Active Polarimeter System for TREK experiment at J-PARC

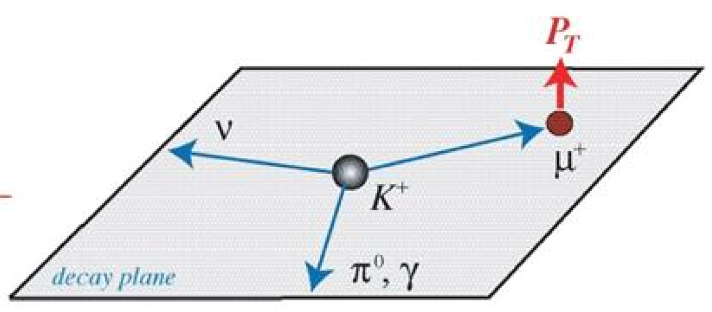
S. Shimizu for the TREK collaboration
Department of physics, Osaka University

1. Transverse muon polarization

$K^+ \to \pi^0 \mu^+ \nu$ decay

$$P_T = \frac{\sigma_\mu \cdot (p_{\pi^0,\gamma} \times p_{\mu^+})}{|(p_{\pi^0,\gamma} \times p_{\mu^+})|}$$

T-odd

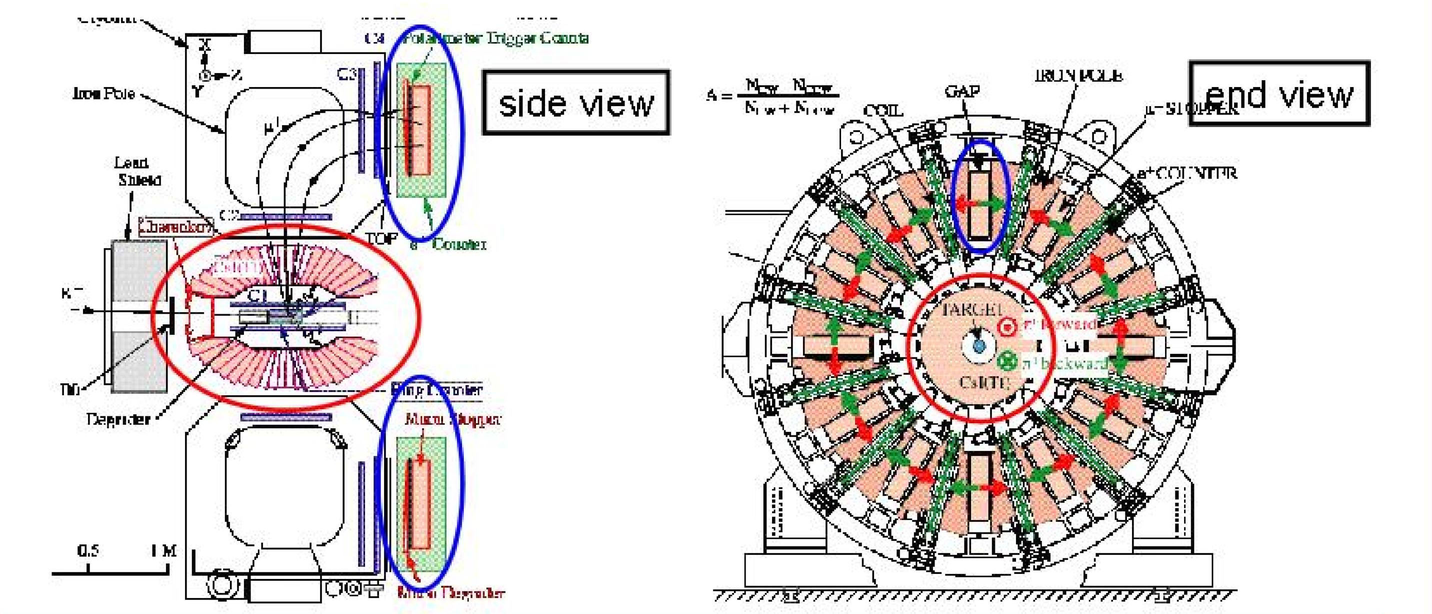


- Non-zero P_T is a signature of T violation.
- Standard model contribution is very small(10^{-7}). Spurious effect from final state interaction is also small(10^{-5}). Therefore, P_T is sensitive to physics beyond the Standard Model.
- Experiment at KEK(E246)
  P_T = - 0.0017 ± 0.0023(*stat*) ± 0.0011(*syst*)
  ($|P_T|$ < 0.0050 : 90% *C.L.*) PRD73, 2005(2006)

2. TREK experiment

