

NewSUBARU Laser Compton Gamma-ray Source and Study on Photo-nuclear Reaction



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Laser Compton Scattering Gamma-ray Source

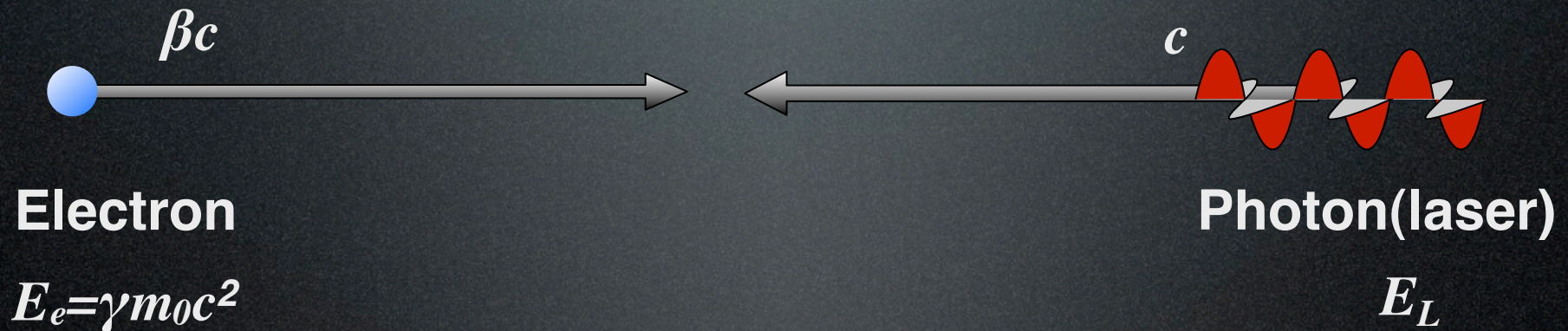
レーザー光子を相対論的電子で散乱することで発生する、高エネルギーガンマ線源。



Laser Compton Scattering Gamma-ray Source

実験室系

実験室系

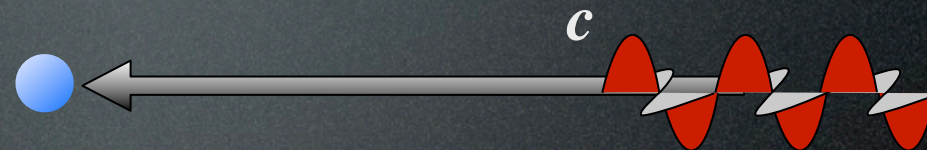


Laser Compton Scattering Gamma-ray Source

実験室系

電子静止座標系

実験室系



Electron

$$E_e = \gamma m_0 c^2$$

Photon(laser)

$$E_L$$



Laser Compton Scattering Gamma-ray Source

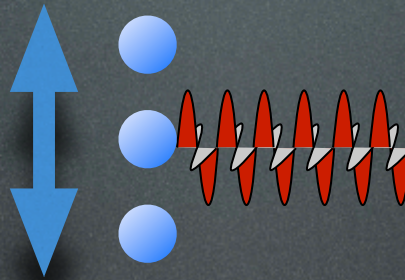
実験室系

電子静止座標系

実験室系

Electron

$$E_e = \gamma m_0 c^2$$



$$2\gamma E_L$$

γ : Lorentz factor
 $\gamma = 2000$ for $E_e = 1$ GeV

Photon(laser)

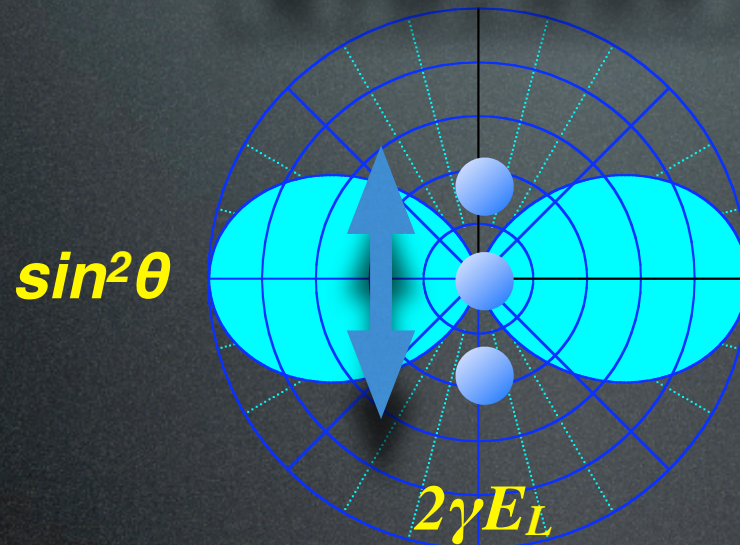
$$E_L$$



Laser Compton Scattering Gamma-ray Source

電子静止座標系

実験室系



Electron

$$E_e = \gamma m_0 c^2$$

Photon(laser)

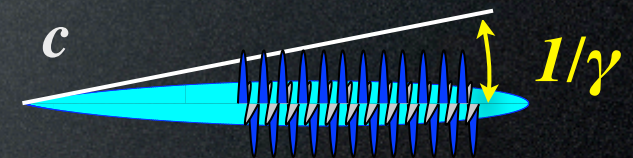
$$E_L$$

γ : Lorentz factor
 $\gamma = 2000$ for $E_e = 1 \text{ GeV}$



Laser Compton Scattering Gamma-ray Source

実験室系

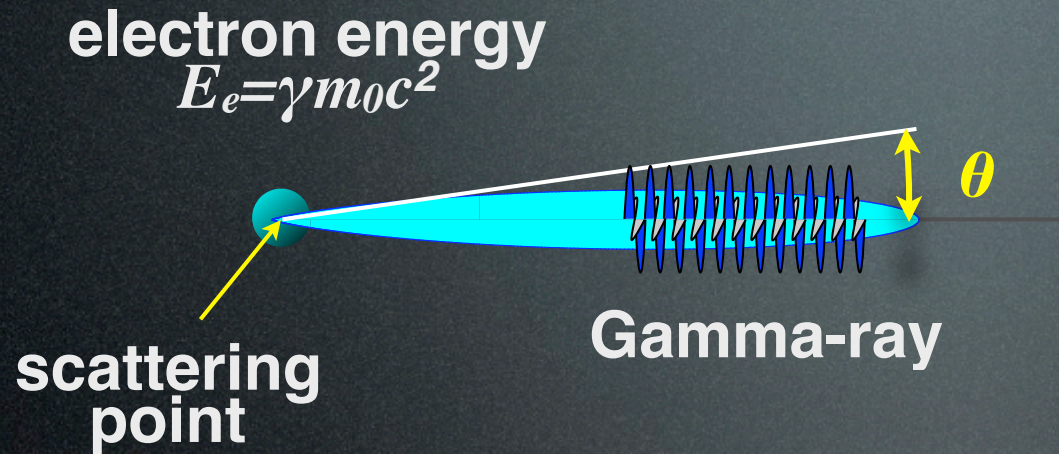


γ : Lorentz factor
 $\gamma=2000$ for $E_e=1$ GeV

$4\gamma^2 E_L$
Gamma-ray
 $1/\gamma \sim 0.06^\circ$



Photon energy of laser Compton gamma-ray



$$E_\gamma = \frac{4 E_L \gamma^2}{1 + \gamma^2 \theta^2}$$

γ : Lorentz factor

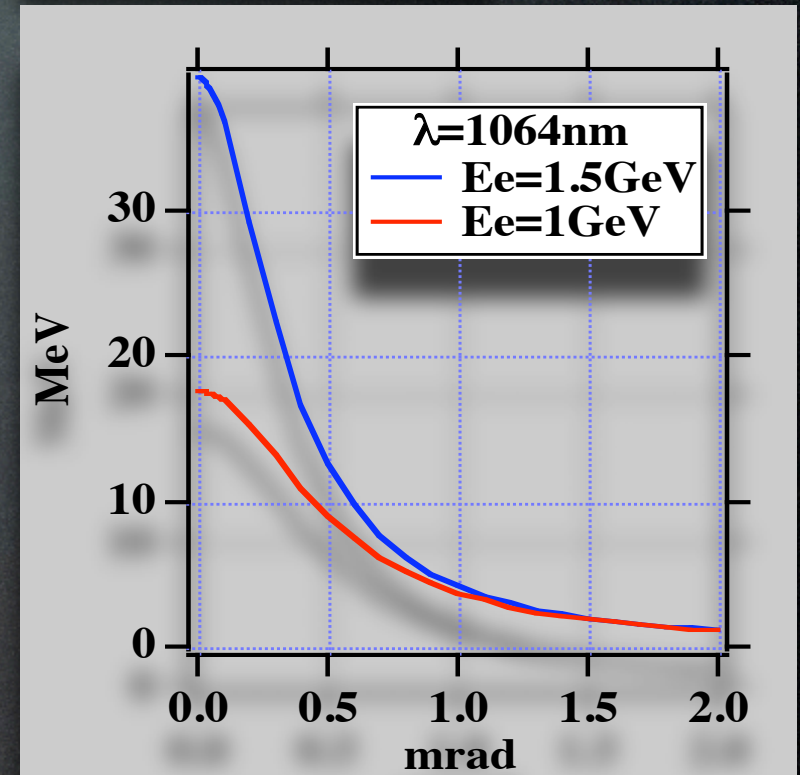
$\gamma = 2000$ for $E_e = 1 \text{ GeV}$

