Positronium intensity measurement preparation (GBAR)

SNU

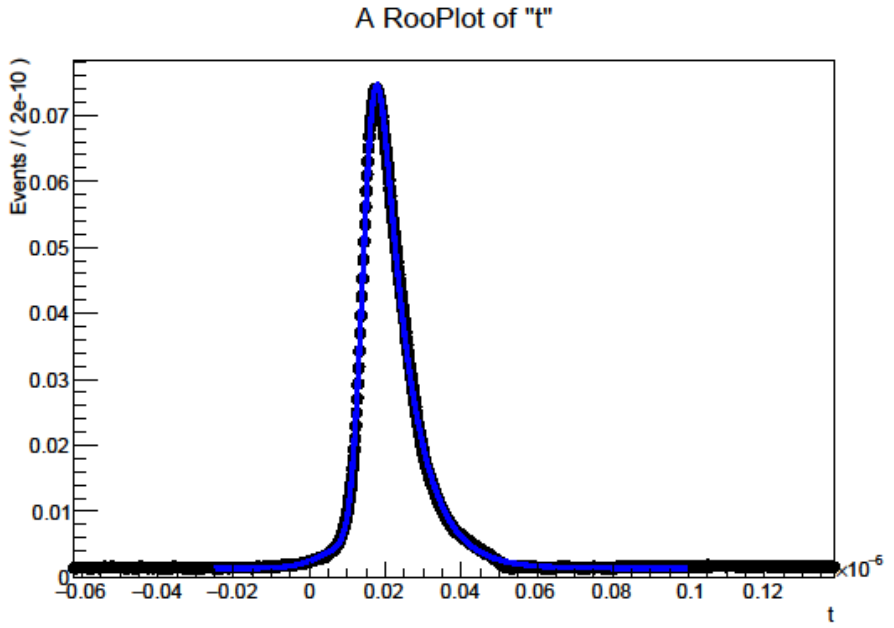
Bongho Kim

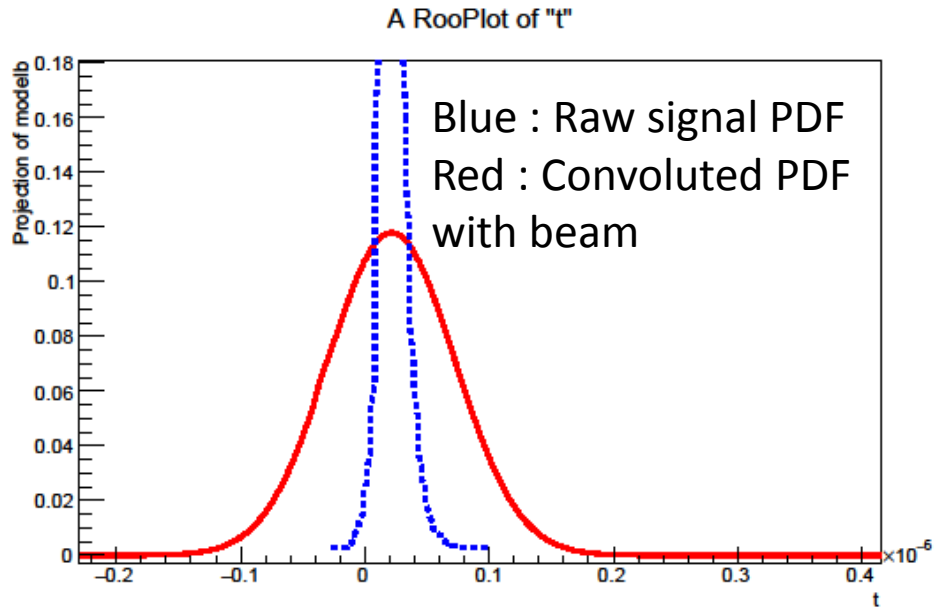
Raw signal fitting

- Gauss (x) exp(-t/tau) + Gauss_a + poly(0)
- Tau = 7.65ns, σ = 2.6ns
- Fraction(Gauss (x) exp /Gauss_a) = 0.905

➔But Beam width is 100ns and this is quite negligible

« Gaus(σ=50ns) (x) Raw signal PDF » looks just like gaussian.

