

Update on TWOCRYS the feasibility of double-crystal fixed- target experiments at the LHC

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On behalf of the TWOCRYS Collaboration

ICHEP 2024, Prague

18.07.2024

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TWOCRIST Collaboration

Memorandum of Understanding signed

CERN with 7 teams involved

INFN, Italy

IJCLab, France

IFIC, University of Valencia-CSIC, Spain

University of Malta, Malta

Warsaw University of Technology, Poland



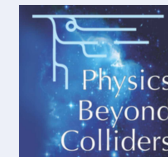
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Acknowledgments for financial support

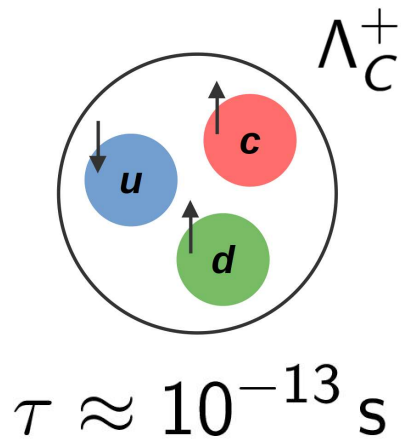


European Research Council
Established by the European Commission



SELDOM
project G.A. 771642

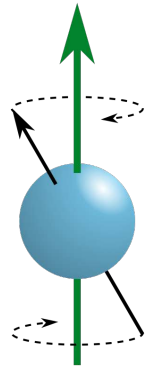
EDM/MDM Measurement of charmed baryons



Lifetime too short for spin precession measurement with magnets

Idea to measure instead with two bent crystals in LHC

TWOCRYST: LHC proof-of-principle test stand for double-crystal experiment





Contents

Channelling in bent crystals

Double-crystal setup: EDM/MDM measurements in LHC

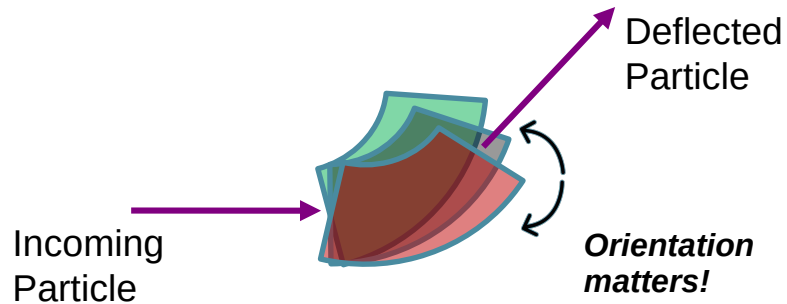
TWOCRIST Proof-of-Principle

Design and Concept
Timeline
Status

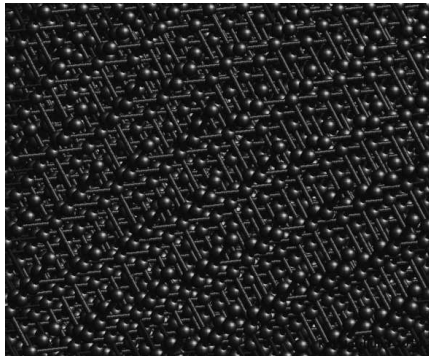
Conclusions

Deflection in bent crystals

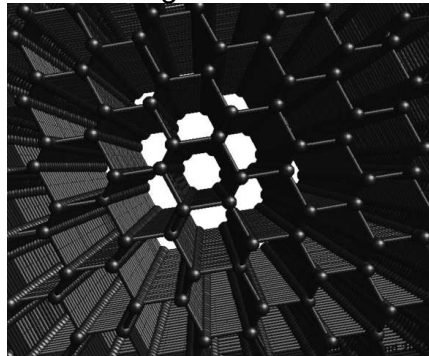
Particle channelling induces deflection



Random orientation

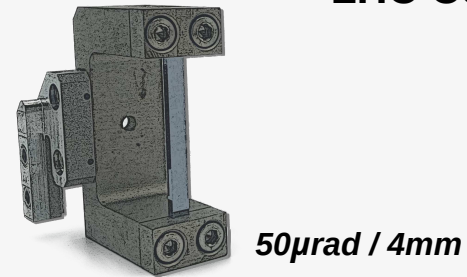


Channelling orientation



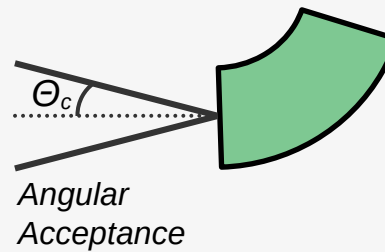
Knordlun, [CC BY-SA 3.0](https://commons.wikimedia.org/wiki/File:Crystal_lattice_random_orientation.png) via Wikimedia Commons

Bent Silicon crystal for LHC Collimation



Equivalent deflection to
~300Tm magnet!

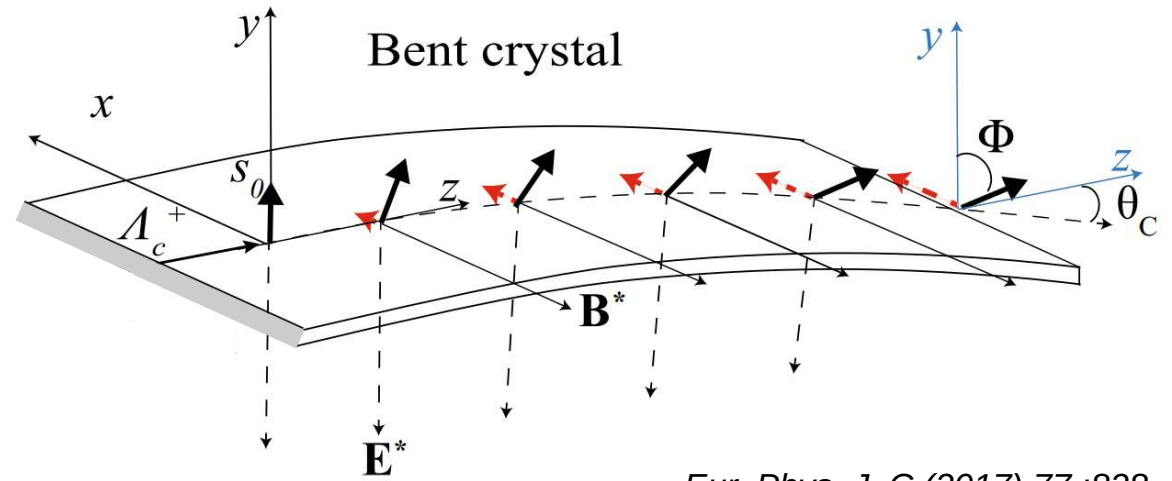
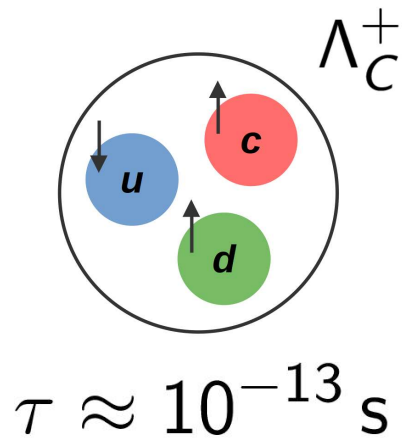
Critical angle Θ_c



