Discussion on Letter of Intent

Nicola Neri
Università degli Studi e INFN Milano

Gargnano del Garda, 25-28 September 2022

Acknowledgements

- **LHCb** contributors: S. Aiola, S. Barsuk, N. Conti, F. De Benedetti, A. De Gennaro, J. Fu, G. Grabowski, L. Henry, Y. Hou, S. Jaimes, C. Lin, D. Marangotto, F. Martinez Vidal, J. Mazorra, A. Merli, N. Neri, S. Neubert, E. Niel, A. Oyanguren, M. Rebollo, P. Robbe, J. Ruiz Vidal, I. Sanderswood, E. Spadaro Norella, A. Stocchi, G. Tonani, M. Wang, Z. Wang
- **LHCb FITPAN** review members: T. Eric, M. Ferro-Luzzi, G. Graziani, R. Kurt, R. Lindner, C. Parkes, M. Palutan, G. Passaleva, M. Pepe-Altarelli, V. Vagnoni, G. Wilkinson
- **Contributions** also from: G. Arduini, E. Bagli, L. Bandiera, O.A. Bezshyyko, L. Burmistrov, G. Cavoto, D. De Salvador, A.S. Fomin, S.P. Fomin, F. Galluccio, M. Garattini, M.A. Giorgi, V. Guidi, P. Hermes, I.V. Kirillin, A.Yu. Korchin, E. Kou, Y. Ivanov, L. Massacrier, V. Mascagna, A. Mazzolari, H. Miao, D. Mirarchi, S. Montesano, A. Natochii, M. Prest, S. Redaelli, M. Romagnoni, W. Scandale, N.F. Shul'ga, E. Vallazza
- Interesting **discussions/suggestions**: V. Baryshevsky, V. M. Biryukov

SELDOM webpage
@SeldomTeam

Letter of Intent

About 20 pages document with an overview of the experimental proposal to be presented to the LHCC

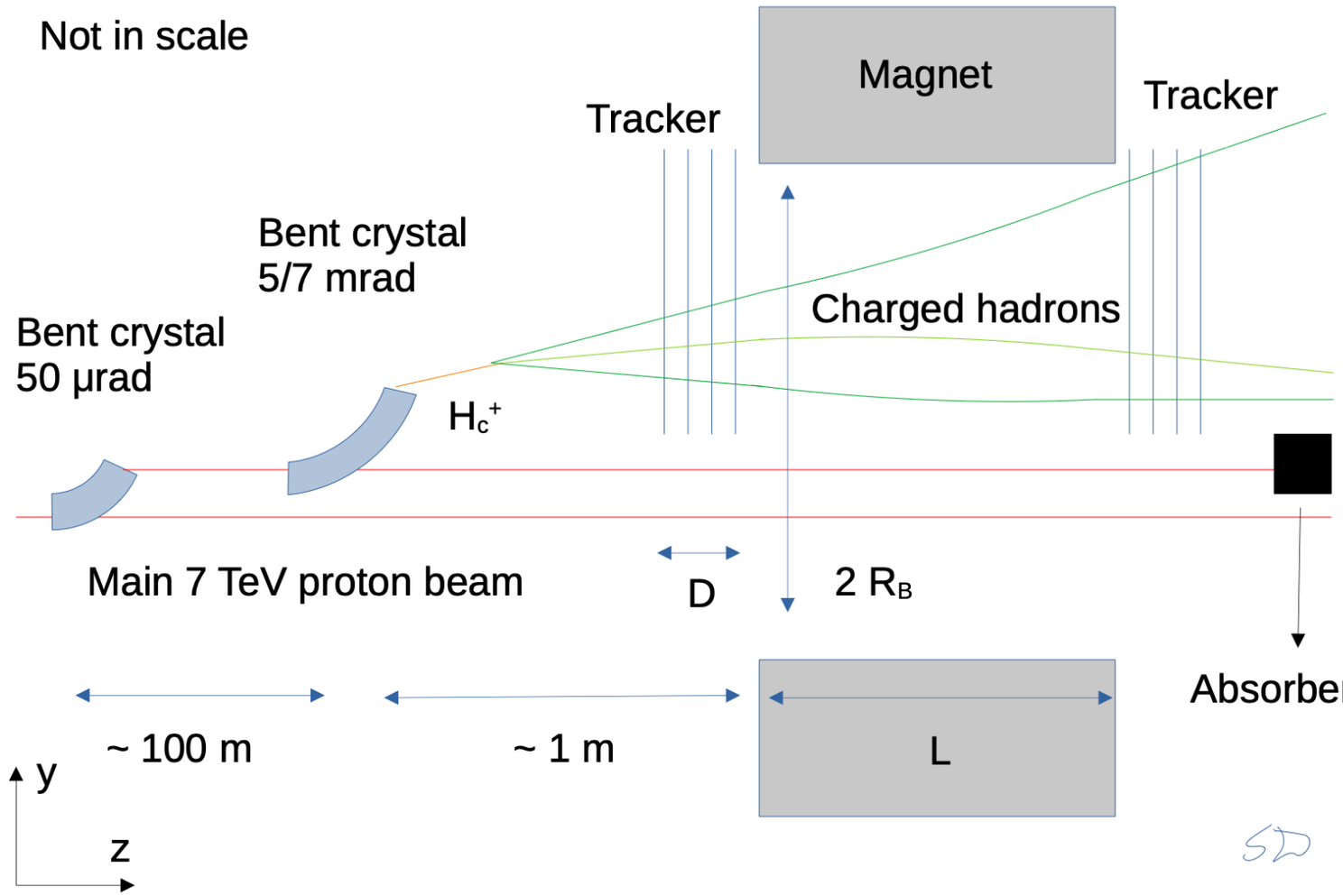
- Physics motivations
  - dipole moments of charm baryons
  - fixed-target physics with very forward acceptance
- Proof-of-principle test at IR3
- Experimental proposals