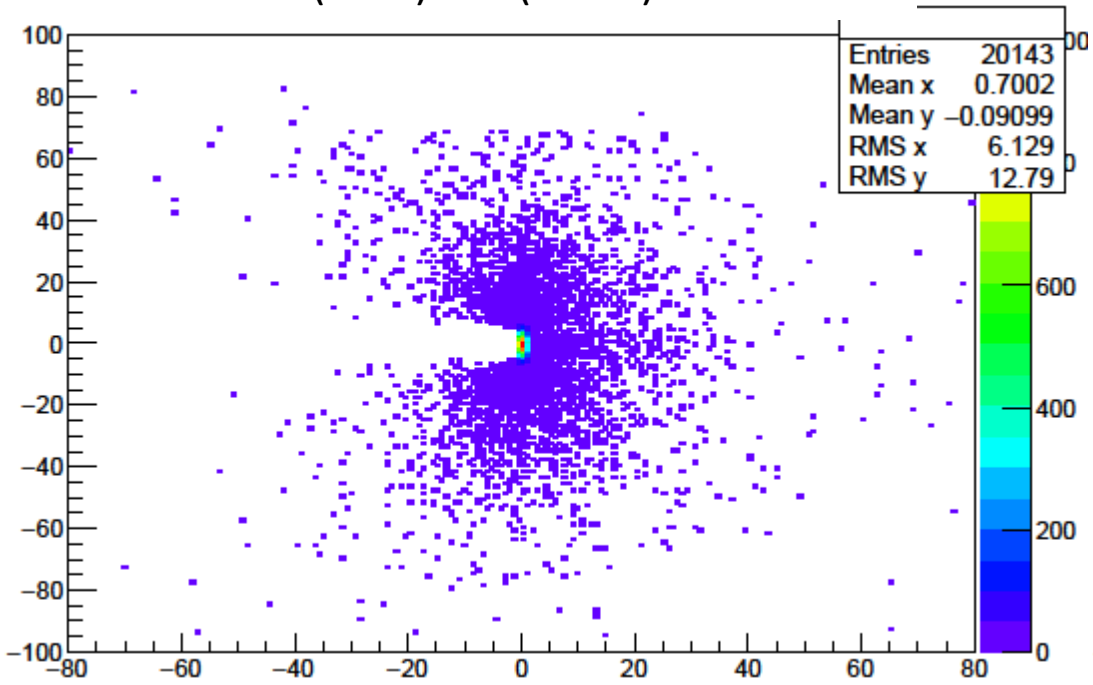




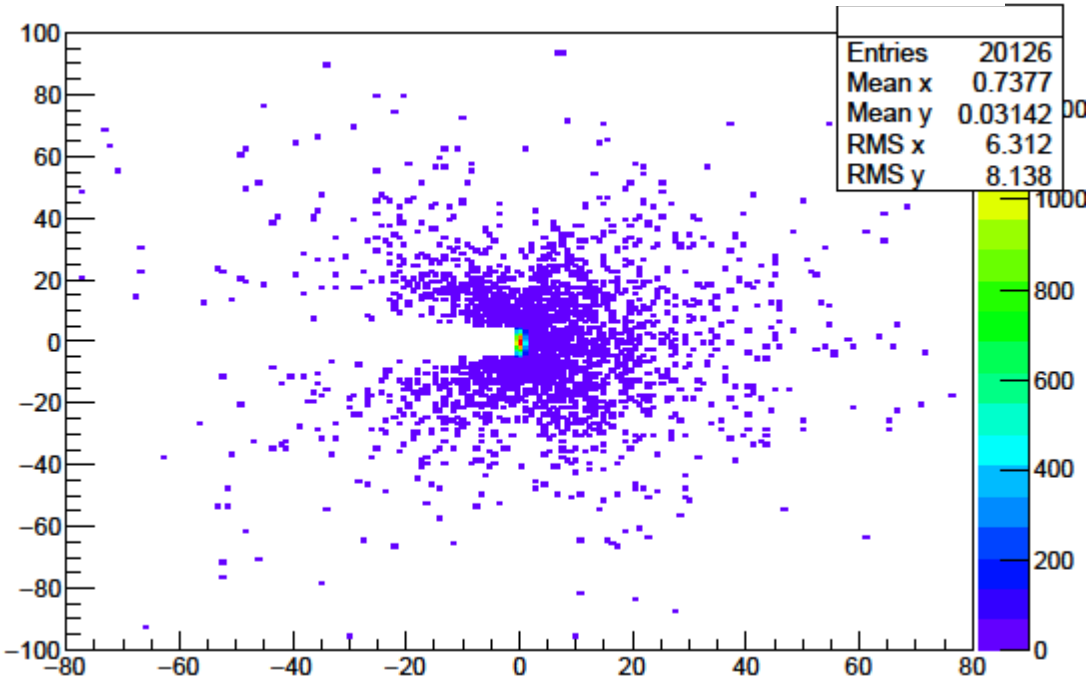
Positronium diffusion (reflection)

Before slide