$\gamma = 3000$ for $E_e = 1.5 \text{ GeV}$

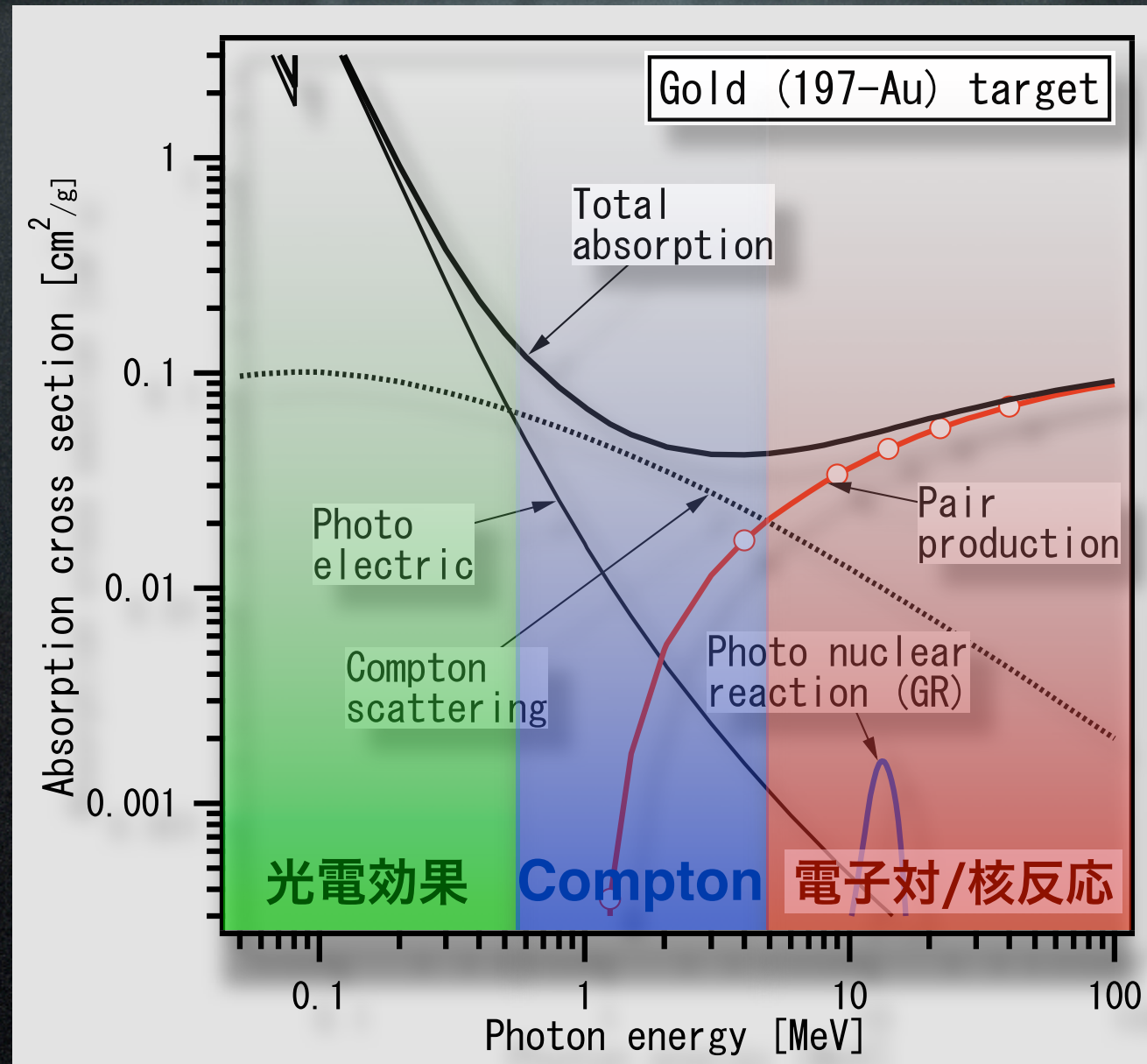
E_L : Laser photon energy

$E_L = 1.16 \text{ eV}$ for Nd - ω

$\lambda = 1064 \text{ nm}$



Gamma-ray absorption coefficient ex: Au



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Outline

1. NewSUBARU放射光施設におけるガンマ線源

ガンマ線フラックスと強度分布

1.7MeVガンマ線の偏極度計測

2. 光核反応などの利用

中性子の発生分布による

17MeVガンマ線の偏極度計測

17MeVガンマ線による電子対生成



NewSUBARU Synchrotron Radiation Facility

Spring-8

1-8GeV
Synchrtron

Linac

SCSS

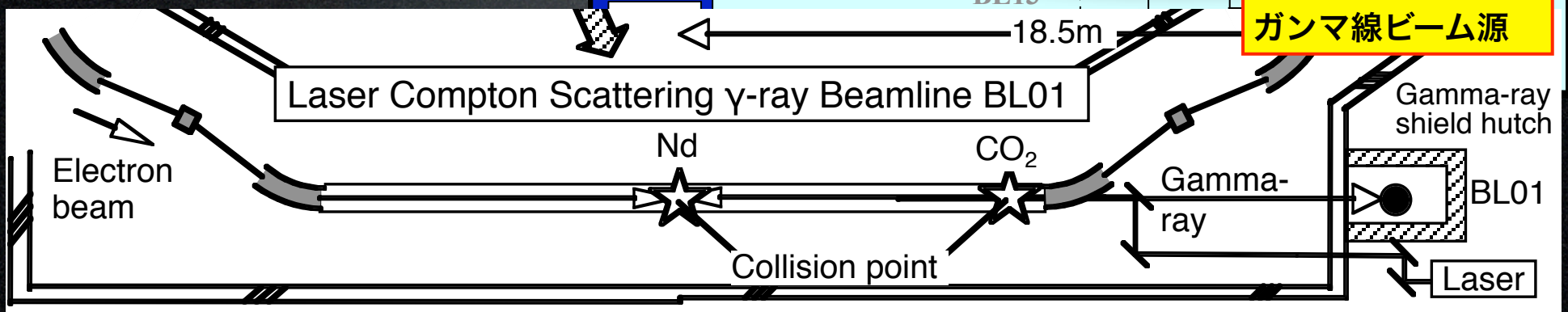
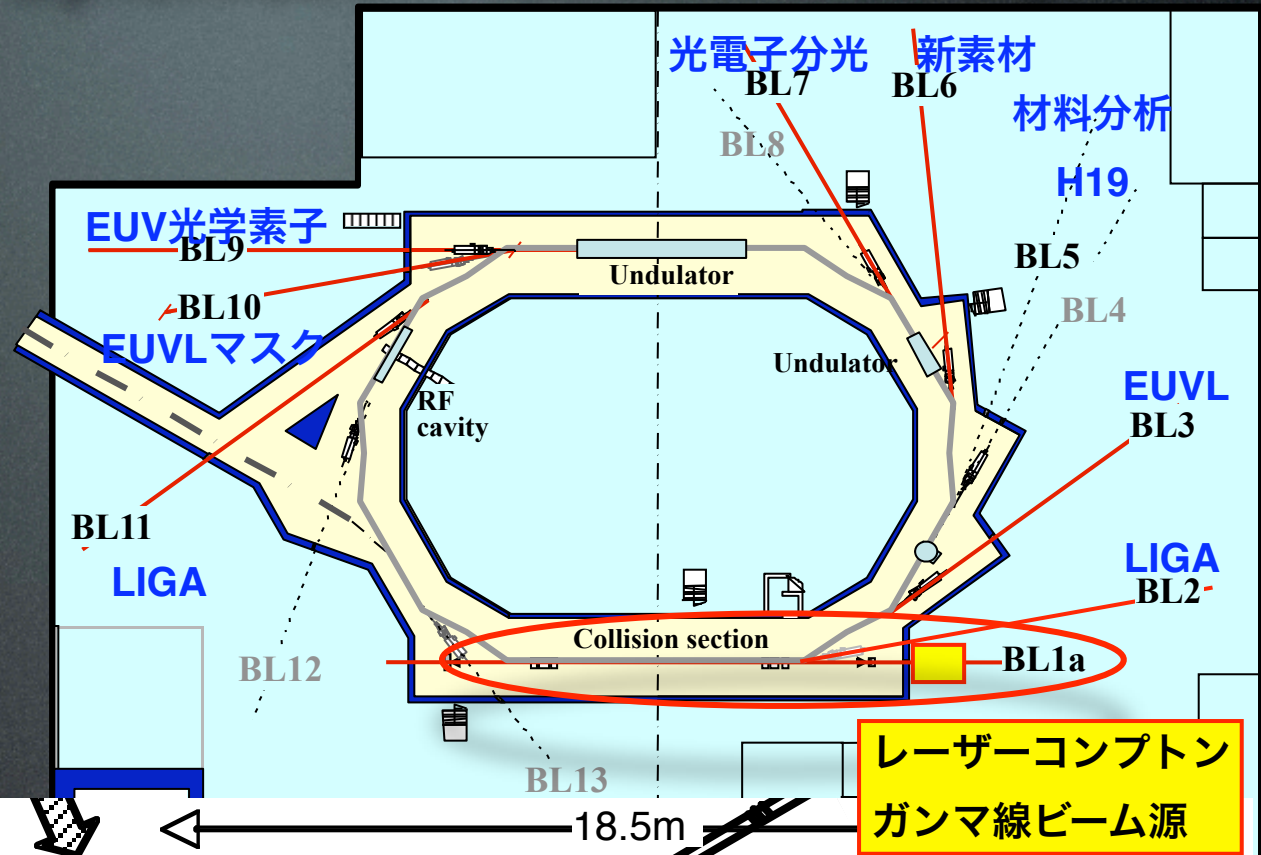
NewSUBARU