Energy [GeV]	Crit. Angle [μ rad]
180	18
450	9.4
7000	2.4

Silicon

Charmed Baryon EDM/MDM



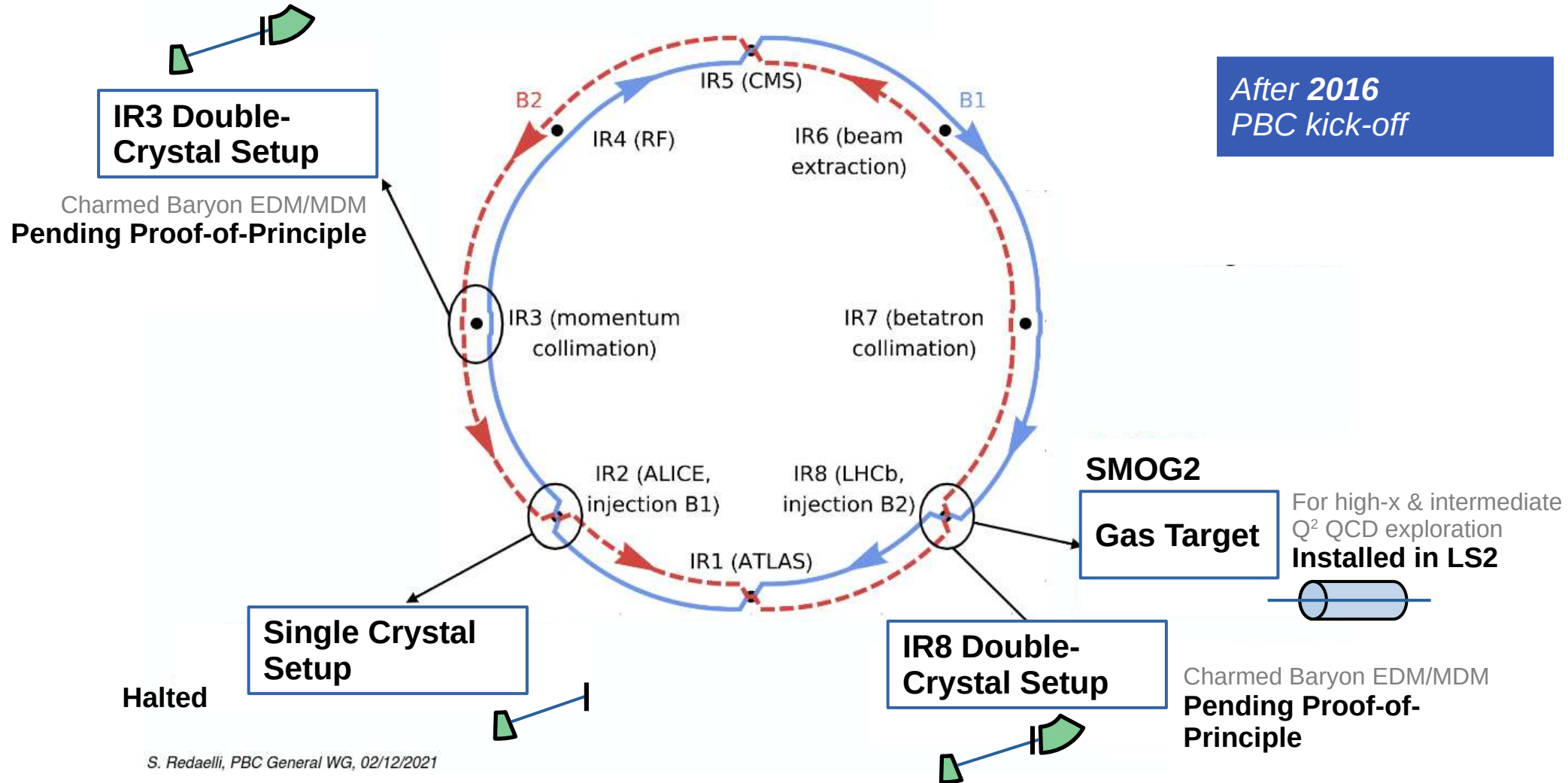
Eur. Phys. J. C (2017) 77 :828

Bent crystals induce spin precession on channelled particles

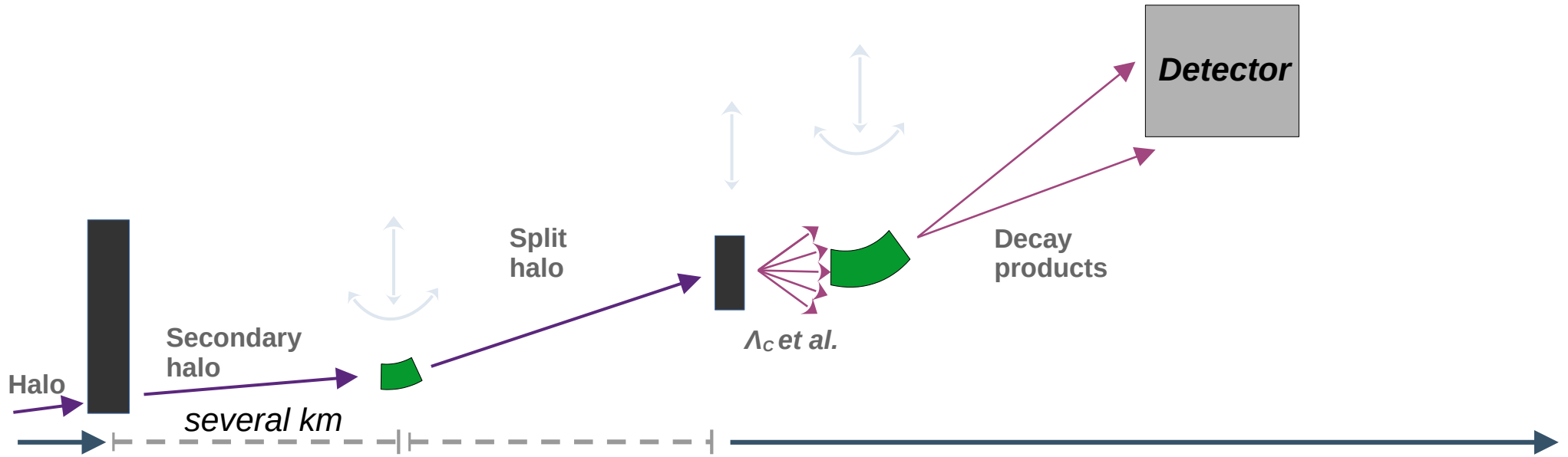
E-field between atomic planes $\sim 1\text{GV/cm}$, effective magnetic field $\sim 500\text{T}$

Λ_c^+ EDM and MDM becomes visible!

