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# Report from the PBC-FT LHC Fixed Targets

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*on behalf of the PBC-FT working group*

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- Introduction and scope**
- 2019 recent results**
- PBC-FT report**
- Conclusions**

## P | B | C LHC FIXED TARGET

[PBC Home](#)[LHC FT in Indico](#)[Resources](#)

Several proposals for **fixed-target experiments at the LHC are being actively studied by physics communities**. For example, the use of splitting of beam halos from the core with bent crystals for internal targets and the use of internal gas (possibly polarised) or solid targets. The working group will address the technical feasibility and impacts on the LHC machine with the aim of bringing together the various initiatives (UA9, LHC collimation team, AFTER collaboration, ...) and presenting a report to the update of the European Strategy for Particle Physics (ESPP).

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

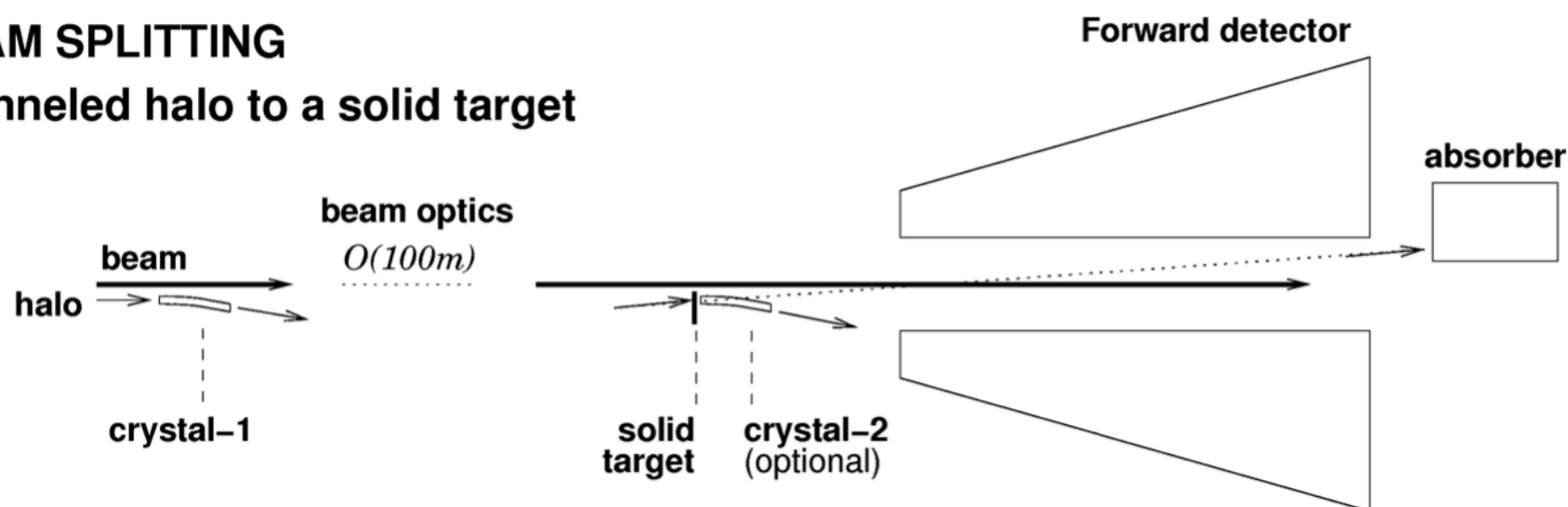
### Caveats:

“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.

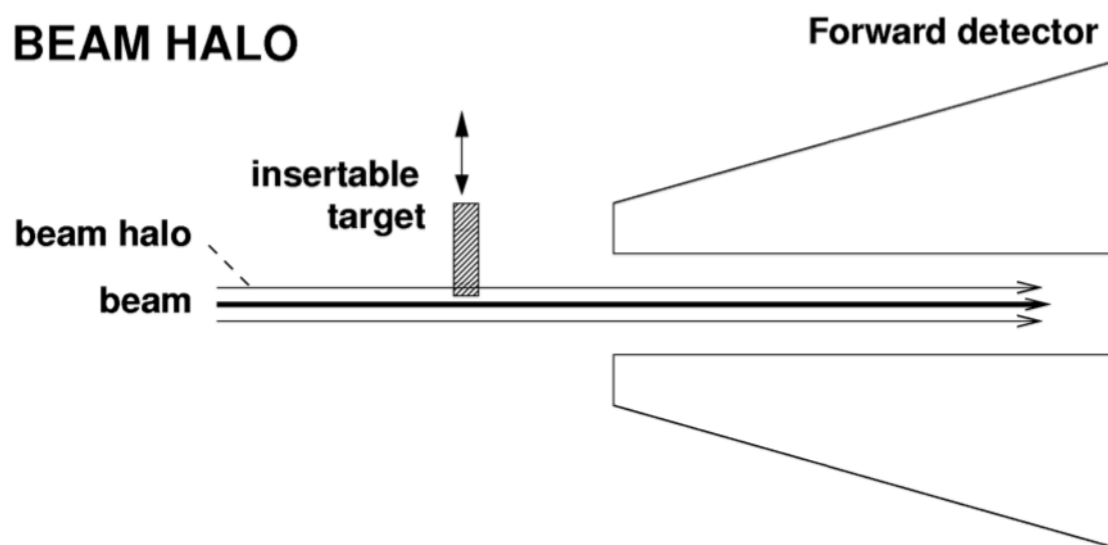
## BEAM SPLITTING channeled halo to a solid target



