A PEPPo Overview

e^+ sources

Basic principles

Experiment setup

Sources

β⁺ decay:

$$^{22}\mathrm{Na} \longrightarrow {}^{22}\mathrm{Ne} + \overrightarrow{e^{+}} + \nu_e$$

$$P_{e+} = 40\%$$

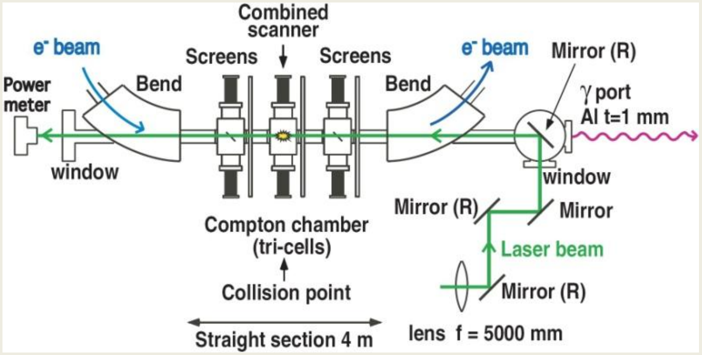
L.A. Page & M. Heinberg. Phys. Rev., 106(6):1220-1224, 1957.

Pair creation: in a high Z target with polarized gamma rays

Compton back scattering

Demonstration at KEK:

Circularly polarized laser photons scatter from a 1.22 GeV electron beam



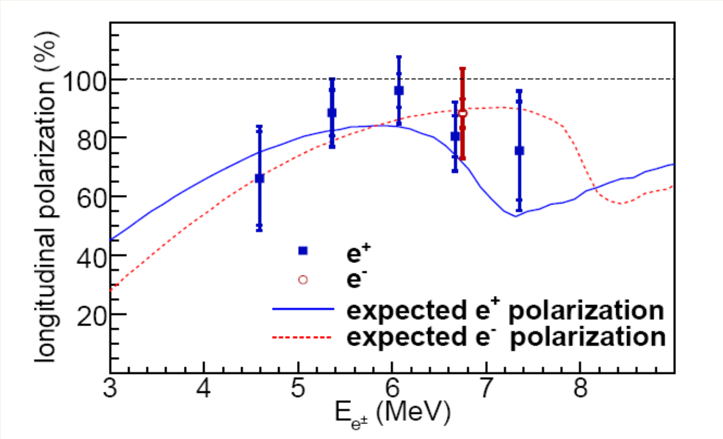
$P_{e+} = 75 + 15 + 19$ for $\overline{T_{e+}} = 36$ MeV

T. Omori et al, PRL 96 (2006) 114801

Helical Undulator

Demonstration at SLAC:

46.6 GeV electron beam in helical undulator producing 8MeV photons at main harmonic



G. Alexander et al, PRL 100 (2008) 210801

Polarized Bremsstrahlung

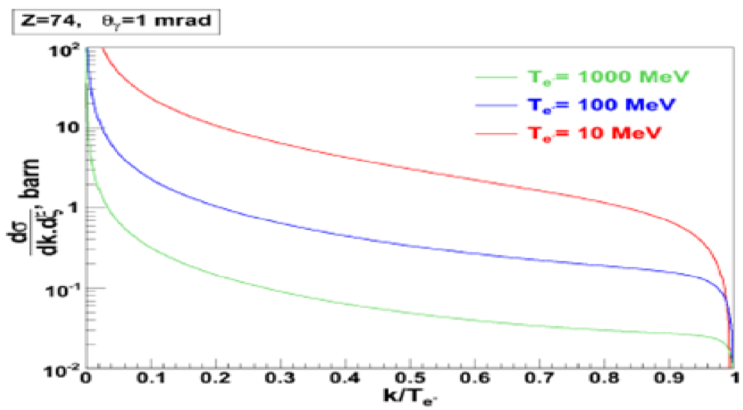
$\vec{e}^- \longrightarrow \vec{\gamma} \longrightarrow \vec{e}^+$ ***Not demonstrated***

