

Anisotropic Effect of ZnWO₄ Scintillator for Direction-Sensitive Dark Matter Search

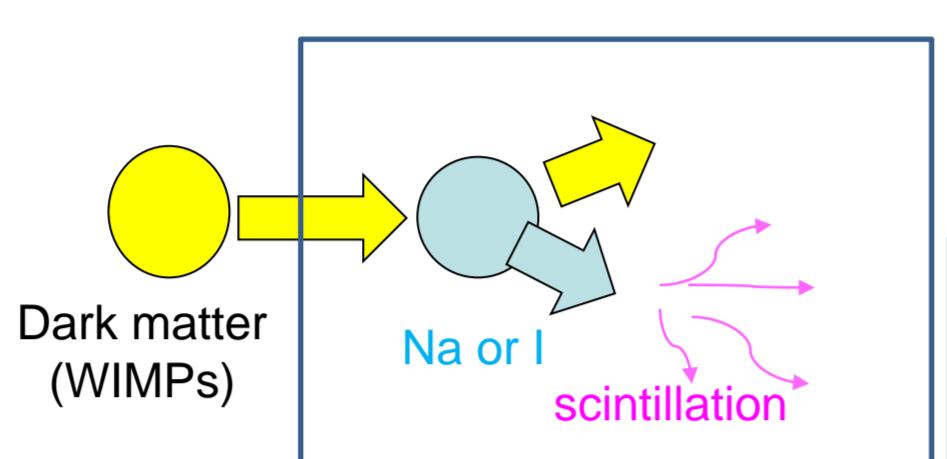
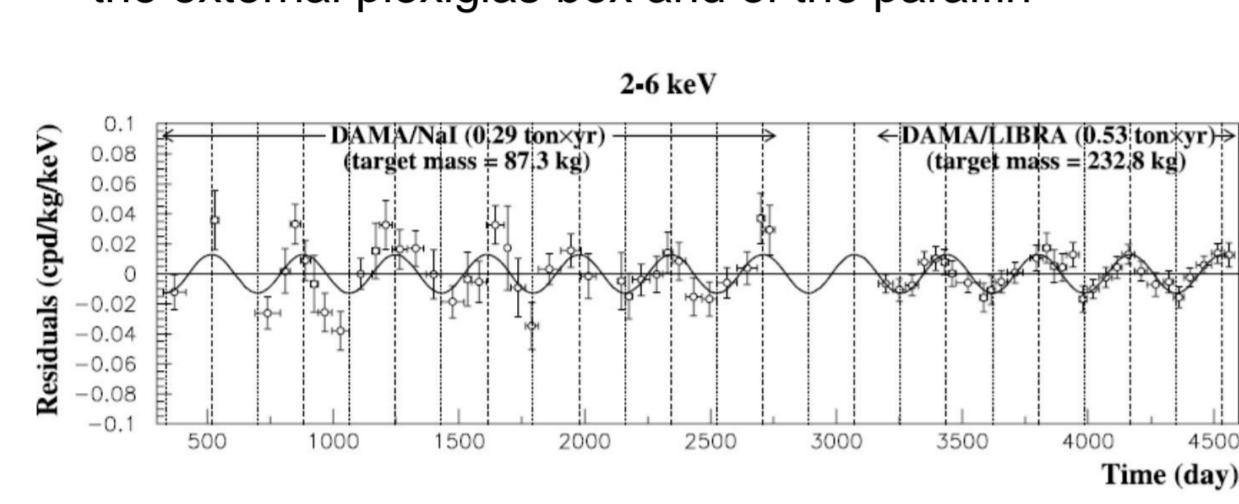
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1. Introduction

DAMA experiment & Scintillator

The ~100 kg NaI(Tl) set-up out of operation.
Opening the passive shield after the removal of the external plexiglas box and of the paraffin