Lambert(emit)&iso(reflec) distribution



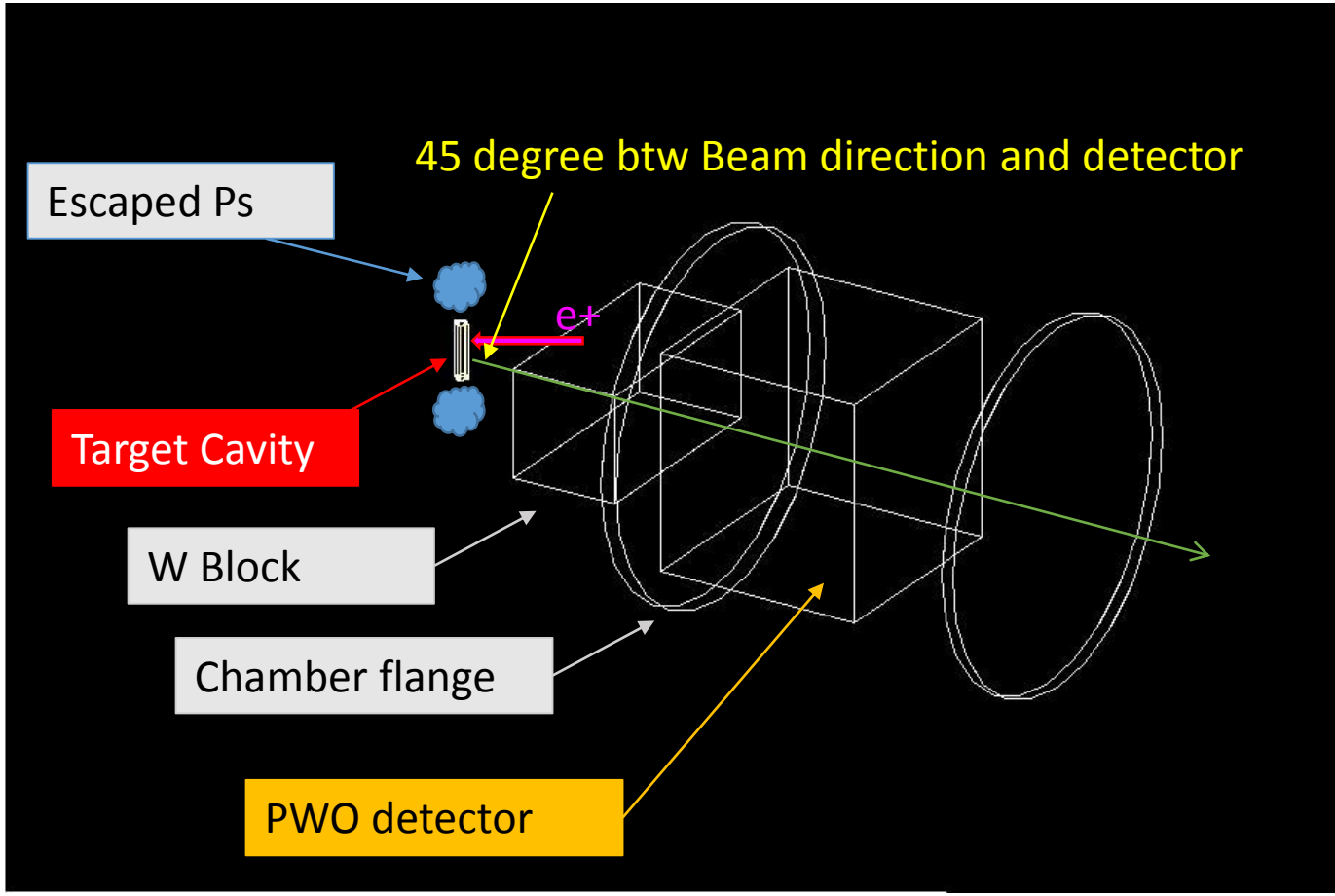
Lambert(emit)&Lamber(reflec) distribution