i) No second crystal, solid target only

ii) With second crystal, for dipole precession experiments

## SOLID TARGETS IN BEAM HALO



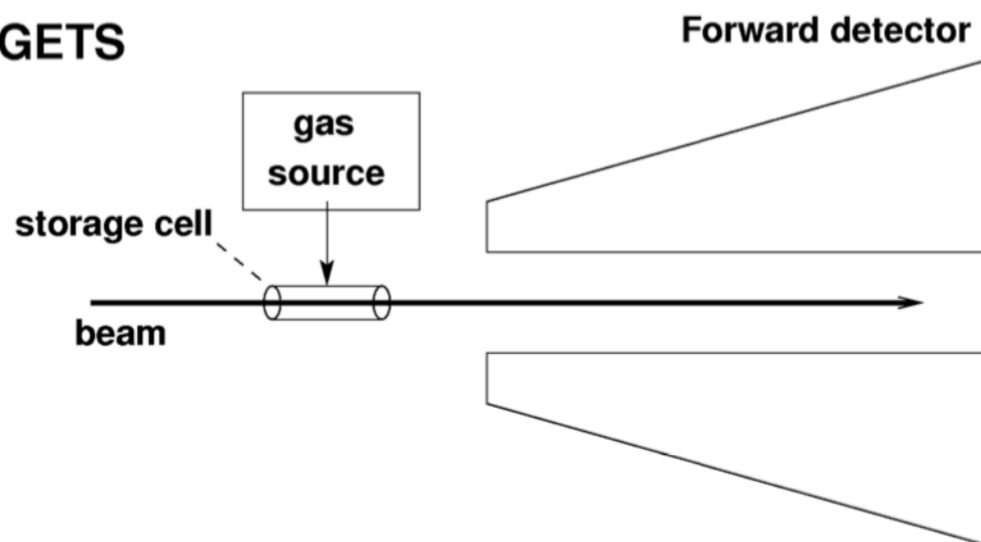
Issues with machine protection (collimators hierarchy, beam intensity).  
Not further looked at.

*No proposals received for experiments in external beam lines*

# Gaseous fixed-targets

## UNPOLARIZED GAS TARGETS

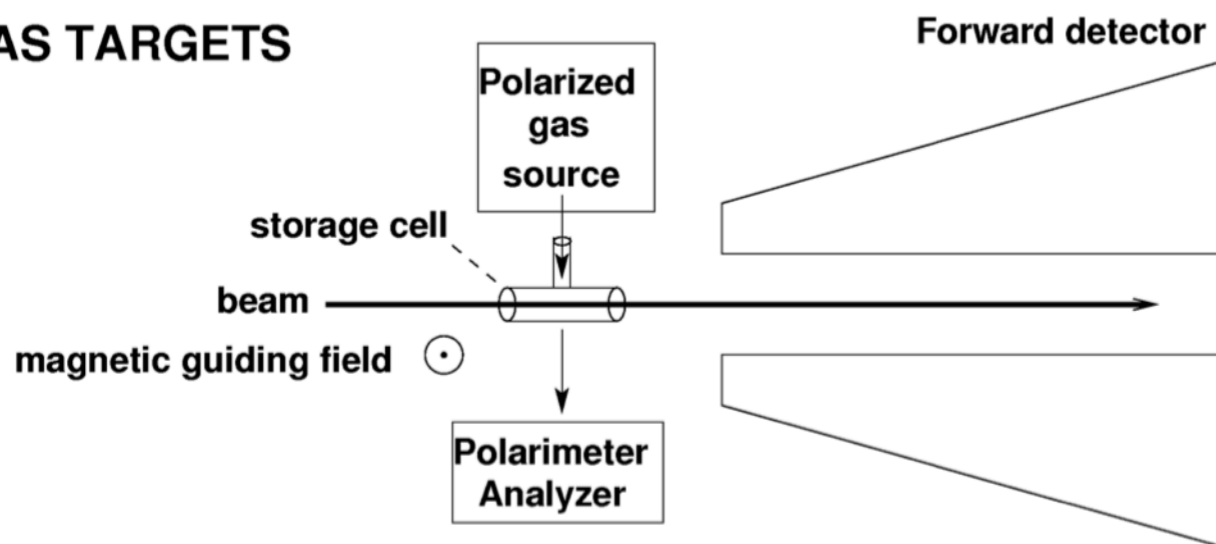
He, Ne, Ar, H<sub>2</sub>, D<sub>2</sub>, N<sub>2</sub> ...



