SPS Beam Dump Facility

B. Goddard (CERN) on behalf of BDF Accelerator Subgroup:
M. Calviani, M. Fraser, L. Gatignon, R. Jacobsson, V. Kain,
M. Lamont, J. Osborne, F. B. Pedrosa, H. Vincke
Contents

• BDF study scope and organisation
• Deliverables
• Study status and plans
• Timeline
BDF subgroup study scope

- “Complete the technical feasibility studies of a Bump Dump Facility as input to the SHiP comprehensive design study (CDS)”
- Aiming to deliver a preliminary Comprehensive Design Report of a general purpose fixed target facility for high intensity beam dump experiments in SPS complex

Proposed NA siting of SPS BDF
EXISTING SITUATION

BDF NEW FACILITIES

1 March 2017

CERN

2015 version (SHiP TP)
Main challenges for BDF

- Beam loss at extraction from SPS
- Beam sharing with existing North Area targets
  - Needs development of new switch/splitter magnet
- Integration of new beamline and switch
- Target design for longevity and reliability
- Target complex design for handling and maintainability
- High cumulated radiation doses
  - Injectors, injection, extraction, target, etc…
- Radiation damage on materials
  - Extraction septa, target and target station
- Personnel and environmental protection
  - Close distance to the CERN site boundary
  - Detailed environmental study needed
BDF subgroup study organisation

- Presently 4 main work packages with associated WGs
  - Target and target complex (M. Calviani)
    - BDF target & target complex WG
  - Extraction and beam transfer (B. Goddard)
    - SPS Losses and Activation WG (SLAWG)
    - SPS Crystal-Assisted Slow Extraction WG (SPS-CASE WG)
    - TT20 for BDF WG: splitters and TL design
  - Radiation protection (H. Vincke)
  - Safety engineering (F.B. Pedrosa)
  - Incoming: Integration and infrastructure, civil engineering
Deliverables

• D1: Beam requirements specification
  • Identify and document potential experiments and relevant beam parameters
    • Requested PoT (total and annual)
    • SPS beam intensity per cycle
    • Extracted cycles per year
    • Extraction type
    • Spill length
    • Spill harmonic content
    • Beam pointing stability on target
    • Beam emittance
    • Beam momentum characteristics
    • Beam characterisation requirements
Deliverables

- **D2**: Key engineering subsystems (substantial!)
  - Document preliminary designs and feasibility evaluation (including performance limits) for key facility subsystems
    - Target
    - Target subsystems (He vessel, beam-target window, shielding cooling, magnetised hadron stop)
    - Target and shielding handling
    - Slow extraction loss mitigation
    - Dilution system
    - New section of transfer line (including new switch/splitter magnets)
  - Main cost and schedule drivers

Target design studies

Dilution sweep studies

Existing splitter
Deliverables

- D3: Evaluation of SPS performance reach per requested beam type
  - Identify and document limiting factors to evaluate overall reach
    - Beam losses at SPS extraction
    - Spill harmonic content
    - Radiation protection
    - Target
  - Summarise PoT per beam type, including impact on existing NA beamlines

Density at ZS entrance with 3 mm W/Re diffuser

Proton sharing scenarios

- SPS-PAGE1
- Current user: LHC25NS
- Last update: 5 seconds ago

<table>
<thead>
<tr>
<th>Target</th>
<th>I/E11</th>
<th>MUL</th>
<th>%SYM</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2</td>
<td>0.0</td>
<td>0</td>
<td>99</td>
<td>H6/H8</td>
</tr>
<tr>
<td>T4</td>
<td>0.0</td>
<td>0</td>
<td>95</td>
<td>NA61/H4</td>
</tr>
<tr>
<td>T6</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
<td>COMPASS</td>
</tr>
</tbody>
</table>

SHIP MD 2015, 1.2*10^12 ppp (low intensity), slow extracted in 1.2 s
Deliverables

- **D4: Safety impact studies**
  - Safety impacts to the existing installations
  - On the different implemented mitigation measures
  - Possible improvements
  - Provide Safety risk assessments as input to design
  - Radiation protection assessments and optimization for target, junction cavern, extraction and transfer tunnels.
- Environmental impact studies
  - Conventional aspects
  - Radiation protection

*Strongly coupled to D2 (subsystems) and D5 (integration and infrastructure)*
Deliverables

- D5: Preliminary integration and infrastructure study
  - Document preliminary integration and infrastructure aspects
    - Target complex
    - New section of transfer line
    - Junction cavern
    - Experimental area
    - Service requirements, including dimensioning of main systems
    - Conceptual routing of services
    - Access requirements
  - Main cost and schedule drivers

Strongly coupled to D2 (subsystems)
Deliverables

- D6: Facility connection planning
  - Analyse and document planning of connection to TT20, potentially impacting NA operation
    - Accelerator and services removal
    - Junction cavern civil engineering
    - Services installation
    - Accelerator installation
    - Commissioning
    - Overall
Deliverables