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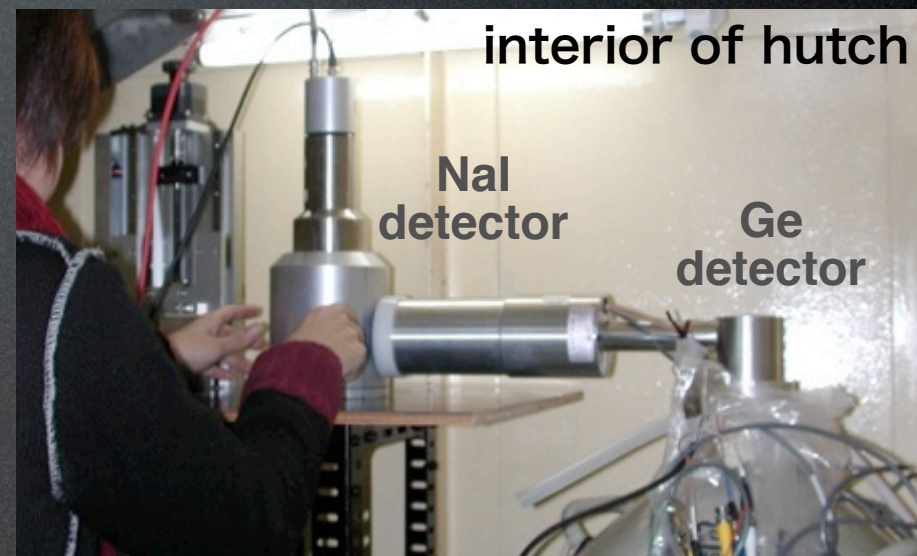
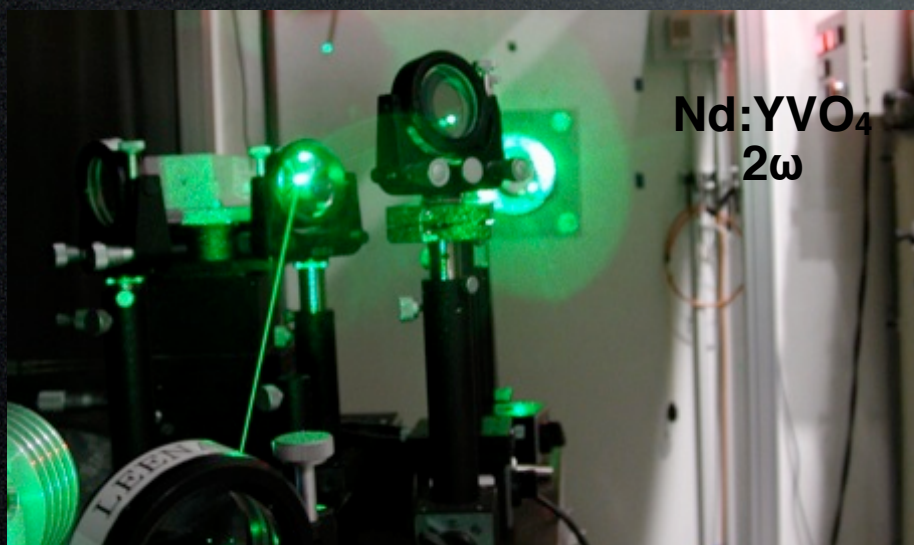
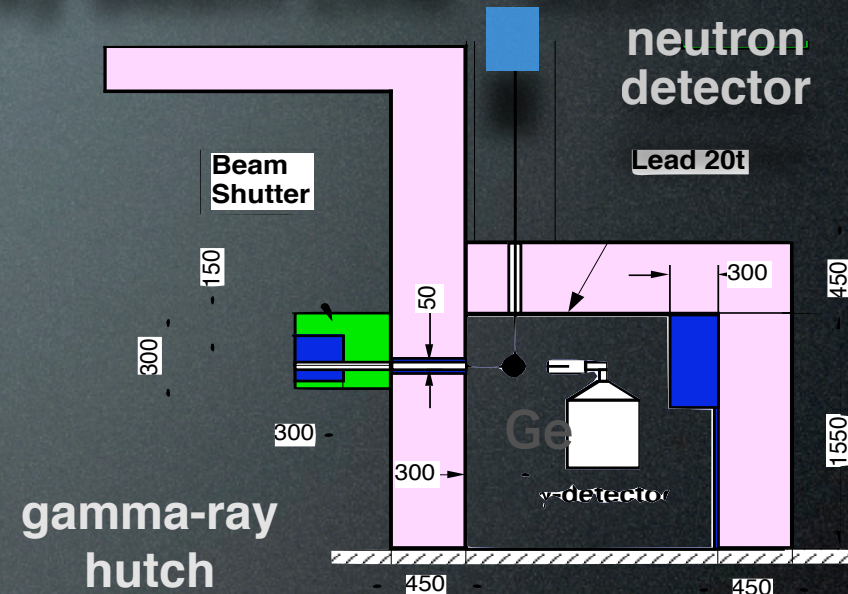
NewSUBARU Synchrotron Radiation Facility

周長	118 m
電子エネルギー	
入射	1 GeV
蓄積	1- 1.5 GeV
電流 最大	500mA
TopUp	250mA
エミッタンス x	40 nm · rad
y	4 nm · rad
レーザー波長	
Nd	1064nm/5W
Nd2ω	532nm/3W
CO ₂	10.5μm/20W



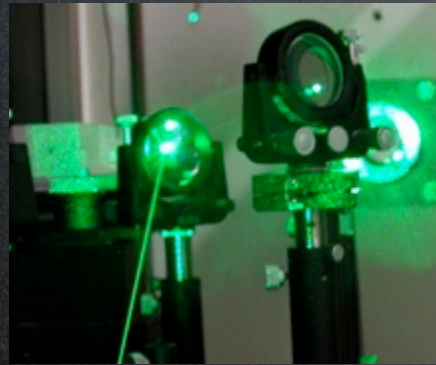
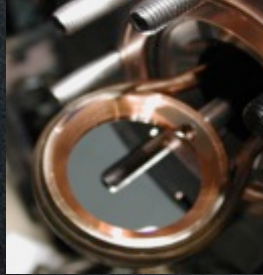
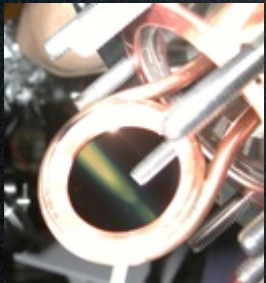
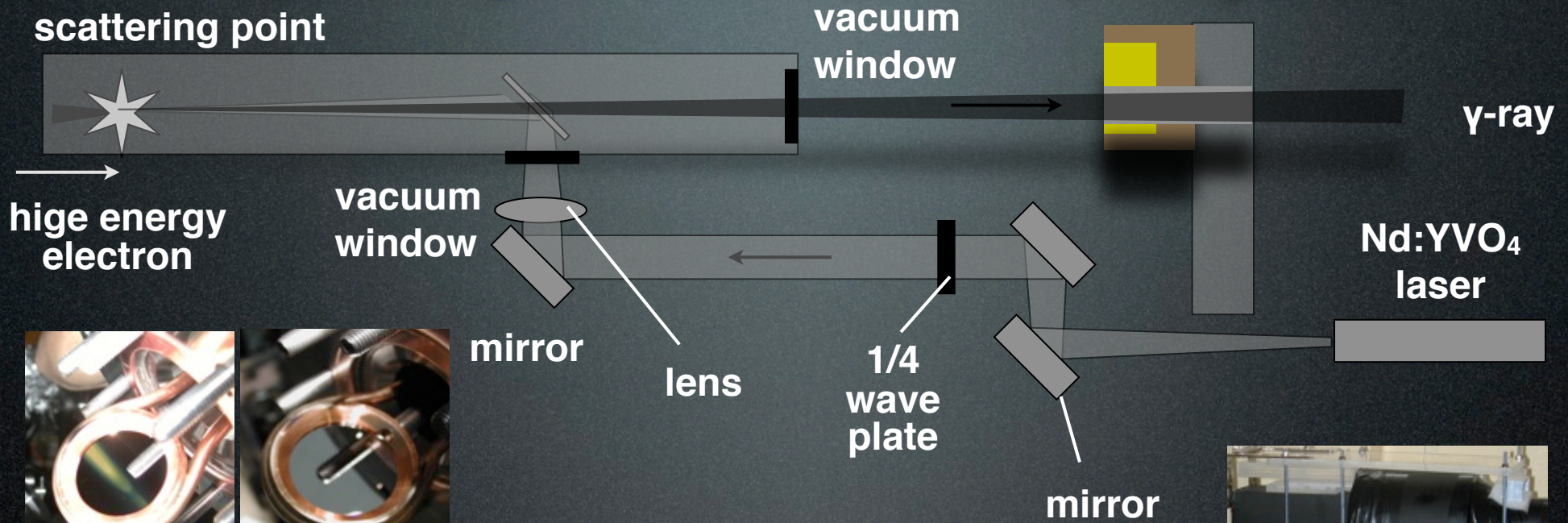
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NewSUBARU Gamma-ray Beam Line BL01