Physics Beyond Colliders – LHC Fixed Target Studies



LHC Double Crystal FT Experiment – (Proposed 2029+)

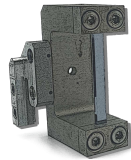


TCP

Primary Collimator

TCCS

Splitting Crystal



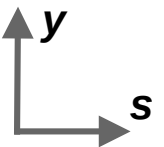
Target

TCCP

Precession Crystal



Detector



2025 Proof of Principle - TWOCRIST



**Validate crystal properties
at TeV energies**



Operational feasibility



Performance estimates

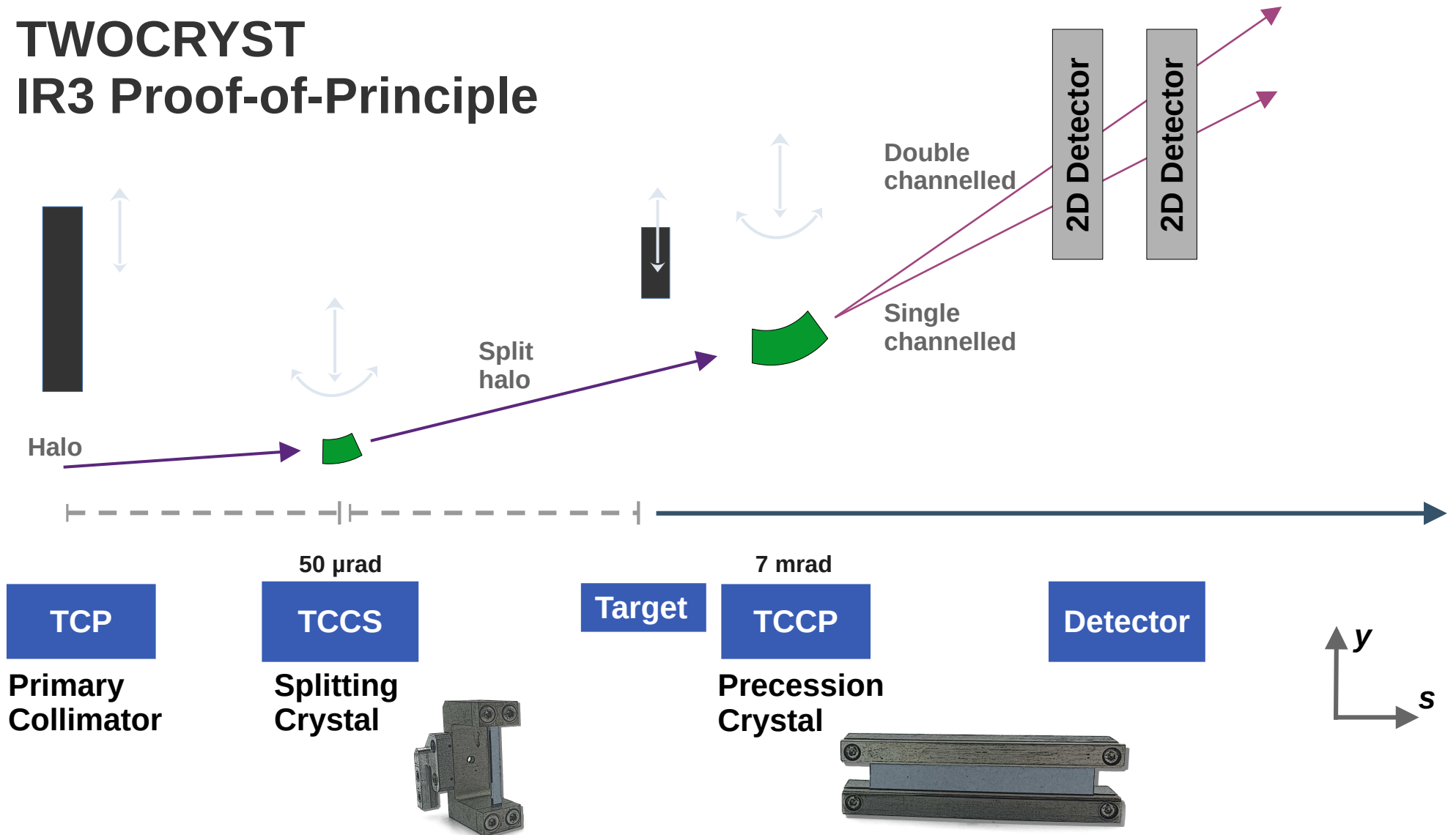
Open questions could be answered
by a proof-of-principle test stand:
TWOCRIST