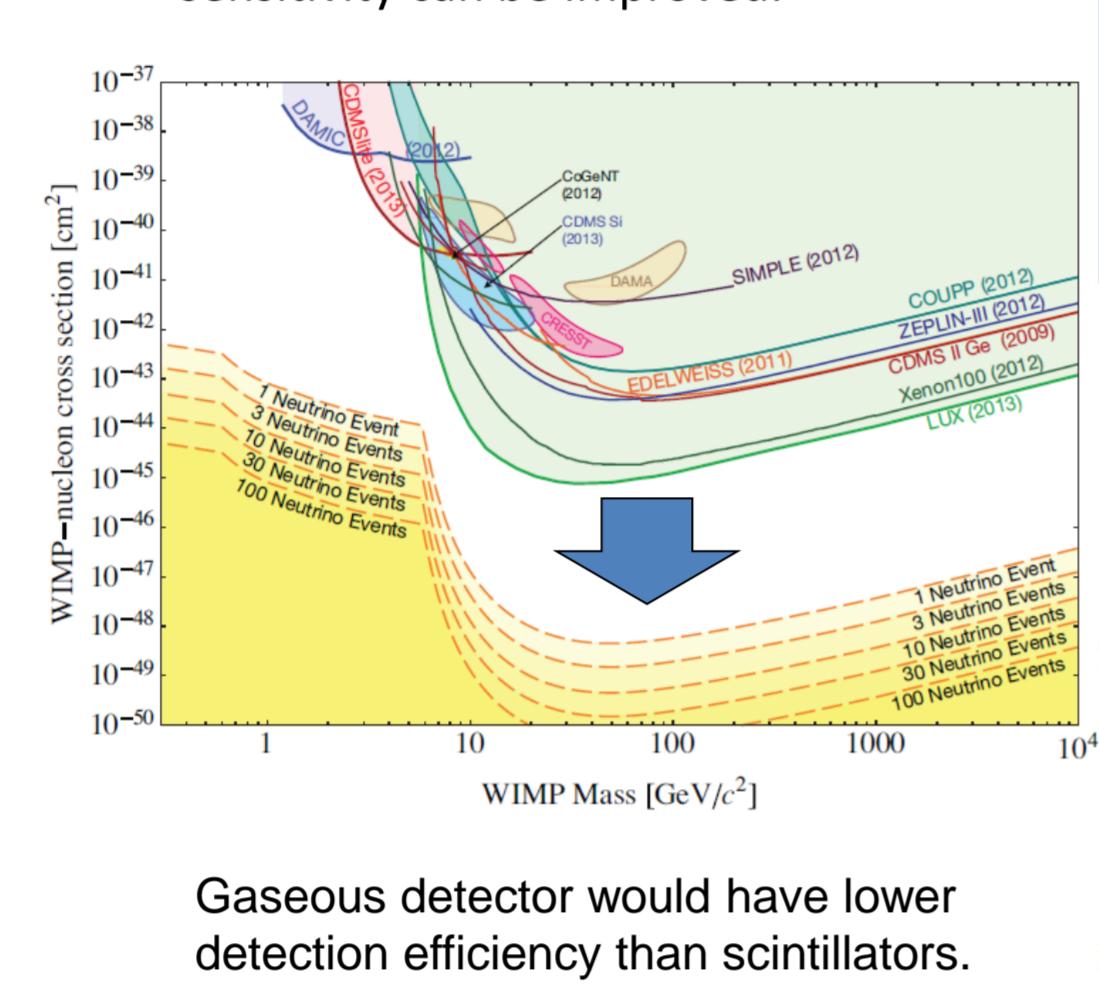
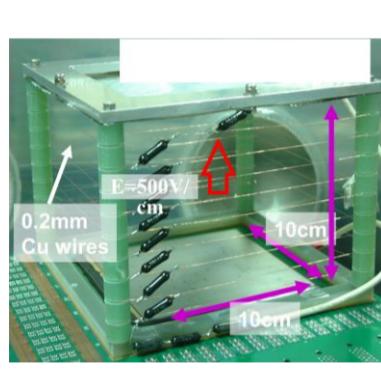
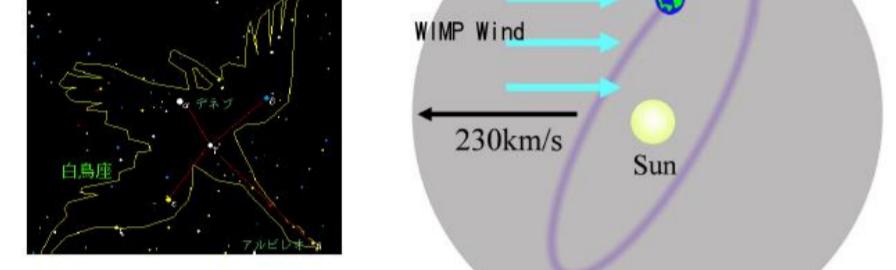