  1)fixed-target setup in LHCb

  2)new dedicated experiments at IR3
- Detector overview
- Cost, funding and timeline

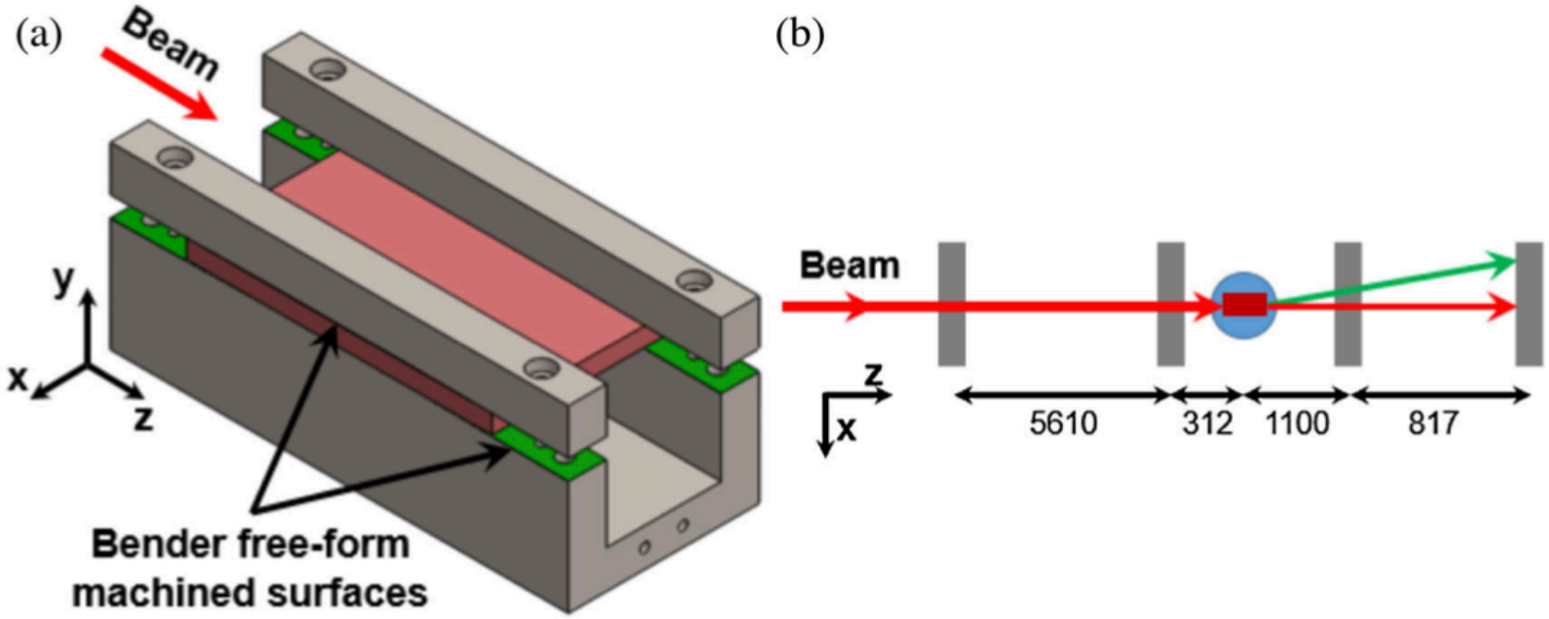
Test in LHC at IR3

- A **proof-of-principle** test at the insertion region 3 (IR3) is considered with LHC machine people
- Main **goals** of the test
  - test **machine** and operational aspects
  - measure **channeling** efficiency at TeV energies
  - study **detector** performance and background level