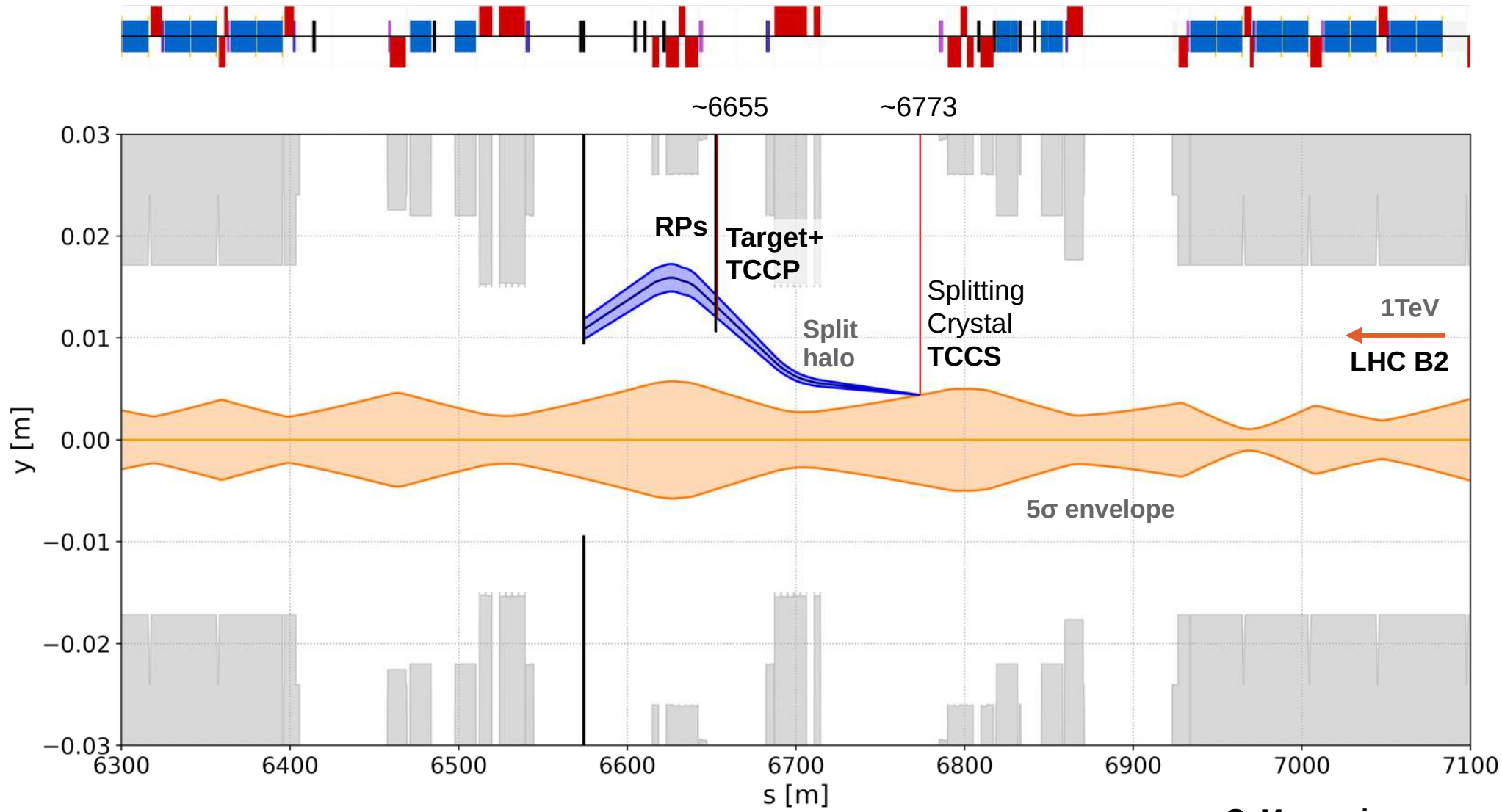


**TWOCRIST input is crucial for experiment
proto-collaboration (LoI in preparation)**

All goals must be achieved in 2025

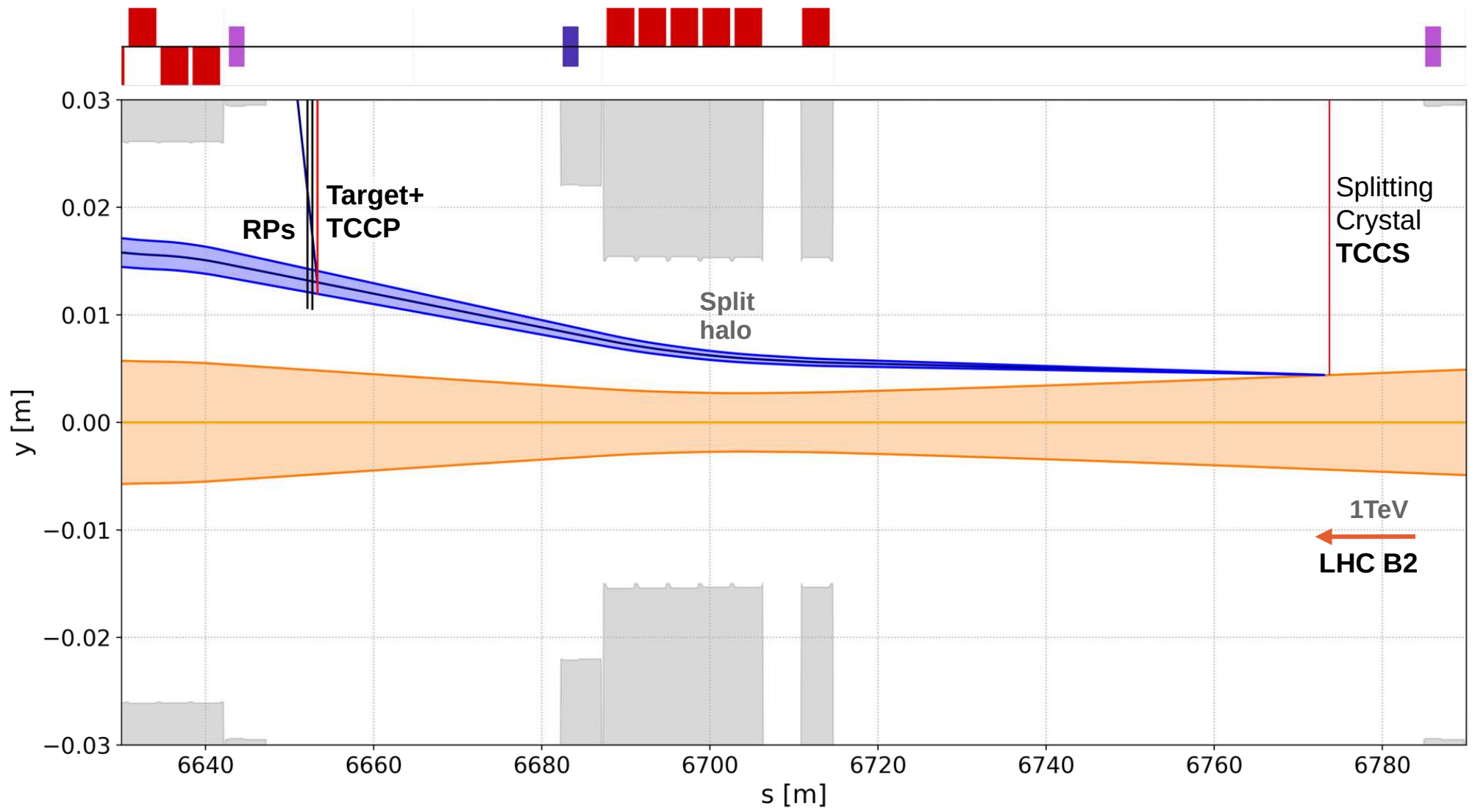
TWOCRIST IR3 Proof-of-Principle





C. Maccani





C. Maccani

