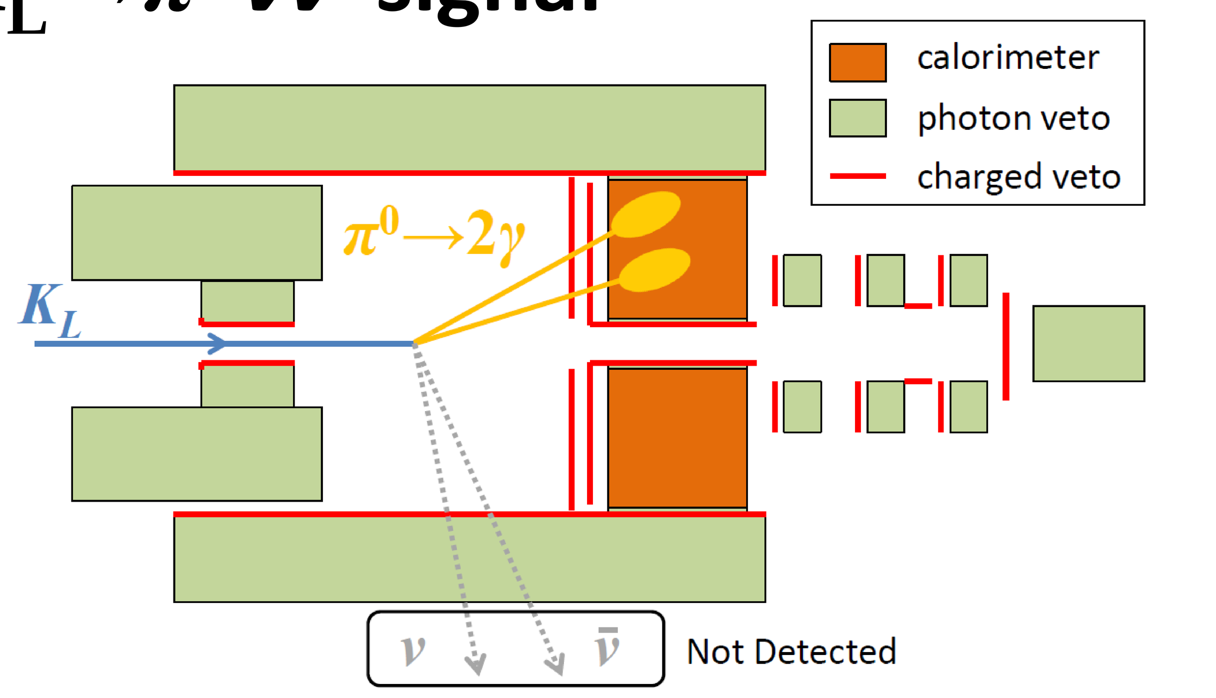
Upgrade of In-Beam Charged Particle Detector for the KOTO Experiment

I. Kamiji (Kyoto Univ.) and K. Nakagiri (Kyoto Univ.), for the KOTO collaboration

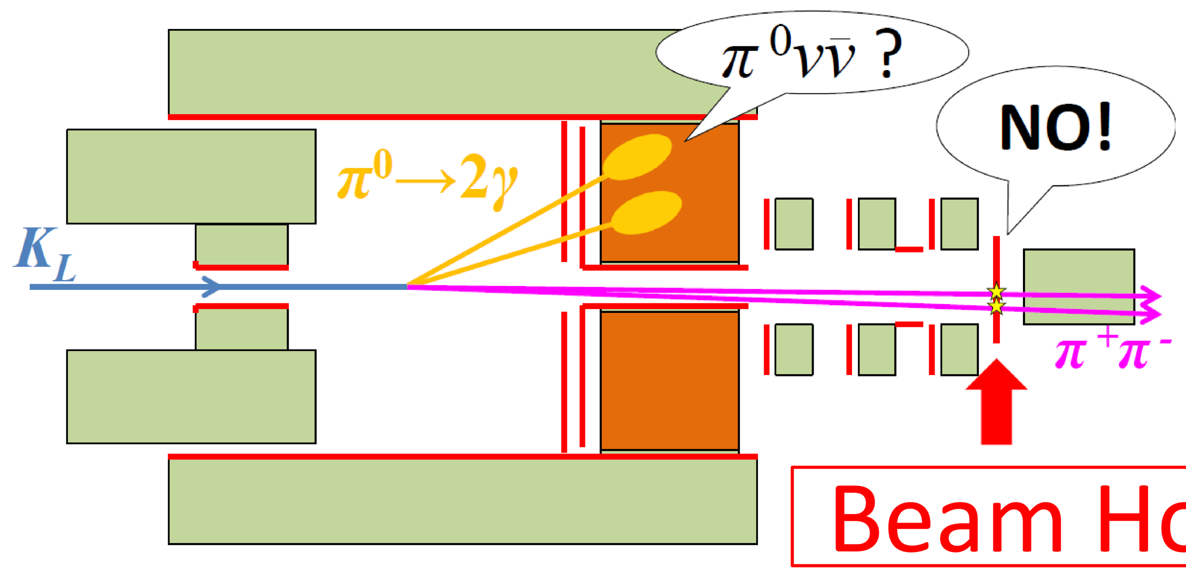
☆ New **thin-gap wire chamber** in neutral beam line to veto charged particles

