Particle source and targets
Lines of research

SAPIENZA
UNIVERSITÀ DI ROMA

Gianluca Cavoto – gianluca.cavoto@uniroma1.it

Tel: +39 06 4991 4344 – Room: 328 VEF

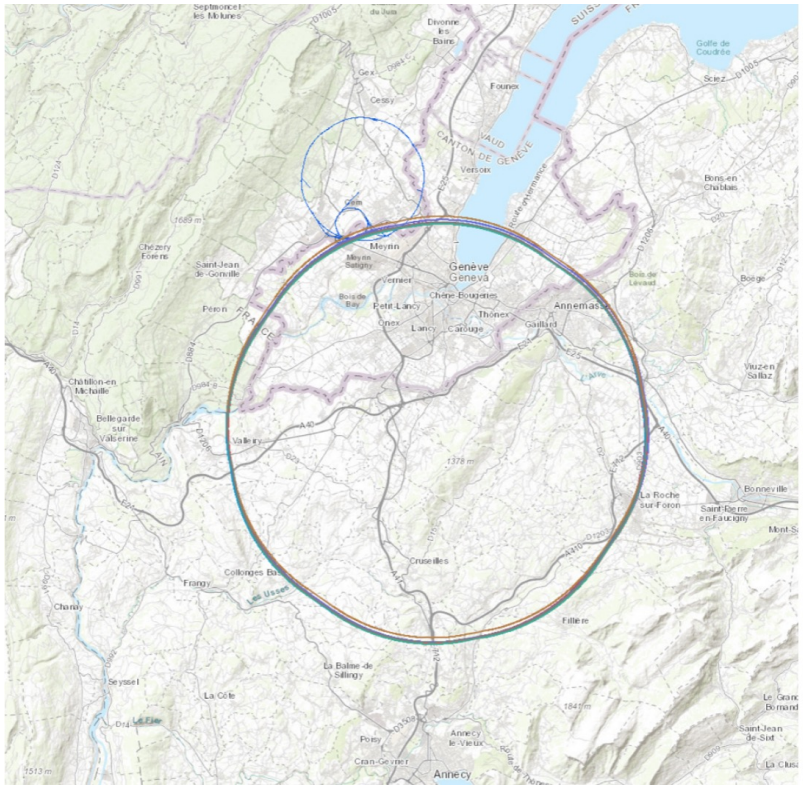
Particle source and targets

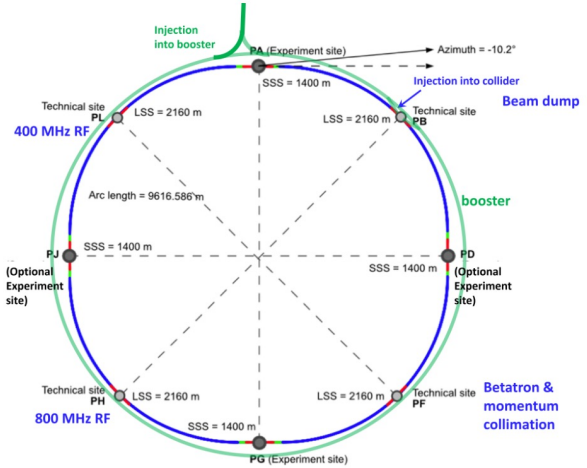
- Accelerator need specific devices to **produce** particles
  - Sources must be used to produce “beam” of particles
- Can be source of charged or neutral particles
- Particles need to be manipulated with targets
  - Collimators, absorbers, septa,…

- Particles are produced from **interaction in matter**
  - i.e. photocathodes
    - Strong interplay with condensed matter physics
  - Secondary particles sources (fixed target experiments)

.

Future colliders: the Future Circular collider FCC





Design of the absorbing systen (the beam dump) for the enornous radiation (400 kW) being produced by the beam (***Beam*strahlung**)

A high-luminosity electron-positron collider
beam energy ranging from 45.6 GeV to 182.5 GeV.