- Lambert(reflection) case : 84.5% of positronium remain in cavity before decayed
- Isotropic case(reflection) : 69.9% of positronium remain in cavity before decayed
- Quite big difference

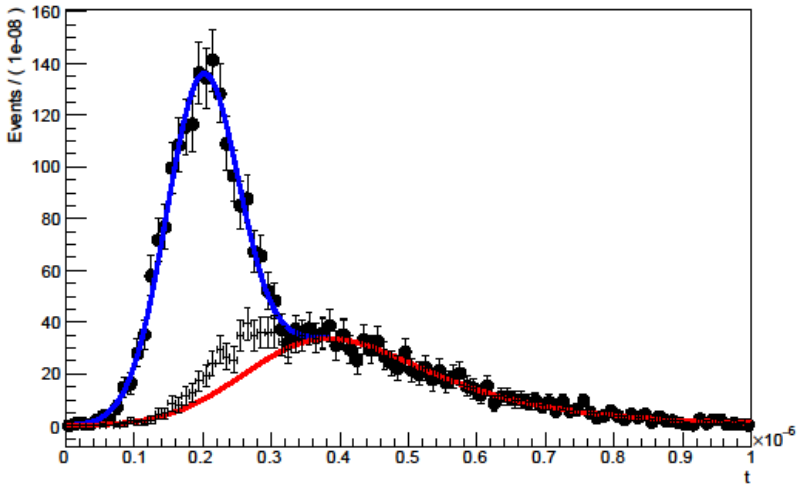
Way to know the N(Ortho-Ps) stayed in Cavity

- By adding Tungsten (W) block in front of PWO detector, we can measure gamma signal only from Ortho-PS which escape from the target cavity.
- By comparing parameters of time spectroscopy, we can expect Ortho-Ps amount inside and outside of cavity