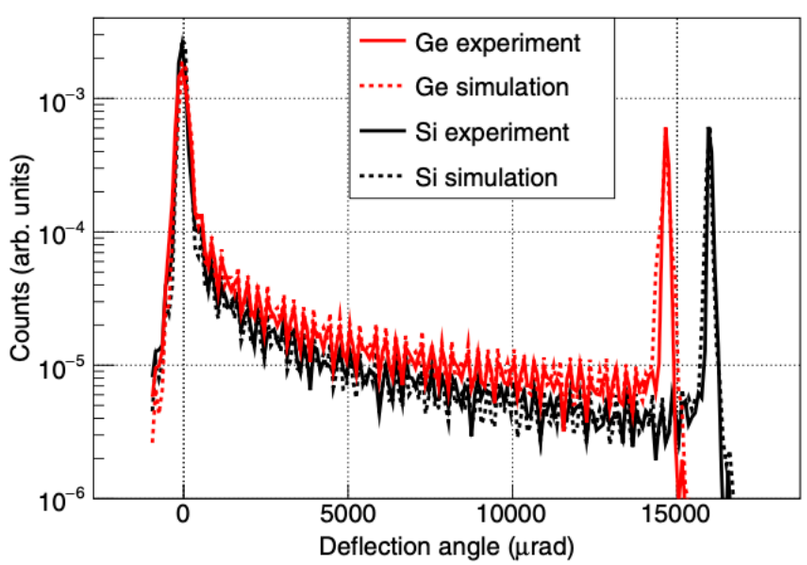
Channeling efficiency measurement at SPS

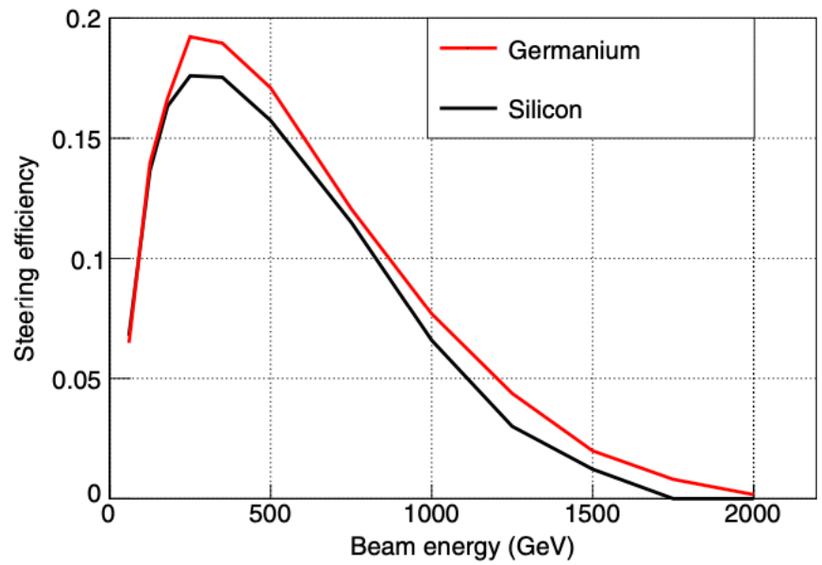
- Sketch of the setup for crystal channeling measurement at SPS H8



Phys.Rev.D 103 (2021) 7, 072003

- (a) Angular distributions of 180 GeV hadron beam after interaction with crystal. (b) Monte Carlo simulations for channeling efficiency





Equipment and detector for IR3 test

Minimal configuration

- 2 goniometers
- 2 silicon bent crystals + W target
- pixel detector inside Roman Pot
- Data acquisition
- Infrastructure, mechanics and services
- Other?

Timeline for IR3 test

- Aim for a test during Run3 (before 2025). A lot of work is needed!
  - definition of program of measurements (e.g. channeling efficiency). Simulation studies to study the performance
  - goniometer design and construction
  - bent crystal construction (specs defined) and test at SPS
  - pixel detector (Velopix)
  - HV/LV and cooling
  - data acquisition (PCIe40)
  - RomanPot design and construction
- Define a timeline with a breakdown structure of activities and responsibilities

MoU for IR3 test

- Mostly a machine test
- MoU has been prepared by CERN team and it is available for signatures
  - contributions from interested institutes are based on best effort, not a binding agreement
  - addenda to the MoU for specific contributions of each institute

Two scenarios after the test

- Assuming the IR3 test is successful

In LHCb

excellent detector ✔

only the fixed-target setup is required ✔

large bending angle 👎

competition with nominal LHCb data taking 👎

Other considerations?