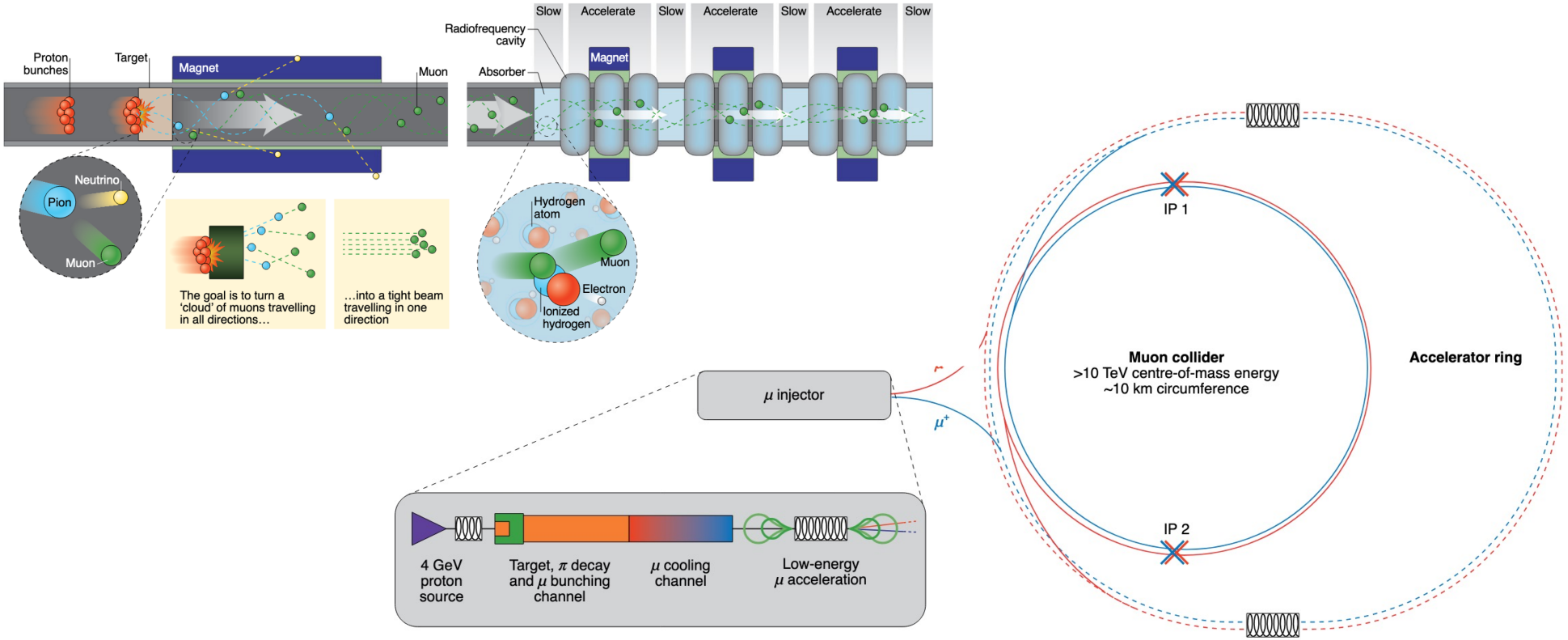
Muon collider

Long, K.R., Lucchesi, D., Palmer, M.A. *et al.*
Muon colliders to expand frontiers of particle physics. *Nat. Phys.* **17,** 289–292 (2021).

International MUON Collider Collaboration

R&D to design it (L= 10^{35}cm^{-2} s^{-1} , sqrt(s)= 10 TeV

Production of muons, must be a lot and with small emittance (*cooling*)

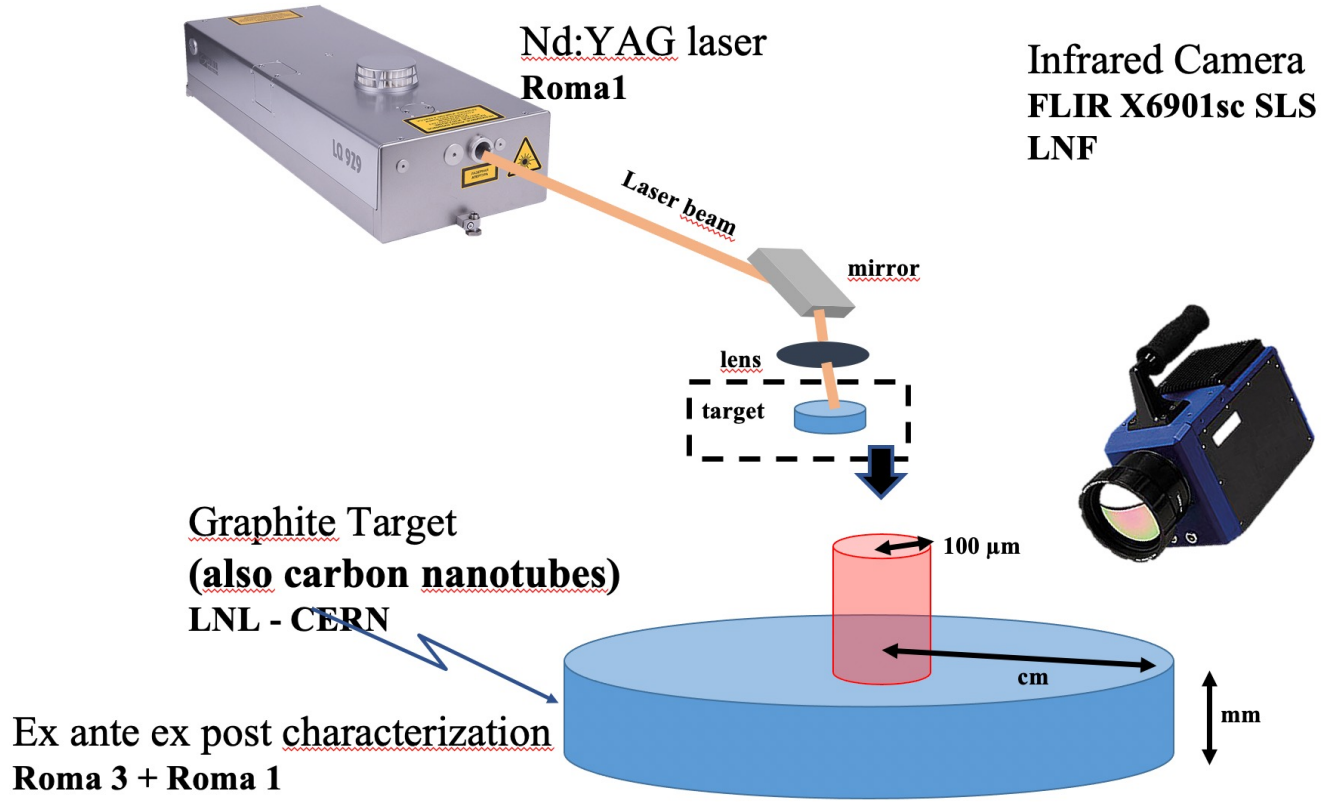


Cesarini, G., Antonelli, M., Anulli, F. *et al.* . *Int J Thermophys* **42,** 163 (2021).

