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Slow extraction tests of components

O. Aberle
CERN-SY

1st Community meeting of the International
Muon Colliders Design Study - 21 May 2021

Slow extraction tests of components - an example

Beam test on prototype target in 2018 in the North area

- Description of target
- Test area and conditions
- Infrastructure available as of today

BDF target prototype

CERN
CH-1211 Geneva 23
CH-1211 Geneva 23



EDMS NO. XXX	REV. 0.1	VALIDITY DRAFT
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REFERENCE
BDF-PM-WD-0002

Date: 2017-09-28

ENGINEERING SPECIFICATION

Beam Dump Facility (BDF) target prototype test in T6 during 2018

ABSTRACT:

This document summarizes the design of the BDF target prototype test foreseen to be executed in the TCC2 area upstream T6 during 2018. In this engineering specification, we report the main concepts of the area configuration, target design, radiation protection considerations, handling, alignment and other critical aspect associated to the test.

DOCUMENT PREPARED BY:
M. Calviani (EN/STI)
O. Aberle (EN/STI)
E. Lopez Sola (EN/STI)
S. Girod (EN/EA)

DOCUMENT CHECKED BY:
K. Kershaw, A. Perillo-Marcene,
D. Grenier (EN/STI)
T. Lefevre, S. Burger (BE/BI)
H. Vincke, H. Vincke, S. Roesler, M. Casolino
D. Forkel-Wirth (HSE/RP)
S. Marsh, E. Cennini (HSE/SEE)
M. Battistini, P. Avigni, B. Bannister (EN/CV)
S. Sgobba, M. Guinchard, B. Riffaud, L. Bianchi
(EN/MME)
L. Gatignon, S. Evrard, F. Galan (EN/EA)
B. Goddard, C. Hessler, M. Fraser (TE/ABT)
R. Jacobsson (EP/LBO)
C. Bertone, J.-L. Grenard, S. Pelletier (EN/HE)

DOCUMENT APPROVED BY:
M. Lamont (BE)
S. Gilardoni (EN/STI)
M. Bruggler (EN/EA)

DOCUMENT SENT FOR INFORMATION TO:
R. Losito (EN), bdf.target-complex-WG@cern.ch

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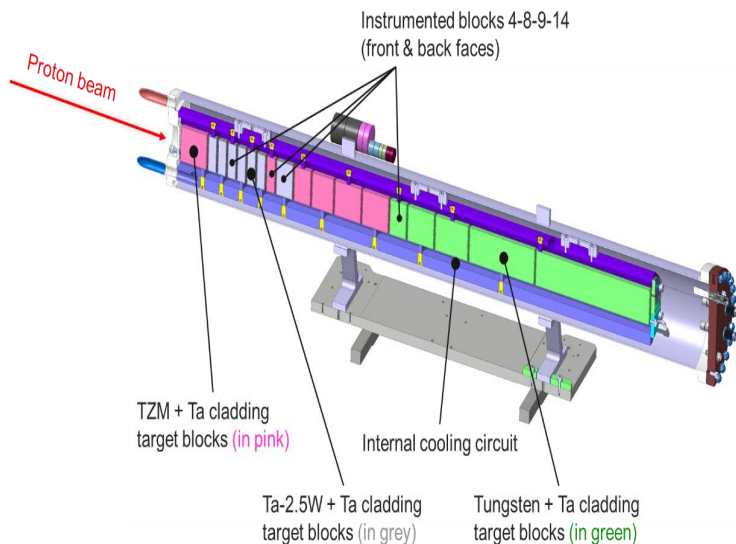


BDF-LJ-ES-0001 (v.0.1) Beam
Dump Facility (BDF) Target
Prototype Test in T6 during 2018

<https://edms.cern.ch/document/1892339/0.1>

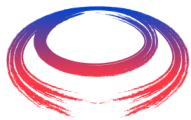
What is required? Where?