http://people.roma2.infn.it/~dama/web/libra_ph1.html
R. Bernabei et al., Eur. Phys. J. C 56, 333 (2008)

WIMPs wind

Dark matter
= WIMP (weakly interacting massive particles)

Wind from Cygnus



Gaseous detector would have lower detection efficiency than scintillators.

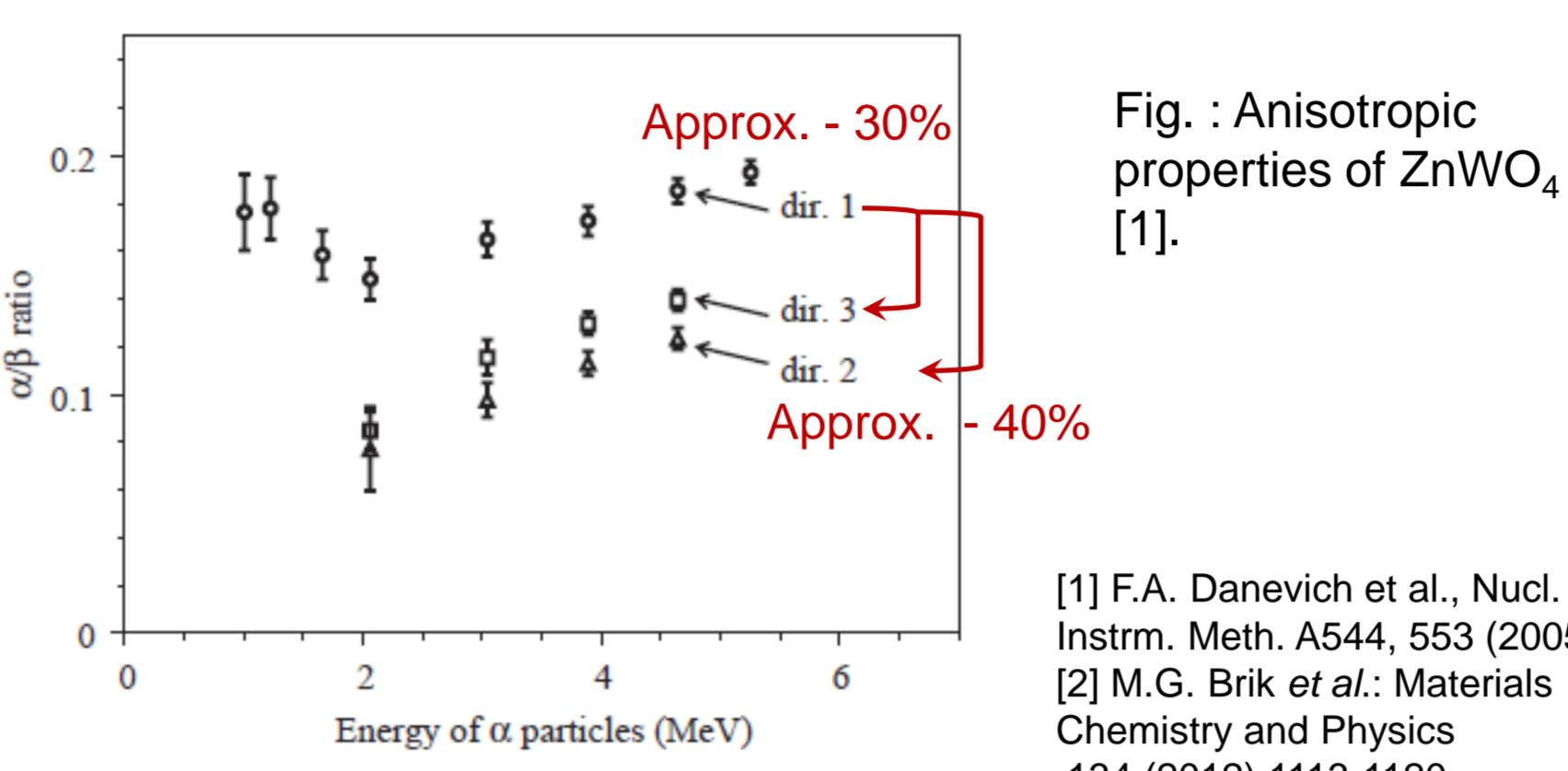


Fig. : Anisotropic properties of ZnWO₄ [1].

[1] F.A. Danevich et al., Nucl. Instrum. Meth. A544, 553 (2005)
[2] M.G. Brik et al., Materials Chemistry and Physics 134 (2012) 1113-1120

Fig. 2. The dependence of the α/β ratio on energy of α particles measured with ZnWO₄ scintillator. The