Target Thermo-physics characterization

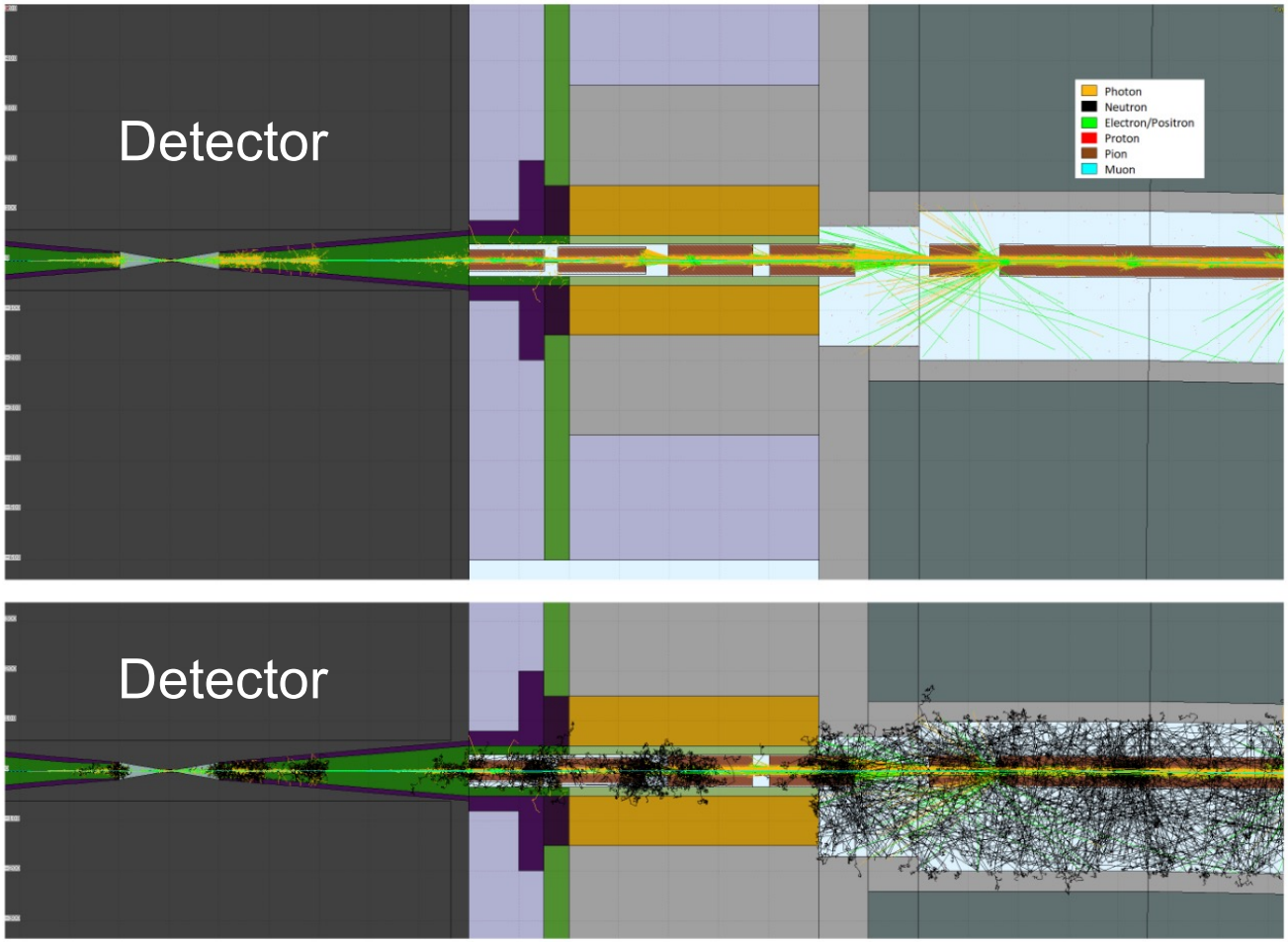
- INFN, **RD_MUCOLL** group (within the Muon collider international collaboration)

  – Study thermal properties for high power class target: wedge, absorbers, thin window for muon cooling