Dedicated experiment

build new detector, many resources needed 👎

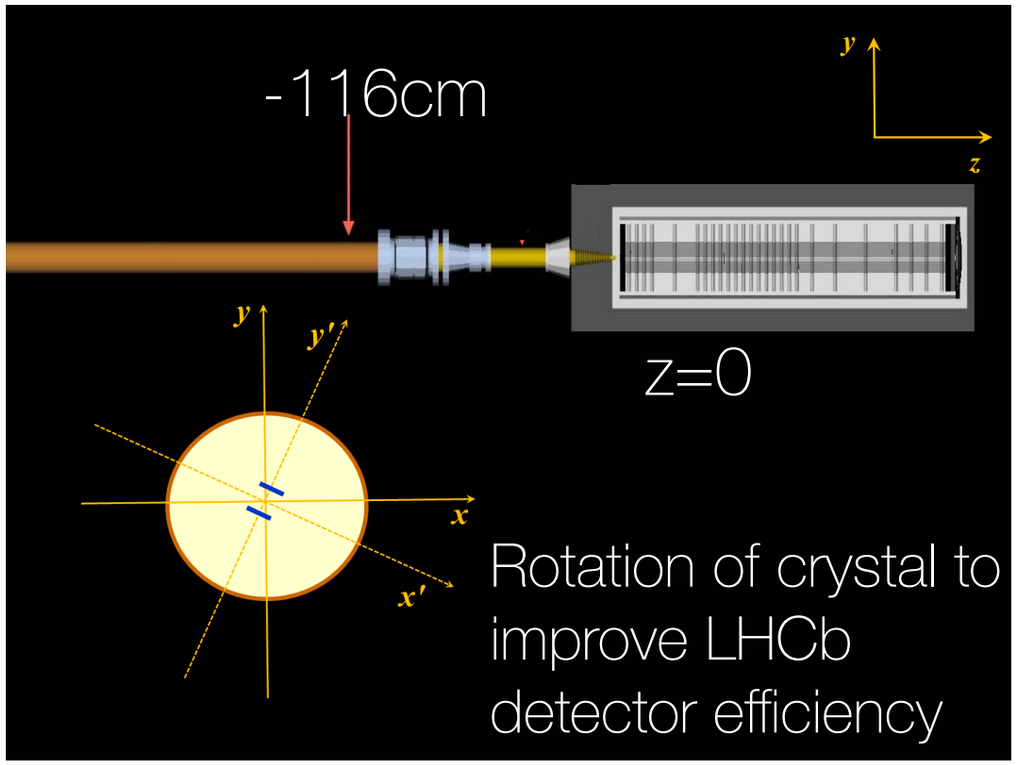
limited space and infrastructures at IR3 👎

optimal experiment ✔

independent physics program ✔

Other considerations?