At LHCb: SMOG upgrade (SMOG2)

## POLARIZED GAS TARGETS

H, D, <sup>3</sup>He



LHCspin.  
Farther in future.  
More R&D needed

## LHC fixed target

June 2019

 21 Jun 16th meeting of PBC-FT

March 2019

 15 Mar 15th meeting of PBC-FT

February 2019

 20 Feb 14th meeting of PBC-FT (gas targets)

January 2019

 11 Jan 13th meeting of PBC-FT

September 2018

 21 Sep 12th meeting of PBC-FT

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

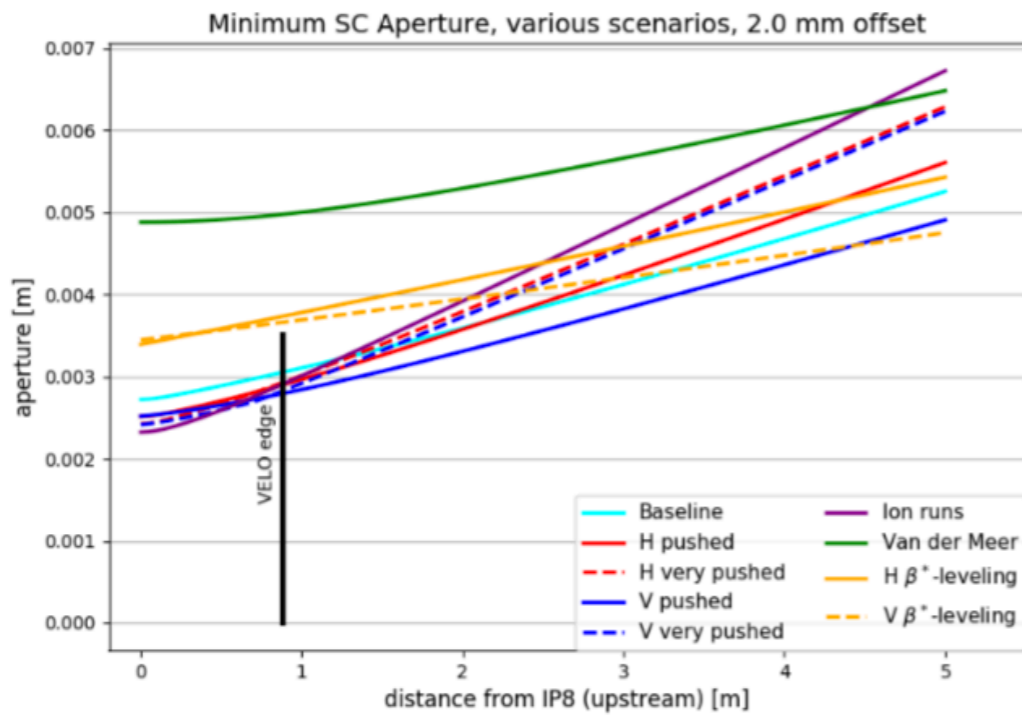
Improved assessment of achievable protons on target.

Alternative layouts in addition to IP8.