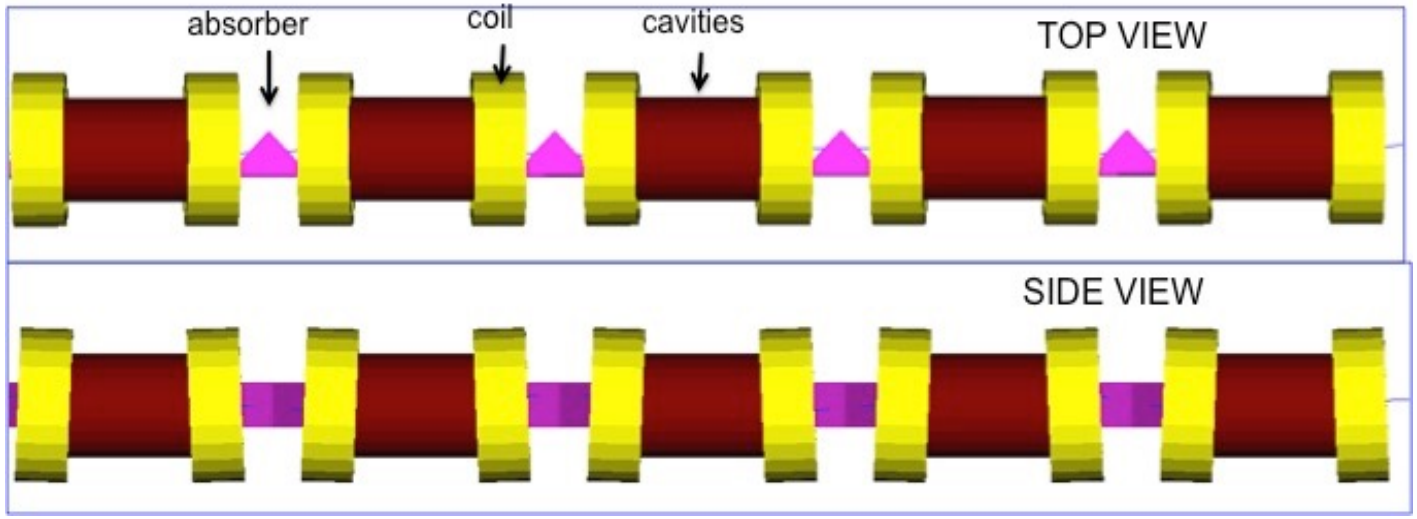
F.Collamati et al https://inspirehep.net/literature/1864142

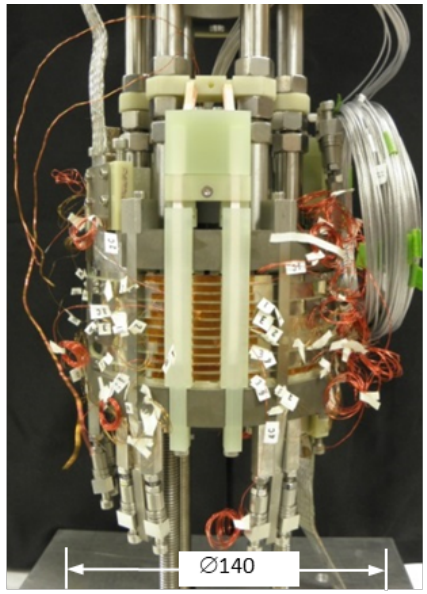
Machine detector interface



- Muon decays can represent a threat for the detector
- Design the Interaction region (simulation)

Magnets for the muon coooling cell





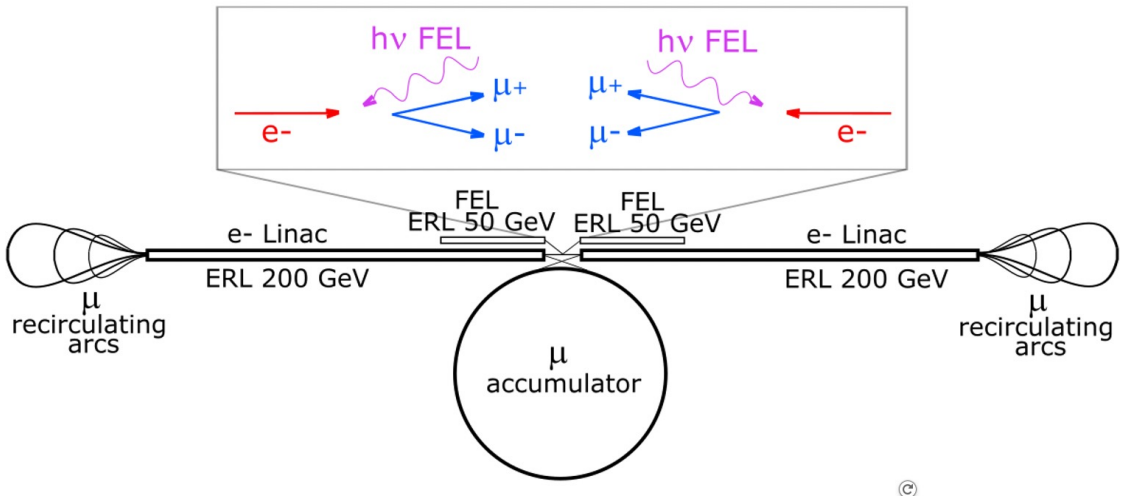
20 - 70:

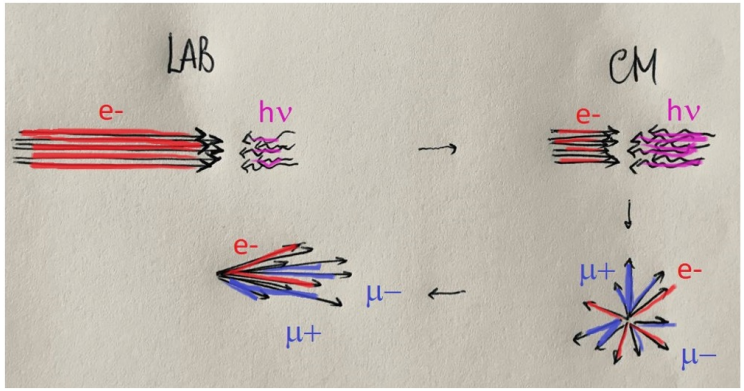
- Design of very high fields (3- 30 T) solenoids with new technologies: **Non-Insulated coil with HTS (high temperature superconductor)**
- Construction and experimental test of a prototype

Muon production with photons

C. Curatolo and L. Serafini, arXiv:2106.03255v1

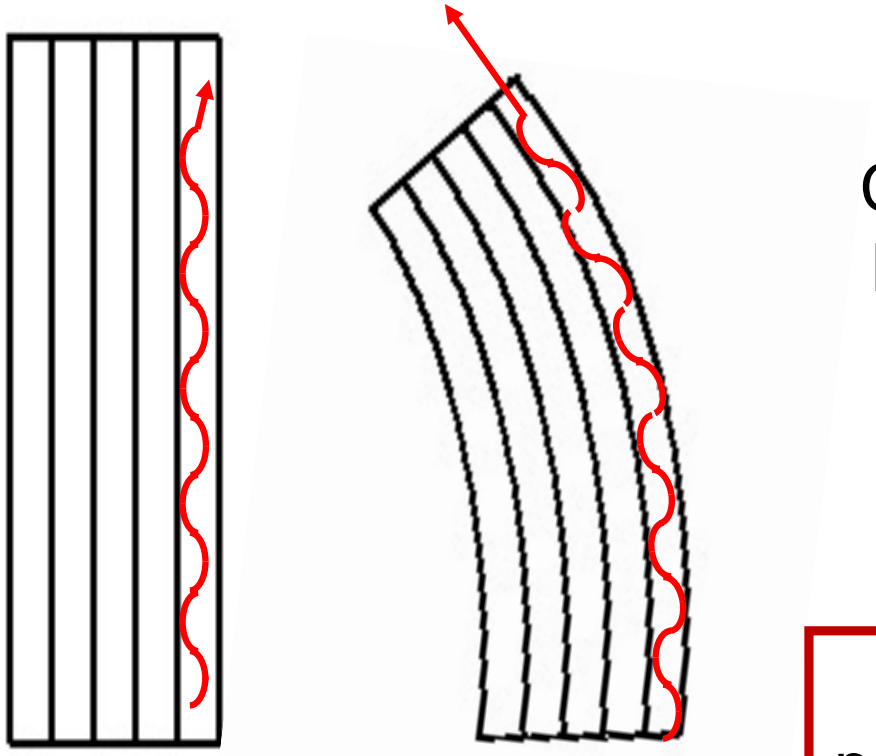
- Recently proposed





X-ray photons (150 keV) against 200 GeV electrons

Coherent interaction in crystals

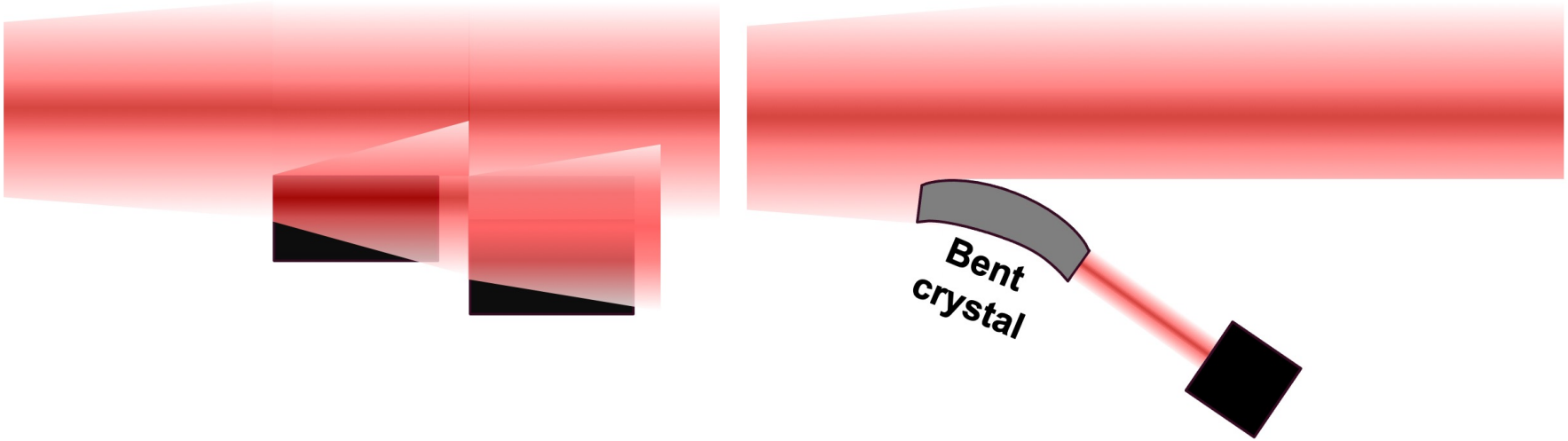


Channeling of a charged particle beam in a bent crystal results in steering of its trajectory

