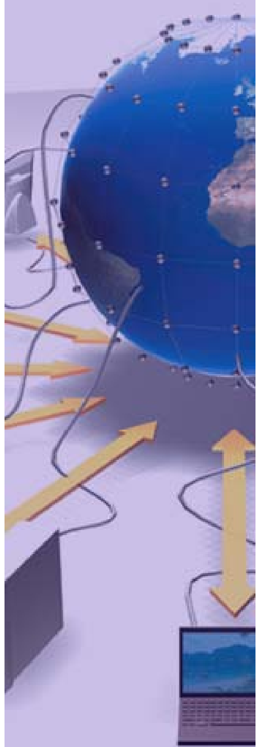
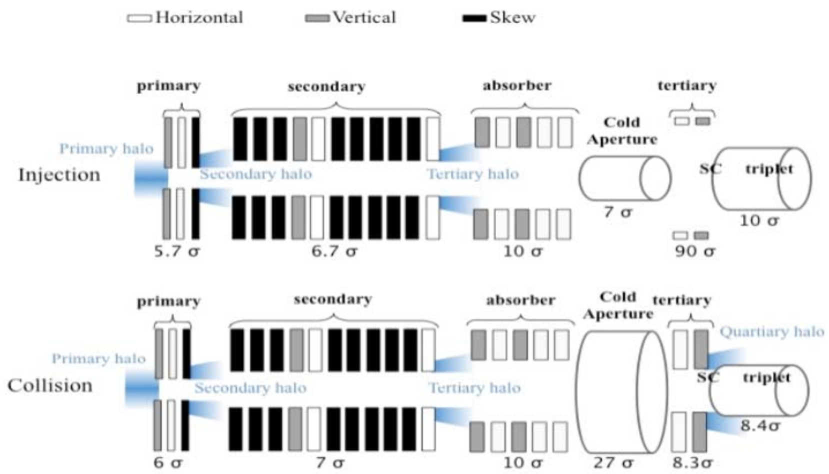
Numerical Issues



- 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



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Gridification Structure

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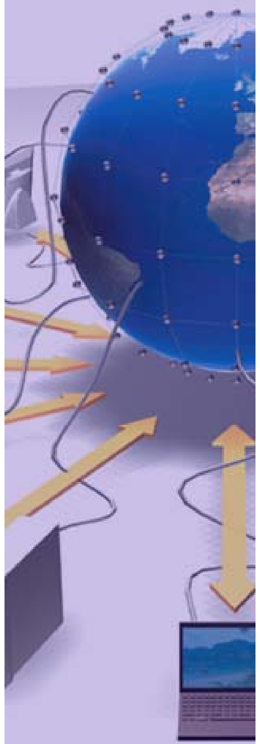
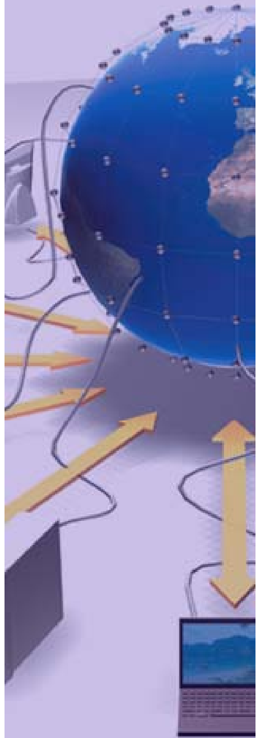


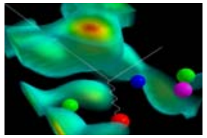
- Standard gridification structure applied to other successfull applications
  - Originally applied to the Geant4 productions, also used for UNOSAT, Lattice QCD, HARP.
- Based on three major blocks:
  - Resources:
    - Basic and full Grid infrastructure is guaranteed to the users
  - Support:
    - Follow up of the productions by one or several dedicated persons of the Grid Support team
  - Tools:
    - After a 1st stage studing and understanding the application, Ganga and/or Diane are proposed as production tools

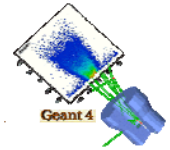
Application support at CERN

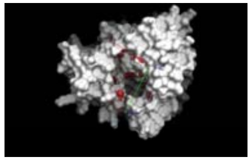
- Infrastructure for scientific communities/generic applications
  - A set of configured master hosts hosted at CERN
  - Grid resources: GEAR VO
  - Tools: DIANE + Ganga