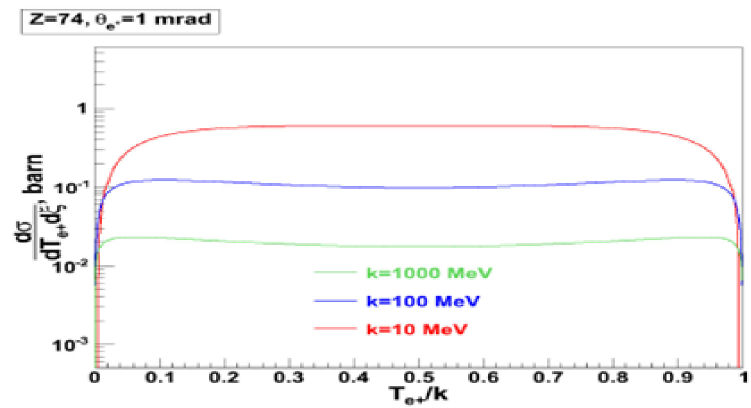
E.G. Bessonov, A.A Mikhailichenko, EPAC (1996) A.P. Potylitsin NIM A398 (1997) 395

Bremsstrahlung

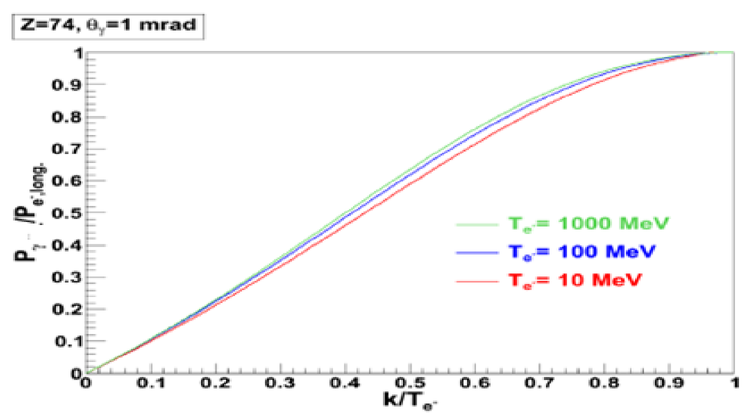
Pair creation

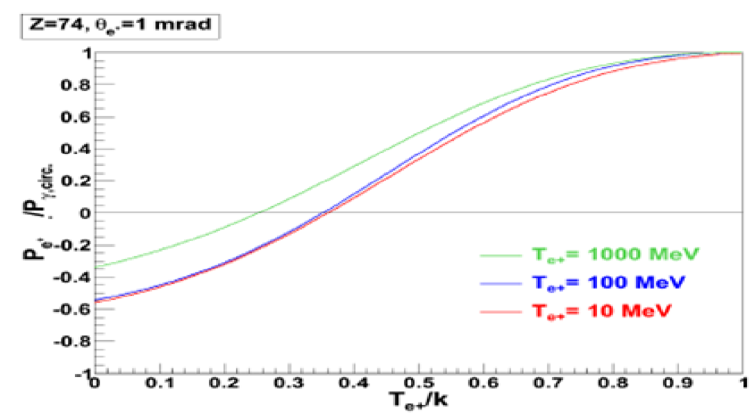
Cross sections





Polar. transfers





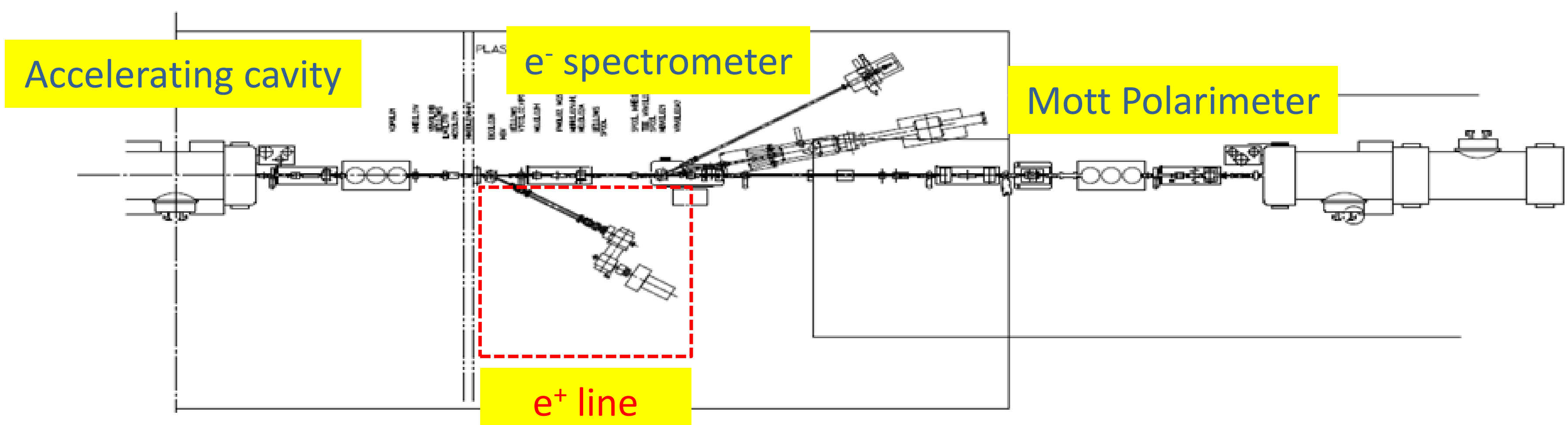
γ energy / e- energy **e+ energy / γ energy**

Experiment

Goal:
Polarization measurement for demonstration of principle of $\vec{e}^{+}$ with $\vec{e}^{-}$ in a single target.

Electron beam in the injector
Current: 1 mA
Max. kinetic energy: 8 MeV
Polarization: 85% (2004)

Advantages:
- ✓ Mott Polarimeter ($\Delta P/P<1\%$)
- ✓ e^- spectrometer ($\Delta p/p<3\%$)
- ✓ Adjustable e^- energy (2-8 MeV)
- ✓ e^- for calibration of e^+ line
- ✓ Demonstration = No high power target
  - low e^- current (1-10 μA)
  - low energy (8 MeV)
- ✓ Same e^+ energy range as E166 experiment $\longrightarrow$ expertise & equipment for e^+ line