Bent crystals can be used in particle accelerators as collimators or as extraction elements

Crystal collimation

- Collimators in accelerators remove unwanted particles
- Crystal can concentrate losses and improve cleaning



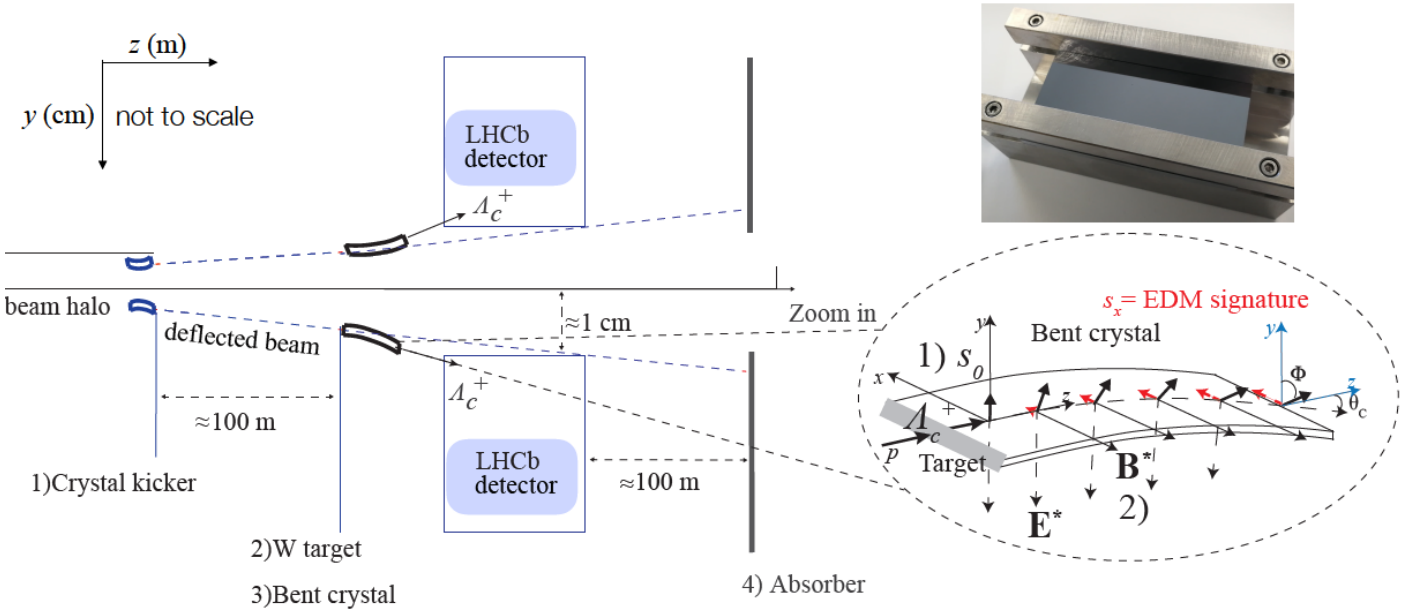
- UA9 demonstrated it at the SPS and the LHC
- Now studying **beam extraction** with crystals

A. Mazzolari et al., *Eur.Phys.J.C* 78 (2018) 9, 720

Magnetic and electric dipole moments of baryons

Novel fixed-target experiment at LHC for charm baryons

- EDM/MDM from spin precession of channeled baryons in **bent crystals**

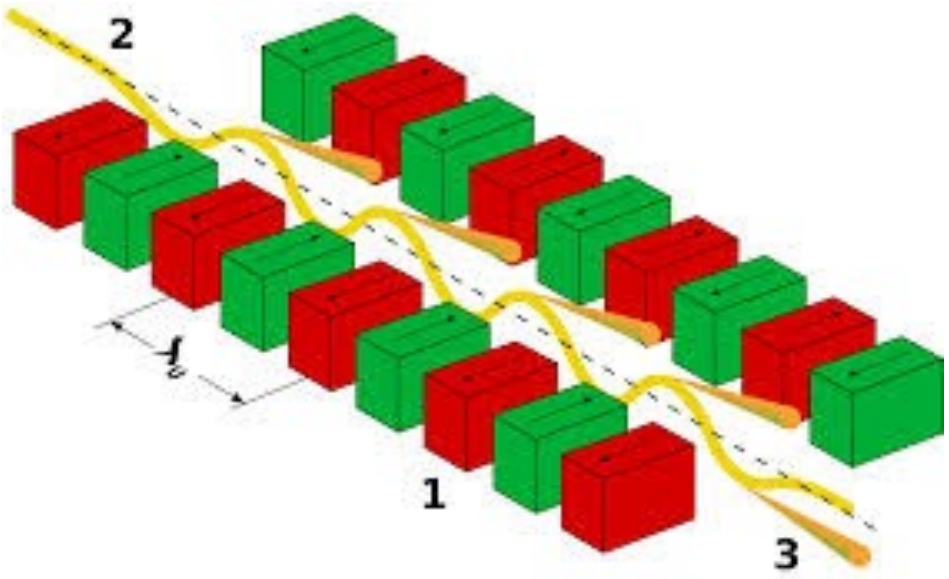


p extraction Λ_c^+ polarised production channeling spin precession event reconstruction