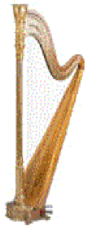


Geant 4





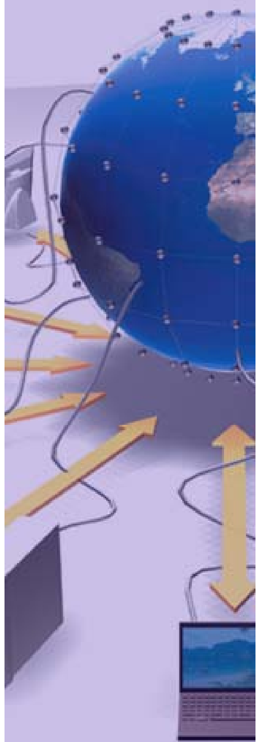




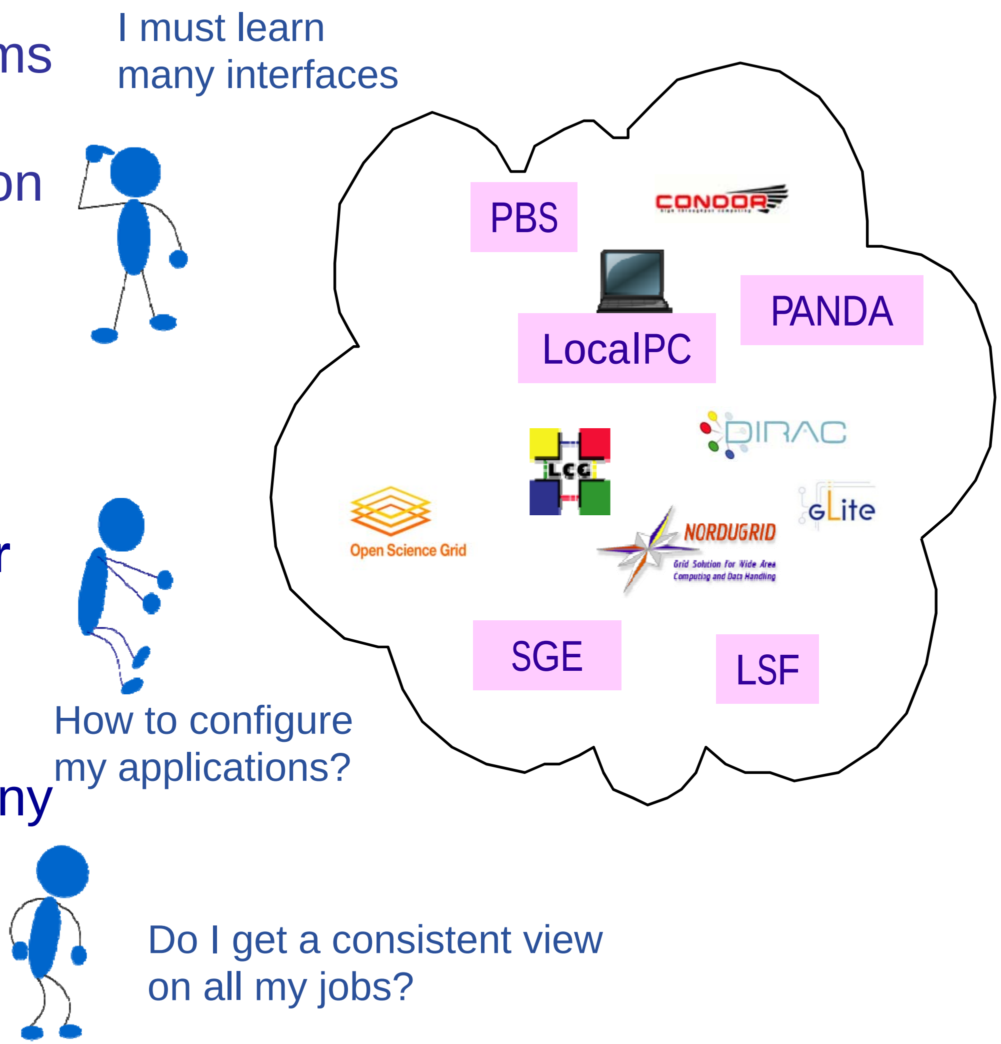
HARP

Garfield

The Tools: Ganga

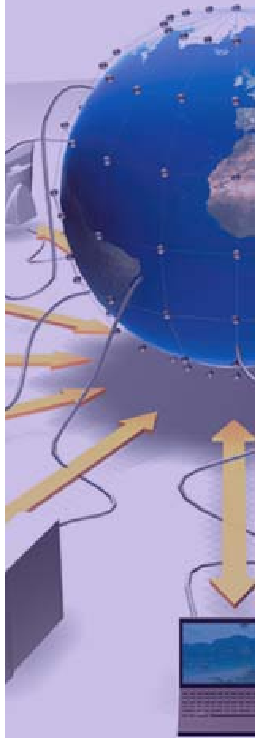


- Submission gateway to many distributed systems
- User Interface with transparent and common interaction to different backends
- Easy job management and application configuration
- **Main analysis tool for ATLAS and LHCb experiments at CERN**
- Considered the gridification toolkit for any new application
- **http:cern.ch/ganga**



Setup on the Grid

- New VO fully approved by EGEE: vo.sixt.cern.ch
  - Grid infrastructure in terms of services provided at CERN
    - Two WMS@CERN and AFS UI submission platform
  - 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 cycles, 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 have been merged into the Grid using the Ganga UI for job submission and tracking