- Stopped K^+ method
- Toroidal Spectrometer and CsI(Tl) calorimeter
- Measurement of e+ asymmetry in cw/ccw direction
  $P_T = \alpha \cdot (N^{cw} - N^{ccw}) / (N^{cw} + N^{ccw})$

$K^+ \to \pi^0 \mu^+ \nu_\mu$ decay, $\mu^+ \to e^+ \bar{\nu}_\mu \nu_e$, $\pi^0 \to \gamma\gamma$



We aim at searching for P_T with an accuracy better than 10^{-4}.

3. Active polarimeter with muon magnet

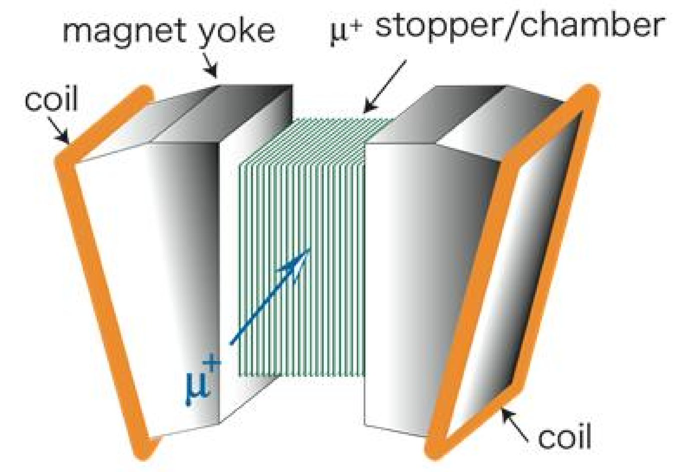
Parallel plate stopper with Gap chamber

Number of plates	31
Plate material	Al, Mg or alloy
Plate thickness	~2 mm
Plate gap	~8 mm
Ave. density	0.24 ρ_{Al}
μ^+ stop efficiency	~85%

Muon Field Magnet

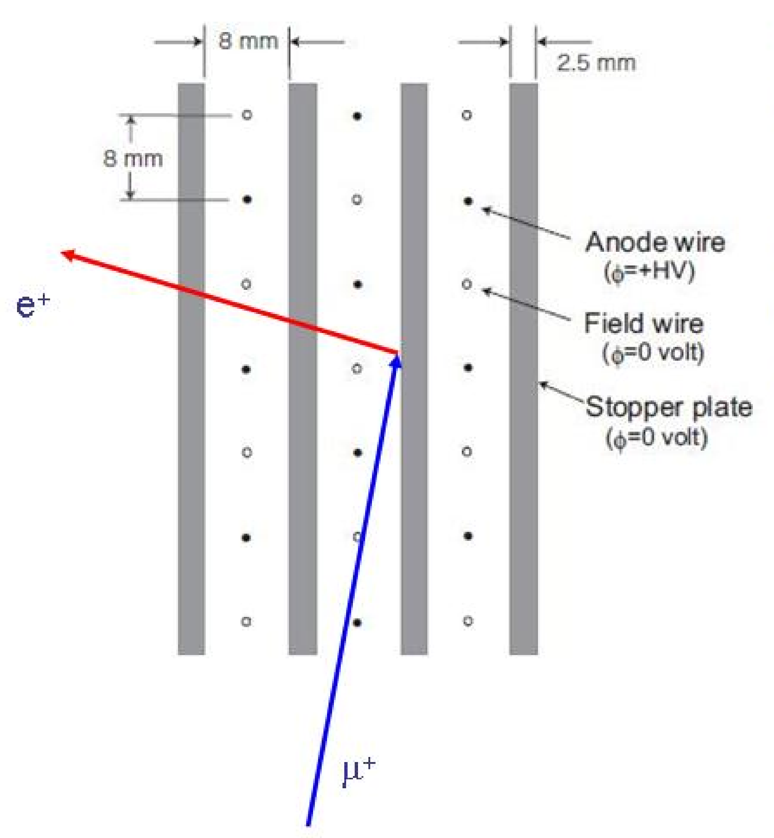
Field srength	0.03 T
Gap	31 cm
Pole face	68 × 44 cm
Number of coils	24
Total power	20 kW
Cooling	indirect water