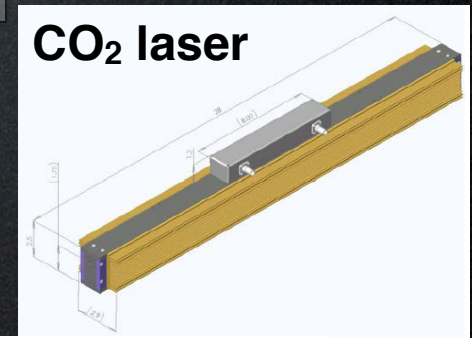
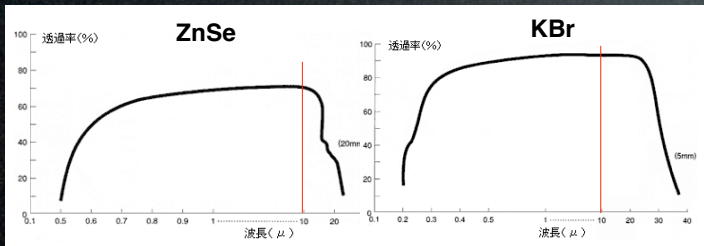
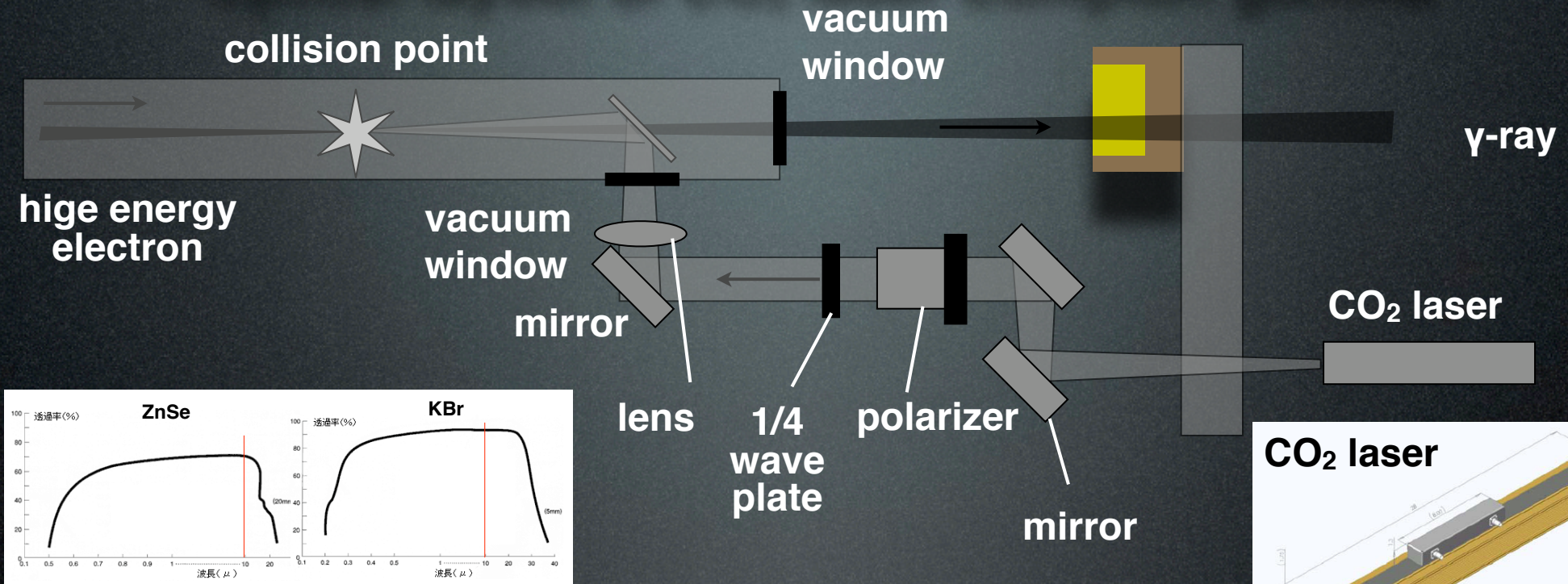
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Optical layout of Nd laser Compton gamma



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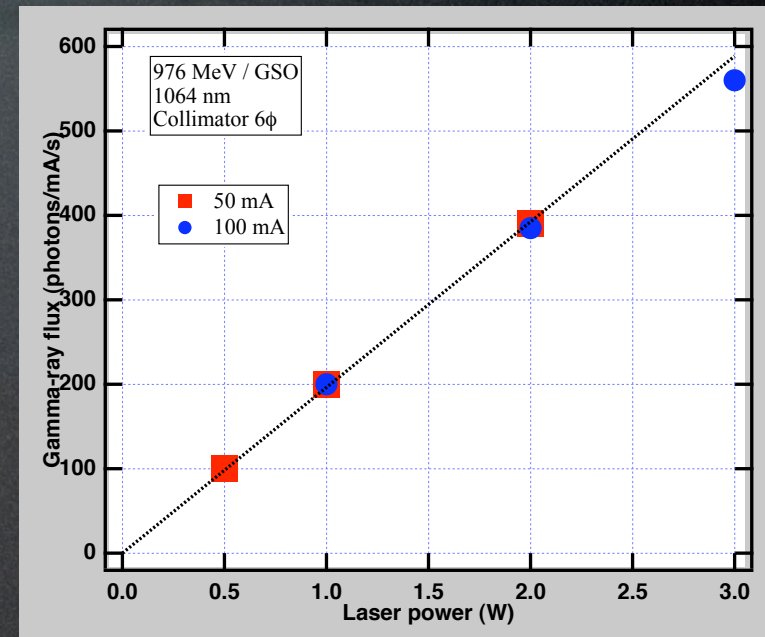
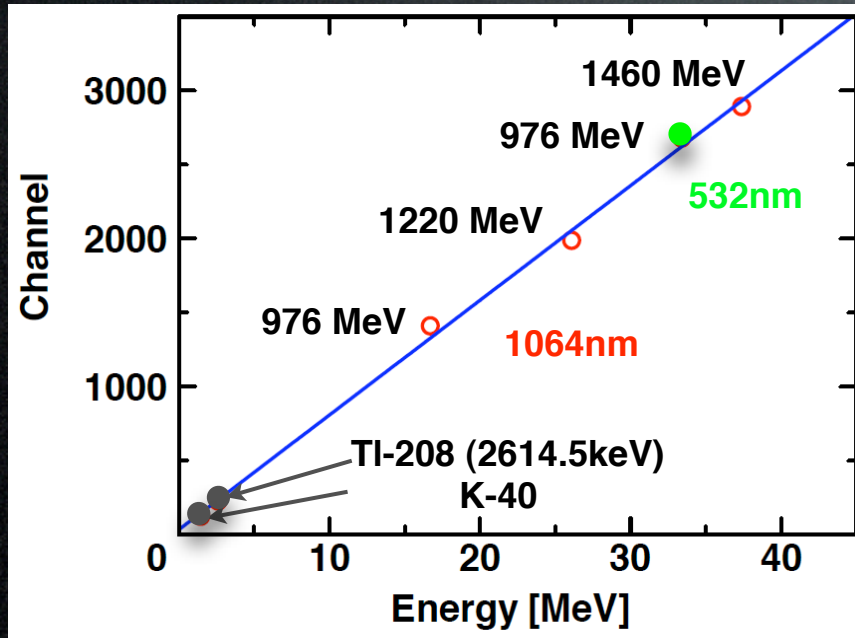
Optical layout of CO₂ laser Compton gamma