Working area TCC2 on the North area between T4 and T6



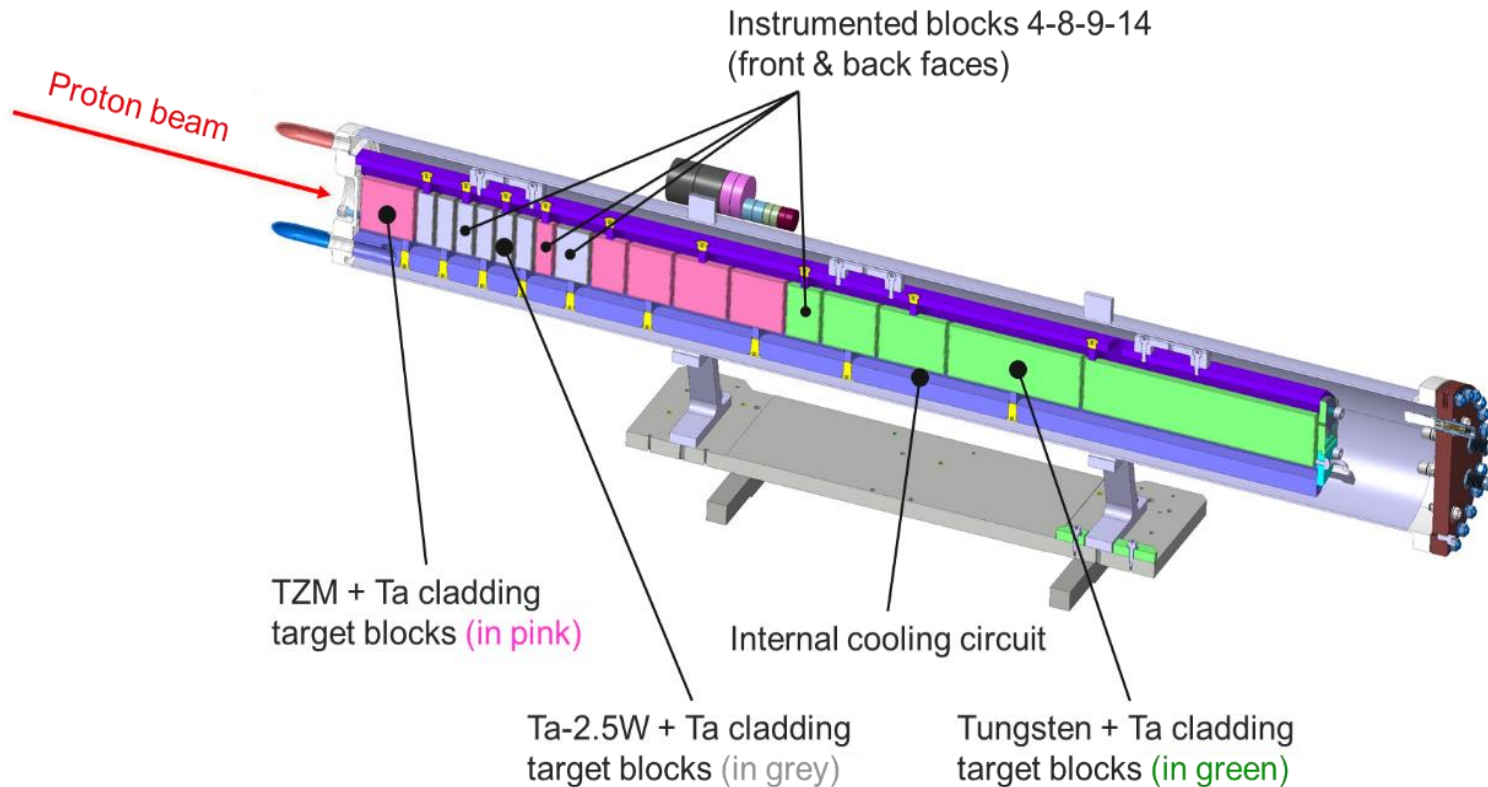
Realistic size target manufactured and tested under equivalent conditions

- up to an average beam power of 50 kW, corresponding to 350 kJ per pulse.
- Water cooling
- Comply with safety rules and RP
- Time and space constraints
- HRMT? Not many options at CERN
- After beam irradiation, dismantle and prepare for PIE