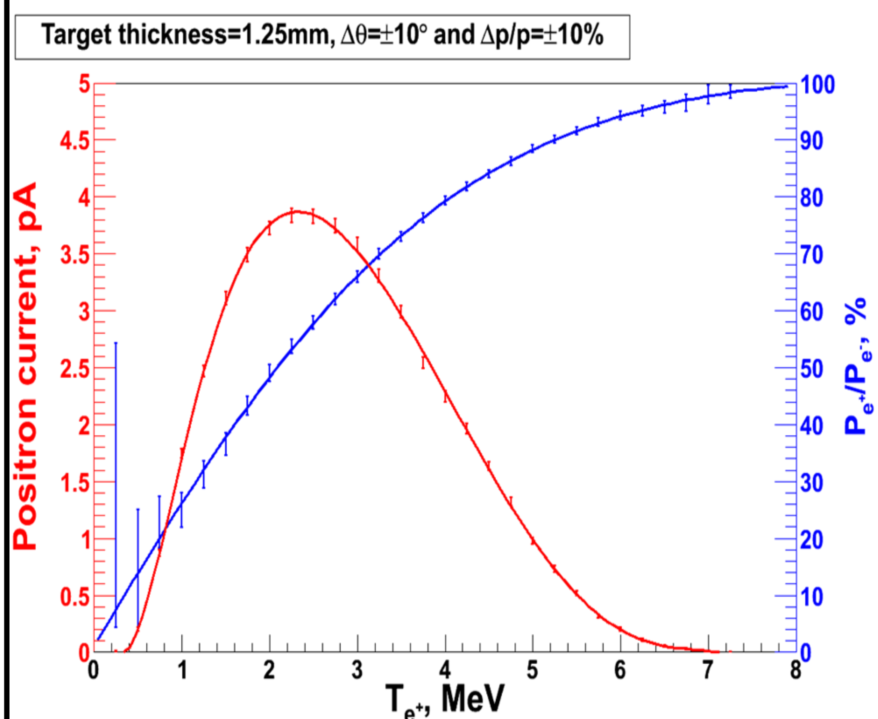


Positron Production

Tungsten target:
high Z and high melting point

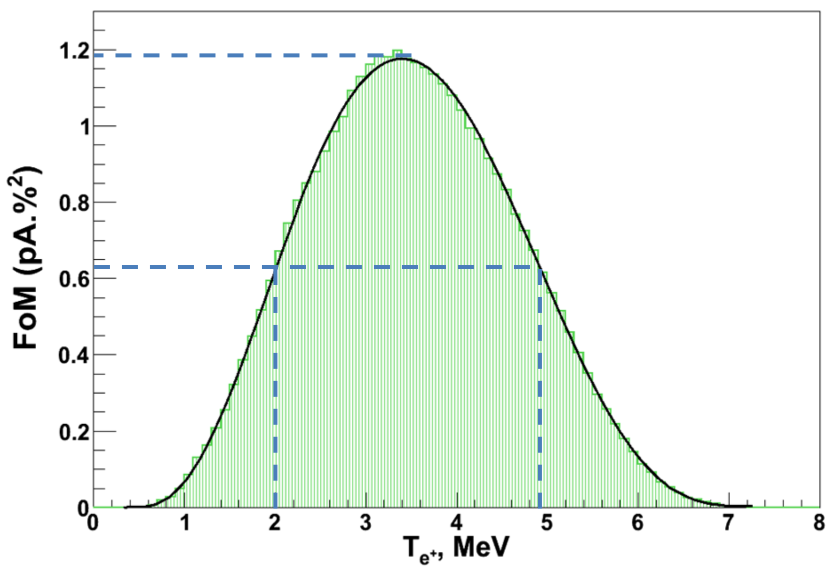
e^- beam:
1 μA, P=85%, 8 MeV to increase EM shower

Experiment: measurement of polarization as a function of the positron energy



Precision of measurements depends on the positron polarization and current and can be characterized by the *figure of merit (FoM)*

