The Design of the Electron and Positron Source for CERN External Beam Lines

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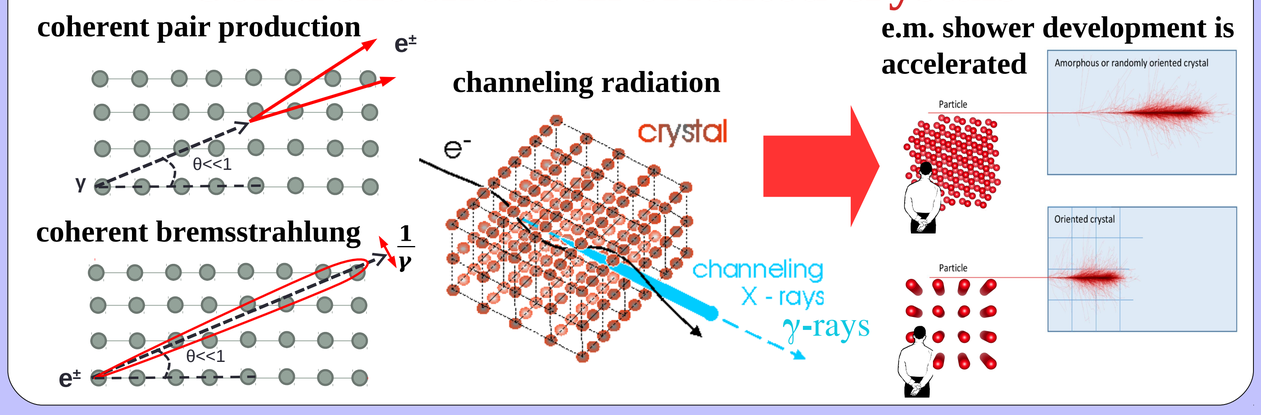
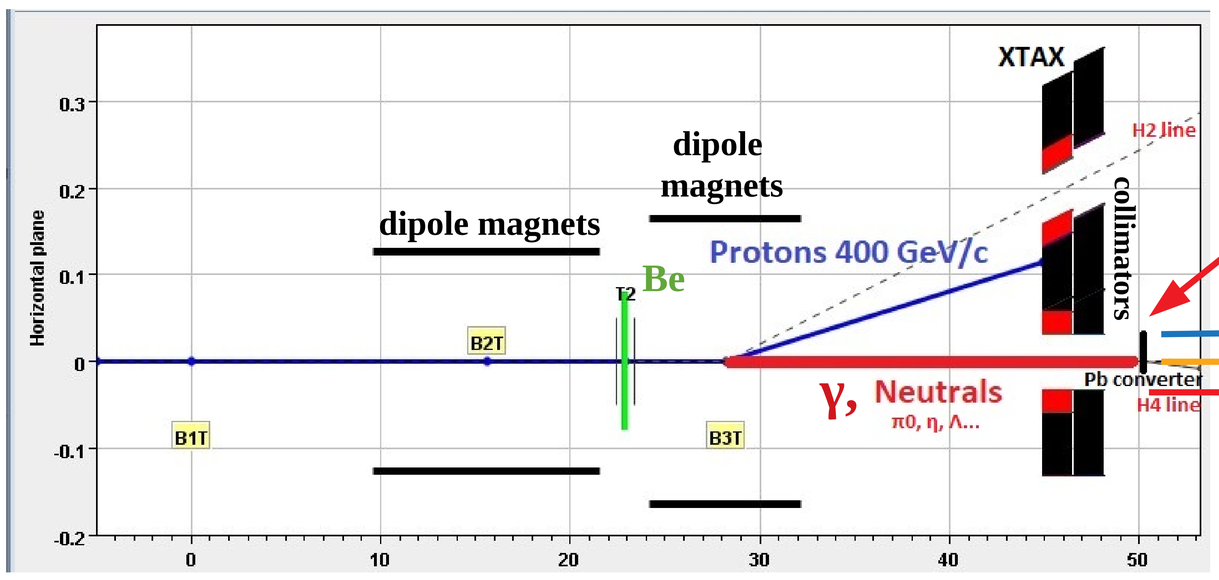
Motivation

- The primary beam from the CERN's **Super Proton Synchrotron** (SPS) is used to produce the electron-positron pairs for various experiments. $e^{\pm}$ in the GeV range are important for **dark matter searches**[1,2], new forces between the **dark-sector** and **visible matter** or **new vector bosons**[3].
- Exploiting **coherent effects** of charged particles interaction with **oriented crystals**[4,5,6] one can drastically reduce the thickness of the γ-to-$e^{\pm}$ converter. This will **considerably reduce** the level of **hadron background** at the converter exit and **increase** the **$e^{\pm}$ yield** in a certain energy range.