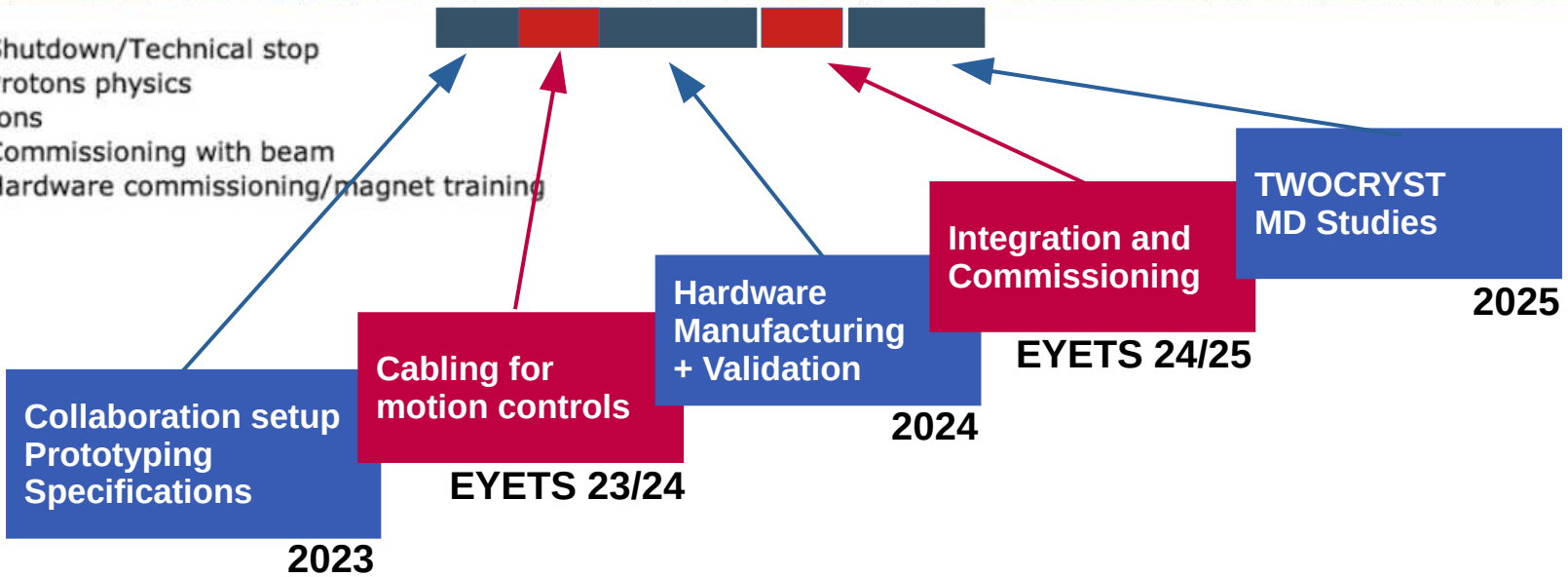
TWOCRYSY inputs needed before LS3

Project Schedule

Now

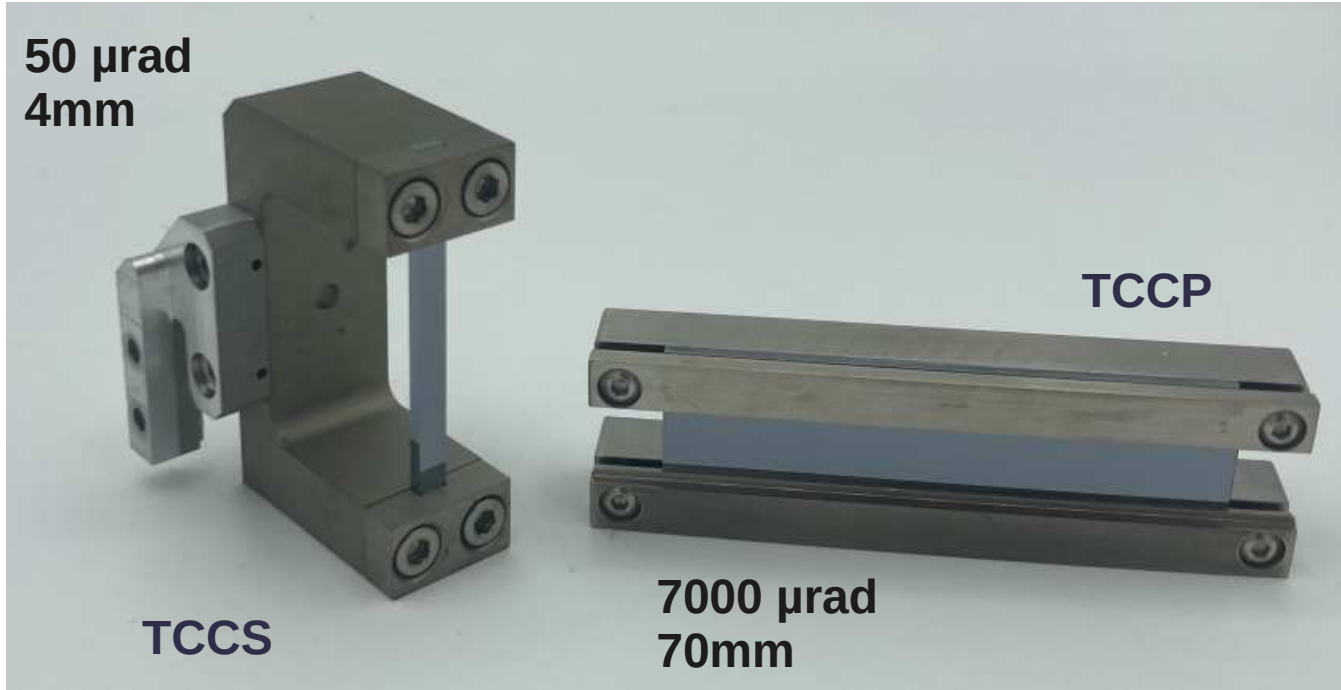


- Shutdown/Technical stop
- Protons physics
- Ions
- Commissioning with beam
- Hardware commissioning/magnet training