ZnWO₄ crystal $\varnothing 14 \times 7$ mm was irradiated in the directions perpendicular to (010), (001) and (100) crystal planes (directions 1, 2 and 3, respectively).

Monoclinic crystal system
luminescence centers : $(WO_6)^6-$
charge transfer transition

To estimate anisotropic properties for a ZnWO₄ crystal and a Mg-admix ZnWO₄ crystal in order to investigate what contributes to anisotropic properties.

2. Crystal Growth

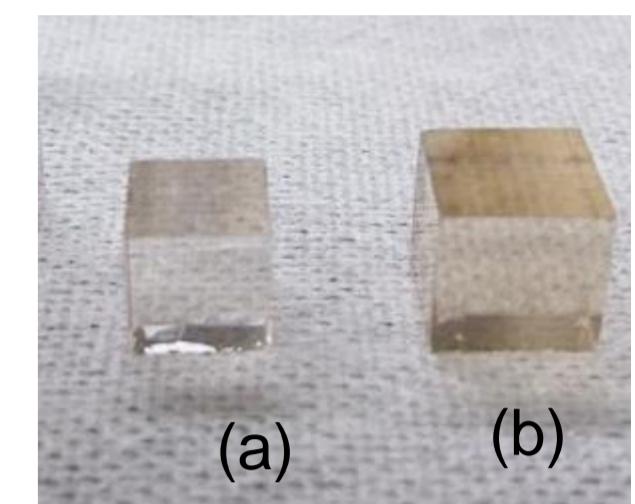
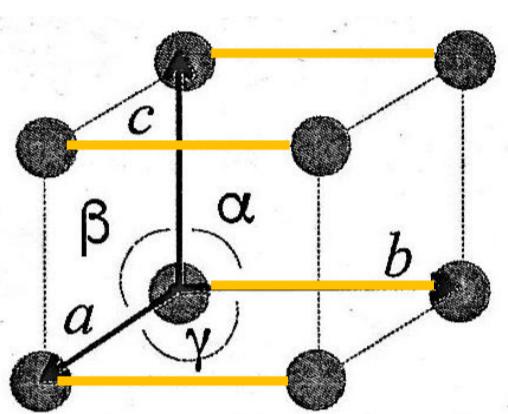


Fig. :Photograph of samples.
(a) 9 mm ZnWO₄,
(b) 10 mm ($Zn_{0.95}Mg_{0.05}$)WO₄.