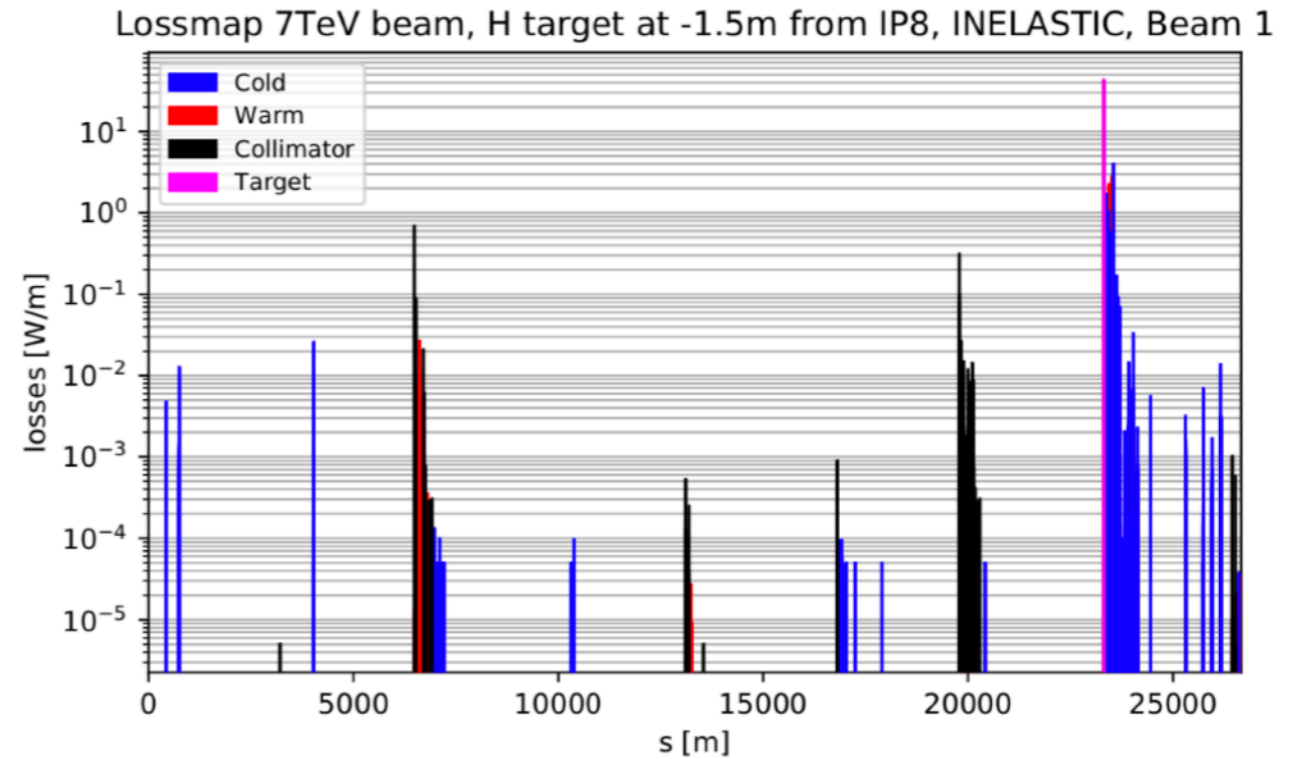
First look at the fixed-target proposal by ALICE.

<https://indico.cern.ch/category/8815/>

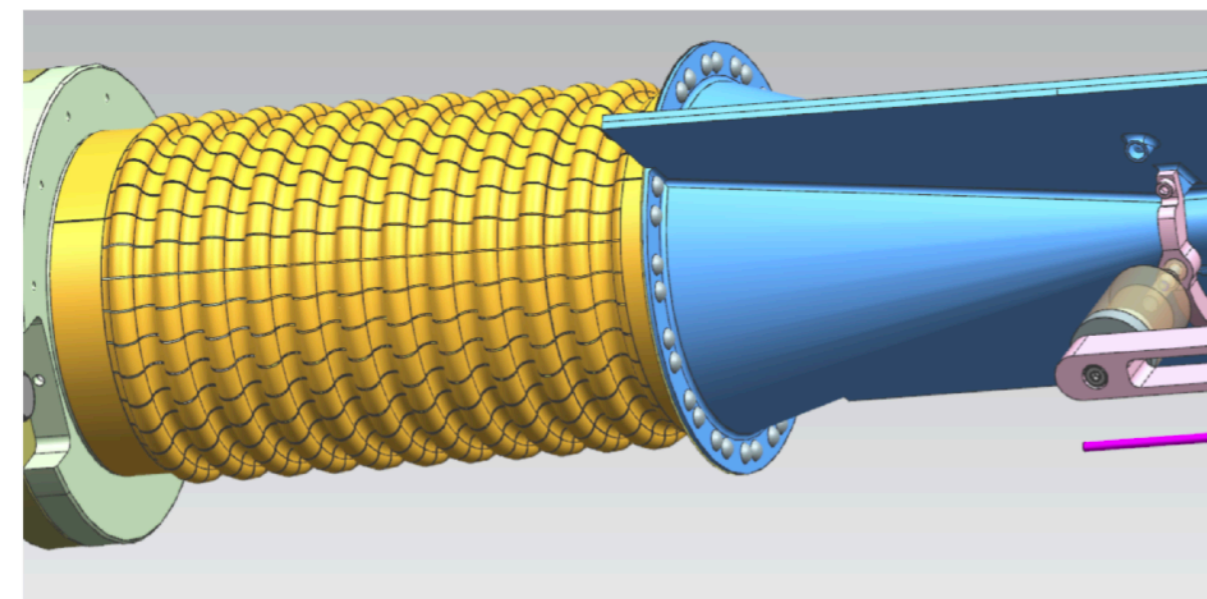
## Aperture



## Beam losses for various gases



## Impedance and RF beam loads



Experiment now being installed!