Coherent effects in oriented crystals[4,5,6]



Experimental setup at CERN SPS H4 External Beam Line



Idea: to replace the Pb converter by a **W oriented crystal**

γ, neutrals, protons, pions

Setup element	Thickness (mm)	Longitudinal position (m)
Be target T2	500	0.25
Dipole magnets		
MTNH020003 ("B1T")	3600	4.95
MTNH020007 ("B2T")	3600	9.15
Collimators		
XTAX022023	1615	23.615
XTAX022025	1615	25.240
Pb converter	4	25.277

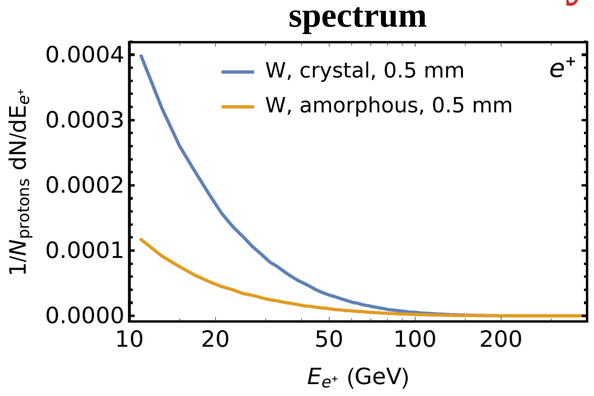
Crystal parameters:
W <111>
Crystal thickness: **0.1-1 mm**

Preliminary simulation results

Simulation technique

- Simulation of the CERN SPS H4 External Beam Line using **Geant4 simulation toolkit**[7].
- Simulation of γ, $e^{\pm}$ interaction with an oriented crystal using the **Baier-Katkov** integral[5] implemented into simulation code[6].

