Prototype test Experiment for Upgrades in the BGOegg Gamma Spectrometer at ELPH

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for the BGOegg collaboration

Physics Motivation for BGOegg Experiment

- The study of the meson properties is one of the most interesting topic in the hadron physics

Pseudoscalar meson mass

- $\pi \approx 135$ MeV
- $K \approx 497$ MeV
- $\eta \approx 548$ MeV
- $\eta' \approx 958$ MeV

Large mass difference

- $U_A(1)$ anomaly
- chiral symmetry breaking to the η' meson

Physics Motivation for BGOegg Experiment

- The ordinary explanation of the mass generation η' is $U_A(1)$ anomaly effect
- The anomalous breaking of the axial $U(1)(U_A(1))$ symmetry by quantum effect

Michael Creutz, arxiv 0901.0150

The η' mass is discussed in terms of the effective $U_A(1)$ restoration

J.Kapsta,et al.,PRD53(1996)5028

Physics Motivation for BGOegg Experiment

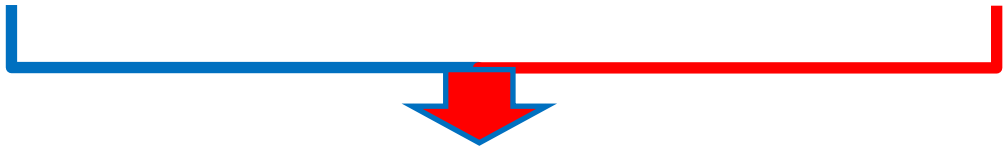
- Some theorists argued the chiral symmetry breaking is also responsible for the generation of eta prime mass

D. Jido, H. Nagahiro, S. Hirenzaki, Phys. Rev. C85, 032201 (2012).

- Thus, We accepted both of them to interpret for mass generation of the η'

Effective $U_A(1)$ restoration

Chiral symmetry breaking



Interpretation of large mass η'