Crystals

Both crystals
manufactured and
delivered by INFN-Ferrara

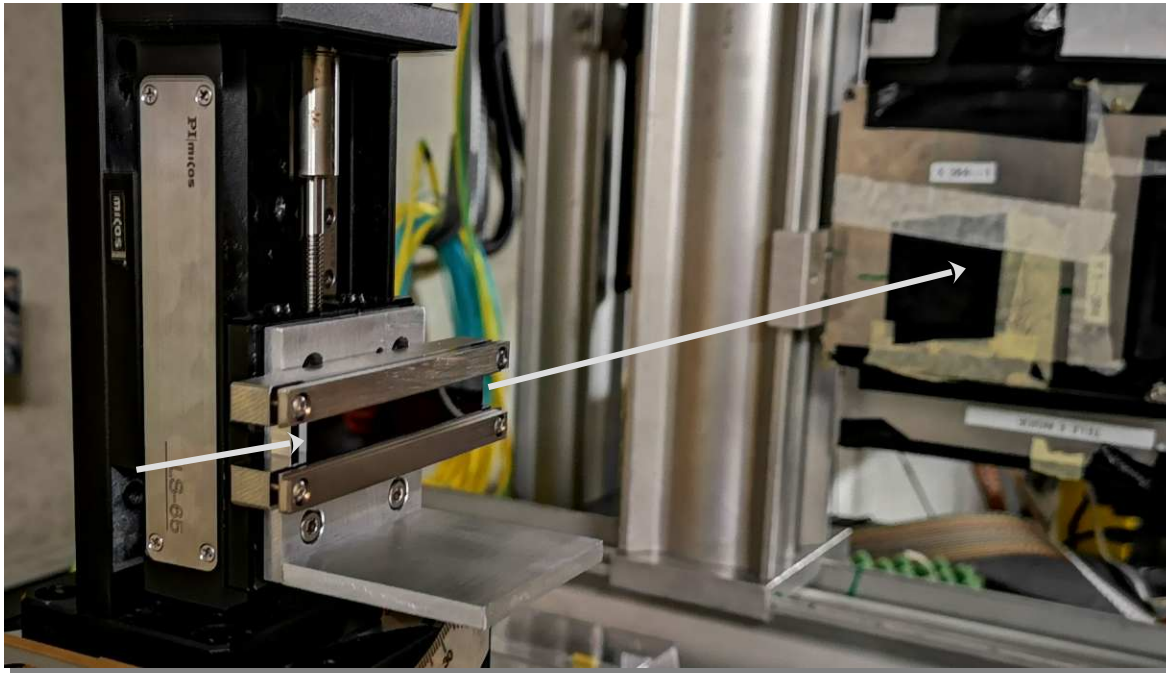


Courtesy of A. Mazzolari

**TCCP crystal also under
development by CERN SY/STI team**

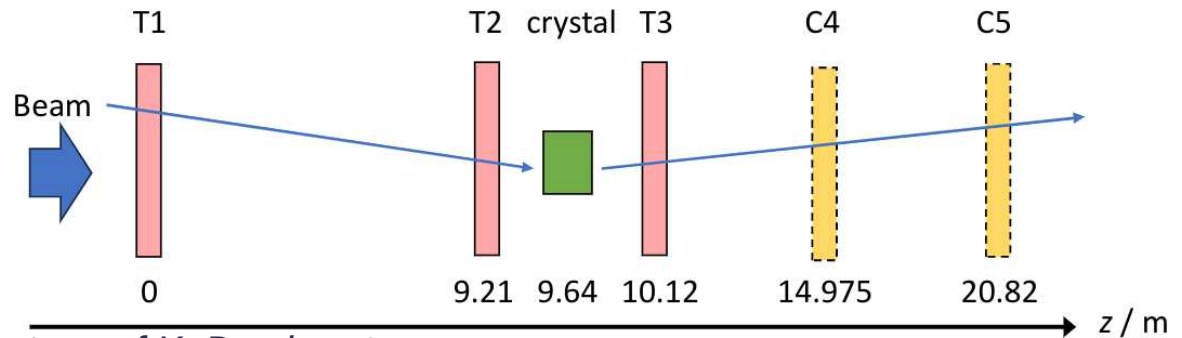
Hadron Beam Test

Both crystals tested in
CERN NA at H8 beam line
(180GeV Pions)



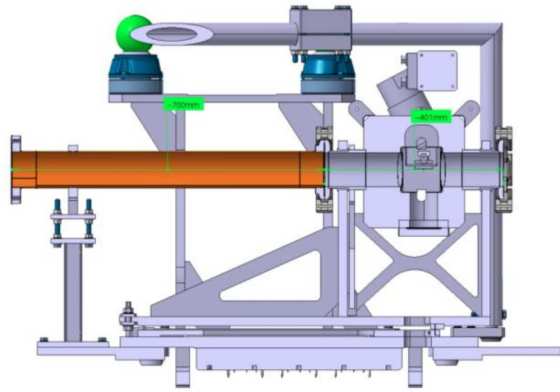
TCCP crystal mounted for H8 beam test

**Good efficiencies
measured for both crystals!
Publication in preparation**



Courtesy of K. Dewhurst

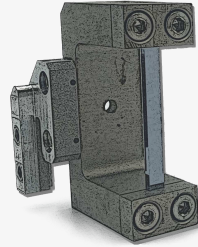
TCCS



TCCS goniometer

Recovered from IR7

Formerly used for crystal collimation



50 μ rad / 4mm

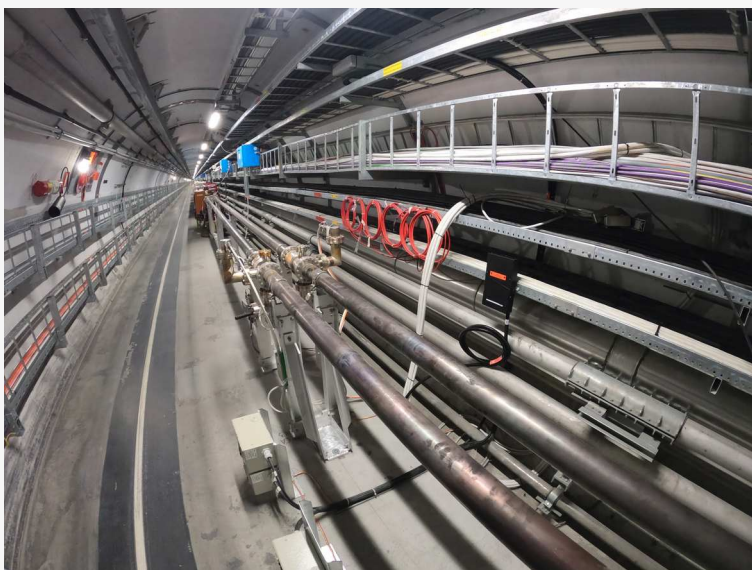
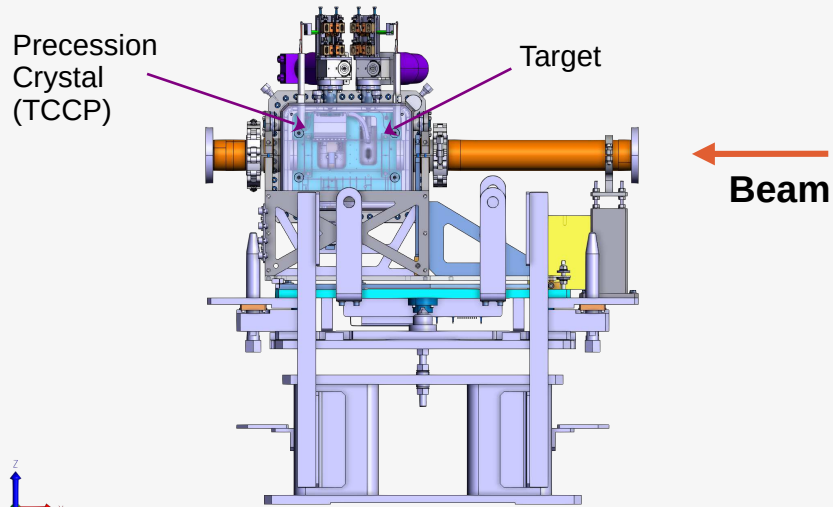
TCCS crystal for splitting of beam particles