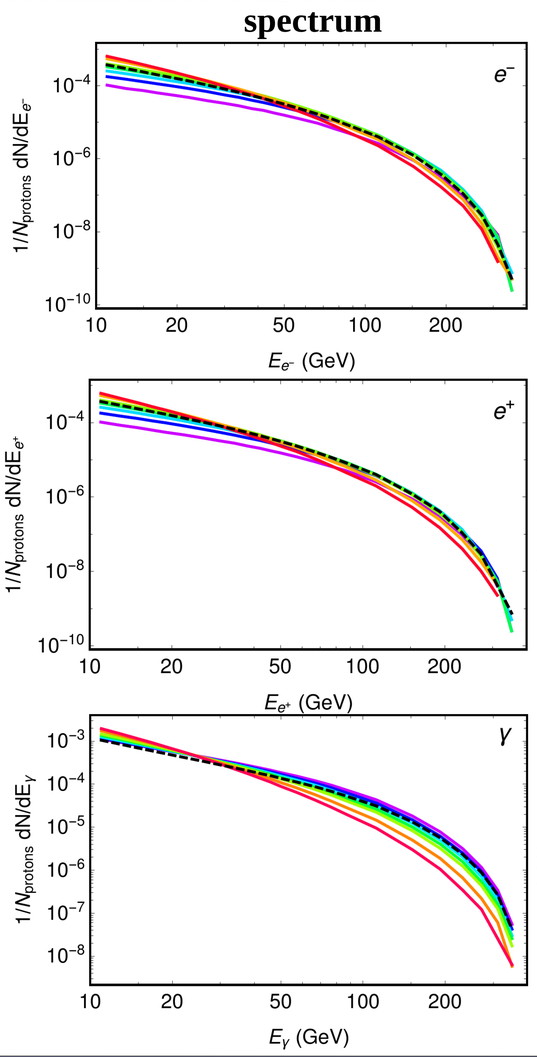
spectrum



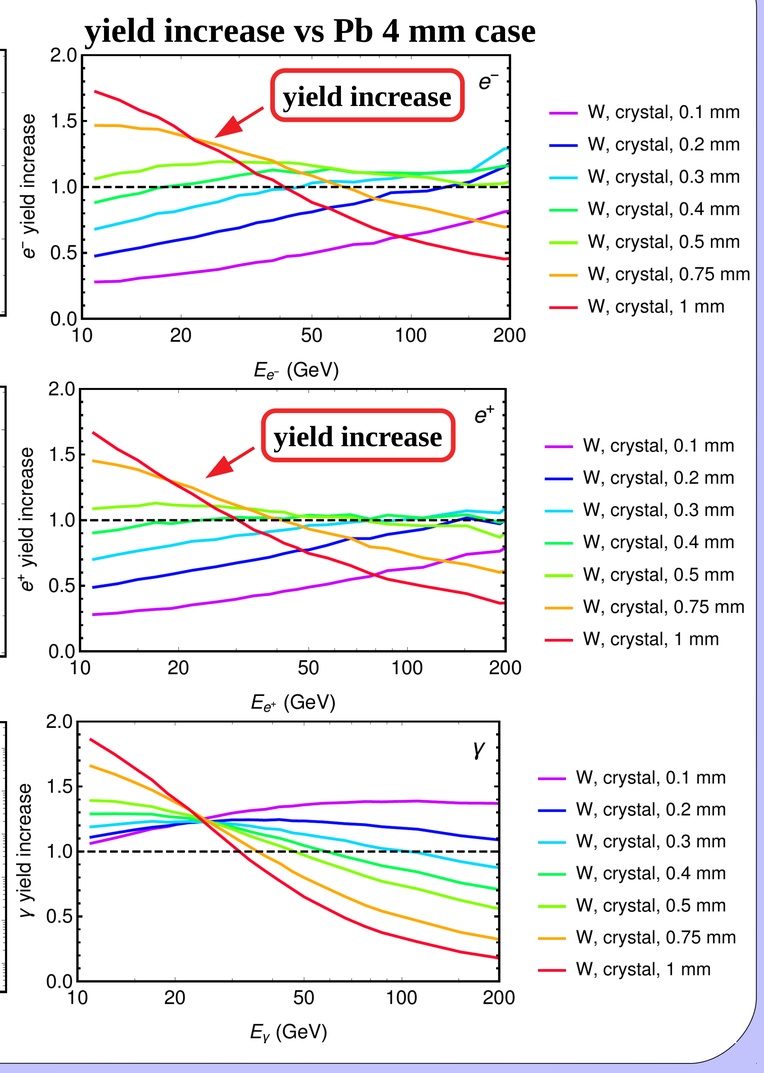
The ratios of particle yields between W target and Pb 4 mm cases

converter	$e^-_{>10\,GeV}$	$e^+_{>10\,GeV}$	$\gamma_{>10\,GeV}$	$p, \bar{p}, \pi^{\pm}$	$n, \bar{n}$
Pb, 4 mm	1	1	1	1	1
amorphous					
W, 0.5 mm	0.331	0.330	1.24	0.761	0.727
W, 1 mm	0.565	0.564	1.15	0.828	0.787
crystal					
W, 0.1 mm	0.384	0.387	1.25	0.706	0.683
W, 0.2 mm	0.641	0.652	1.19	0.720	0.694
W, 0.3 mm	0.838	0.863	1.16	0.734	0.704
W, 0.4 mm	0.981	1.02	1.14	0.748	0.838
W, 0.5 mm	1.08	1.14	1.13	0.762	0.727
W, 0.75 mm	1.19	1.30	1.12	0.797	0.757
W, 1 mm	1.17	1.30	1.09	0.827	0.786

spectrum



yield increase vs Pb 4 mm case



Conclusions

We propose to use an oriented **W crystal** instead of Pb converter target at the CERN SPS H4 External Beam Line. This will **increase** the **$e^{\pm}$ yield** up to **10 %** in a certain energy range and **reduce** the **hadron background** on more than **20 %**.

These **$e^{\pm}$** beams are of interest of experiments on **exotic particles** and **dark matter search**.

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