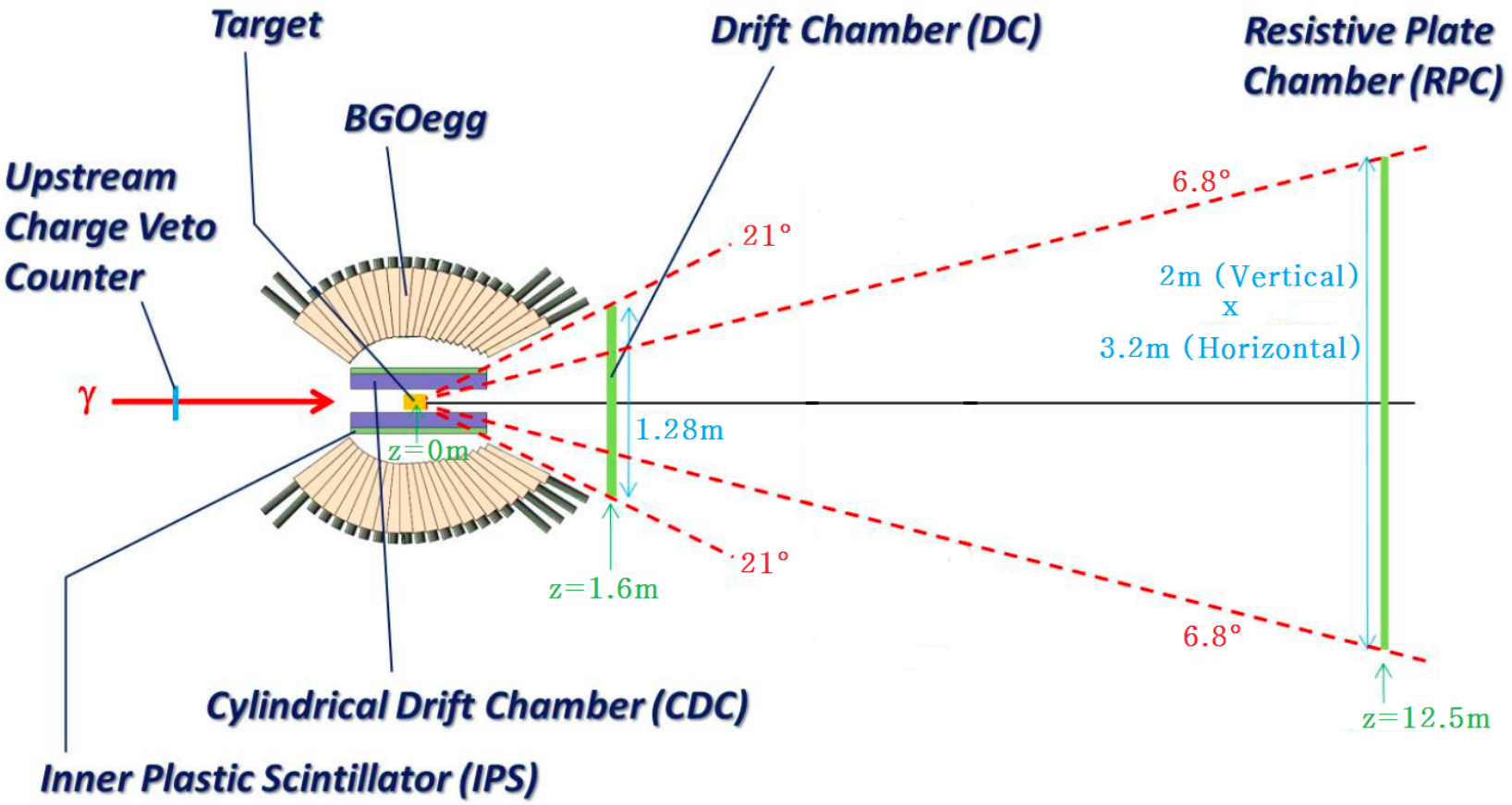
Physics Motivation for BGOegg Experiment

- Recently, the issue of the η' mass generation is related to the partial restoration of chiral symmetry
- The possibility of the η' mass reduction in the nuclear matter through the partial restoration of chiral symmetry
- The possibility of η'N bound state is also argued

Sakai, S. & Jido, D. Hyperfine Interact (2015) 234: 71.

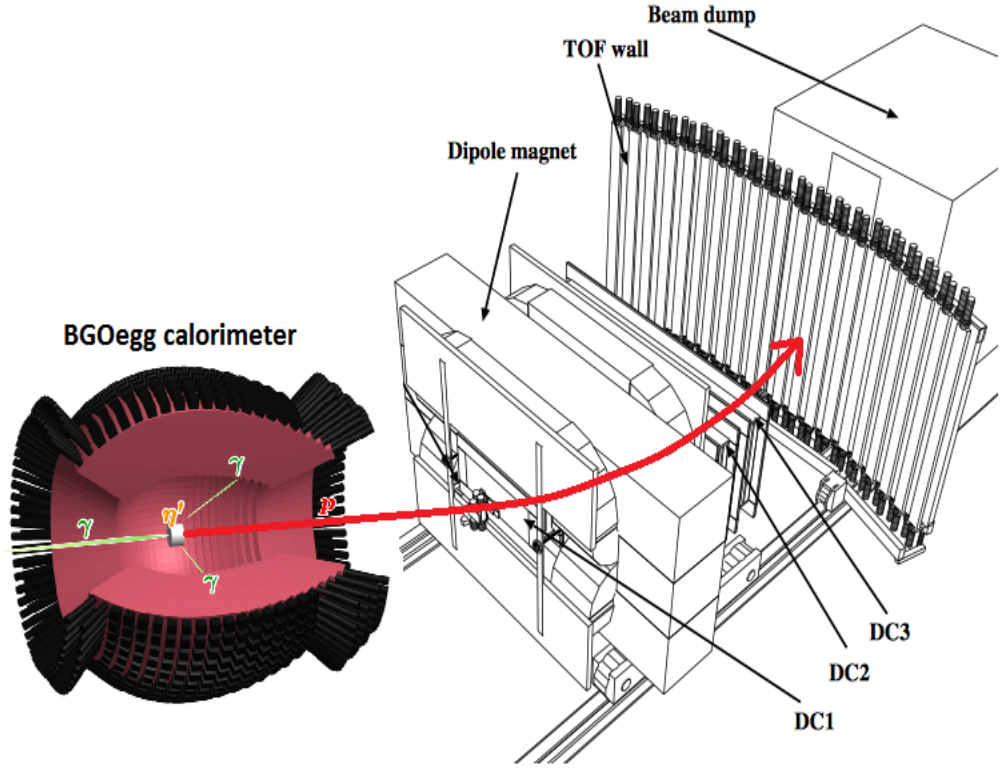
$\eta' N$ binding energy [MeV]	$\eta' N$ scattering length [fm]	$\eta' N$ effective range [fm]
12.3-3.3i	-1.91+0.24i	$0.24\text{-}7.6\times10^{-3}i$