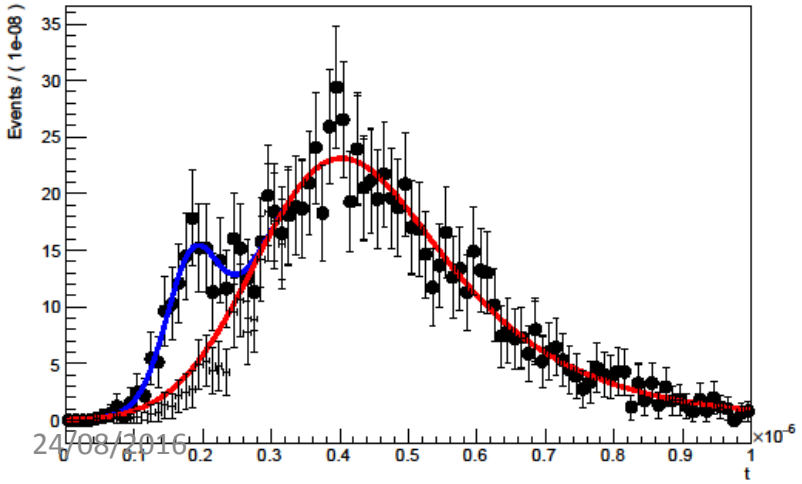


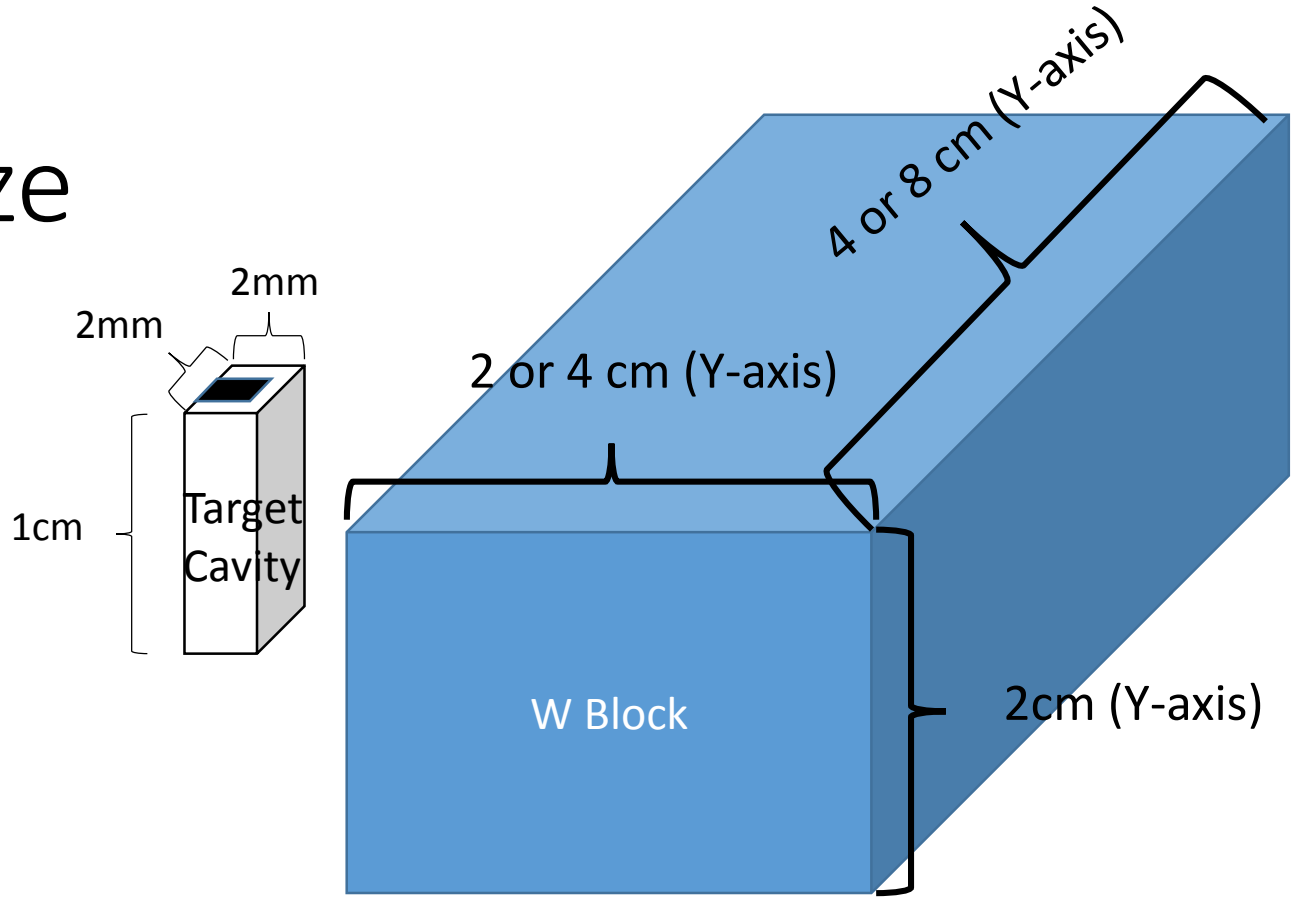
Changing W block size

W block : 4cm x 2cm x 2cm



W block : 8cm x 2cm x 4cm

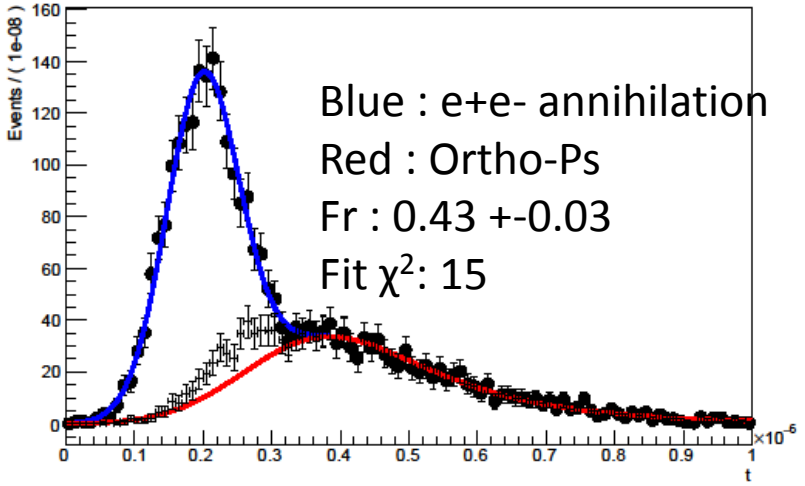