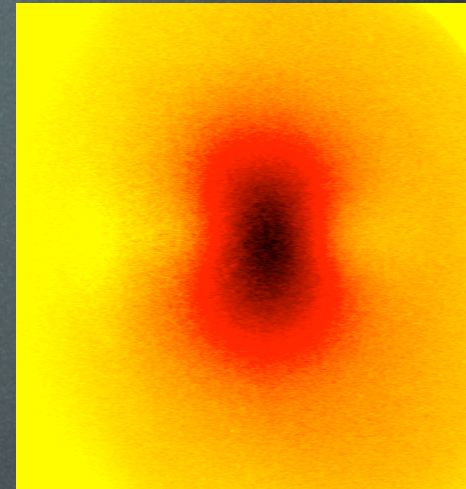
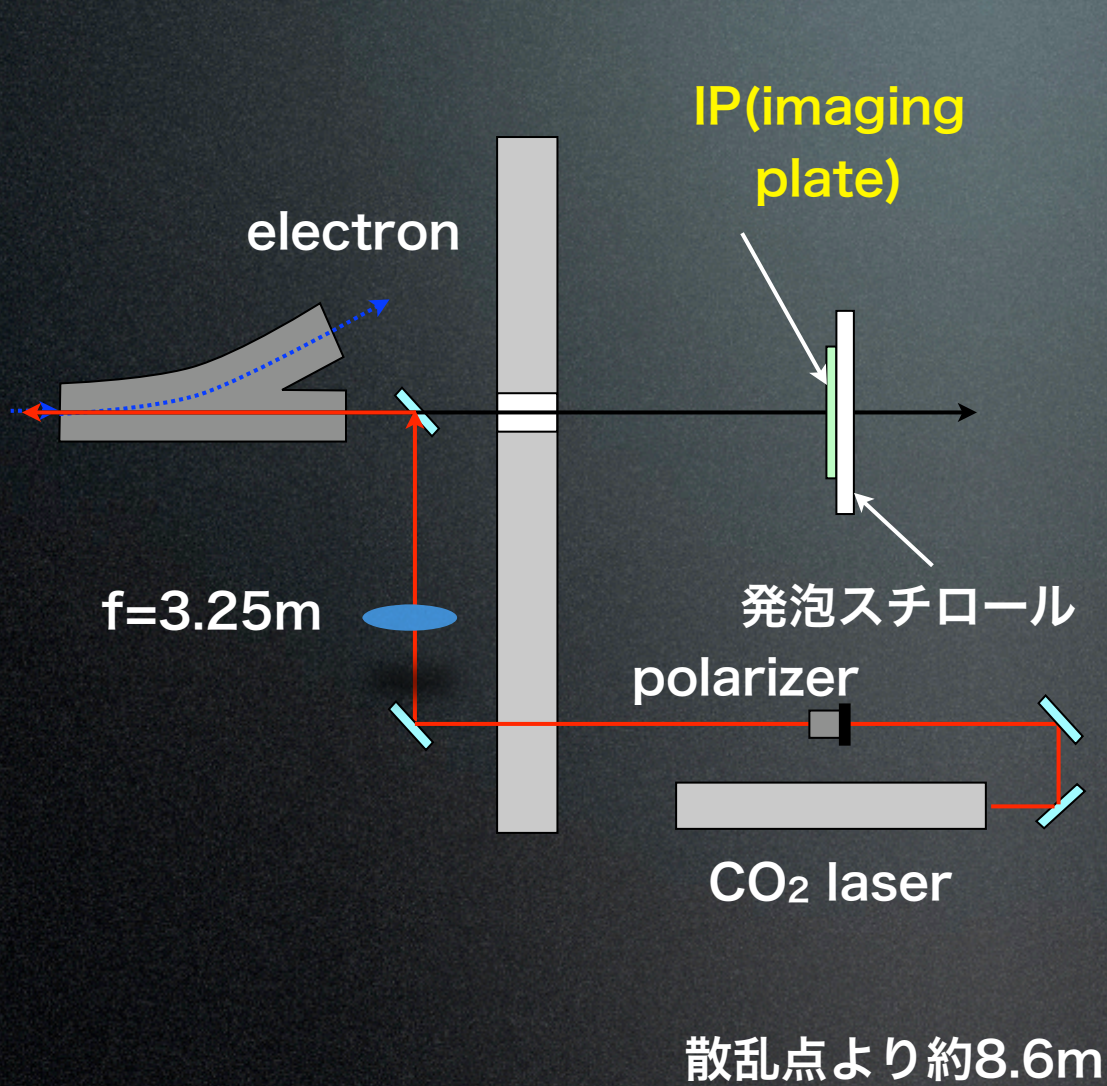
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Gamma-ray Yield

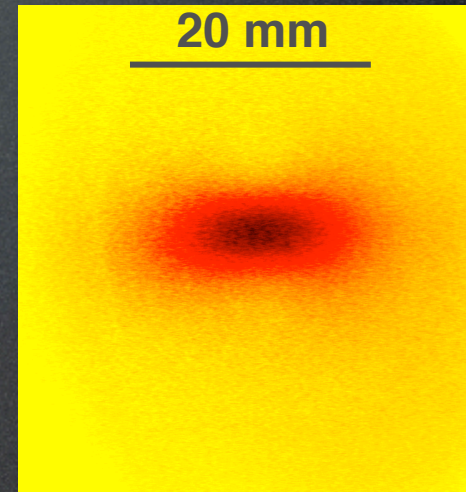
Collimator mm ϕ	yield γ /s/mA/W	yield at 250mA/5W	E range MeV
no	6000	7×10^6 γ /s	6-16.7
6	800	1×10^6 γ /s	14.2-16.7
3	260	3×10^5 γ /s	15-16.7



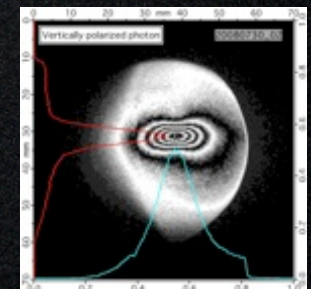
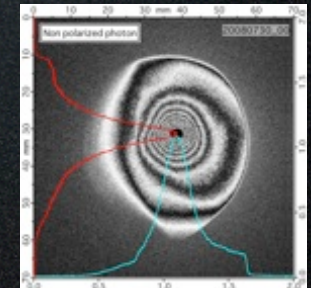
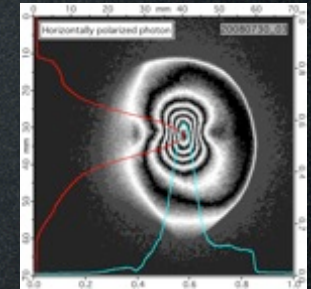
1.7MeVガンマ線強度分布の入射レーザー偏光方向依存性