☆ Accidental loss is only **14% in 6 MHz environment** (**40% reduction**)

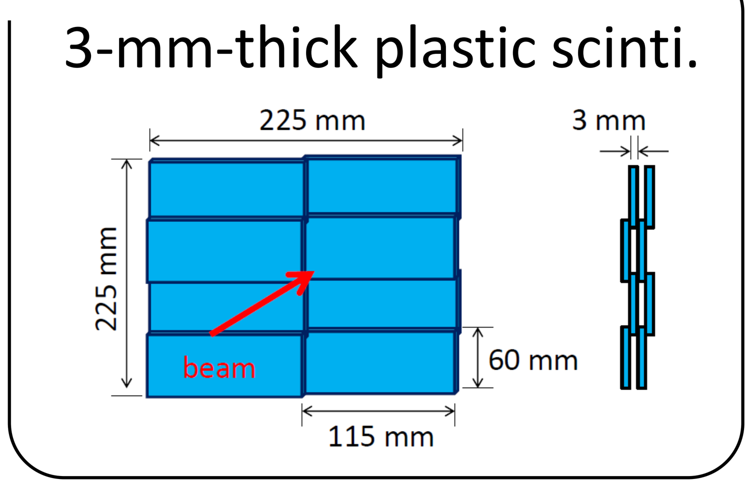
$K_L \to \pi^0 \nu\bar{\nu}$ signal



$K_L \to \pi^0 \pi^+ \pi^-$ Background



old BHCV



Beam Hole Charged Veto (BHCV)