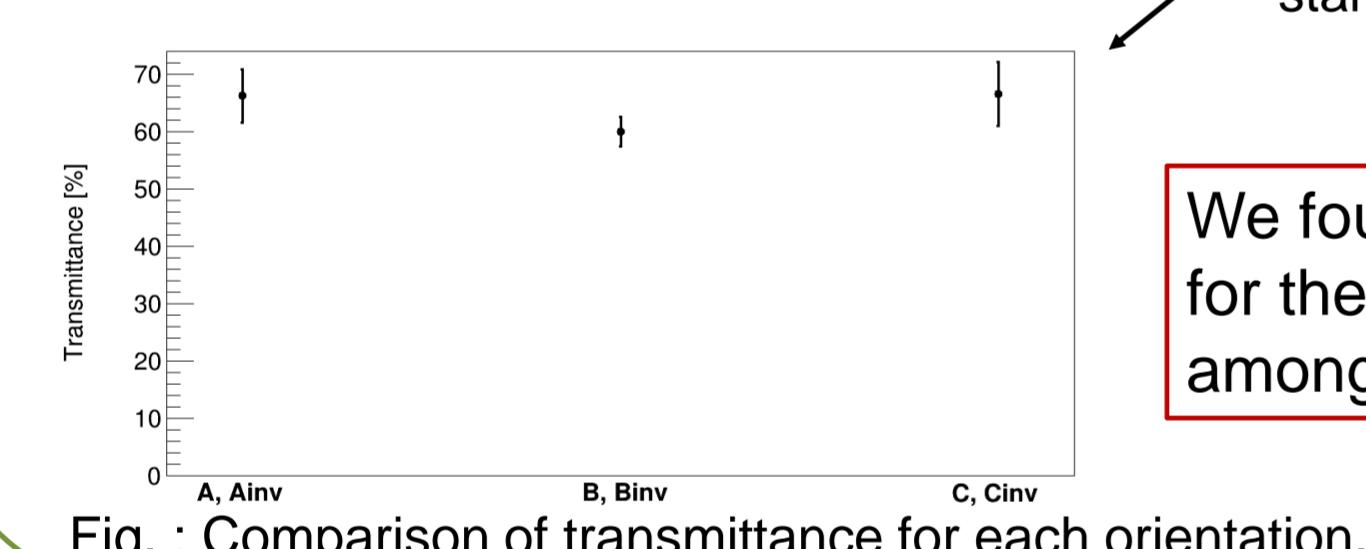
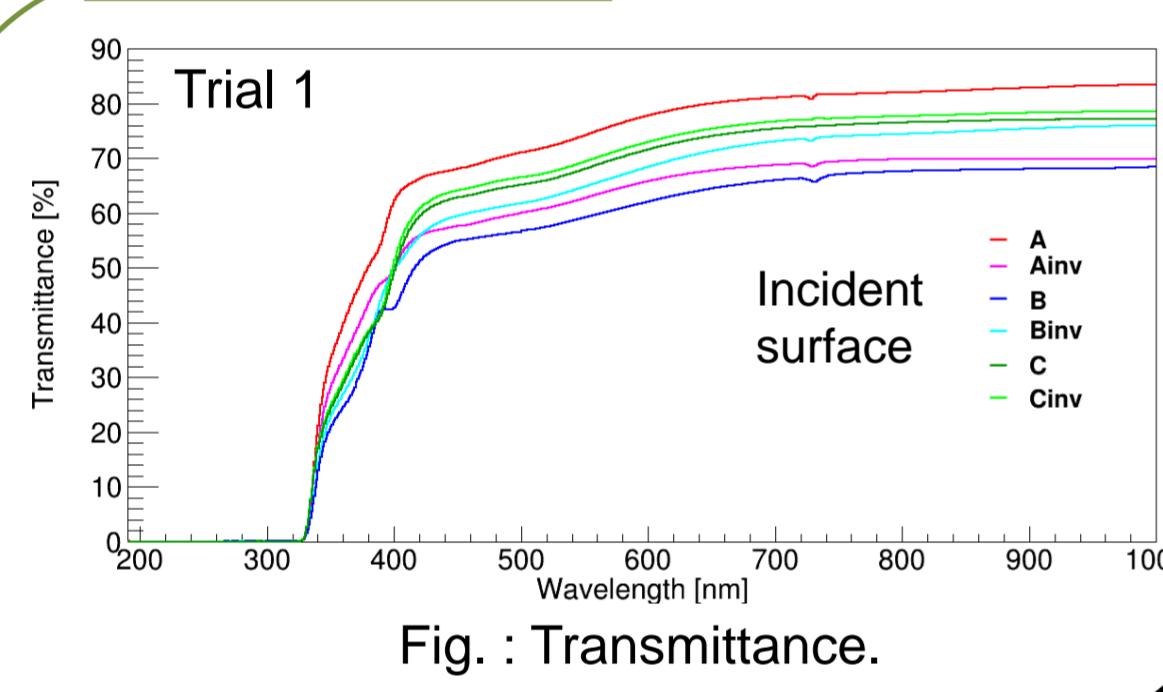
Table : Lattice constant of ZnWO₄ and ($Zn_{0.95}Mg_{0.05}$)WO₄.