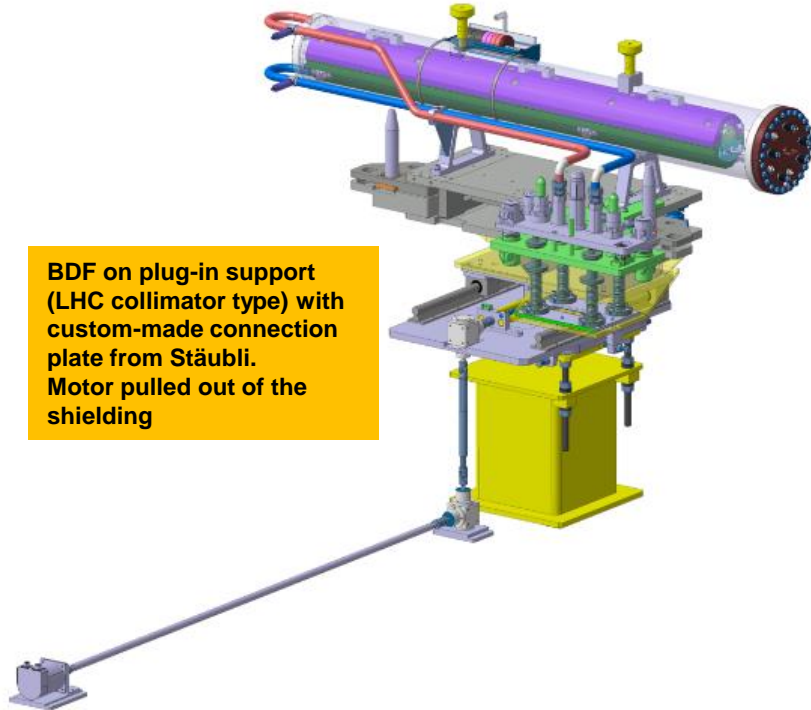
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What is the BDF test target?

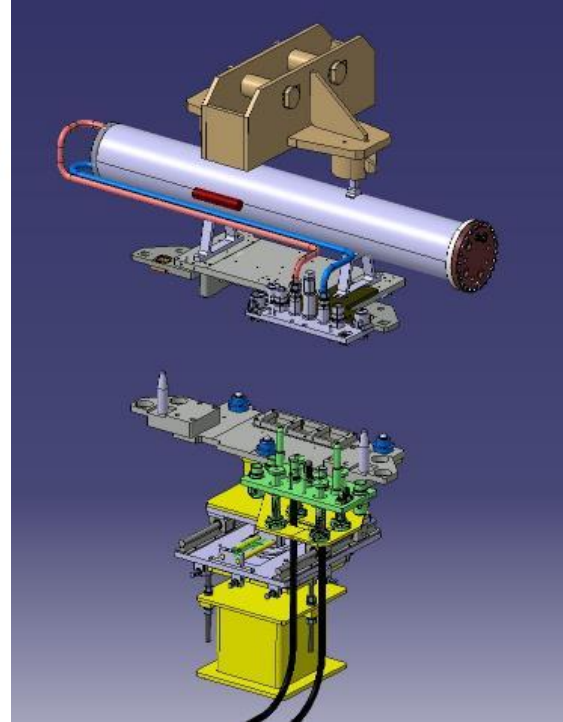


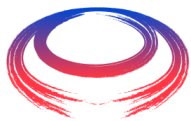
What is the BDF test target?

Working area TCC2 on the North area between T4 and T6



BDF on plug-in support
(LHC collimator type) with
custom-made connection
plate from Stäubli.
Motor pulled out of the
shielding