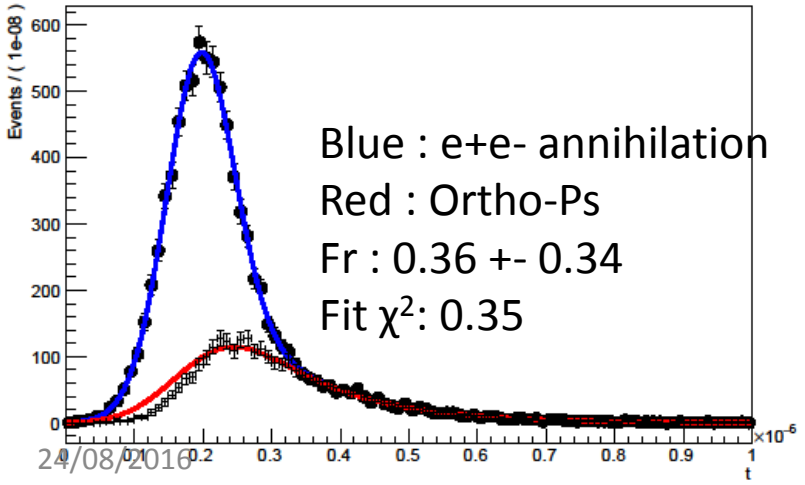
- By making W block thicker & longer, annihilation fraction become decreased.
- More time required for optimization

Isotropic reflection & Isotropic formation

W block installed (100,000 e+)