	ZnWO ₄	($Zn_{0.95}Mg_{0.05}$)WO ₄
a[Å]	4.6937(15)	4.6929(10)
b[Å]	5.7197(18)	5.7155(12)
c[Å]	4.9275(16)	4.9303(11)
$\beta[\text{°}]$	90.638(4)	90.643(3)



3. Transmittance

9 mm ZnWO₄



spectrometer JASCO V-730.

10 mm ($Zn_{0.95}Mg_{0.05}$)WO₄



5. Pulse height spectra / proton

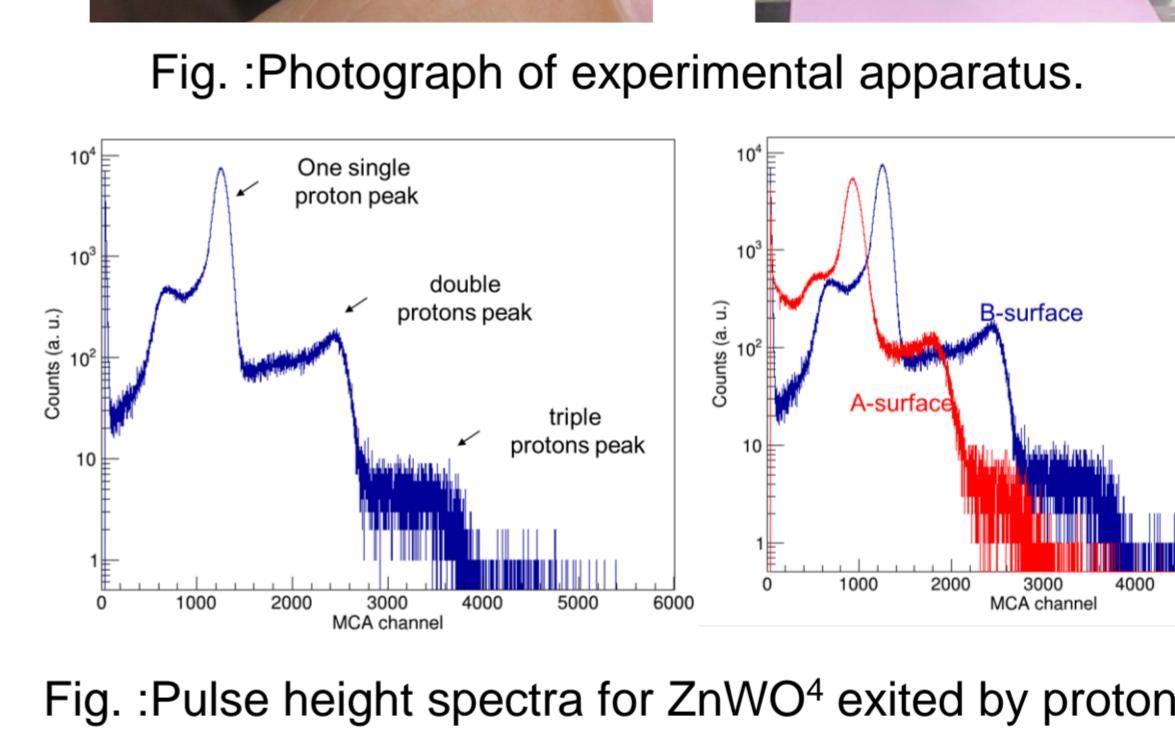
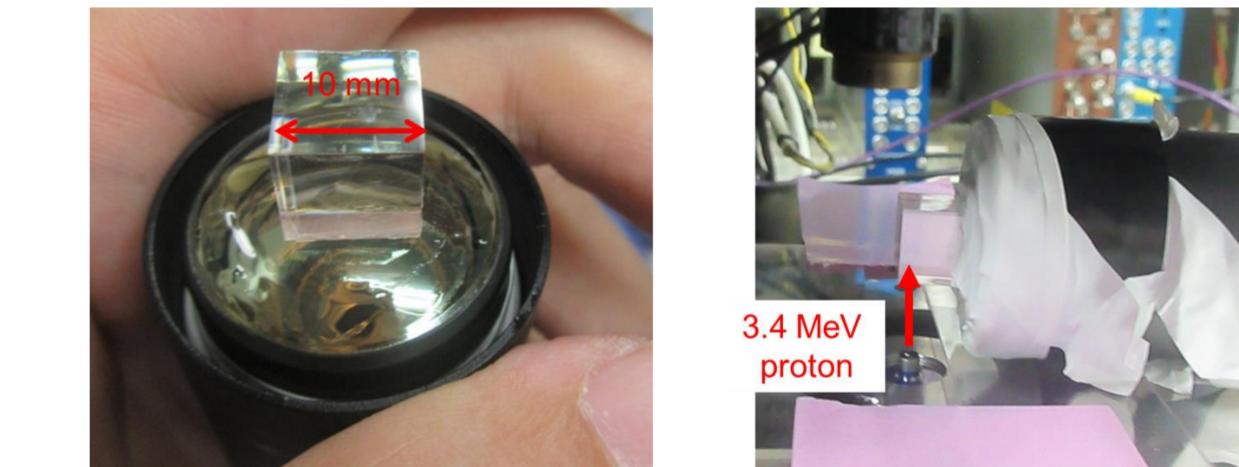