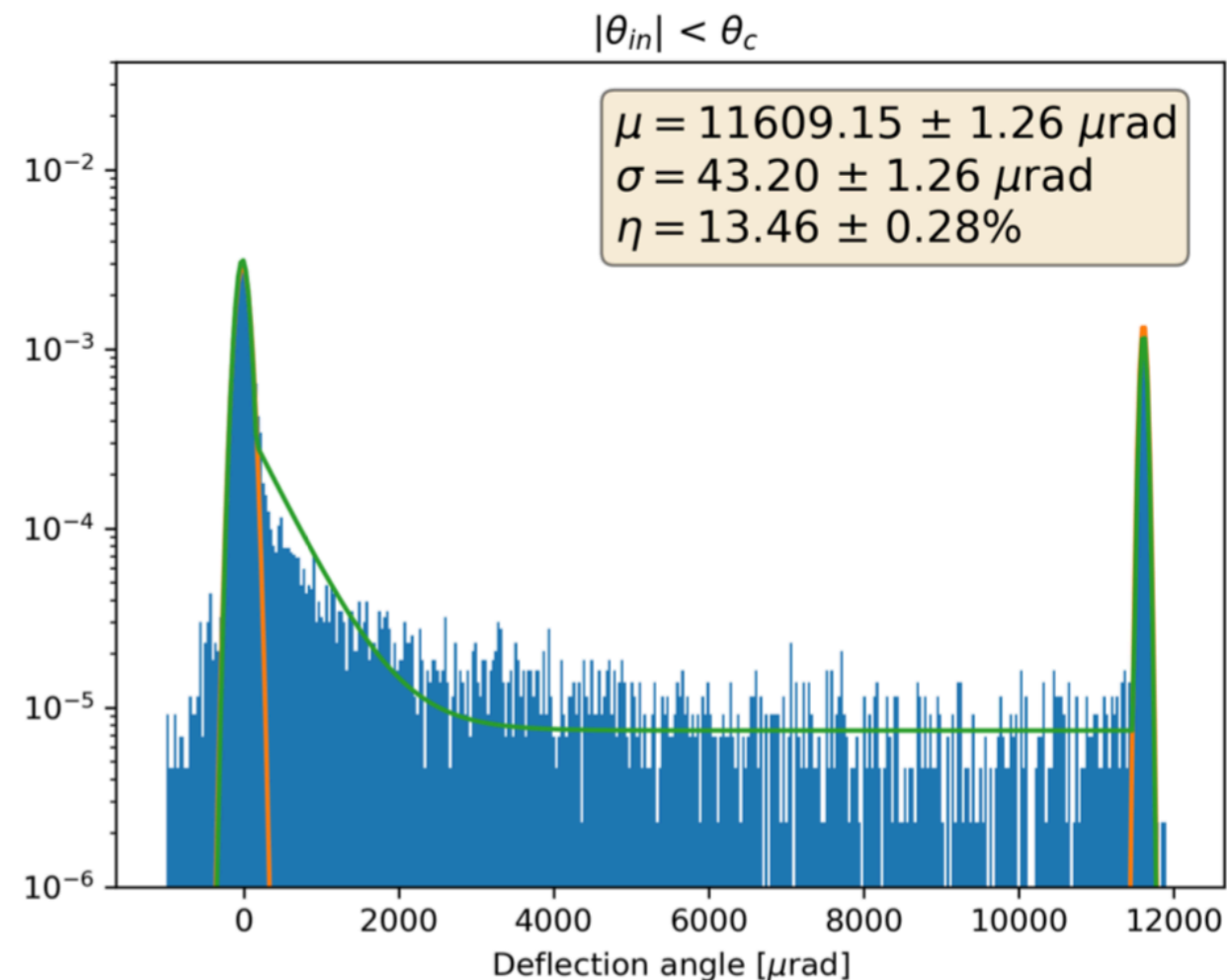
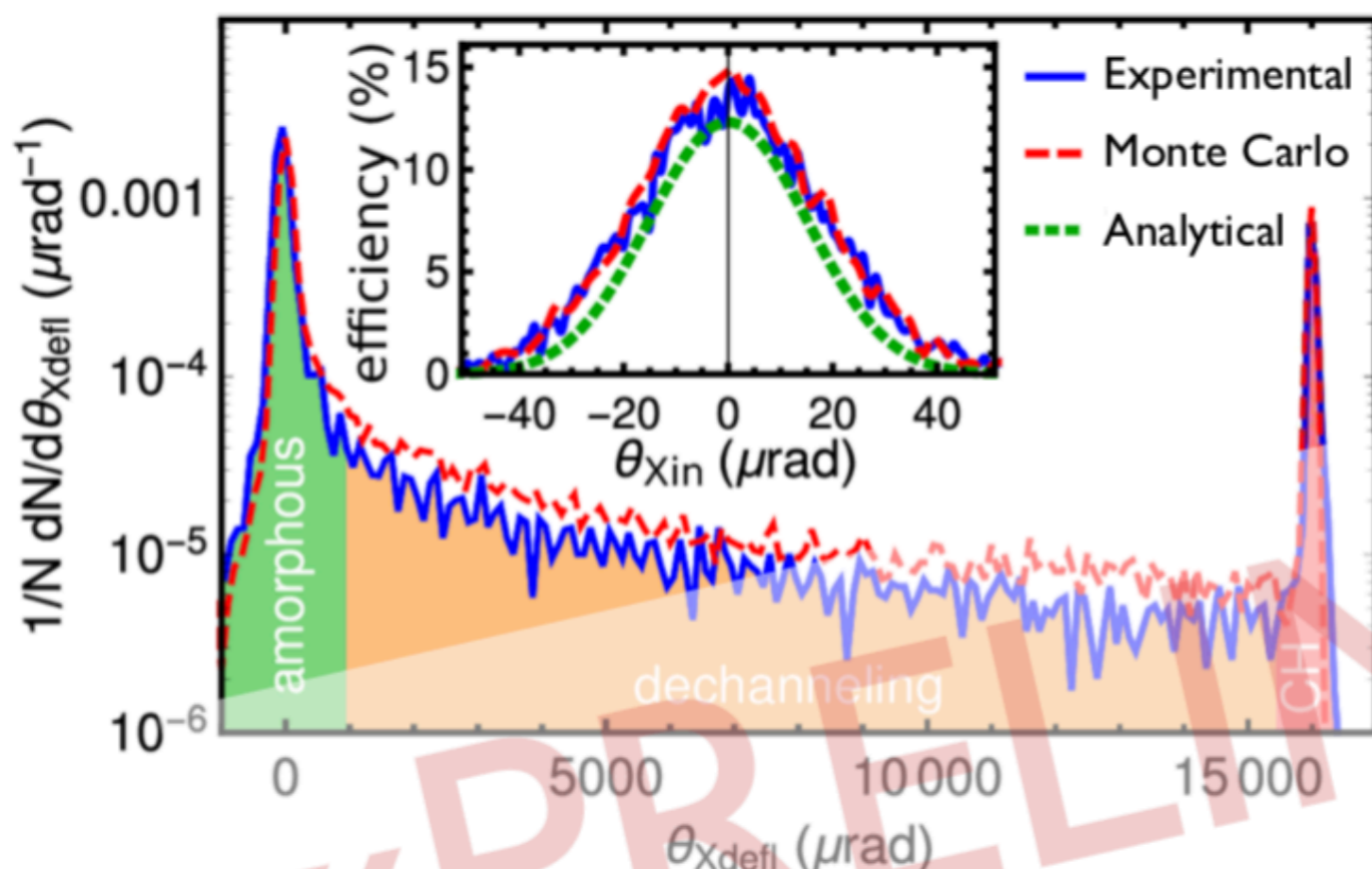
*List of gases for Run III still to be finalised (and subject to approval).*