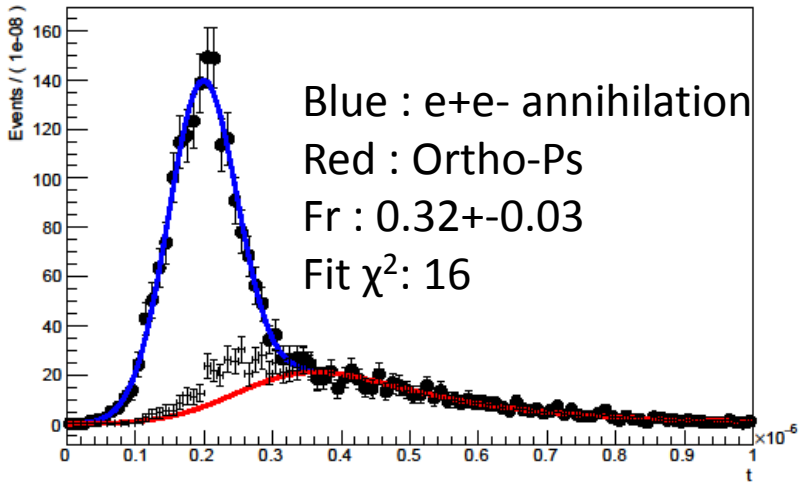
Target cavity only (10,000e+)



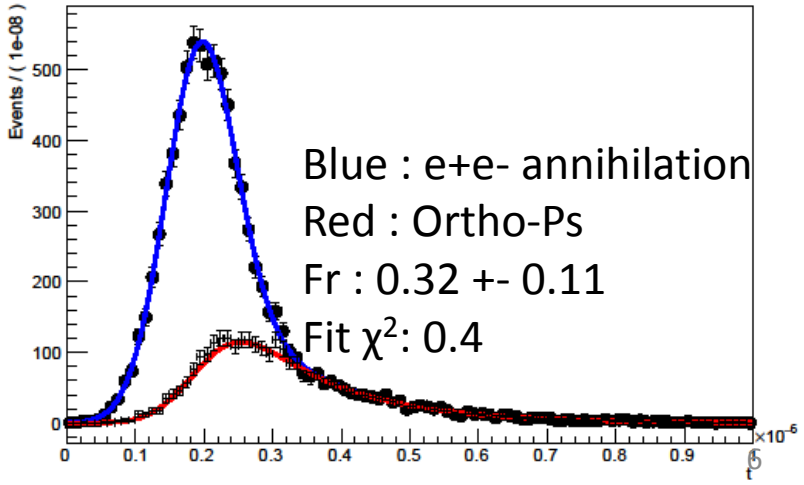
Fitting is failed : PDF need to be changed.

Lambert reflection & Lambert formation

W block installed (100,000 e+)



Target cavity only (10,000 e+)



With W block

- No block case
- fraction(Ortho-Ps/annihi) = 0.32 +-0.13 (too low statistics in Simulation)
- (iso)Tau : 1.29ns, sigma : 65 ns, mean : 178 ns
- (lamb)Tau : 1.40ns, sigma : 51ns, mean : 195ns
- W block case (iso)
- fraction(Ortho-Ps/annihi) = 0.43 +-0.03 (too low statistics in Simulation)
- Tau : 1.59ns, sigma : 98+-15ns, mean : 294+-19ns
- W block case (lambert)
- fraction(Ortho-Ps/annihi) = 0.32 +-0.03 (too low statistics in Simulation)
- Tau : 1.85ns, sigma : 88+-18 ns, mean : 271+-26ns

→ We can check roughly how much Ortho-Ps escape from cavity.