Fig. :Photograph of experimental apparatus.
Fig. :Pulse height spectra for ZnWO₄ excited by proton

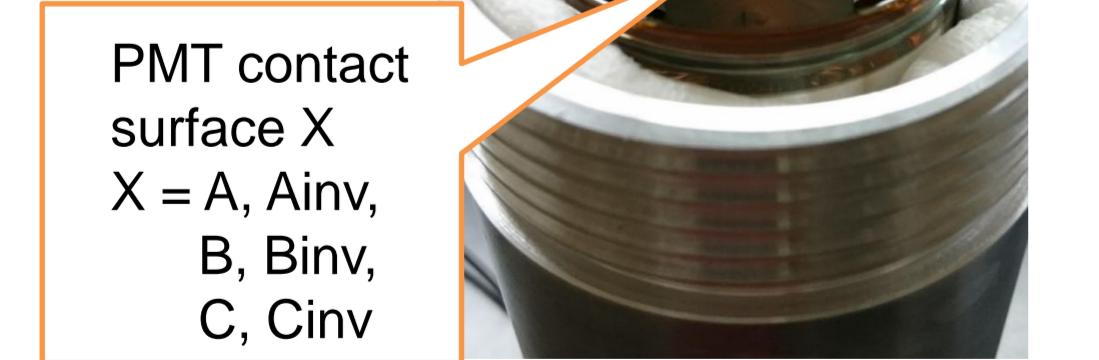
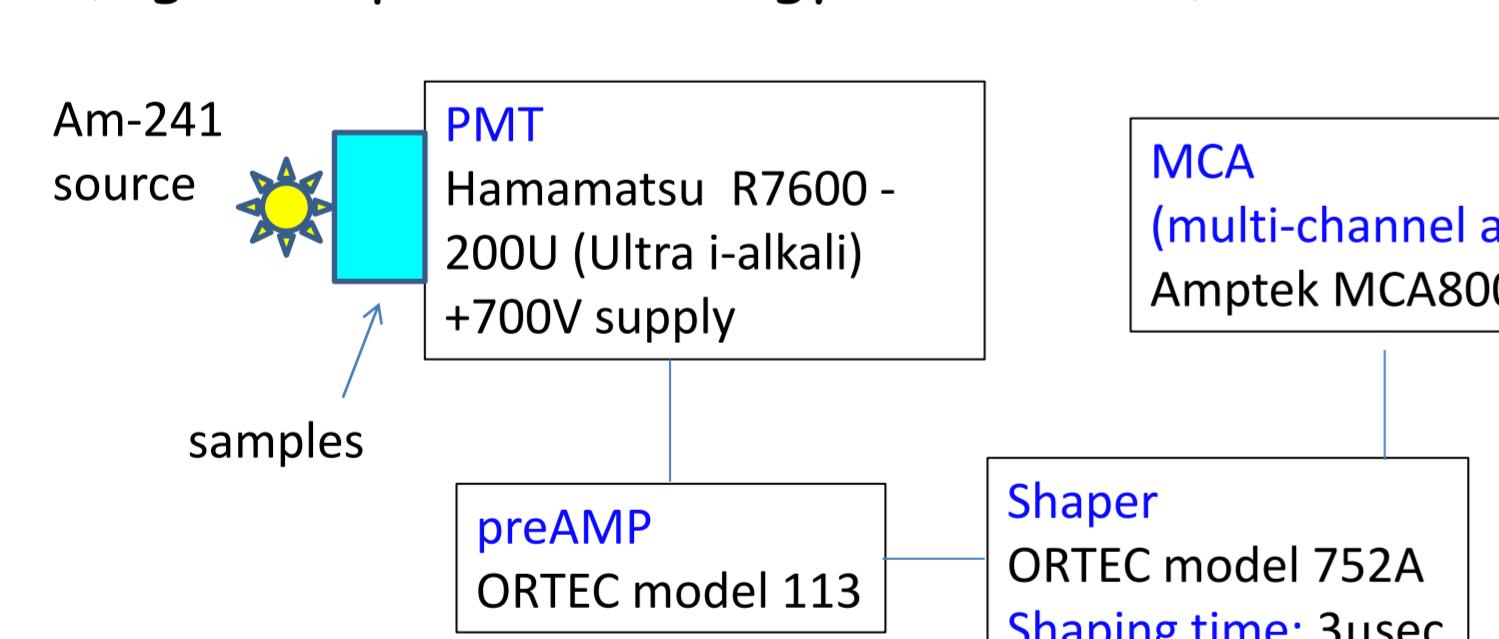
We estimated light outputs of the ZnWO₄ crystal irradiated with 3.4-MeV proton using single electron counting at Single Particle Eradication for Cell (SPICE) of Institute for Quantum Medical Science ,National Institutes for Quantum Science and Technology (QST)

Result:

The difference > 5% (preliminary)

4. Pulse height spectra / alpha

Pulse height spectra (Light outputs and energy resolutions)



We estimated light outputs of the crystal irradiated with 5.5-MeV alpha rays and 511-keV gamma rays. The crystals were irradiated in the directions perpendicular to (100), (010) and (001) crystal planes (directions A, B and C, respectively).

PMT contact surface X
X = A, Ainv,
B, Binv,
C, Cinv

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We estimated light outputs of the crystal irradiated with 5.5-MeV alpha rays and 511-keV gamma rays. The crystals were irradiated in the directions perpendicular to (100), (010) and (001) crystal planes (directions A, B and C, respectively).

Fig. :Photograph of experimental apparatus.

We estimated light outputs of the crystal irradiated with 5.5-MeV alpha rays and 511-keV gamma rays. The crystals were irradiated in the directions perpendicular to (100), (010) and (001) crystal planes (directions A, B and C, respectively).

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