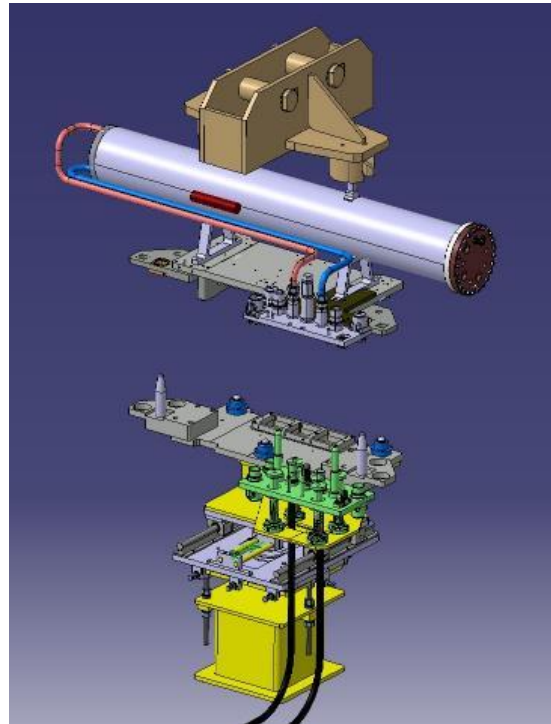
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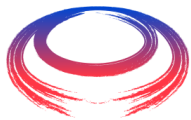
What is the BDF test target?

Working area TCC2 on the North area between T4 and T6



**BDF on Plug-in support
(LHC collimator type) with
custom-made connection
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Motor pulled in outside the
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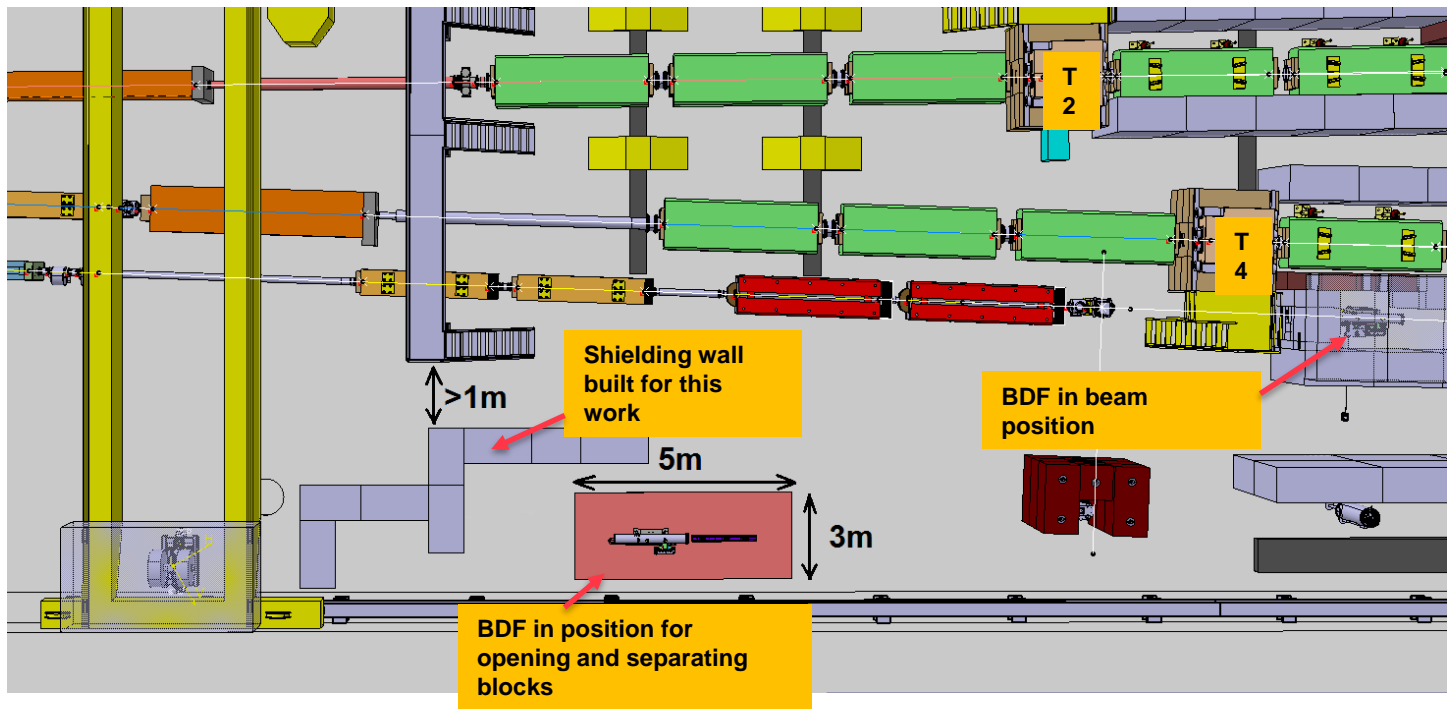




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Where is the BDF test target?