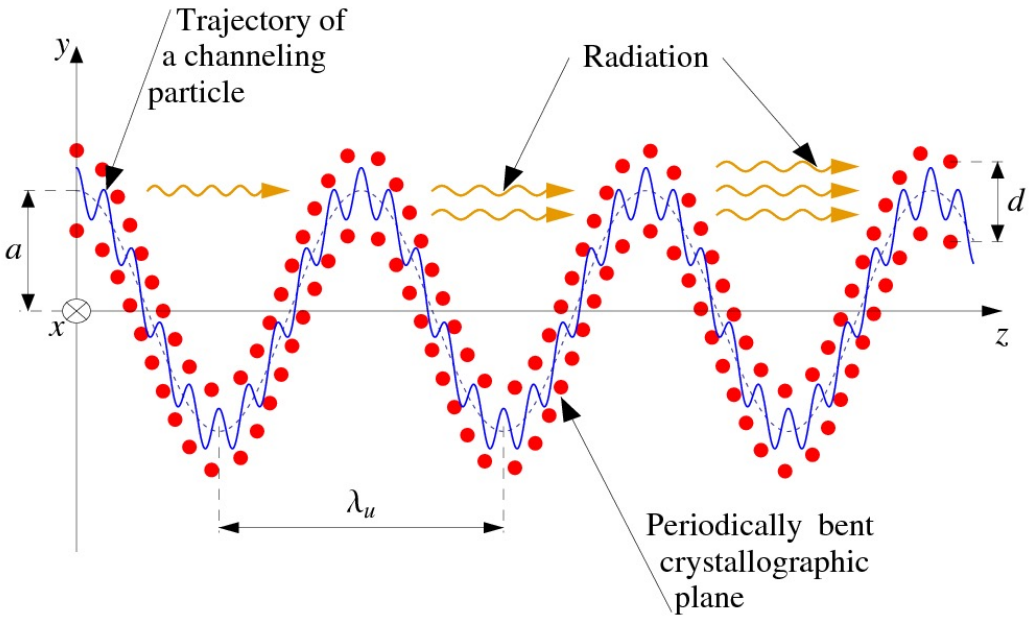
- CERN Physics Beyond collider Fixed target WG

A crystalline undulator

A classical scheme: FEL



Innovation: crystalline undulator

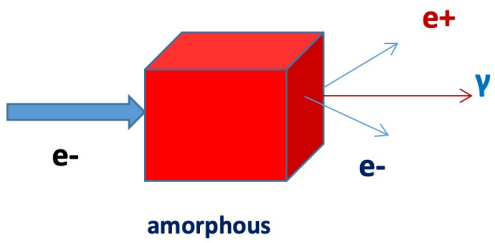


Hybrid crystal based positron source for future colliders

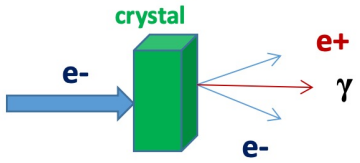
L. Bandiera et al., Eur. Phys. J. C (2022) 82:699

UNPOLARIZED POSITRON SOURCES

1. Conventional

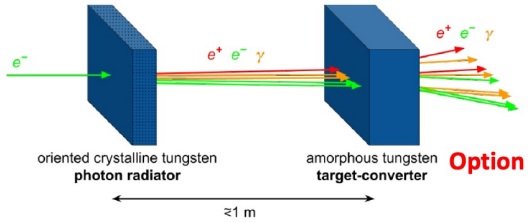


2. e+ from channeling radiation



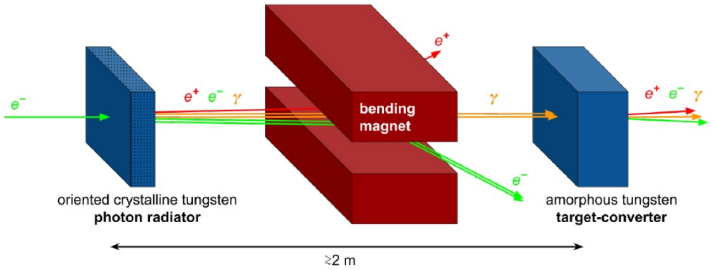
Tests performed at CERN (WA 103) and at KEK