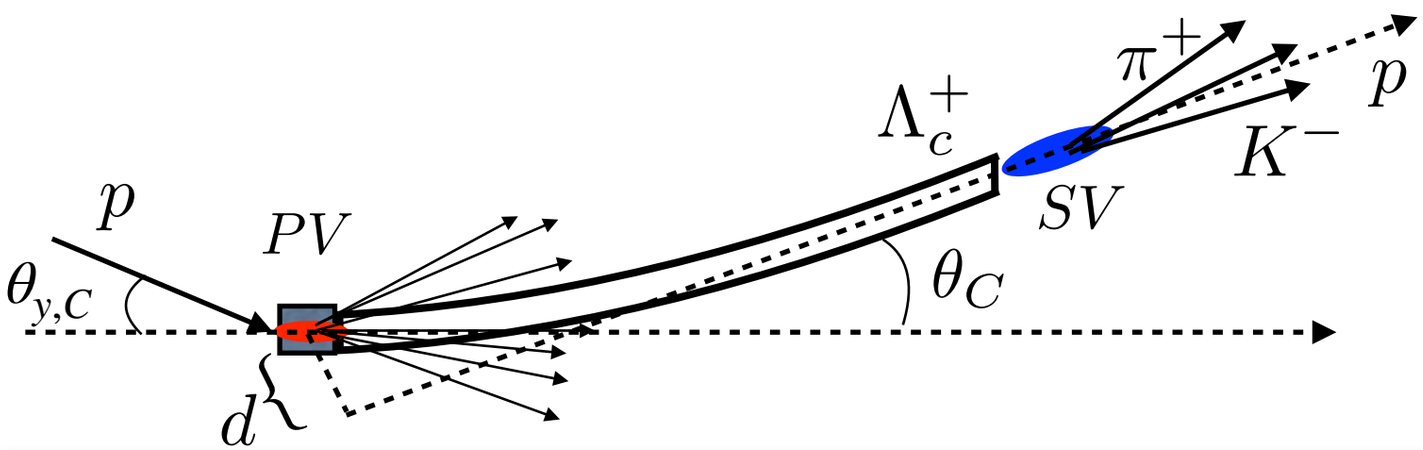
Simulation studies in LHCb

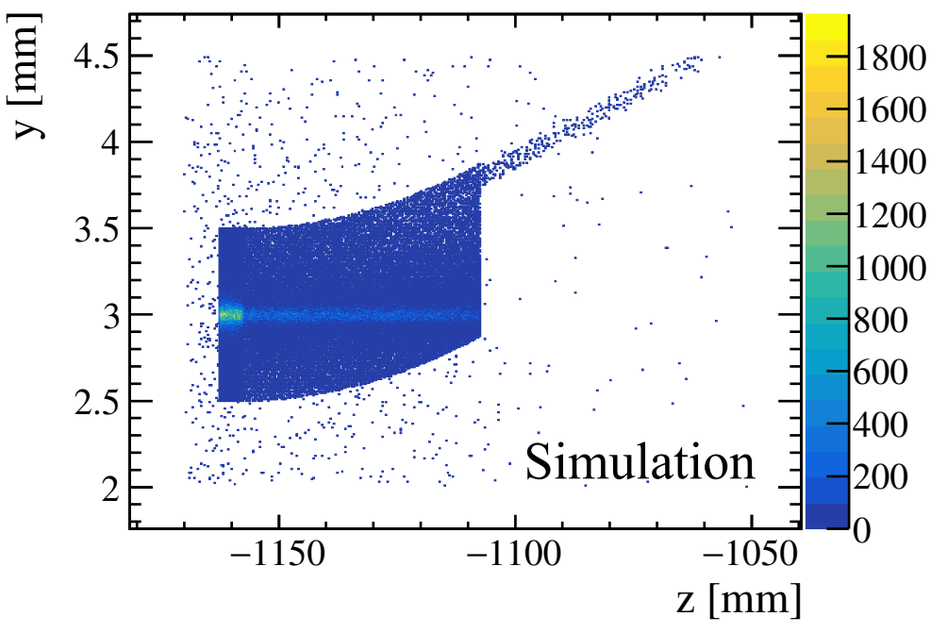


Andrea Merli PhD thesis CERN-THESIS-2019-108

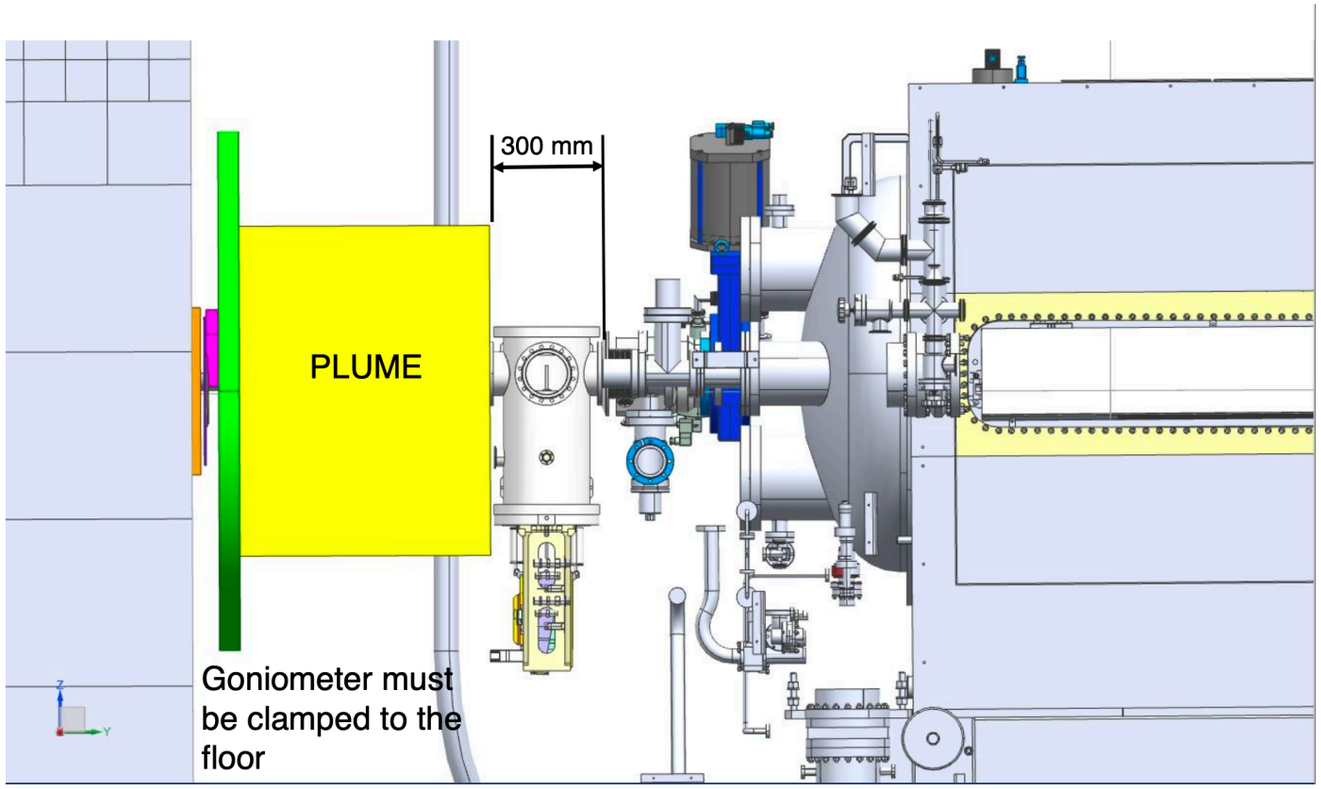
- Good performance (signal and bkg) with LHCb detector. Full **simulation** of **fixed-target setup:** W target 0.5-2.0 cm and bent crystal
- $\nu_{target} \lesssim 0.01$ with 10^6 p/s on target
- About 10^{-4} Λ_c^+ are channeled and have **high momentum** ≳1 TeV

Good res. on production and decay vertex (7-8mm), θ_C angle (25μrad), m(pKπ) (20 MeV)