Installation slot in IR3



6773.9m from IP1

B2

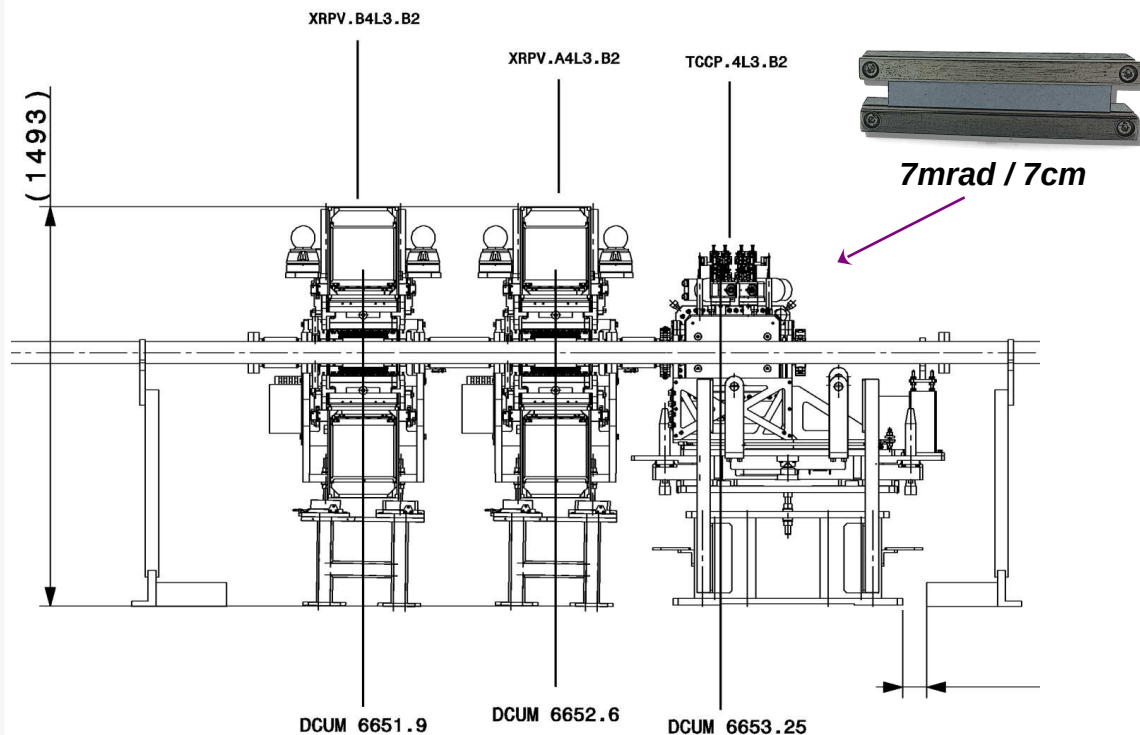


Target - TCCP Assembly

Assembly designed for TWOCRIST

Independent motion of target and TCCP crystal

Construction and validation within 2024



Roman Pot Stations



Removal of two
ATLAS-ALFA stations
after high- β run 2023

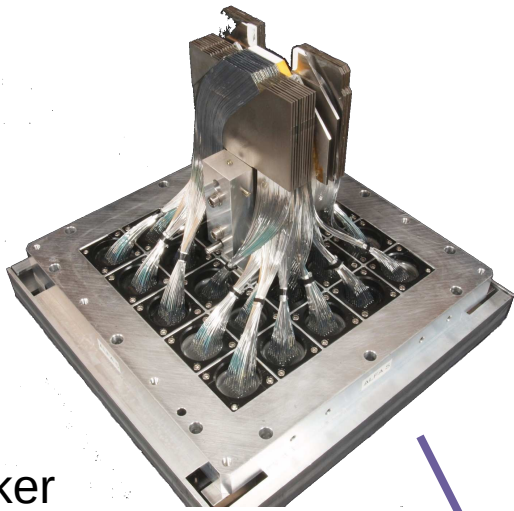


ALFA detectors removed
Station refurbishment ongoing



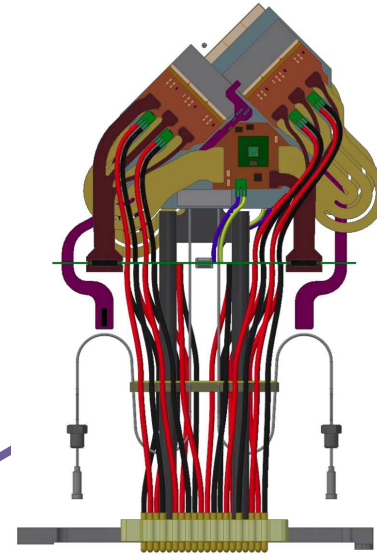
Photographs: Courtesy of S. Jakobsen

Courtesy: S. Jakobsen

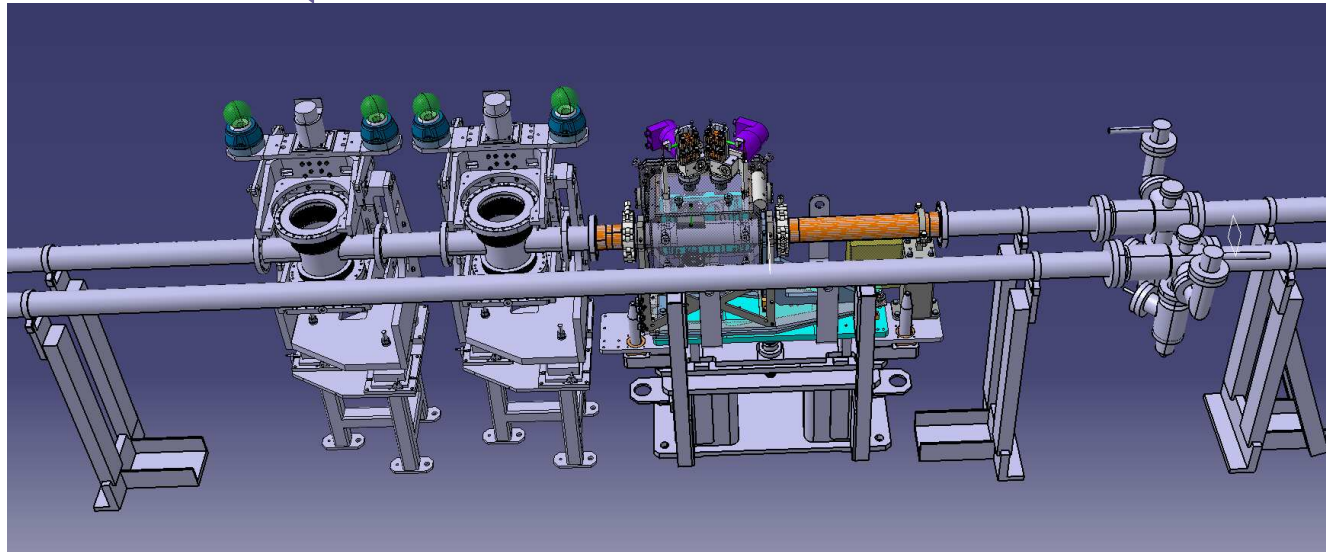