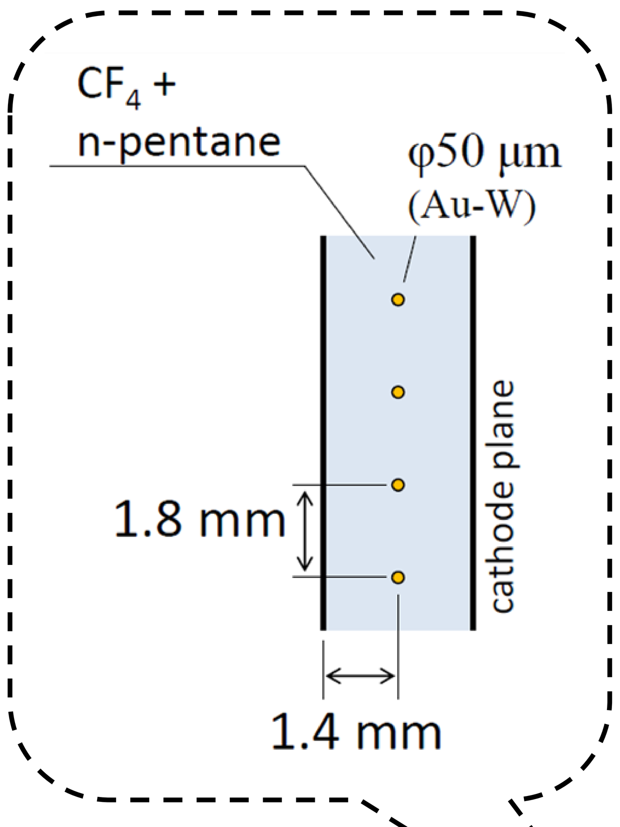
Large Accidental Loss is expected ⇨

✓ High efficiency is required : **99.5%**

✓ High incident rate of neutron/γ : ***10 MHz/cm²**

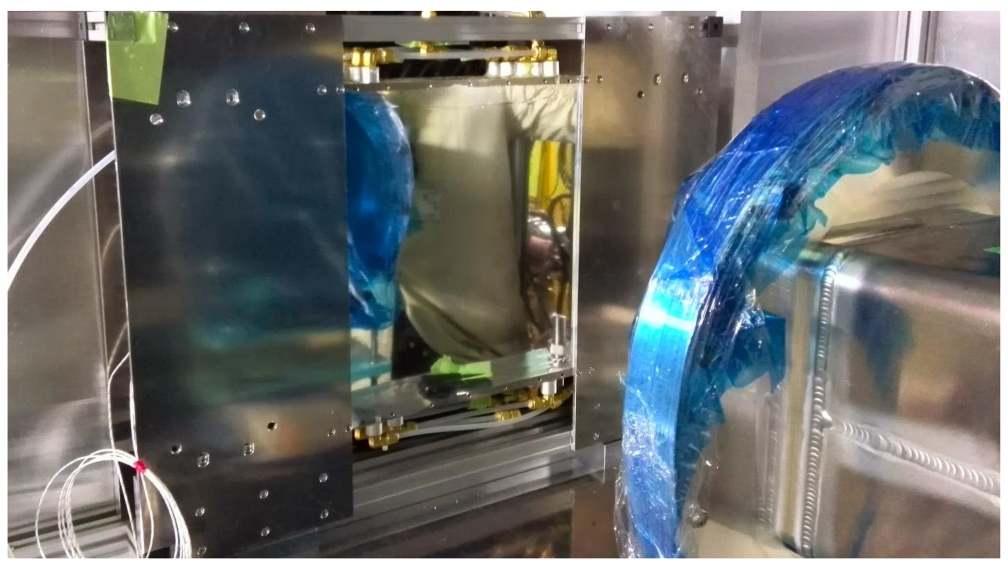
*beam power: 300 kW, target: Ni (KOTO design value)

