

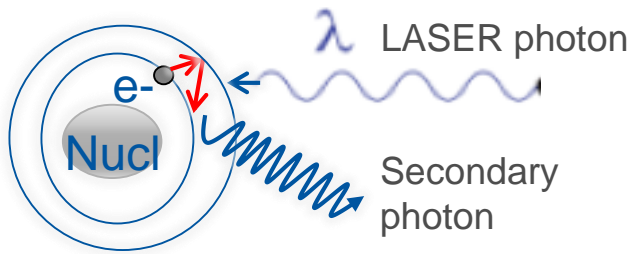
MD-3284: Partially Stripped Ions in LHC

R. Alemany, J. Jowett, W. Krasny, [M. Schaumann](#)

Motivation

Initial studies for the **Physics Beyond Colliders** initiative of the **CERN Gamma-Factory**

- Broadening the present CERN research program
- Development of a **novel concept of light source** via the **existing accelerator** infrastructure



1.) Resonant absorption of the laser photons by the Partially Stripped Ion (PSI) beam:

2.) Followed by a spontaneous atomic-transition emissions of secondary photons

LASER photon strongly boosted by $4\gamma_{rel}$ → For LHC energy, photon energy exceeds those reachable for FEL at high light intensity.

Goals of the MD

- Injection and acceleration of Partially Stripped Ions.
 - Study of beam lifetime at injection and top energy
 - Beam loss characterization

Main Questions to be answered in this Talk

- Beam properties and filling scheme
- (Pilot) beam for first injection
- Total intensity and Setup-Beam flag requirements

SPS MD results with Pb81+ and Pb80+

- 27.06.2018:
 - Pb81+ has better intensity and lifetime than the Pb80+
- 04.07.2018:
 - Pb81+ injected and ramped the to 450 GeV/c (proton equivalent energy) in the SPS
 - Extraction of the beam to TT40 and TT60 TED.
 - First successful setting up of the LHC-SPS synchronization.

→ Ready for injection into LHC

Status of Beams: **NOMINAL 2b-batch**

- Intensity transmission efficiency LEIR \rightarrow SPS: 1/10
- **2b** trains with **8e9 charges/bunch**
 - Bunch spacing **200ns**
 - Desired train spacing in the LHC $>1\mu\text{s}$
 - Distribute total number of bunches evenly around the ring.
 - Filling scheme:
 - Depends on max. number of bunches and total intensity approved
 - Detailed filling scheme to be created



Status of Beams: EARLY/Pilot 1b

- 1b with $<1e9$ charges
 - Never injected into SPS
 - 1 injection for LINAC3→LEIR
 - Intensity $<1e9$ in TT10 (after stripper), additional losses at SPS injection and uncaptured beam at start of ramp
- *Too small intensity to be transferred to LHC*
- Alternatives:
 - Use NOMINAL beam (2b) as pilot beam: total $1.6e10$ charges
 - Normally max. pilot intensity is $1.4e10$
 - Scrape $\sim 50\%$ in SPS to get to normal total pilot intensity
 - Single bunch intensity $\sim 4e9$
 - Can we still see it?
 - Kick out one bunch in the SPS?

Total Intensity & Number of Bunches

- Need statistics: **inject few tens bunches**
 - Single bunches have **pilot intensity**
- Stay below SETUP-BEAM intensity to be able to mask in order to avoid unnecessary dumps and perform loss maps.
- *Same strategy as during Xe-Xe run*
 - *When Setup-Beam intensity limit was exploited with new a species in the first ramp as well...*

Collimator Settings

Roderik & Stefano

- Interesting to take loss maps with this new species
- Proposed strategy:
 - If 1st ramp with tens of bunches: use nominal settings, (as in the Xe run), since this is a "new" configuration.
 - For coarse settings: 1st ramp with only a few bunches and perform loss maps to check that everything works, before going with full intensity.

Back up

Requirements

- **Beam:** **2b bunch** injection, pilot-like intensity
- **Total circulating intensity:** **<3e11** (SETUP beam)
- **Additional set-up:** the usual for ion beams ...
 - **RF set-up:** new type of ions (lower RF-frequency than Pb82+)
 - **SPS-LHC resynch,**
 - **transfer-line** set-up,
 - Maybe, **coarse collimator settings** (to limit losses to a minimum)
 - Injection & ramp
- **Cycle:** **nominal proton cycle** until flat top (no squeeze, no collisions)
- **Ion species:** Pb81+

New ion species
SETUP beam intensity
Nominal optics (FT)
450 GeV & 6.5 TeV

Procedure Outline

- **Similar to Xe-Xe run**
- **Set-up** of new particle species in the LHC
- **Inject** ~30 bunches of $0.1e11$ charges
- **Loss maps** at injection
- **Observe** beam evolution at injection (for 30min – 1h)
 - Measurement of bunch intensity, BLM losses, lifetime, instabilities, transverse and longitudinal profiles
- **Refill**, depending on intensity left
- **Ramp** to 6.5TeV
- **Observe** beam evolution at high energy (for 1h)
 - BSRT beam size evolution, WS
- **Loss maps** at flat top

If MD is successful we will request another 10 hours in the next MD block for studies with trains & higher intensity