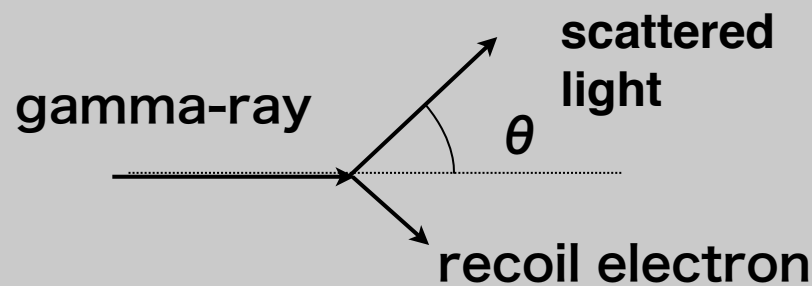
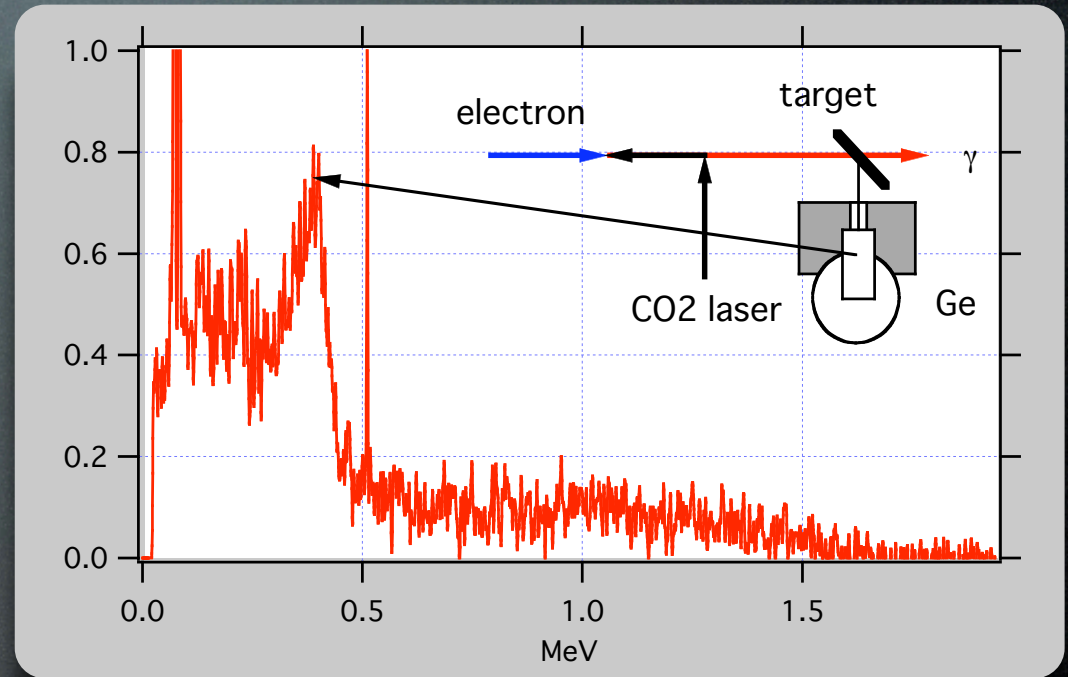
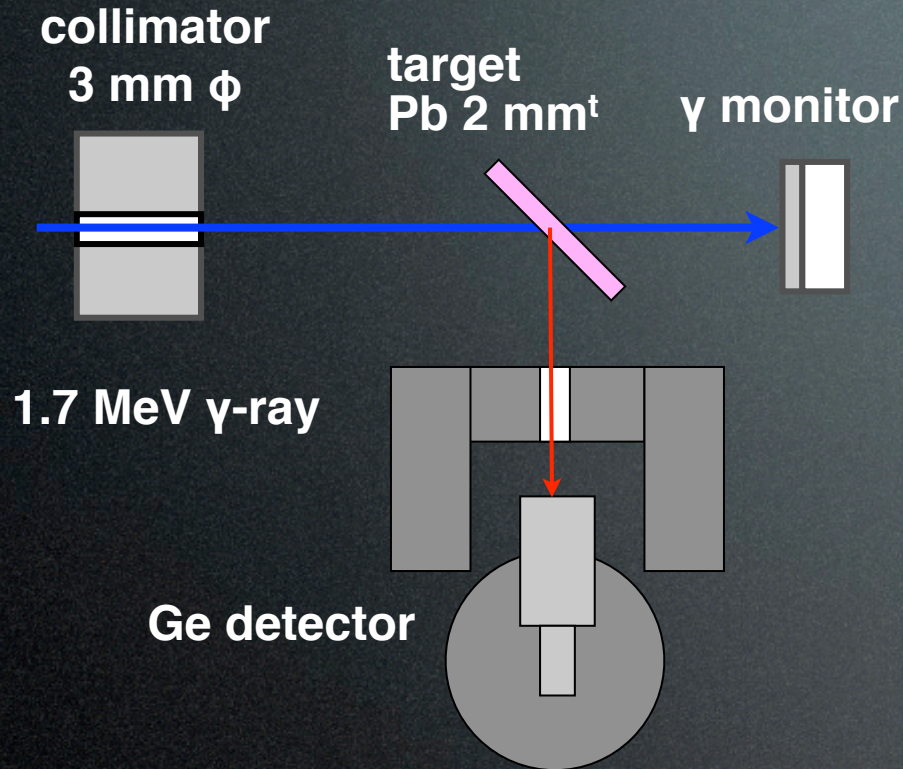
水平偏光
20 mm



垂直偏光



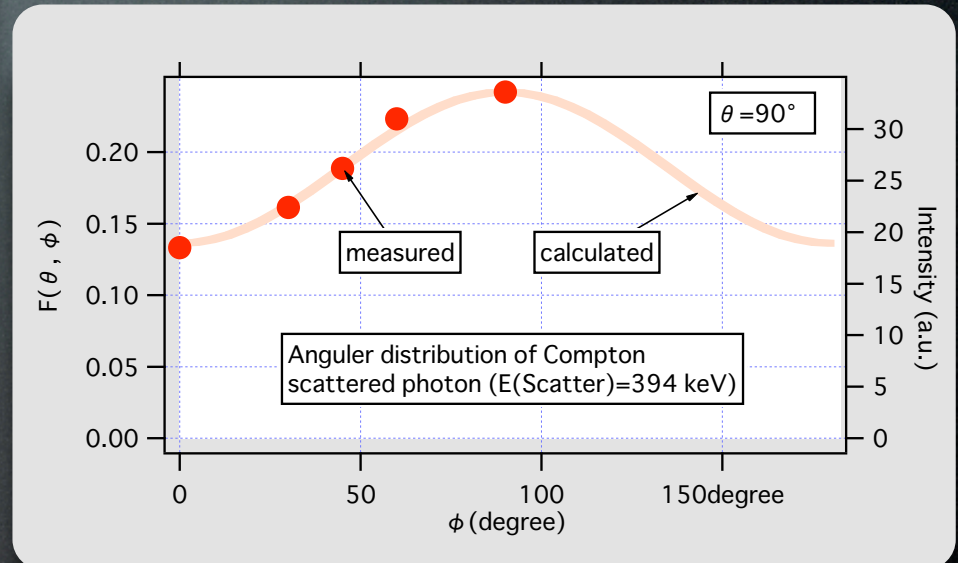
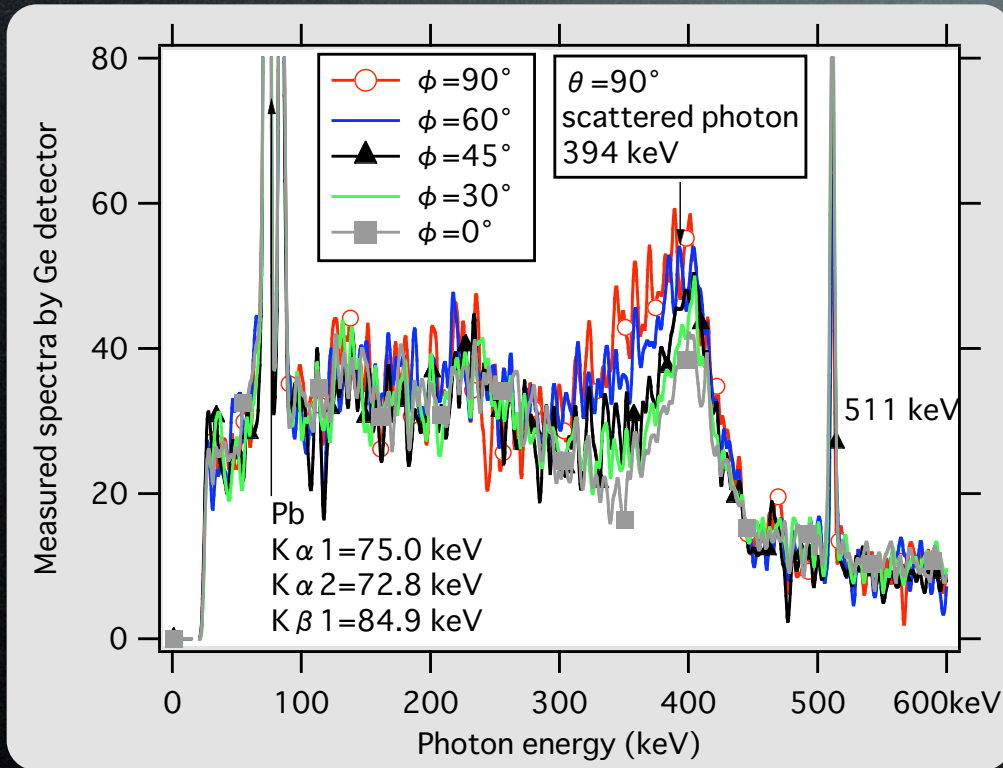
直線偏光ガンマ線のコンプトン散乱角度依存性



$$E_{\gamma}^{\text{Scatter}} = \frac{E_{\gamma}}{1 + \frac{E_{\gamma}}{mc^2}(1 - \cos\theta)}$$