- **D7: Preliminary project safety folder**
  - Analyse and document aspects needed for descriptive and demonstrative part of Safety File for this Study Phase
  - Facility description from Safety point of view;
  - Preliminary list of hazards and risks;
  - Identification of Safety requirements that shall be considered at study phase;
  - Definition of Safety organisation within project
  - Study with different teams involved the feasibility of possible mitigation measures
  - Clear identification of major Safety risks for Organization
Deliverables

- D8: Preliminary Civil Engineering design
  - Preliminary design of new CE infrastructures, with 3D models, cross sections and plans
    - Junction to TT20
    - New transfer line
    - Target complex
    - Muon shielding infrastructure
    - Experimental area
  - Main cost and schedule drivers
Deliverables

- D9: Implementation analysis
  - Analysis and documentation of preliminary project-level aspects
    - Overall works and operational milestones fitted in CERN master schedule
    - Outline planning for main subsystems
    - Cost estimates
    - Resource estimates
Deliverables

- D10: Design Reports
  - Provide Comprehensive Design Report documents and related publications for BDF
  - Provide Comprehensive Design Report input for SHiP
Study status: key R&D activities

1. Target & Target complex: in progress
   - Pursue design of production target towards a robust and reliable configuration & radiation damage
   - Development of gas- and water-cooled target options
   - Helium vessel purification system
   - Design of a fully remote handling system for target area

2. Extraction and beam transfer: in progress
   - SPS extraction losses and activation minimization
   - TT20 & new beamline optics, powering, interlocking & instruments
   - Development of laminated splitter and dilution magnets
   - 1 s slow extraction spill quality
   - Deployment of BDF-like cycle
Study status: organisational

- BDF subgroup in place, meetings started
- Sub-sub WGs in place (and working) for Target and Beam Transfer
- Resources already allocated or being set up:
  - Fellow recruited in EN/STI and working on **target** design
  - Fellow recruited in TE/MSC and working on **splitter magnet** design
  - Fellow recruited in HSE and working on **conventional safety** aspects
  - 2 Fellows recruited in EN/MME and EN/CV and starting in March for **target and associated complex**
  - Fellow recruited in HSE for **RP aspects** starting March 2017
  - Fellow requested in TE/ABT for **extraction + beamline** for 05/17 AFC
  - Fellow requested in EN/ACE for 05/17 AFC for **integration**
  - Fellow requested in SMB/SE for 2018/19 for **civil engineering**
Recent technical highlights and progress

• Progress with target design (modified longitudinal segmentation)
• Two options for target remote handling identified and being compared
• Simulated single turn dilution sweep with 1 s spill: should be acceptable for target
• Adopted double coil system for hadron absorber magnetization
• Simulated concepts for passive / active crystal diluters give a factor 2 / 4 extraction loss reduction
• Demonstrated 270 GeV proton slow extraction into TT20 in 2016 using crystal channelling in SPS
Main milestones

- **D1**: Beam requirements specification
- **D5**: Integration studies
- **D6**: Facility connection planning
- **D8**: Preliminary CE design
- **D2**: Engineering subsystem feasibility
- **D3**: SPS beam performance reach
- **D4, D7**: Safety impact studies
- **D9, D10**: Implementation analysis, Design report
- **Review**: Review with experiments

Timeline:
- 2017:
  - Jan
  - Feb
  - Mar
  - Apr
  - May
  - Jun
  - Jul
  - Aug
  - Sep
  - Oct
  - Nov
  - Dec
- 2018:
  - Jan
  - Feb
  - Mar
  - Apr
  - May
  - Jun
  - Jul
  - Aug
  - Sep
  - Oct
  - Nov
  - Dec
Summary and next steps

- Roadmap to preliminary Comprehensive Design of a general purpose SPS Beam Dump Facility outlined
- Study teams (BDF subgroup, subsub groups) set up and active
- Results continue to come
- Need to demonstrate that the facility can be built with requested performances: key R&D identified
- Urgent to finalise beam parameters specification
- Need to start already on framework of CDR
Main milestones

- **D1**: Q2 2017: Beam requirements specification
- **D5**: Q4 2017: Conceptual integration study for CE baseline
  - Q2 2018: Preliminary integration study
- **D6**: Q4 2017: Facility connection planning
- **D8**: Q2 2018: Preliminary Civil Engineering design
- **D2**: Q2 2018: Key engineering subsystem feasibility evaluations
- **D3**: Q3 2018: Evaluation of SPS performance reach per requested beam type
- **D4**: Q3 2018: Safety impact studies
- **D7**: Q3 2018: Preliminary project safety folder
- **D9**: Q4 2018: Implementation analysis
- **D10**: Q4 2018: Comprehensive Design Report