New BHCV: Thin-Gap Wire Chamber

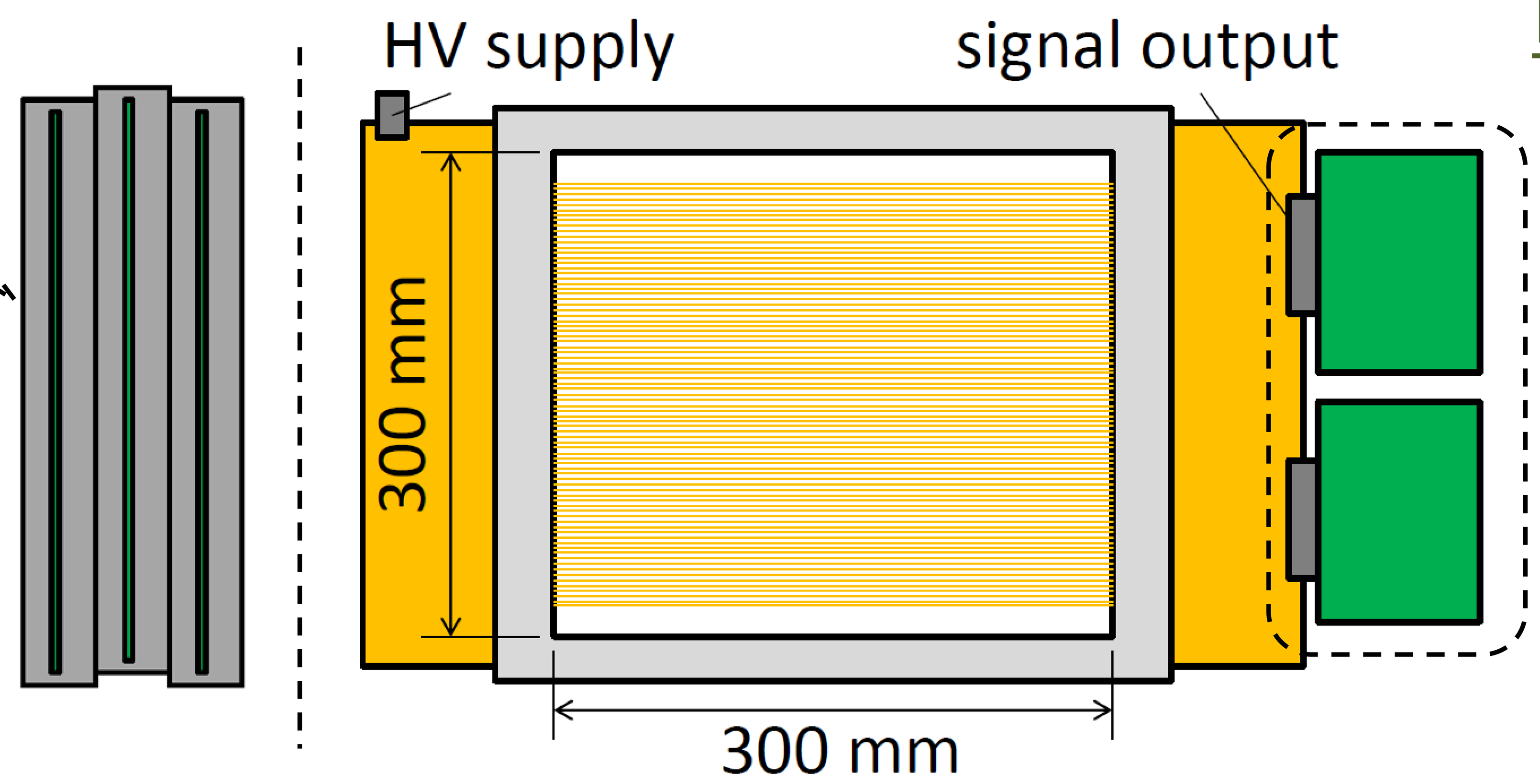


Feature1: Thin gap, Low Mass, Fast Gas

- stable operation in high rate **: 100 kHz/cm²**
- with high gain **: 1 x 10⁵**
- Fast drifting electron (CF_4) **-> small timing fluctuation**
- Low mass & thin cathode plane **-> reduce neutron/γ hits**
  (graphite coated polyimide film)



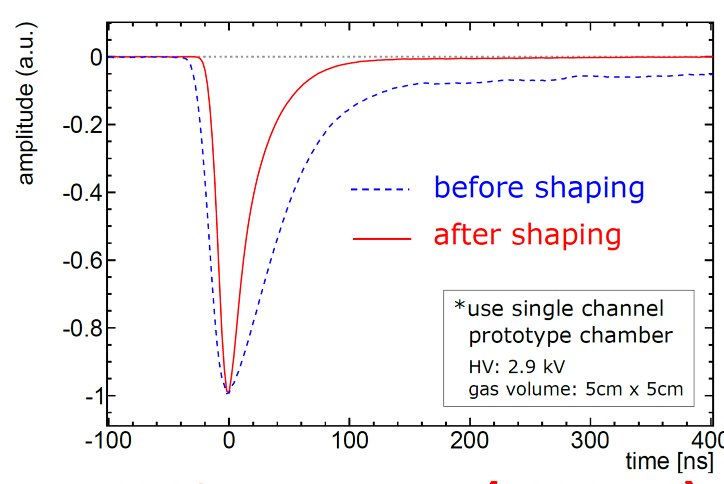
beam →



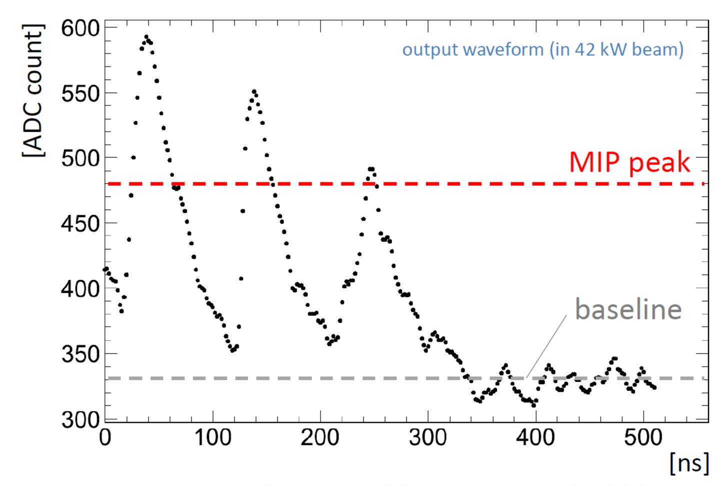
# of wires	160 + 2 (outer)
# of readout	16 CH (10-wire/CH)
Operation HV	2.7 kV
Capacitance	50 pF / CH