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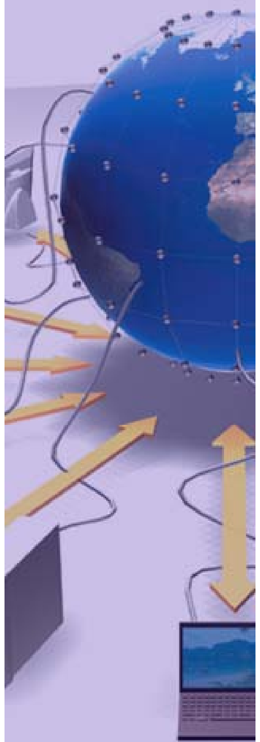
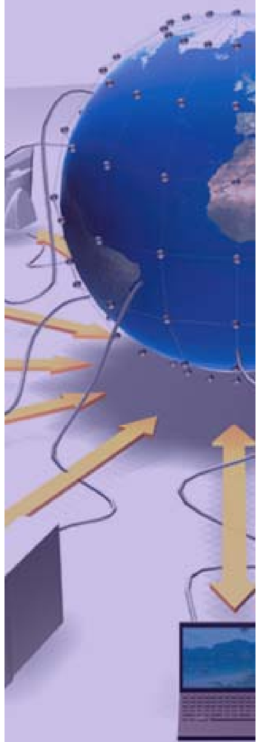
Potential for ITER



- Within the EGEE project, the HEP cluster has established a collaboration with the Fusion scientific community
  - Collaboration triggered by the experience gained with the beam team at CERN
  - Common points with Fusion from the physics point of view
  - Based on the same procedure established for SixT, some small ITER applications have been implemented into the Grid using the Ganga toolkit
    - ITER applications also very CPU demanding
    - HEP/FUSION demostration performed at the EGEE UF4 (2-6 March 2009)
- Looking forward to continuing this collaboration in the future

Conclusions and Summary



- Fundamental studies of tracking and collimation at the LHC@CERN have entered the WLCG in 2008
  1. Tracking studies for the neutrino factory
  2. Collimation studies for the LHC experiments
- Analysis required during the whole life of the LHC experiment
  – Together with the 4 LHC experiments, this VO can be considered the 5th LHC VO
  – Ganga has played a central role in the gridification of this applications
  – Still ramping up as VO in terms of world-wide resources
    - CERN will provide the 50% of the required resources
    - Implication and support of the LHC sites is therefore required
  – These are fundamentally CPU intensive applications
    - No heavy storage resources required at the sites

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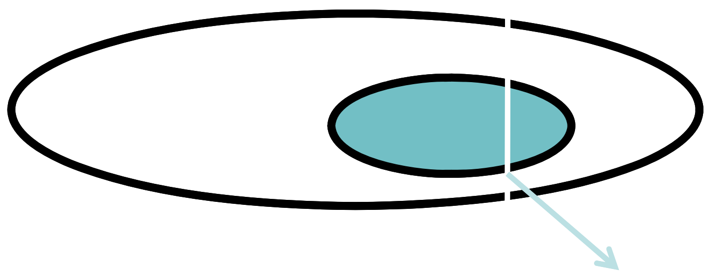
Backup slides

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 towards 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 legal issues prevent it



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Extraction procedure

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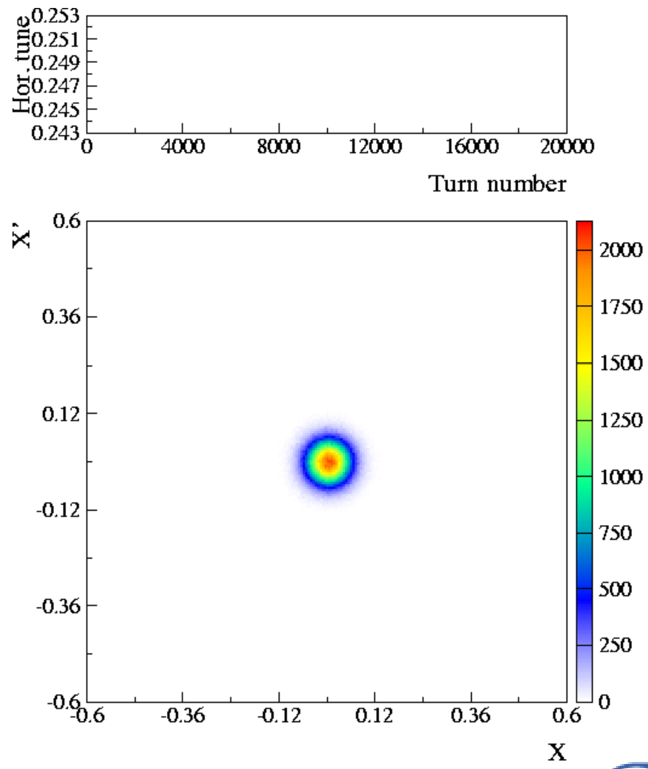
- Basic Idea: Separation of the beam in 5 beamlets by using octupole magnets
  - A field of $V=kx^4$ and a horizontal tune value of Qx = 6.25 creates 5 islands (4 beamlest + core)
  - Variating the Qx until 6.258 the islands are separated until 3cm
    - Separation achieved at 100,000 turns
    - Fast magnetic field then applied to move the island out of the PS without touching the metal blade



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