Report from the PBC-FT
LHC Fixed Targets

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Outline

- Introduction and scope
- 2019 recent results
- PBC-FT report
- Conclusions
Focus of the WG: assess impact on the LHC accelerator.

Three areas of studies addressed were by the WG:

- Double-crystal experiment
- Solid targets
- Standard and polarised gaseous targets

Caveats:

"Best effort" of a few people, no dedicate resources initially allocated; [a project associate joined the team in Nov. 2018]

No experiment in the WG scope was yet approved.

Several proposals mention ALICE or LHCb, but only SMOG-2 is now approved.
Concepts for in-beam fixed targets

i) No second crystal, solid target only

ii) With second crystal, for dipole precession experiments

Issues with machine protection (collimators hierarchy, beam intensity).
Not further looked at.

No proposals received for experiments in external beam lines
Gaseous fixed-targets

UNPOLARIZED GAS TARGETS
He, Ne, Ar, H₂, D₂, N₂ ...

storage cell
beam

gas source
Forward detector

At LHCb: SMOG upgrade (SMOG2)

POLARIZED GAS TARGETS
H, D, ³He

storage cell
beam
magnetic guiding field

Polarized gas source
Forward detector
Polarimeter Analyzer

LHCspin.
Farther in future.
More R&D needed
PBC-FT activities in 2019

2019: main focus was the preparation of the PBC-FT summary report.

Topics/results of 2019 meetings:

Detailed assessment of impact on LHC from SMOG2:
   — Impedance, e-cloud, beam losses, aperture, …
   — ECR: LHC-X8FTS-EC-0001, with references to various studies addressed by the PBC-FT
   — Approval process steered at the LMC

First looks at new results from long crystals producing > 10 mrad
   — Inputs from 2 independent experiments: UA9, SELDOM

Improved assessment of achievable protons on target.

Alternative layouts in addition to IP8.

First look at the fixed-target proposal by ALICE.

https://indico.cern.ch/category/8815/
SMOG2 machine studies

Aperture

Beam losses for various gases

Impedance and RF beam loads

Experiment now being installed!

List of gases for Run III still to be finalised (and subject to approval).

Implementation of future polarized gas:

Preservation of polarisation, with coating compatible with LHC vacuum, needs further R&D.

Deployment not before LS3.
Experimental results with long crystals

A. Mazzolari, 15th FT meeting

R. Rossi, 16th FT meeting

Measures in H8 two crystals made by INFN, 16mrad and 12mrad. Measurements done with secondary beams at 180 GeV. Both experiments showed channeling efficiencies above 10%. The WG identified some followup items about consistencies of two analyses and benchmark of simulation tools.
LHC layouts for crystal/fixed targets

**Double-crystal setups**

**Single-crystal setup**

Optimised layouts promised a production of $\sim 10^6$ PoT/s for the IP8 layout, in fully parasitic mode for the other experiments.

This corresponds to a yield of $\Lambda_c$ out of CRY-2 of $\sim 10$ per [10h fill]

This does not yet take into thicker targets nor different crystal material.

Further studies are ongoing to assess the prospect to improve, in semi-parasitic operation modes where a small fraction of bunches is blown up.

Identified some urgent next steps if LHCb confirms interest:

— design of the goniometers for CRY-2;
— study the detailed implementation of downstream collimation;
— elaboration of operational modes (while LHCb is levelling).

Similar studies should be done for the IP2 case.

Additional challenge: operation with heavy ion beams.
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Report from the LHC Fixed Target working group of the CERN Physics Beyond Colliders forum

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Thanks to the WG participants for their contributions and for the preparation of several supporting documents.

Several supporting notes / articles were produced — details in reference.

Completed in July (after reports on long crystals from both experiments), then 2 iterations with co-authors over summer.
Conclusions

☑️ The PBC-FT produced a final report on the assessment of various proposals for fixed-target implementations at LHC

The present status of the studies is presented, matching proposals to ESPP. Not all proposals were equally advanced: from initial ideas that were developed further, to experiments now approved!

☑️ SMOG2 was approved by the LHCC during this process.

Looking forward to the operation in Run III! Gases beyond what was used for SMOG: subject to case-by-casa validation.

☑️ Good maturity reached for various options based on halo-splitting with crystals.

Next steps will depend on the expression of interest / encouragement to continue that must come from LHCb/ALICE. Areas of studies identified by the WG. Detailed work for implementation will have to be steered in dedicated WGs (with adequate resources).

☑️ A few important studies are still ongoing.

Improvement of PoT from semi-parasitic operation modes at the LHC. Further optimization of layouts, studies for IP2.