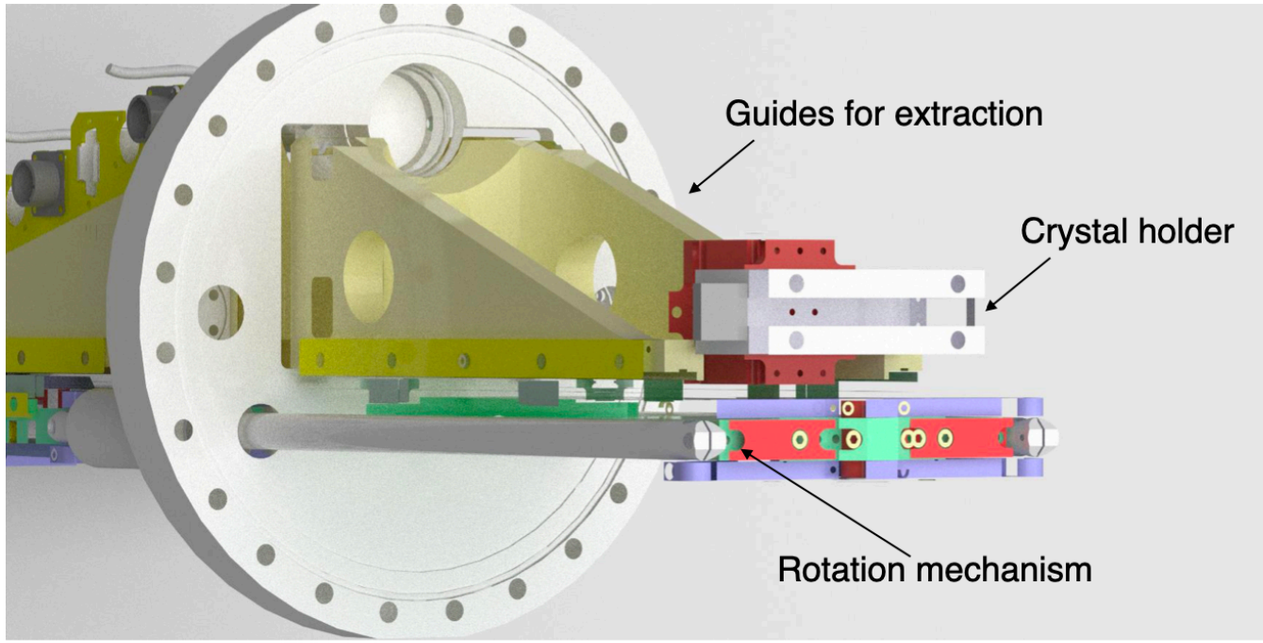


Fixed-target setup upstream of LHCb



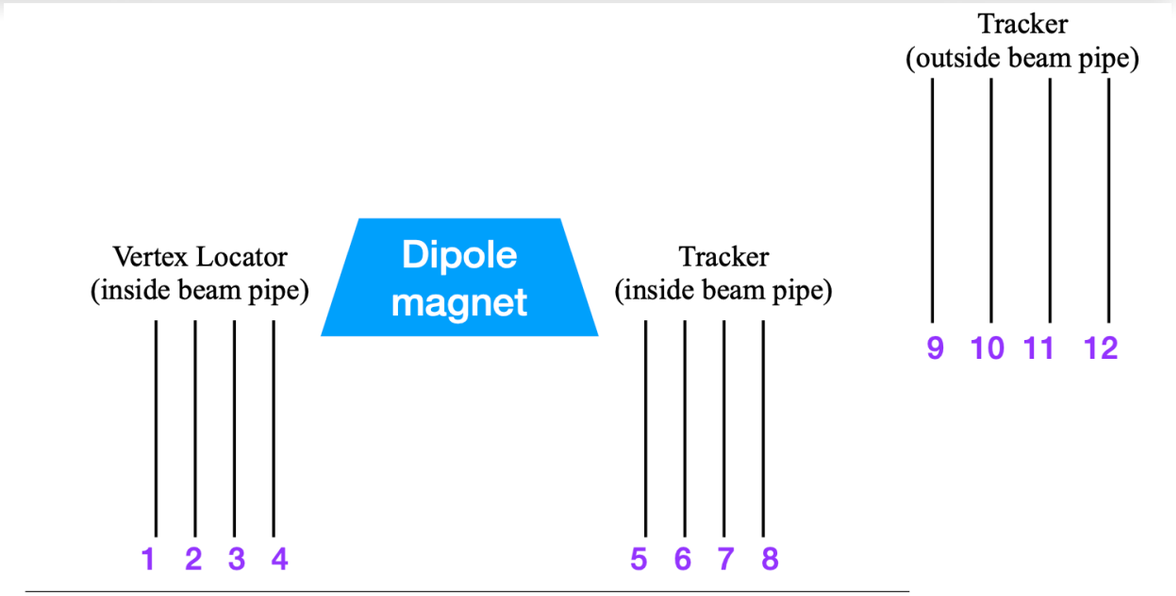
- Goniometer for target+crystal positioned in the region upstream of the LHCb detector
- Space of 30 cm is required for the goniometer along *z* direction

- Goniometer internal structure: compatible with operations in ultra-high vacuum
- Accuracy on position ~20 μm, rotation angle ~20 μrad



Studies for a dedicated experiment at IR3

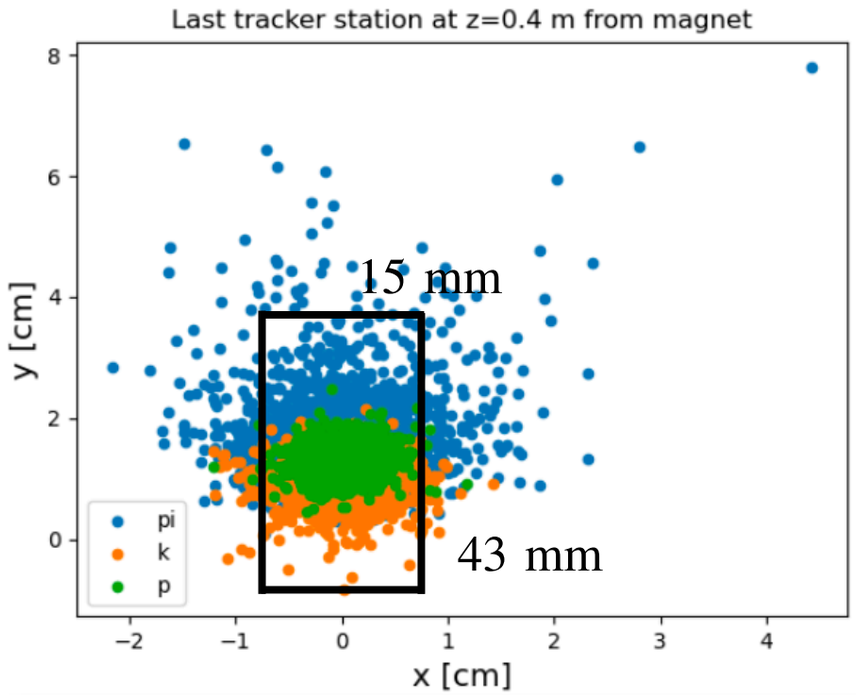
- Channeled Λ_c^+ in bent crystal are very focused in few cm^2
- Preliminary simulations: with 8 **VELO tiles** + existing 1.9Tm dipole magnet in situ can build a spectrometer