Small systematics for *L/R* positron



- Full angular acceptance for positrons
- Determination of decay vertex
- Measurement of e^+ angle and energy

4. chamber structure

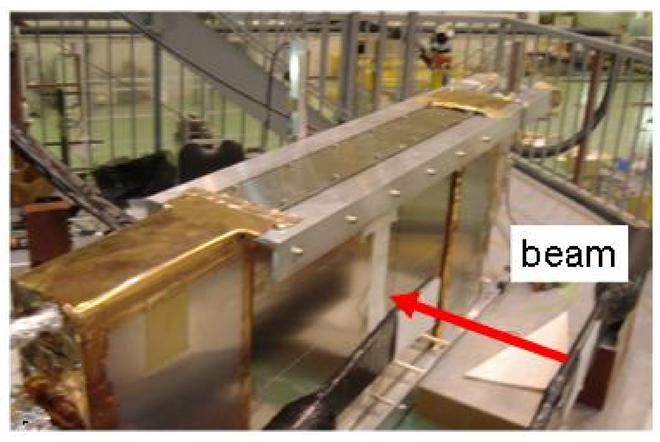


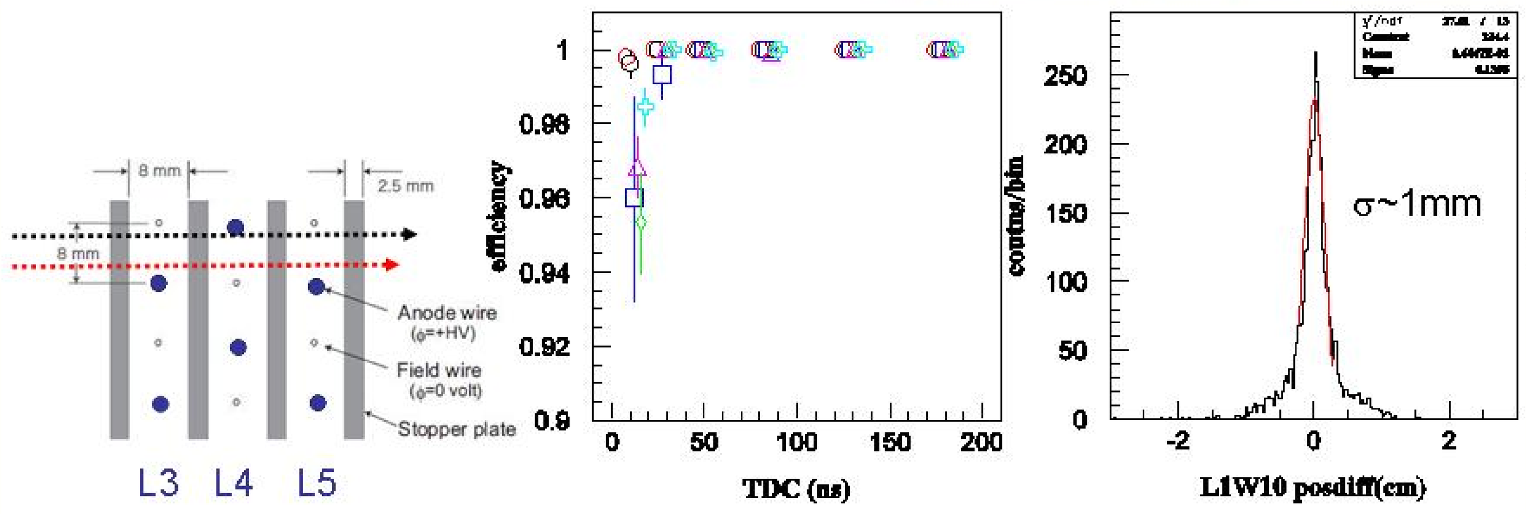
- Stopper plates as electrodes
- Long cell of A.R.=2.0 with staggered wire structure.
- Small number of wires. Cost was reduced.
- Wire coordinate readout
  - R coordinate: Charge division method
  - Z coordinate: DC analysis