Implementation of future polarized gas:  
*Preservation of polarisation, with coating compatible with LHC vacuum, needs further R&D.*

*Deployment not before LS3.*

A. Mazzolari, 15th FT meeting

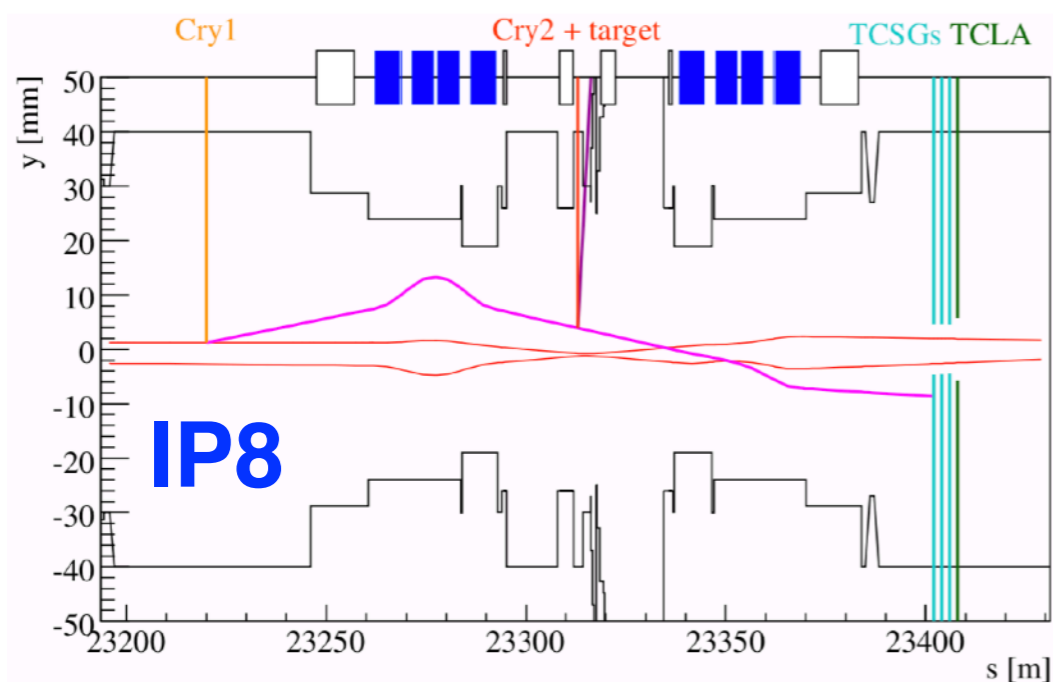
R. Rossi, 16th FT meeting



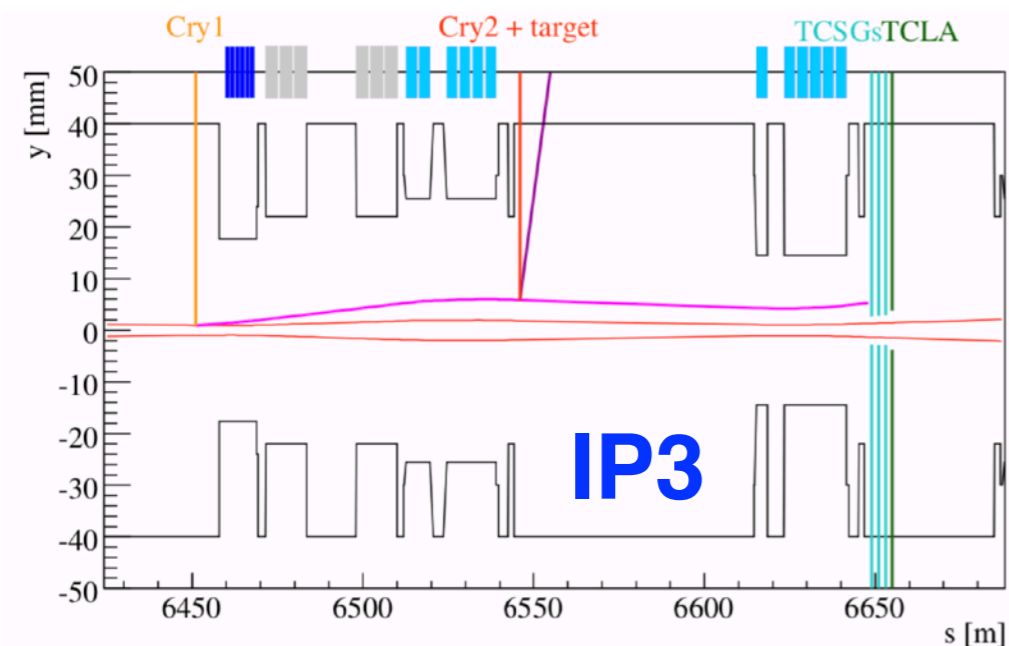
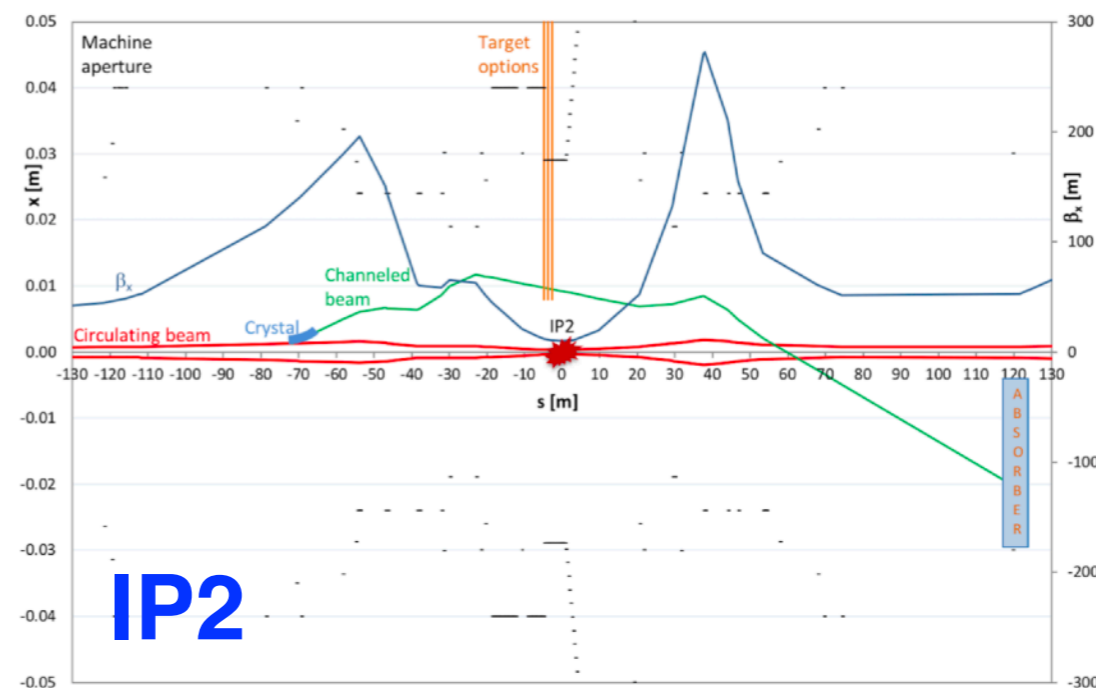
Measures in H8 two crystals made by INFN, 16mrad and 12mrad.  
 Measurements done with secondary beams at 180 GeV.  
 Both experiments showed channeling efficiencies above 10 %.  
 The WG identified some followup items about consistencies of two analyses and benchmark of simulation tools.