Feature2: Pulse shaping amplifier

- **Fast FET operational amplifier**
- Sharp signal output: **width ~150 ns**

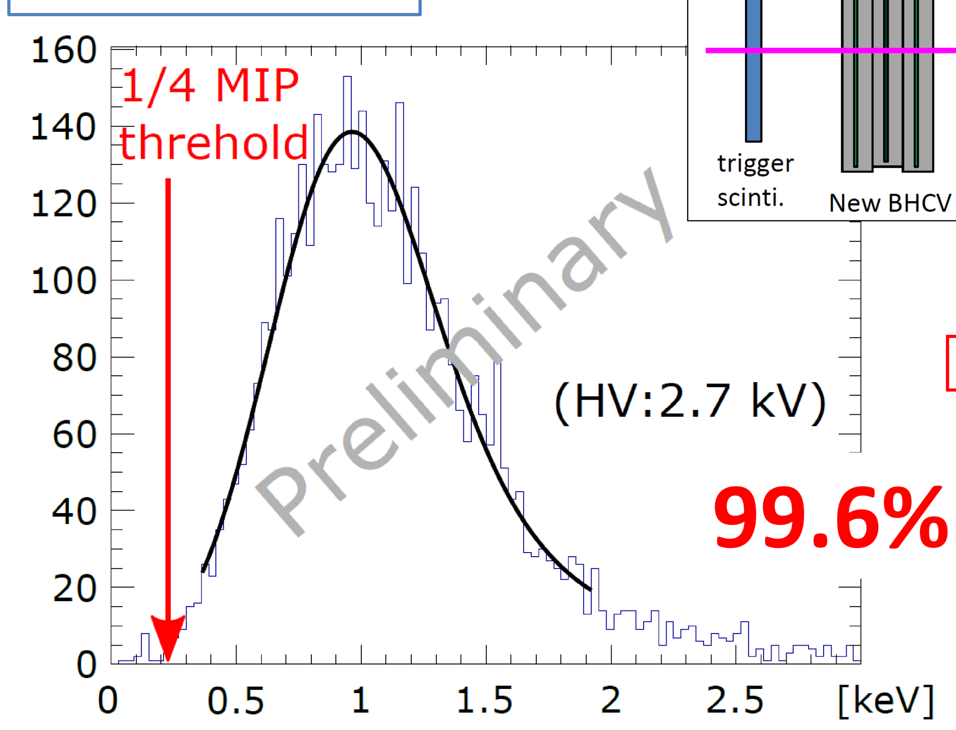


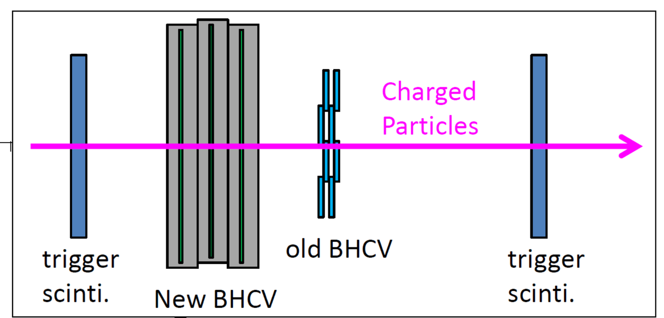
60% narrower (FWHM)