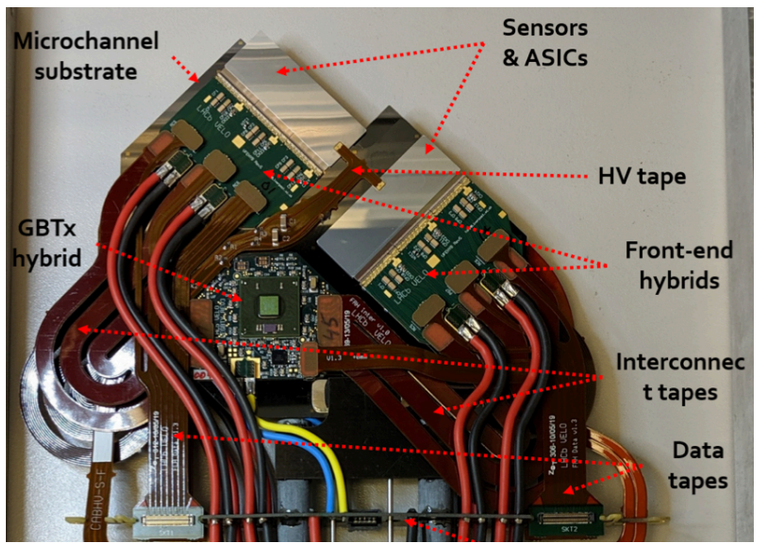
VeloPix modules in Roman Pots

Hit distribution for $\Lambda_c^+ \to pK^-\pi^+$

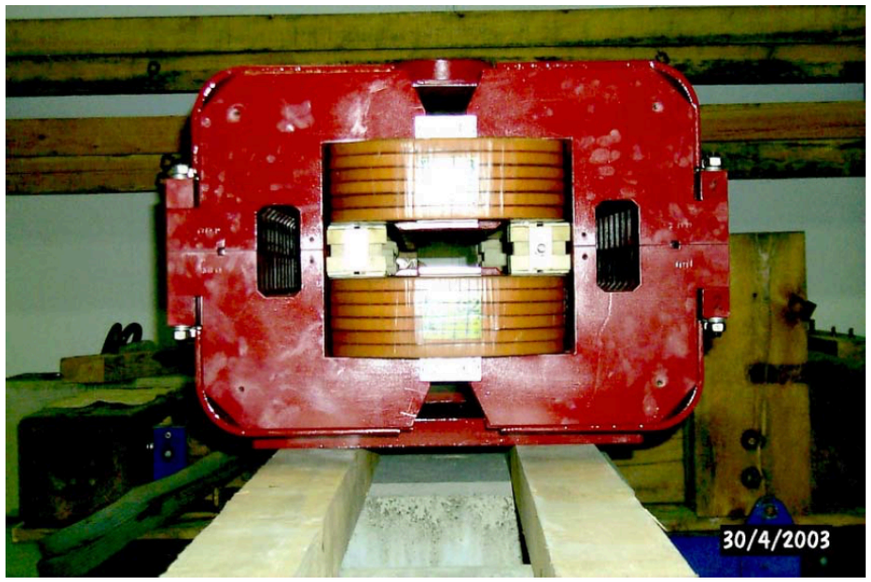
Area ≈ few cm^2. rate ≈ 100 MHz/cm^2



for Vertex and Tracker stations
1 cm from the beam
55x55 μm^2 pixel,
pixel hit rate 600 MHz/cm^2,
12 μm hit resolution



LHC orbit correction dipole MCBW (1.7 m, 1.1 T) is considered for the spectrometer (Credits: Pascal Hermes, CERN)



Equipment and detector for a dedicated experiment

- 2 goniometers
- 2 silicon bent crystals + W target
- pixel tracking detector (Velopix) inside Roman Pots
- 4 T m dipole magnet
- Data acquisition
- Infrastructure and services
  - Simulations are needed to study impact of:
    - PID detector for p>100 GeV. TRD detector?
    - Calorimeter?
    - Muon detector?
- Other?

Timeline

- Possible timeline for the experimental proposals in LHCb or for a dedicated experiment