## Double-crystal setups



## Single-crystal setup



Progress on layout studies and optimization. Asses of losses in the machine, and mitigations. Studied alternative locations (IP3). Reviewed yield production in light of LHC operational experience 2018.

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.*

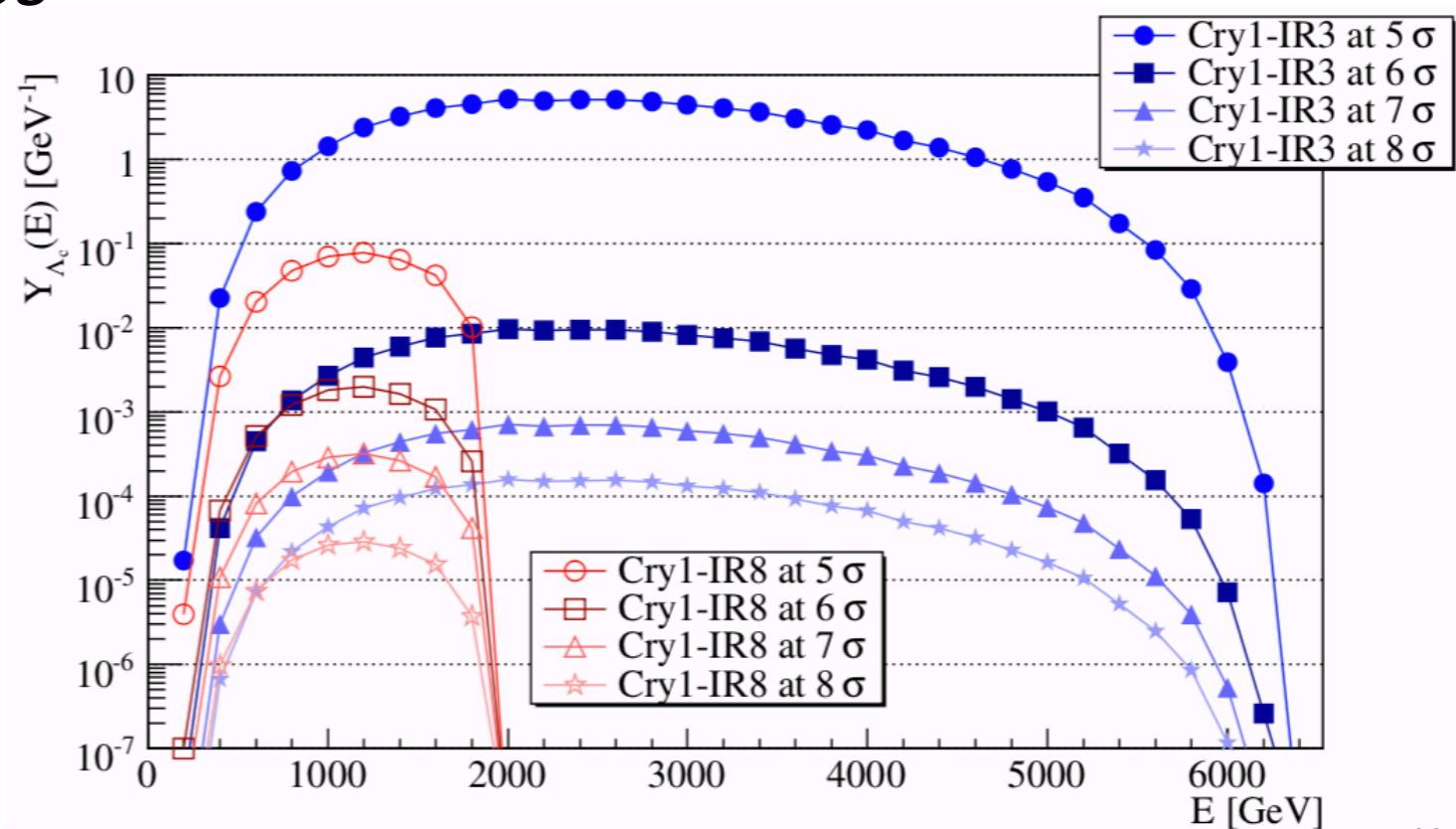
Further studies are ongoing to assess the prospect to improve, in semi-parasitic operation modes where a small fraction of bunches is blown up.

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).*

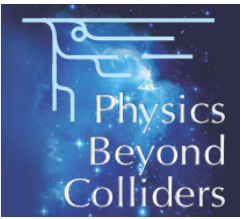
Similar studies should be done for the IP2 case.

*Additional challenge: operation with heavy ion beams.*





# PBC-FT WG report



CERN-PBC-REPORT-2019-001

## Report from the LHC Fixed Target working group of the CERN Physics Beyond Colliders forum

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

**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.*

- ☑ 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-case 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.*