Fibre tracker recovered from ATLAS-ALFA

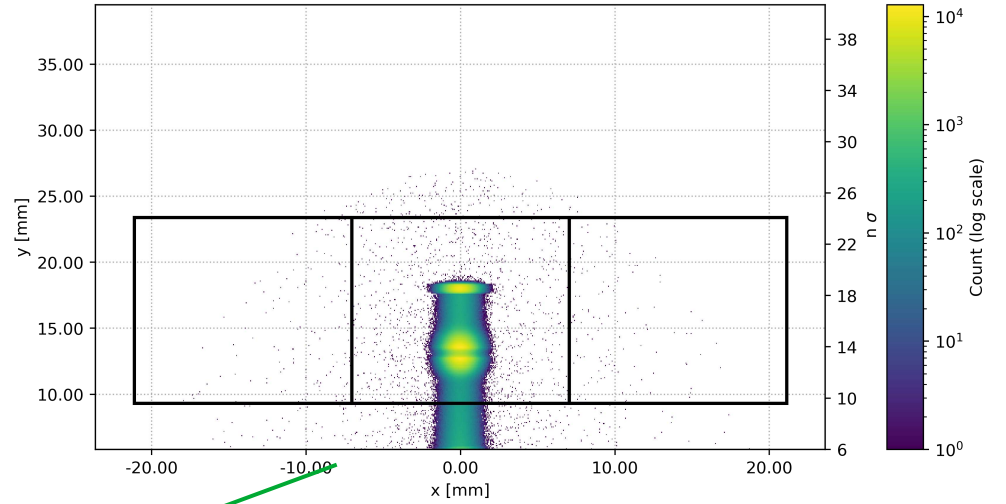
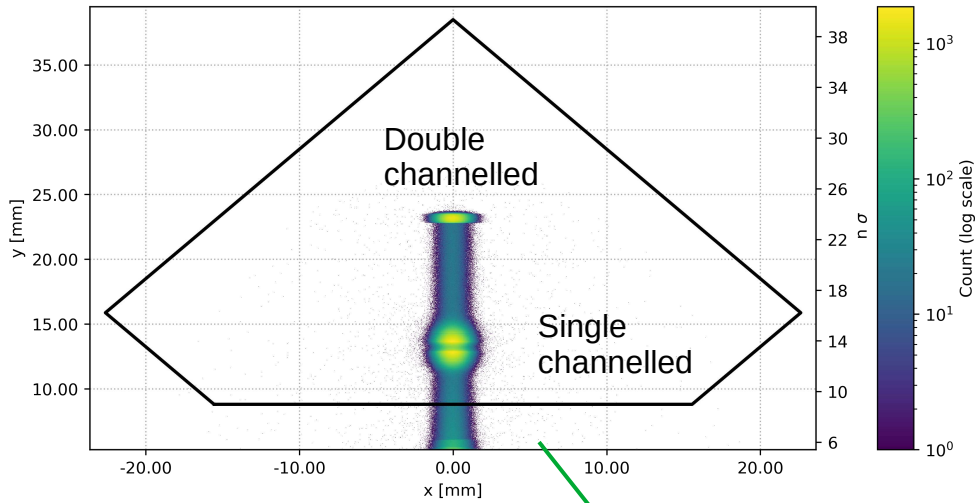
Courtesy: S. Cesare



VELO silicon pixel sensor

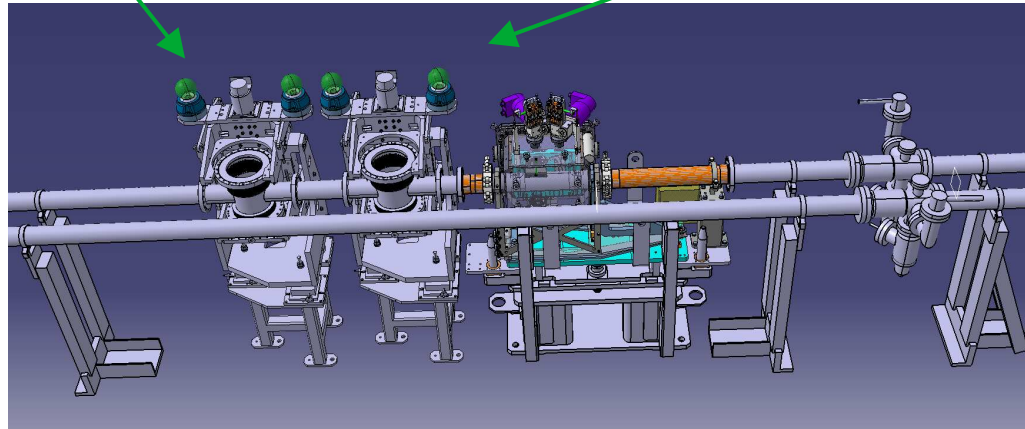


Measurement



TWOCRYS
fiber tracker

TWOCRYS
silicon pixel
detector



Conclusions

- TWOCRIST:
A proof-of-principle for a double-crystal based FT experiment in the LHC
- Active and fruitful collaboration: ambitious for potential physics experiment
- Project on track aiming to start data taking in 2025



Paving the way to getting to know the Λ_c a bit better!