5. Detector preparation (polarimeter chamber)

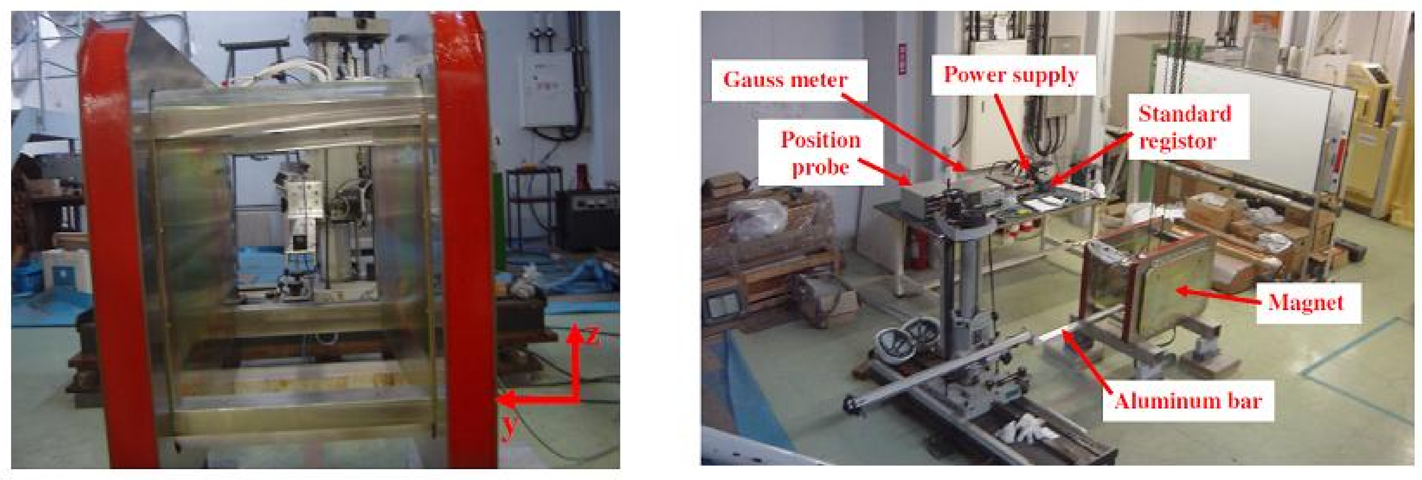
Beam test for 1/5 size prototype

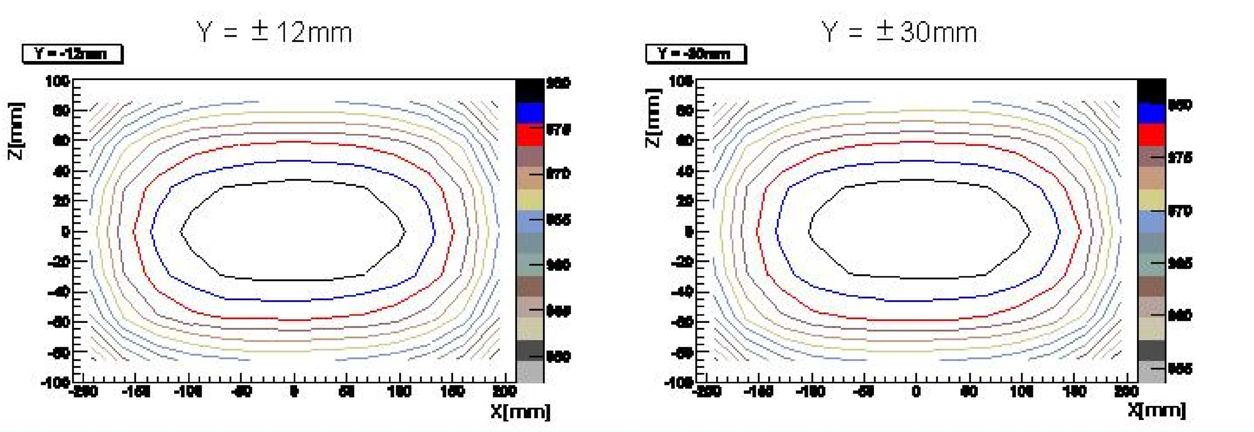
- Position resolution in radial direction and detection efficiency were determined.
- We are now constructing full size model.





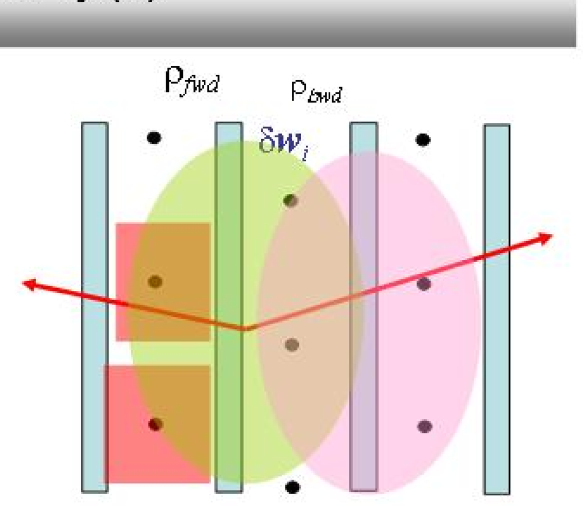
6. Detector Preparation (muon magnet)