Working area TCC2 on the North area between T4 and T6



Beam conditions

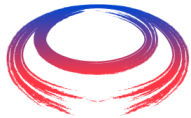
SPS main parameters



- ▶ Injection
 - ▶ 14 GeV or 26 GeV protons
 - ▶ 26 GeV proton equivalent Pb ions
 - ▶ Multi-batch injection from PS
- ▶ Lattice: FODO with dispersion free SS
 - ▶ Transition crossing for injection below 20 GeV. No gamma-jump
- ▶ Acceleration cycle
 - ▶ Up to 21.6 s (depending on user)
 - ▶ 1.2 cycling period
- ▶ RF:
 - ▶ Main system: 200 MHz travelling wave
 - ▶ 800 MHz to control longitudinal emit.
- ▶ Extraction:
 - ▶ Slow extraction at 400 GeV
 - ▶ Fast extraction at 450 GeV
- ▶ Operation in p-pbar collider mode
 - ▶ Machine on indefinite coast @ 270 GeV
- ▶ Particles types:
 - ▶ Protons, Pb, pbar, e+, e-, O, In, S, Xe
- ▶ Max total intensity: $\sim 5.3e10^{13}$
- ▶ External Exp. Area: North Area, HIRADMAT, AWAKE, Neutrino Platform

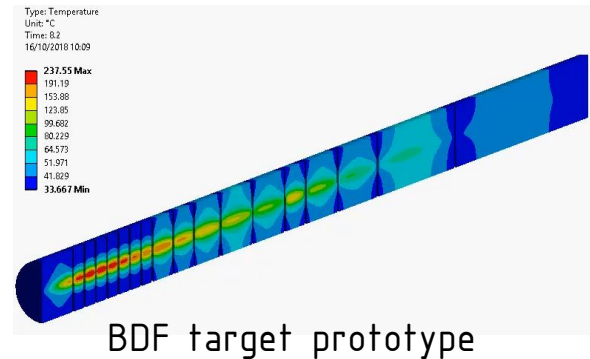
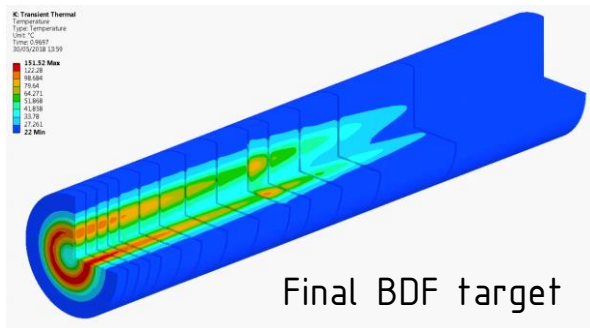
Beam conditions

Baseline characteristics	Final BDF target	Target prototype
Proton momentum [GeV/c]	400	400
Beam intensity [p+/cycle]	$4.0 \cdot 10^{13}$	$3.0 - 4.0 \cdot 10^{12}$
Beam dilution	4 circular sweeps / s	No
Cycle length [s]	7.2	7.2
Spill duration [s] (slow extraction)	1.0	1.0
Average beam power [kW]	350	35
Average beam power/spill [MW]	2.56	0.26
Beam size (H/V) [mm]	8/8	3/3

