Scraping in the SPS for LHC injection
My work as Technical Student at CERN

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Technical Student
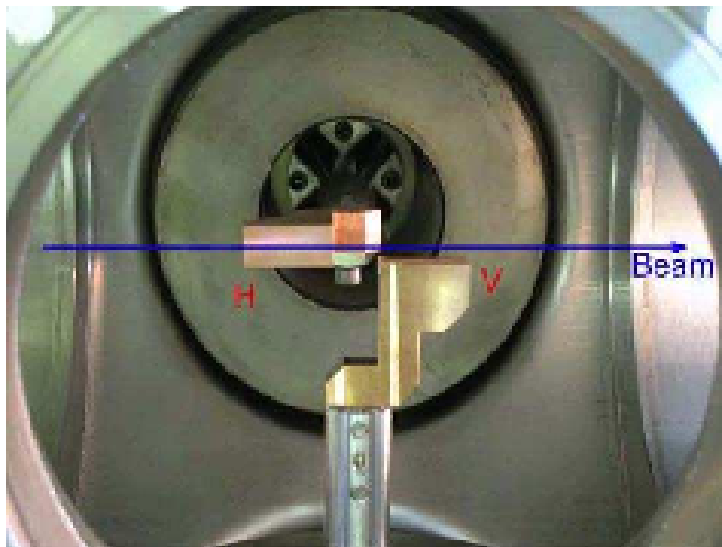ABP Group, AB Department
CERN

LCU meeting 24.sept.07

Outline

Why Beam Scraping?

- LHC injection: Nominal LHC beam intensity exceeds:
  - Damage level by one order of magnitude
  - Quench level by four orders of magnitude
- If tail intensity is $\geq$10%, this will cause damage!
- If tail intensity is as low as $\sim$0.01%, it can still cause quenches!
- Beam scraping is a useful MD tool: Detect long tails
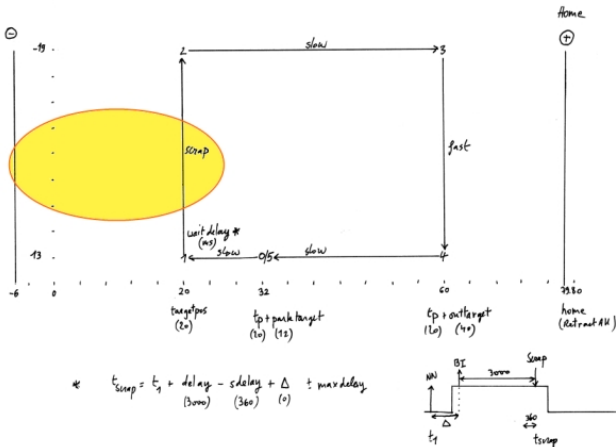- Scrapers and BLMs are extremely sensitive together

What Has Been Done?

- Scraper with 2 Cu jaws installed in SPS
- FESA class is ready for use (S. B. Pedersen)
- japc: Java library for communicating with FESA (AB/CO software engineers)
- A "beta" high level scraper control application (me, help from E. Hatziangeli, G. Kruk, W. Sliwinski)
- Simulations to understand scraper's effect on the beam (Helmut and me)
- 2 MDs to test scrapers and measure repopulation (Helmut, S. B. Pedersen(AB/BI), A. Brielmann(AB/ATB) and me)

Basic Workings Of Current Scrapers (1/2)

Basic Workings Of Current Scrapers (2/2)

See also http://bdidev1.cern.ch/bdisoft/development/BDI-Domains/bdeyelids/bdeyelids.php, choose

Domain → SPS and Instrument → BOSCRA. Figure: Courtesy of S. B. Pedersen.

MD Results (briefly)

- 3 technical tests without beam, debugging application, FESA, low-level servers
- MD 1
  - ► Scrapers were working 15 minutes after MD start
  - ► We were able to scrape the beam each cycle we wanted to
  - ► Tails are repopulating in both planes
  - ► Learned that intensity should be "far away" from high res BCT saturation limit
- MD 2
  - ► Beam delivered varied in intensity (pulsed mode)
  - ► Beam more stable than last time (coast): Tail repopulation mainly in horizontal plane
  - ► Measured scraping time scale via beam loss monitors
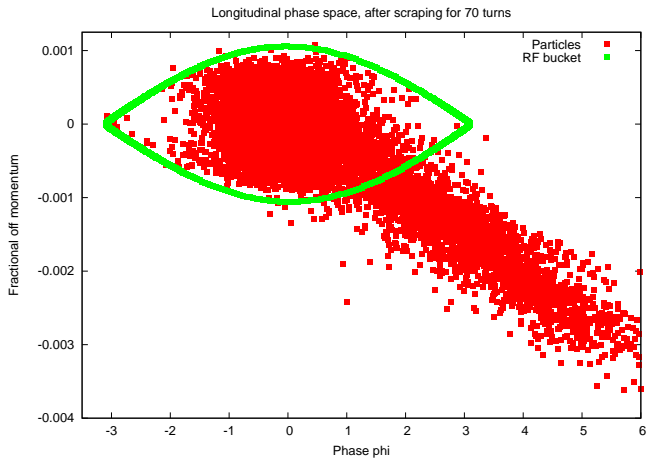- Details to be presented in an APC meeting

Simulations (briefly)

- Scraping takes $\sim$100 SPS turns
- $<$1000 turns available for scraping
- Scraping at around 3.5σ will remove dangerous tails

A nice plot

Longitudinal phase space, before scraping
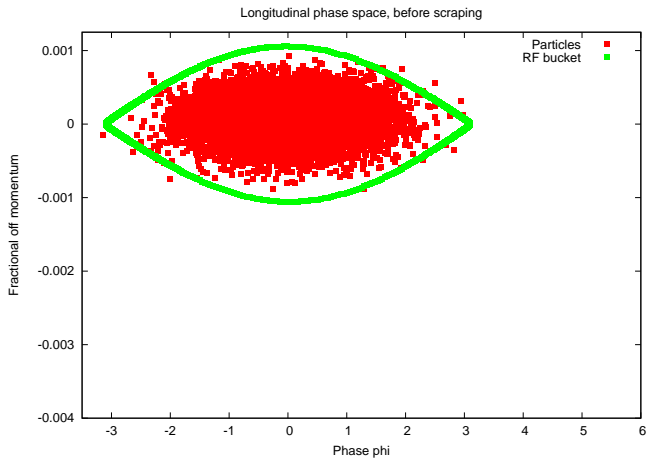
Another nice plot

Suggestions: What Should Be Done?

- Hardware:
  - ▶ Install diagonal scrapers?
- Analysis:
  - ▶ Can scrapers be damaged by the LHC beam?
  - ▶ What do scrapers do to SPS optics?
  - ▶ Is diagonal scrapers necessary?
  - ▶ SPS aperture model and/or loss distribution?
  - ▶ Intra-beam scattering leads to tail repopulation?
- Software:
  - ▶ Release Java control application for "β" testing (clients: J. Wenninger and others)
  - ▶ Possibly simplify user interface for regular operation
  - ▶ Safety interlocks: Dump if large loss? (Must be done low level!)
- Any ideas from the audience?

Summary

- Scrapers are already working and useful
- Need to study what will happen with high intensity beam in LHC injection case