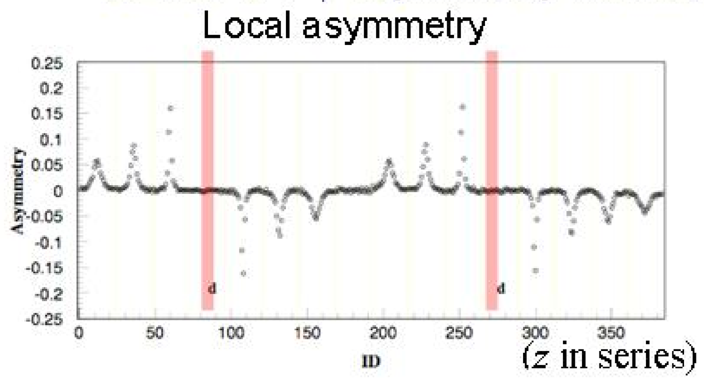


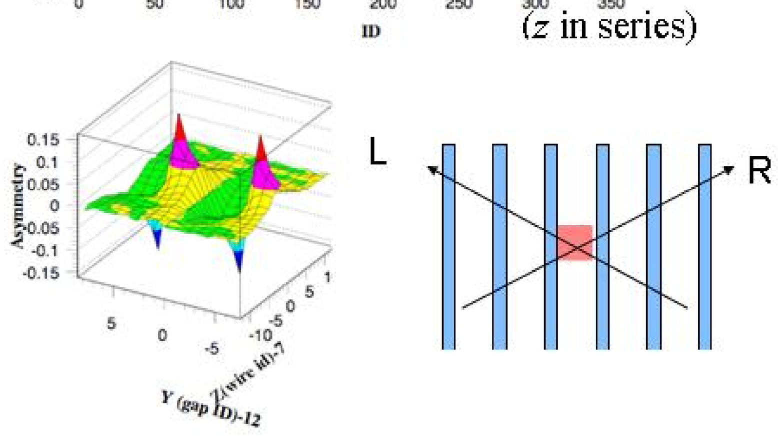


7. Systematic error from wire inefficiency(1)

- One of serious effects = wire inefficiency
  → Change of e^+ left/right response
  → Bias to P_T asymmetry measurement



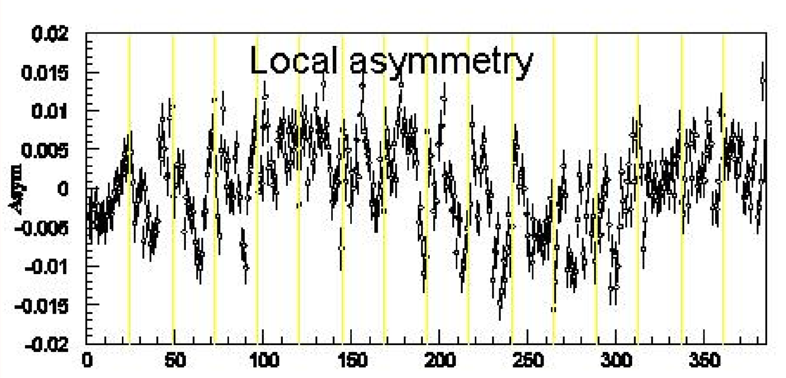




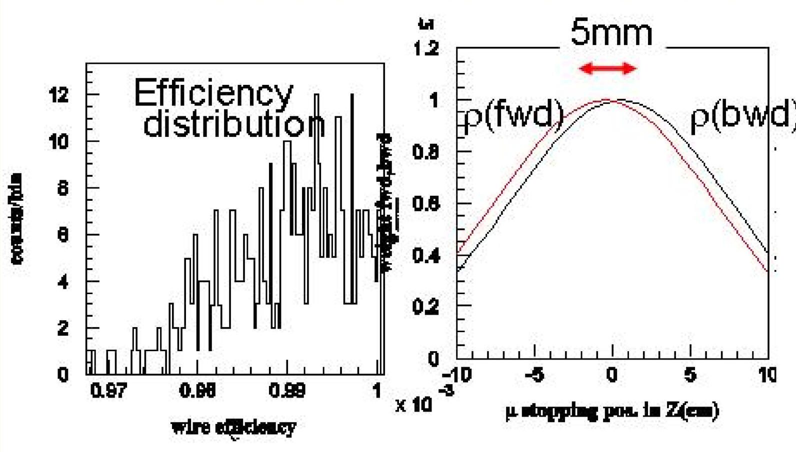
- Assumption
  - Bad 2 wires with ε=0.5
  - 4 layer tracking
- Result
  Integrating over entire region, this effect can be diluted.

8. Systematic error from wire inefficiency(2)

MC simulation of local asymmetry distribution



Assumption of MC :
- Random efficiency
- $\langle\varepsilon_{wire}\rangle$ = 99.5%
- σ_{eff} = 0. 5%



If ρ(fwd) is different from ρ (bwd), the above cancellation mechanism does not work ideally.

$\langle A^{sp}\rangle$ = (-0.24±0.82) × 10^{-4}
δP_T = (-0.8±2.7) × 10^{-4}