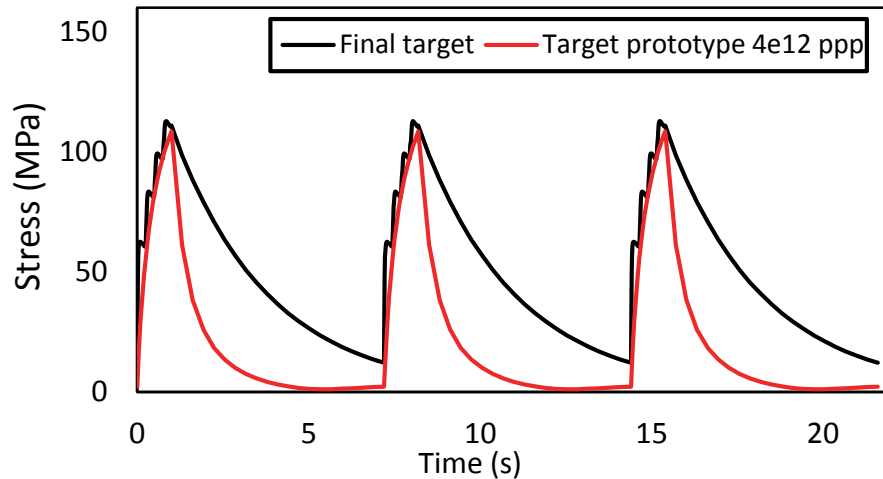


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Beam conditions



Von Mises Equivalent stress Ta2.5W cladding



Reasonable approximation of the level of stresses in the core and cladding materials

3 MD's for beam on target

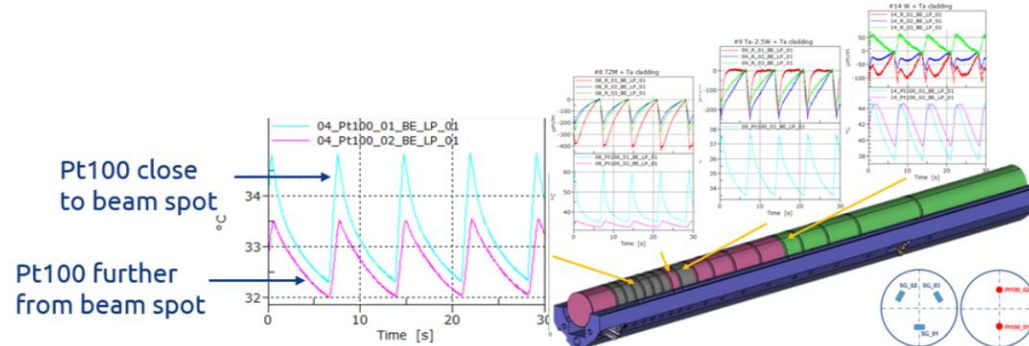
Sept – Dec 2017
Design

Jan – Aug 2018
Construction

Aug – Sep 2018
Installation

Oct – Nov 2018
Beam tests

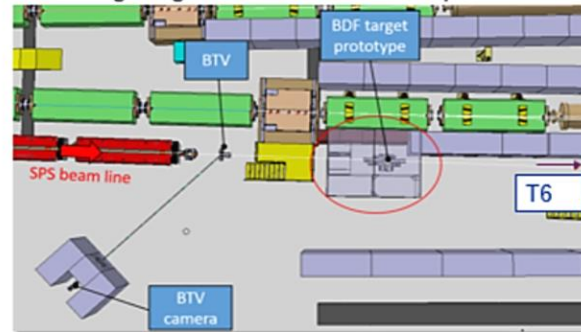
- 1st MD day – Successful target operation
 - Almost all sensors survived



- **Average power on target = 35 kW** (deposited = 24 kW)
- **Total cumulated POT $\approx 1E16$** (POT goal = $3E16$)

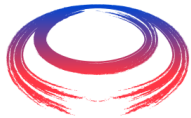
Charged particle beam testing

- In the framework of the **Beam Dump Facility Study**, a high intensity slow extraction test area was setup in the **TCC2 Target Area at CERN**
 - ± 400 GeV/c, up to several 10^{13} p/pulse, $>10^{16}$ POT possible (competition with beam to T6 though)
- **Could be potential employed to validate certain aspects of MUC Targetry systems**
 - E.g. target & solenoid for example