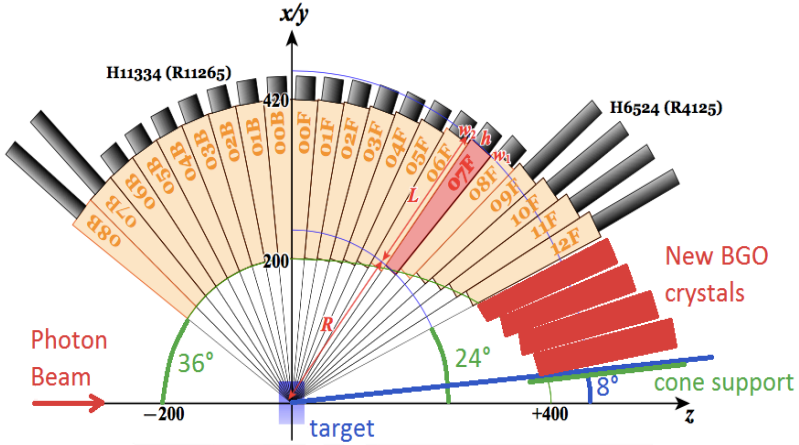
BGOegg Experiment at SPring-8



- Recoil protons are now measured using time-of-flight information with RPC at LEPS2