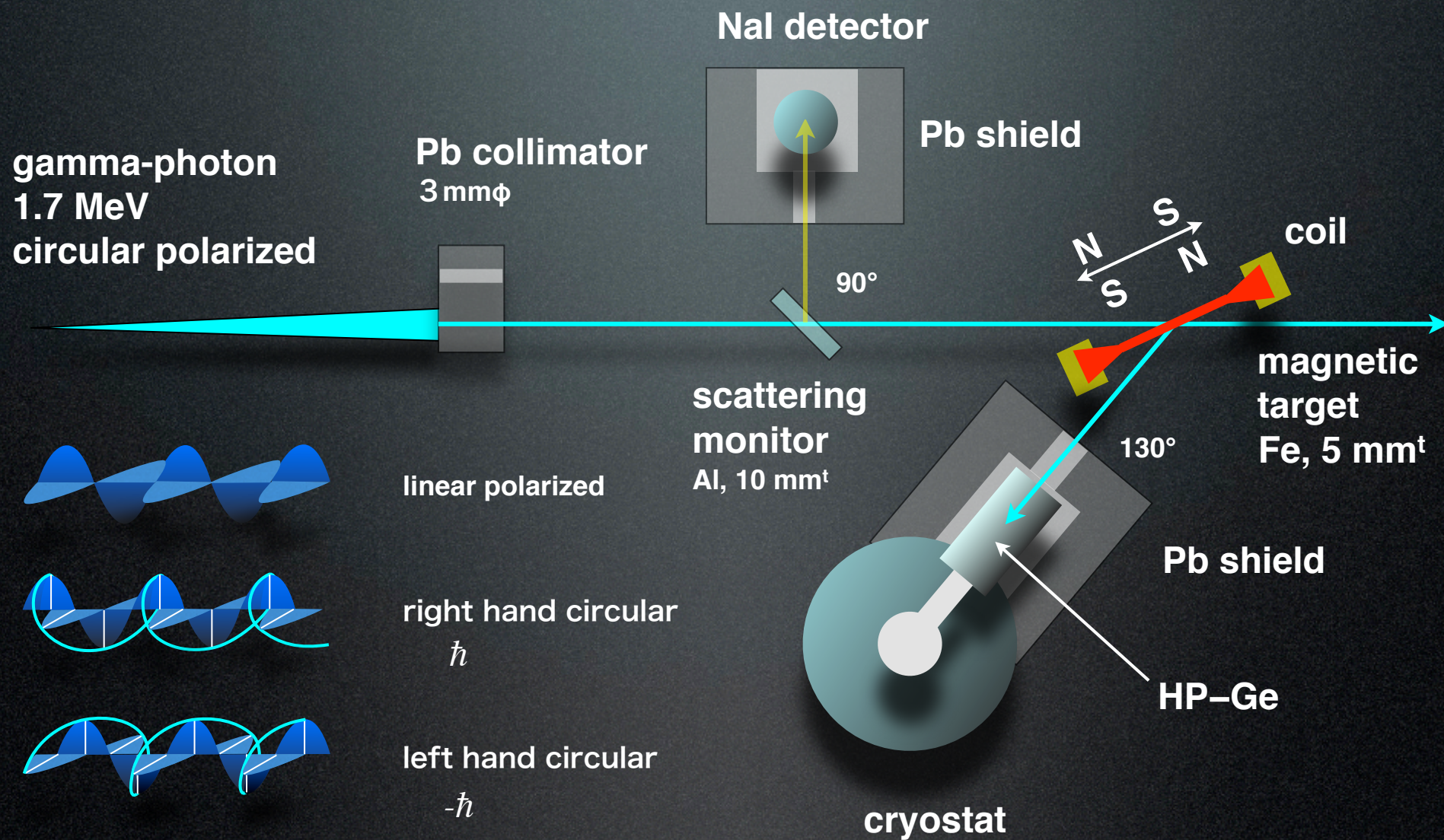
コンプトン散乱強度測定によるガンマ線偏光度測定性



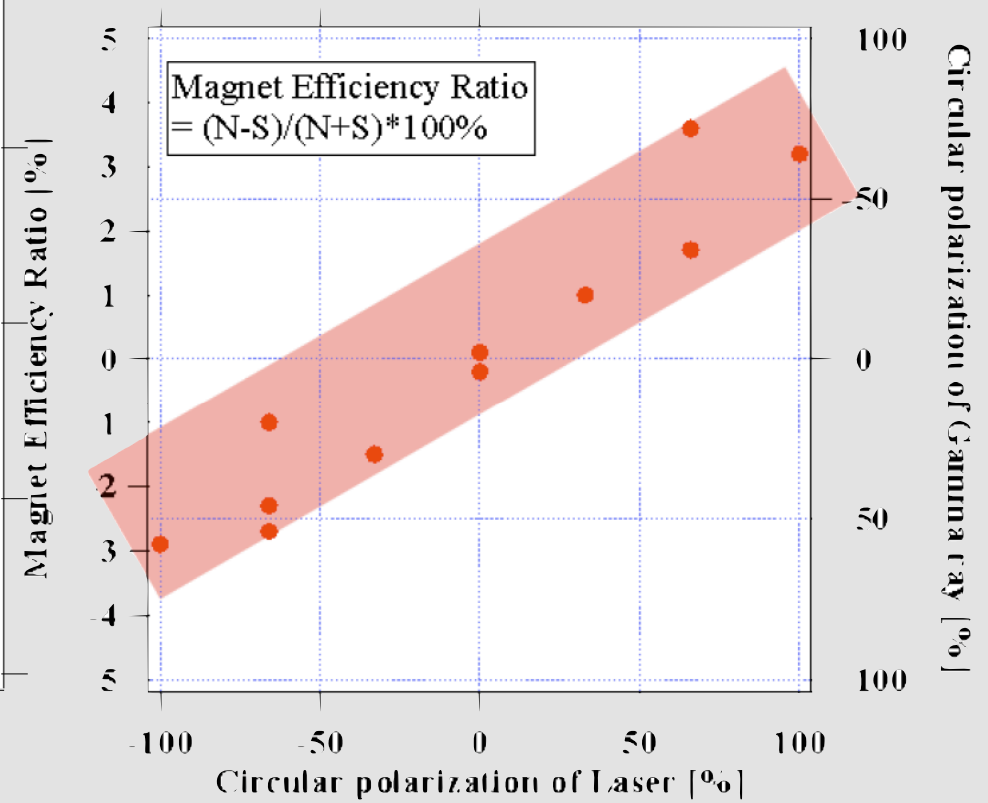
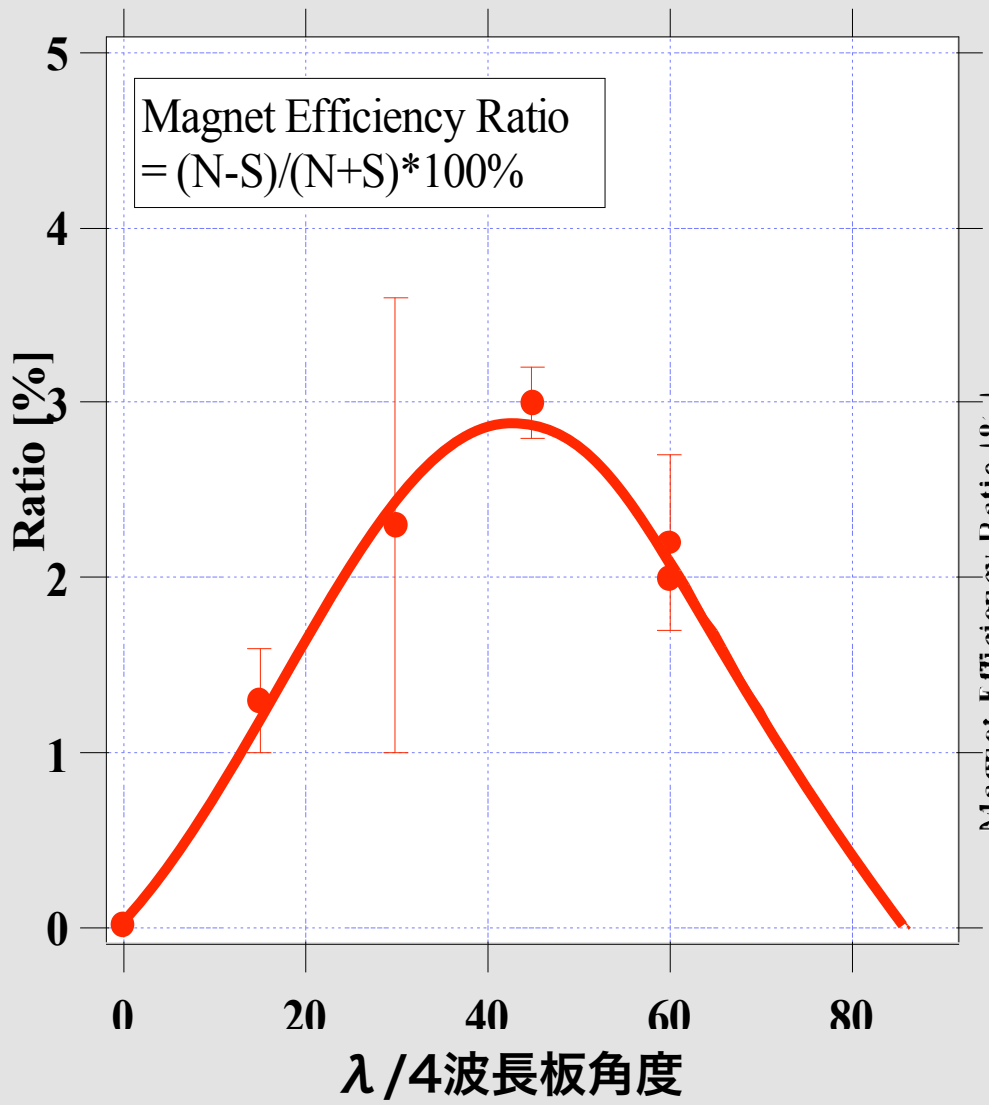
$$\left. \frac{d\sigma}{d\Omega} \right|_{\text{ComptonScatter}} = \frac{1}{2} r_0^2 \left(\frac{E_{\gamma}^{\text{Scatter}}}{E_{\gamma}} \right)^2 \left(\frac{E_{\gamma}^{\text{Scatter}}}{E_{\gamma}} + \frac{E_{\gamma}}{E_{\gamma}^{\text{Scatter}}} - 2 \sin^2 \theta \cos^2 \phi \right)$$