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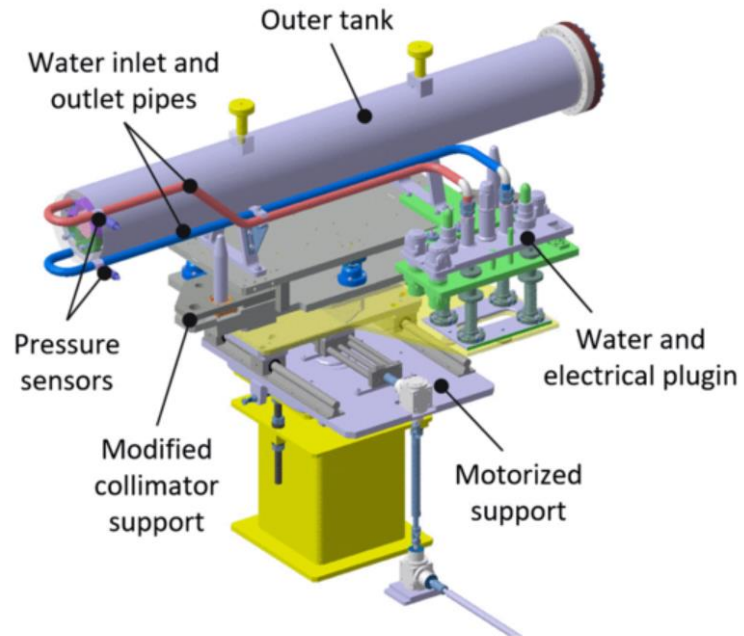
<https://journals.aps.org/prab/abstract/10.1103/PhysRevAccelBeams.22.113001> and
<https://journals.aps.org/prab/abstract/10.1103/PhysRevAccelBeams.22.123001>



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Infrastructure available as of today

- YETS 2017-2018:
Preparation of the area
 - Shielding blocks and working area
 - Motorization
 - BTV: Upstream and downstream
 - Target support with plug-in interface



Infrastructure available as of today

- Optical fibers and cables (for motorization, monitoring and beam instrumentation) towards rack at first floor



Infrastructure available as of today

CERN
Explosive des Particules 1
1217 Meyrin - <https://cds.cern.ch>

EDMS NO. 2397738 REV. 1.0 VALIDITY RELEASED

REFERENCE
SPS-TARBD-EC-0001

SPS Date: 2021-02-15

ENGINEERING CHANGE REQUEST
Adaptation of the North Area BDF Target Prototype Test setup into a permanent multipurpose Test Bench for SX Beam Intercepting Device testing

BRIEF DESCRIPTION OF THE PROPOSED CHANGE(S):
Relocation of the cooling station to behind the access shaft in TAB01, as it is currently in the middle of the transport zone. The cooling pipes will be re-routed. The control rack to be moved to 889/R-405. Plug-in base and ETVs supports to be kept in place.

DOCUMENT PREPARED BY: O. Aberle, R. Frangoula Ximenes, A. Amanou	DOCUMENT CHECKED BY: M. Battistini, J. Bernhard, M. Brugger, M. Cariani, S. Delerail, S. Evrard, C. Galignant, F. Galeazzi, L. Gatignon, S. Girod, S. Gianoni, J. L. Grenard, G. Gros, V. Kadi, M. Lazzaroni, D. McFarlane, G. Romagnoli, F. Sanchez, H. Vincke	DOCUMENT APPROVED BY: B. Goddard M. Headrick (on behalf of the IEF C)
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SPS ECR distribution list

DOCUMENT SENT FOR INFORMATION TO:
IEFC members and alternates

SUMMARY OF THE ACTIONS TO BE UNDERTAKEN:

- Install supports and shielding in south-east end of TAB01.
- Relocate cooling skid and cartridge to south-east end of TAB01.
- Relocate electronics rack to 889/R-405.
- Re-cable and re-piping to the new positions of the rack & skid.

Note: When approved, an Engineering Change Request becomes an Engineering Change Order.
This document is unclassified unless stated. Check the IEF C to verify that this is the correct version before use.



<https://edms.cern.ch/document/2397738/1.0>

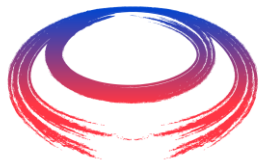
■ During LS2:

- Repositioned cooling skid
- Dedicated, closed loop cooling circuit

Short summary

Successful test of prototype target with:

- Slow extracted beam
- High power on target (50 kW)
- Full remote handling (already during design phase), many RP aspects considered
- Not a test facility! Normal physics program in competition. To be agreed case by case.



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*Thank you
for your attention*