$$\boxed{FoM = I \times P^2}$$



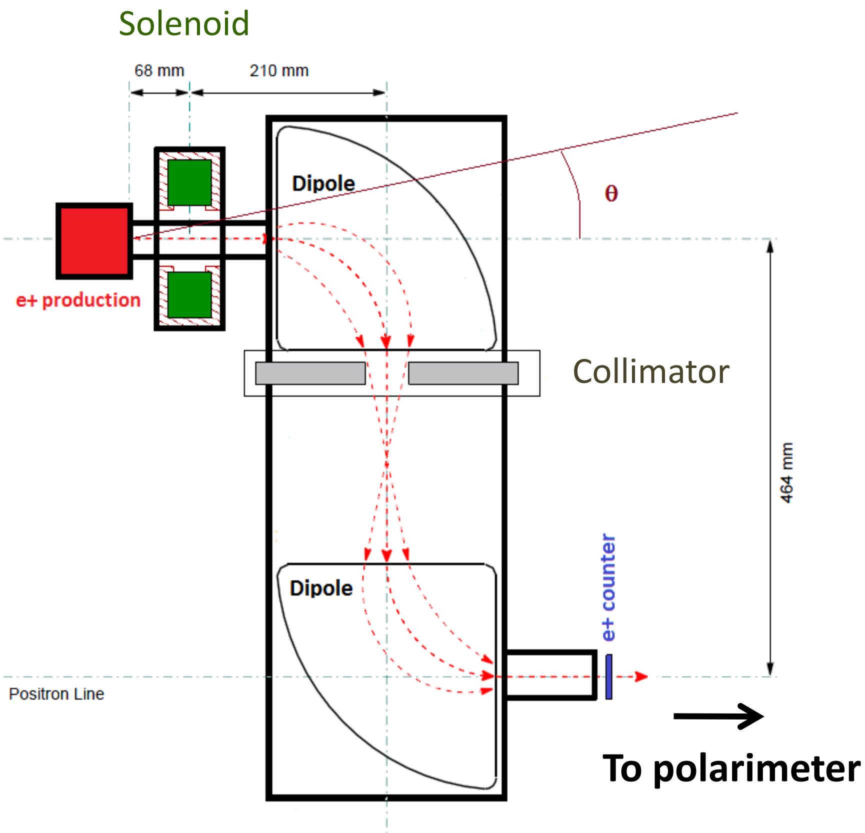
Energy selection

Successfully used for **E166** experiment, loan for **PEPPo**

2 dipole spectrometer conserving longitudinal polarization

Solenoid to help collect particles after W target

Room for improvements:
Addition of diagnostics/collection optics at the spectrometer exit



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Polarimetry

Compton Transmission polarimeter

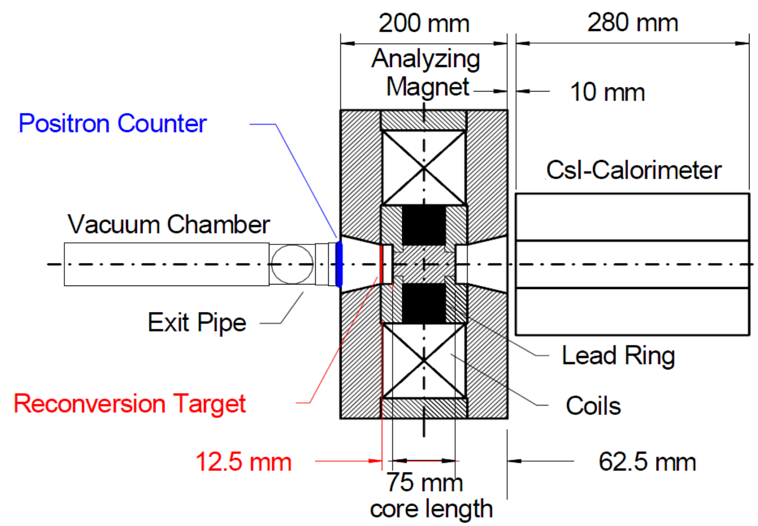
used for E166, loan for PEPPo

Reconversion target ($\vec{e}^{+} \longrightarrow \vec{\gamma}$)

The asymmetry δ of the photon transmission through an analyzing target (P_t), when flipping the sign of P_t, gives the positron polarization

$$P_e = \frac{\delta}{P_t . A_e}$$

A_e is the analyzing power determined by simulation or cross checking of electron polarization with Mott



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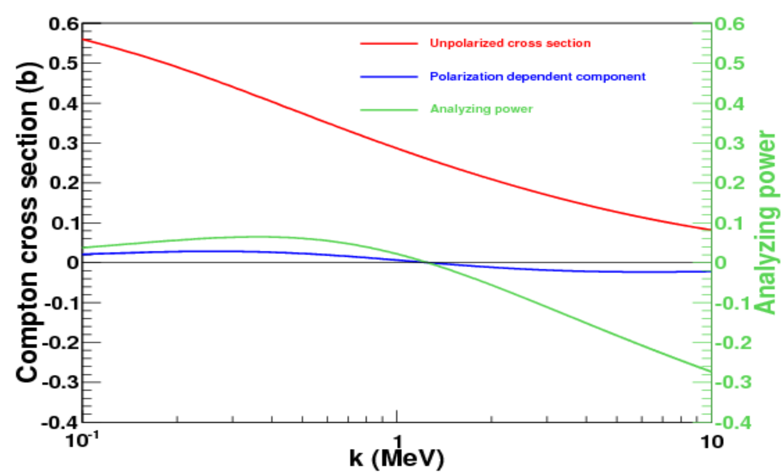

Conclusion

- Polarized positrons via bremsstrahlung never been tested
- Technological advances of high-P electron sources make this demonstration experiment relevant.
- E166 apparatus for spectrometry and polarimetry available for PEPPo helps a lot.
- Electron beam in the same energy range as the positrons for spectrometry and polarimetry calibration