→From fraction of fitting, we may say something of reflection angle. (With already studied kinetic energy of Ortho-Ps)

About kinetic E of Ortho-Ps

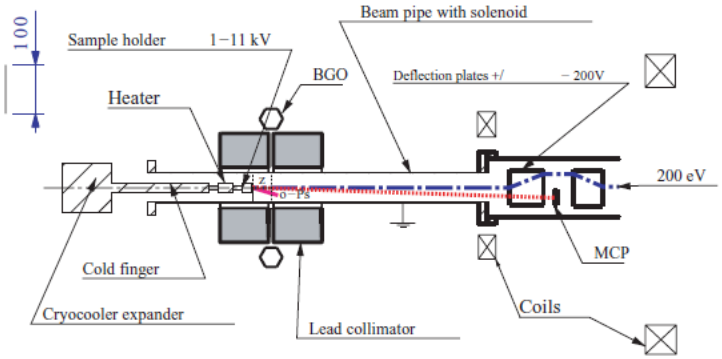


FIG. 1. (Color online) Experimental setup for the TOF measurements (the scale is in mm). The dashed line is the trajectory of the incoming positrons (blue) and the dotted line is the one of the secondary electrons (red).

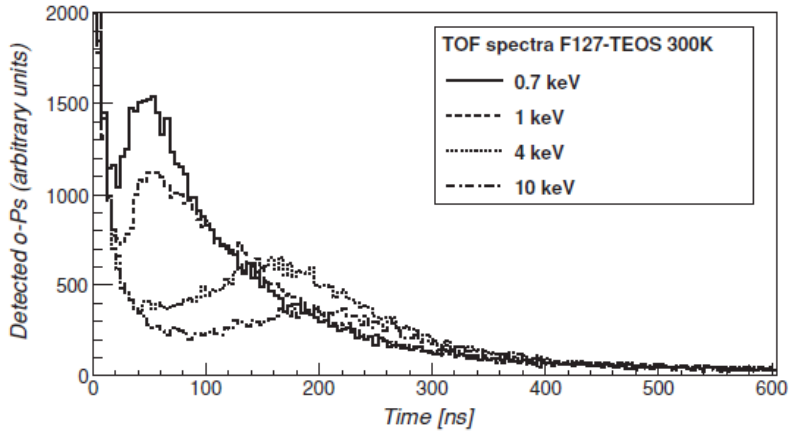


FIG. 3. TOF spectra of the F sample for positron implantation energies of 0.7, 1, 4, and 10 keV.

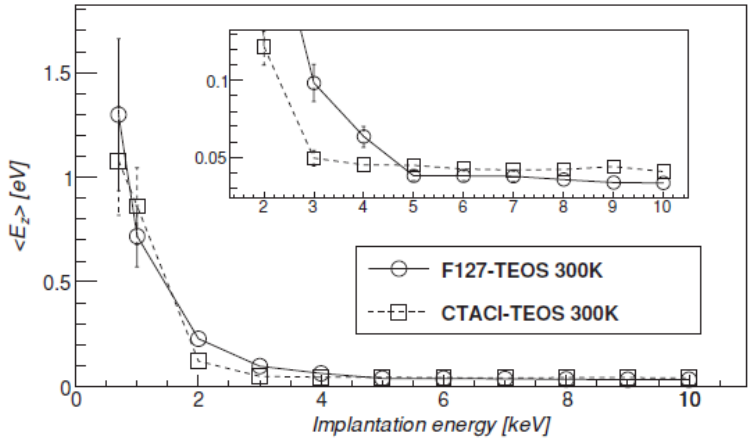


FIG. 6. Ps mean emission energy $\langle E_z \rangle$ as a function of the positron implantation energy for C and F samples at 300 K.

- Laszlo looks that he want to check positronium kinetic energy but our beam has too wide width (100ns)
- So the best way is just using right Figure's Kinetic E as assumption.

To do list

- By using simulation, I will try to check adequate W block size to reduce annihilation gamma and to detect escape positronium's gamma.
- Adequate PDF(Probability density function) need to be find to distinguish Ortho-Ps signal in raw signal.

Appendix

Systematic error concern

- How can we prove our simulation is okay. (gamma detection)

- Test with Si plate which will not generate Ps with and without W block,

  See the fraction of Gamma signal and Compare the fraction with simulation.