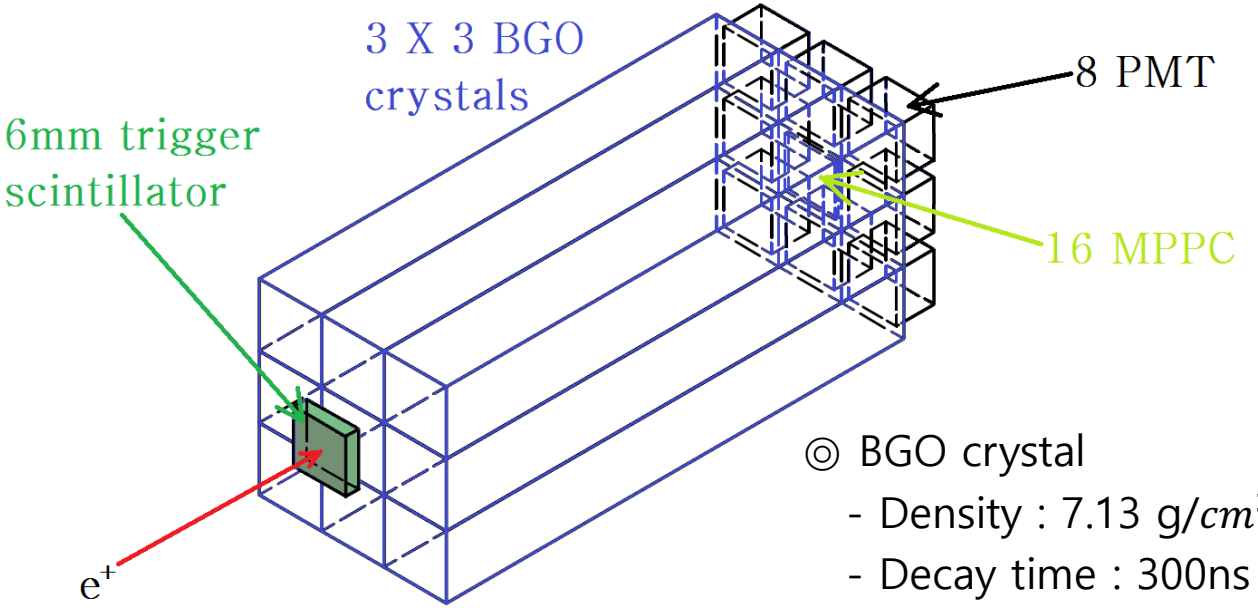
BGOegg Upgrade



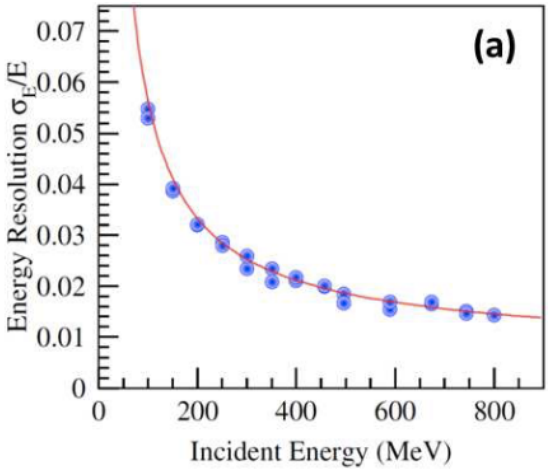


- Recoil proton momentum will be measured using a dipole magnet at LEPS, as well as BGOegg updates with 120 additional crystals