Good baseline stability

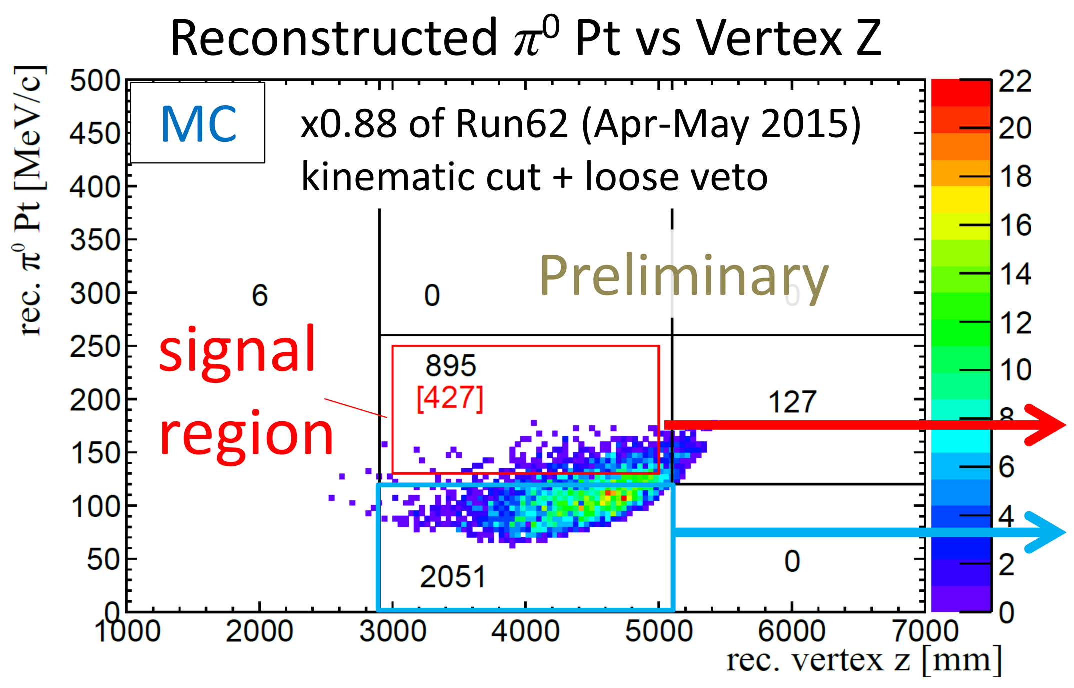
Efficiency





99.6% Achieved!

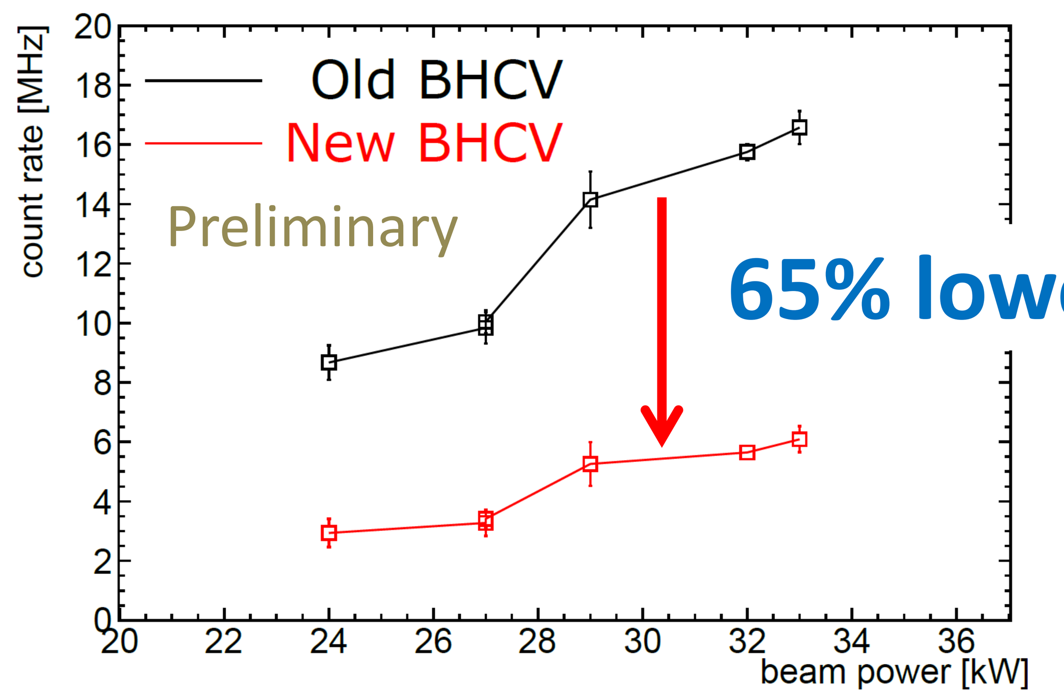
$K_L \to \pi^0 \pi^+ \pi^-$ Background suppression



Veto performance of New BHCV is the same as BHCV's!

Old BHCV	New BHCV
334 (78±2%)	342 (80±2%)
1336 (65±1%)	1362 (66±1%)

Counting Rate



65% lower rate

Accidental Loss

* loss of $K_L \to \pi^0 \nu\nu$ signal due to accidental hits on veto detectors

Accidental Loss ~ CountingRate x VetoWindow

✕

	veto window		Accidental Loss
old BHCV	15 ns	⇨	22%
new BHCV	25 ns		14%

40% reduction!