3. Hybrid crystal based positron source



Option for FCCee

Ideal for linear colliders or LEMMA

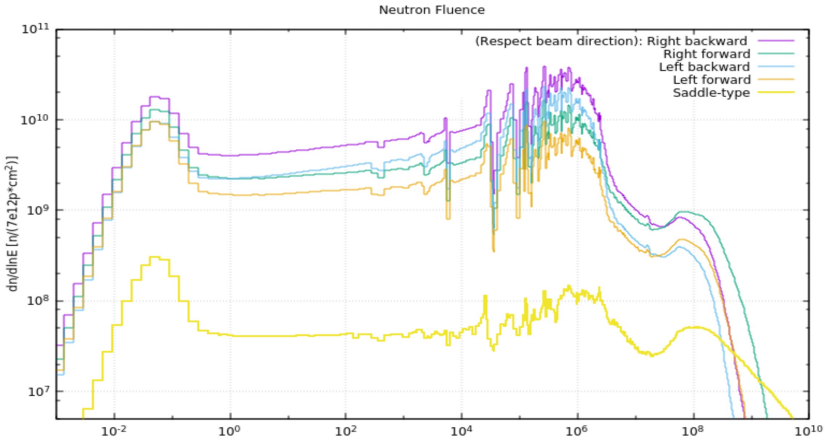


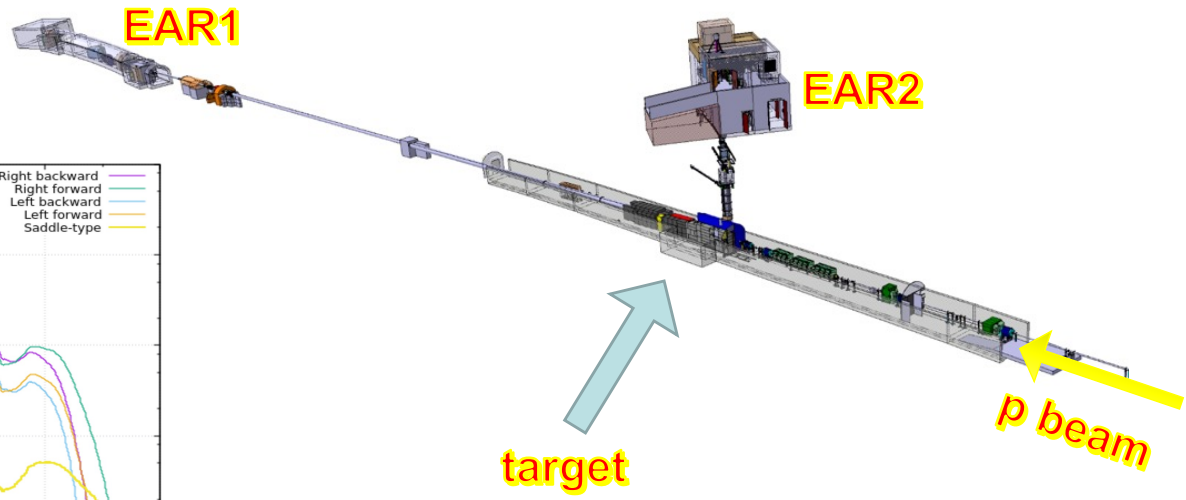
Idea of R. Chehab, V. Strakhovenko and A. Variola, NIM B 266 (2008) 3868

Being considered
in the R&D of the
FCC-ee positron source

The CERN nTOF neutron production facility

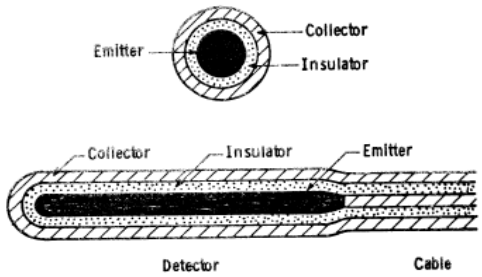
- The **nTOF experiment at CERN** exploits the 20 GeV PS proton beam interaction with a **lead target**, to produce neutrons by **spallation**.
- Neutron spectrum close to the target has a wide **energy spectrum up to hundred MeV** and a long tail down to thermal neutrons

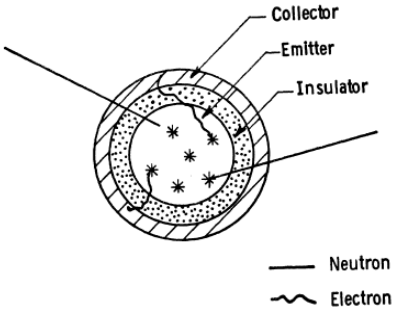


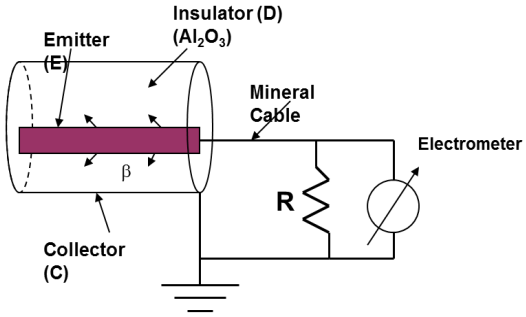


Self Powered neutron detector for fast neutrons

- **Self Powered (Neutron) Detectors** (SPNDs) are **rugged miniature** devices used for **fixed in-core reactor monitoring** both for safety purposes and neutron and gamma flux mapping.operate **without any bias voltage**







Design and commissioning of SPND at CERN

Particle production, particle interaction, particle monitoring

- Many and diverse opportunites for PhD projects

- Interplay between condensed matter physics, material science and accelerator physics extremely interesting
- International collaborations with activities mainly at CERN

Details in the slides on indico
Contacts: FCC: M.Boscolo (LNF); muon collider: M.Bauce (RM), L.Rossi (MI); crystals: L.Bandiera (Ferrara); neutrons: S.Fiore (ENEA Frascati)