Prototype test for BGOegg Upgrade

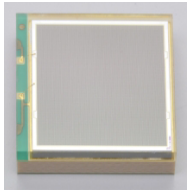


◎ BGO crystal
- Density : 7.13 g/cm^3
- Decay time : 300ns

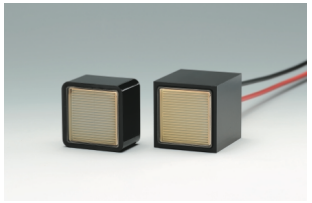


N. Muramatsu et al.
ELPH Report 2044-13

◎ Positron beam
- Energy range : 50 ~ 800MeV

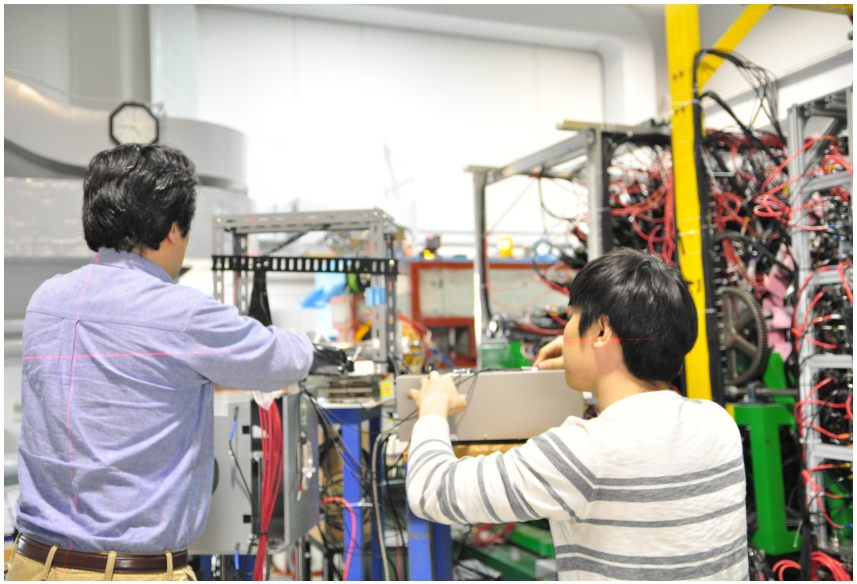


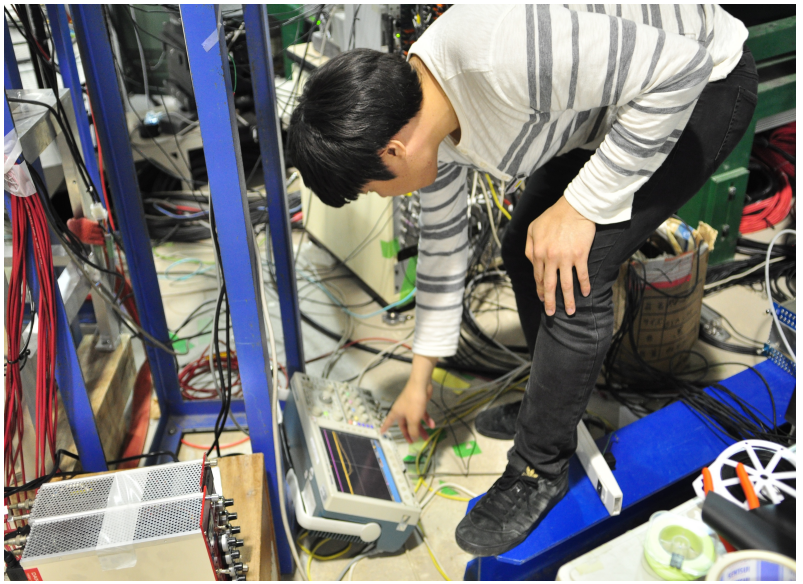
◎ S13360-6025PE
- V_{op} ≅ 57V = V_{br} + 5V



◎ PMT
- H11334(R11265)
- Effective area : 23 X 23mm

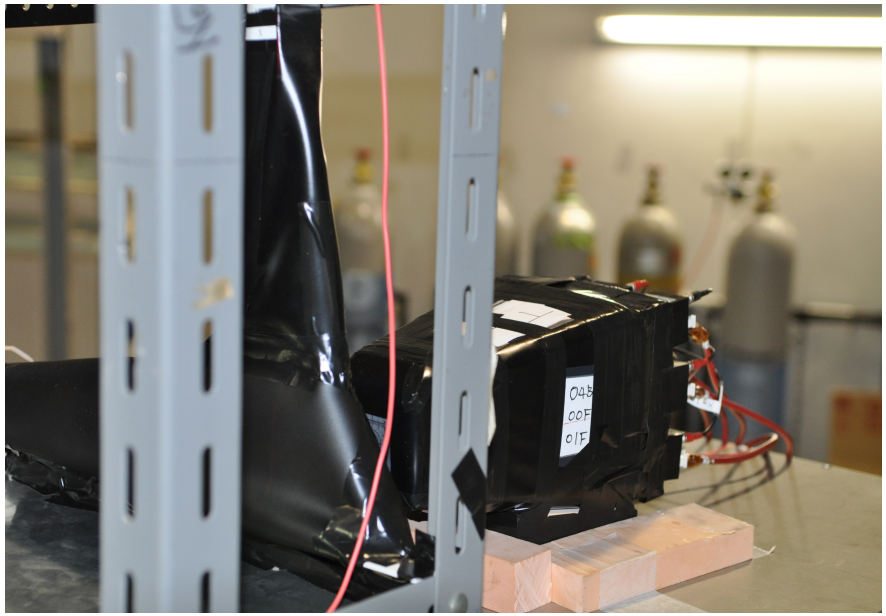
Prototype test for BGOegg Upgrade

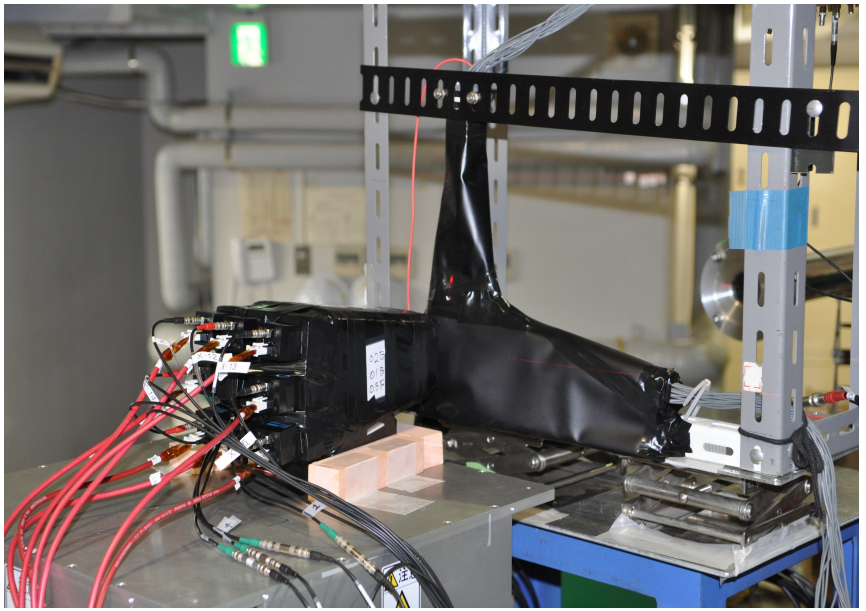


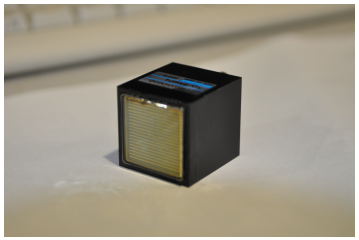


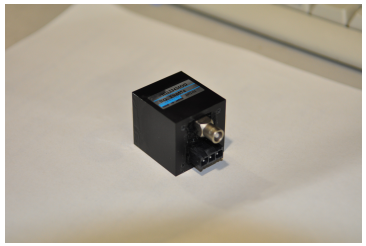
- We use a BPM(Beam Position Monitor) kind of fiber tracker for the trigger
- We received four kinds of data during the experiment.
  - 9 PMT
  - 8 PMT + 16 MPPC
  - 8 PMT + 16 MPPC + wider gate
  - 8 PMT + 16 MPPC + filter

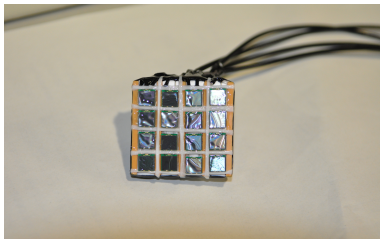
Prototype test for BGOegg Upgrade

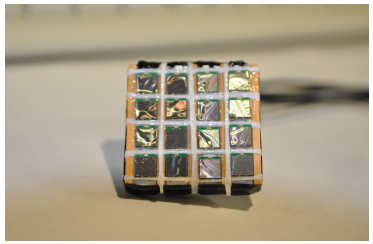












- Pictures for after the setting & PMT, MPPC

Analysis Plan of the Prototype test

- Final Goal of this prototype experiment is to compare a energy resolution of each experiment condition

- ADC calibration, TDC cut, convert ADC to energy, Draw momentum vs energy(ADC) graph, get a energy resolution of the central BGO crystal, compare PMT & MPPC