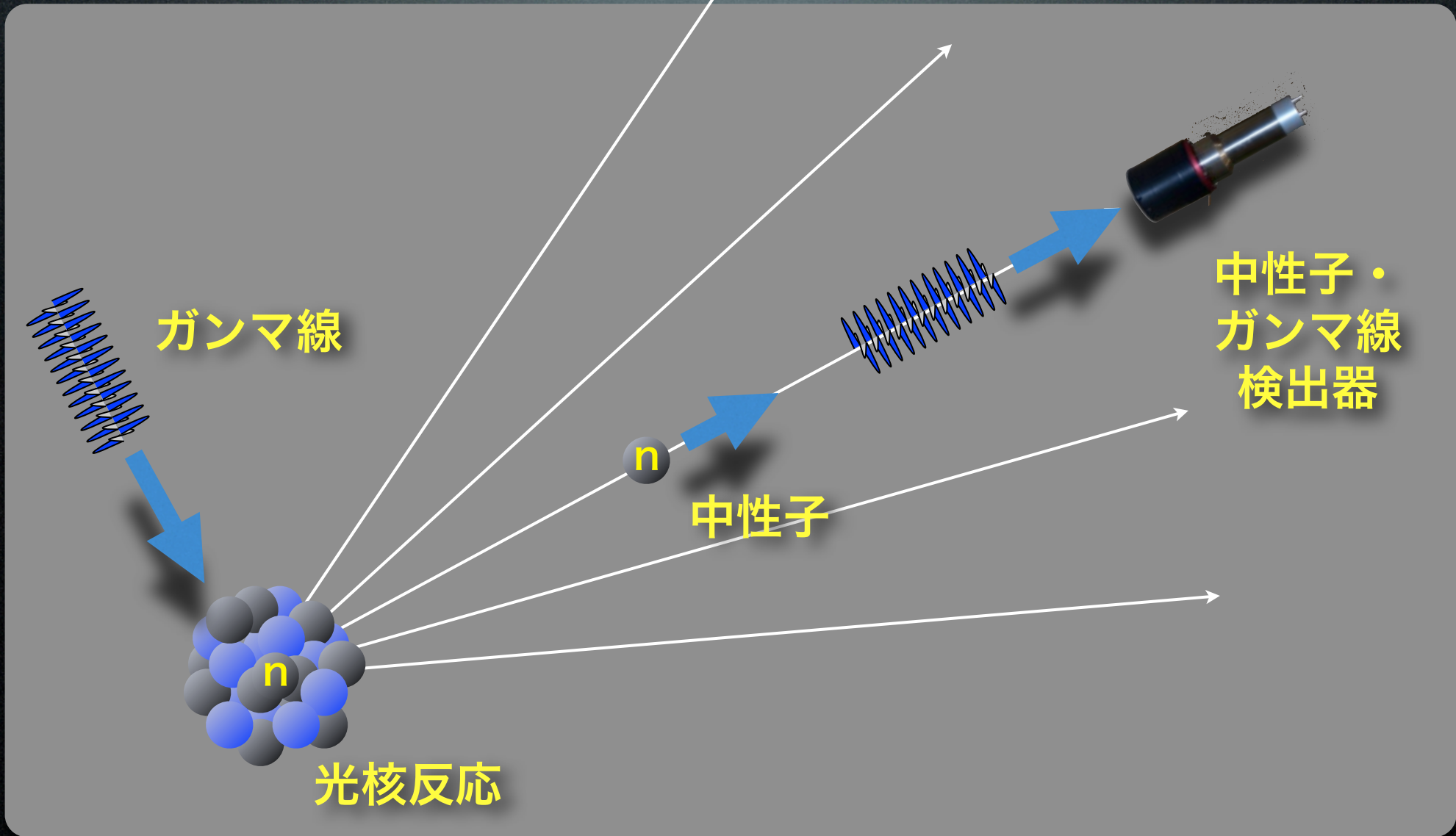
磁性体による円偏光ガンマ線の散乱



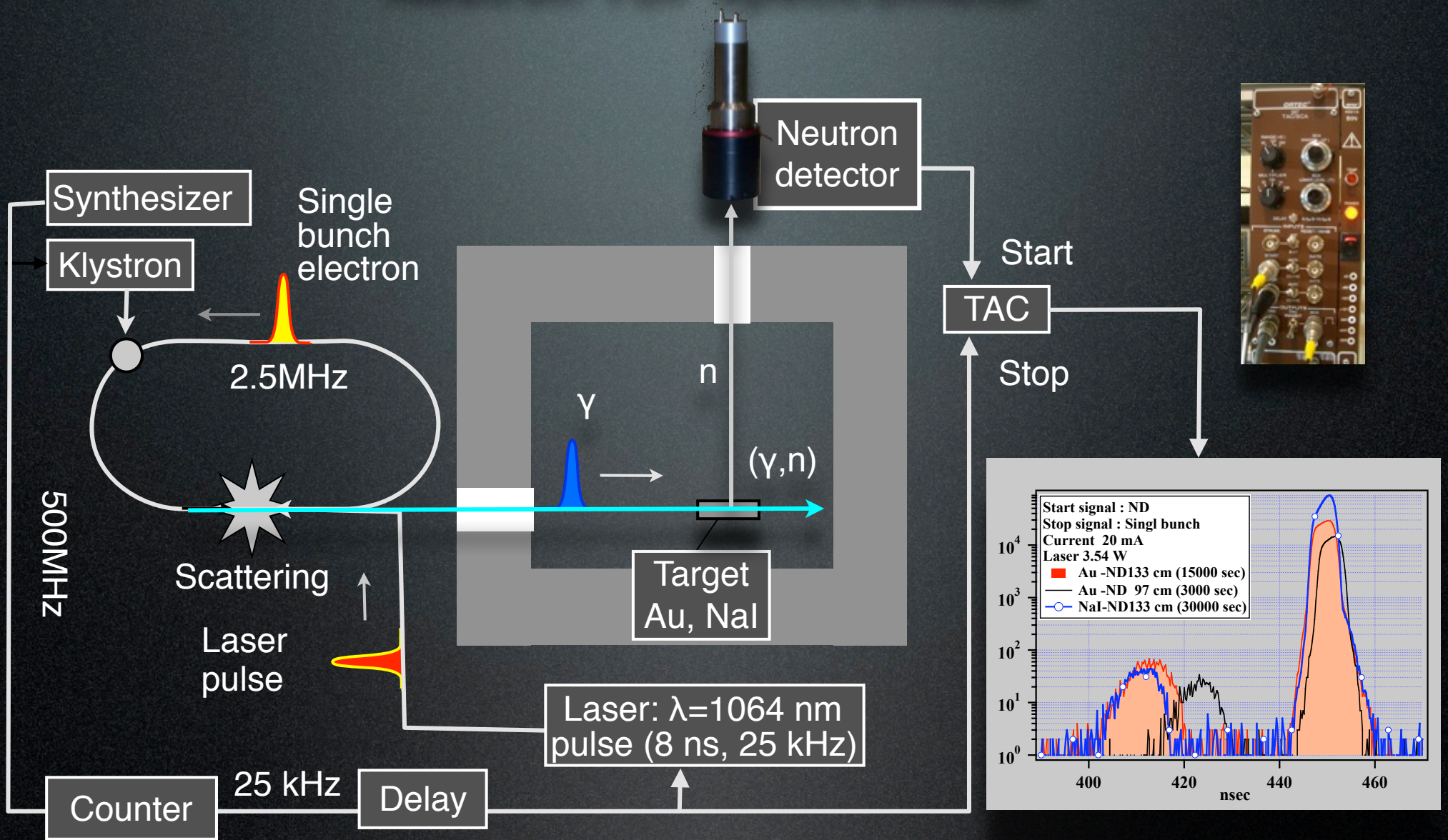
磁気Compton散乱強度測定によるガンマ線円偏光度測定



Basic research for nuclear waste disposal

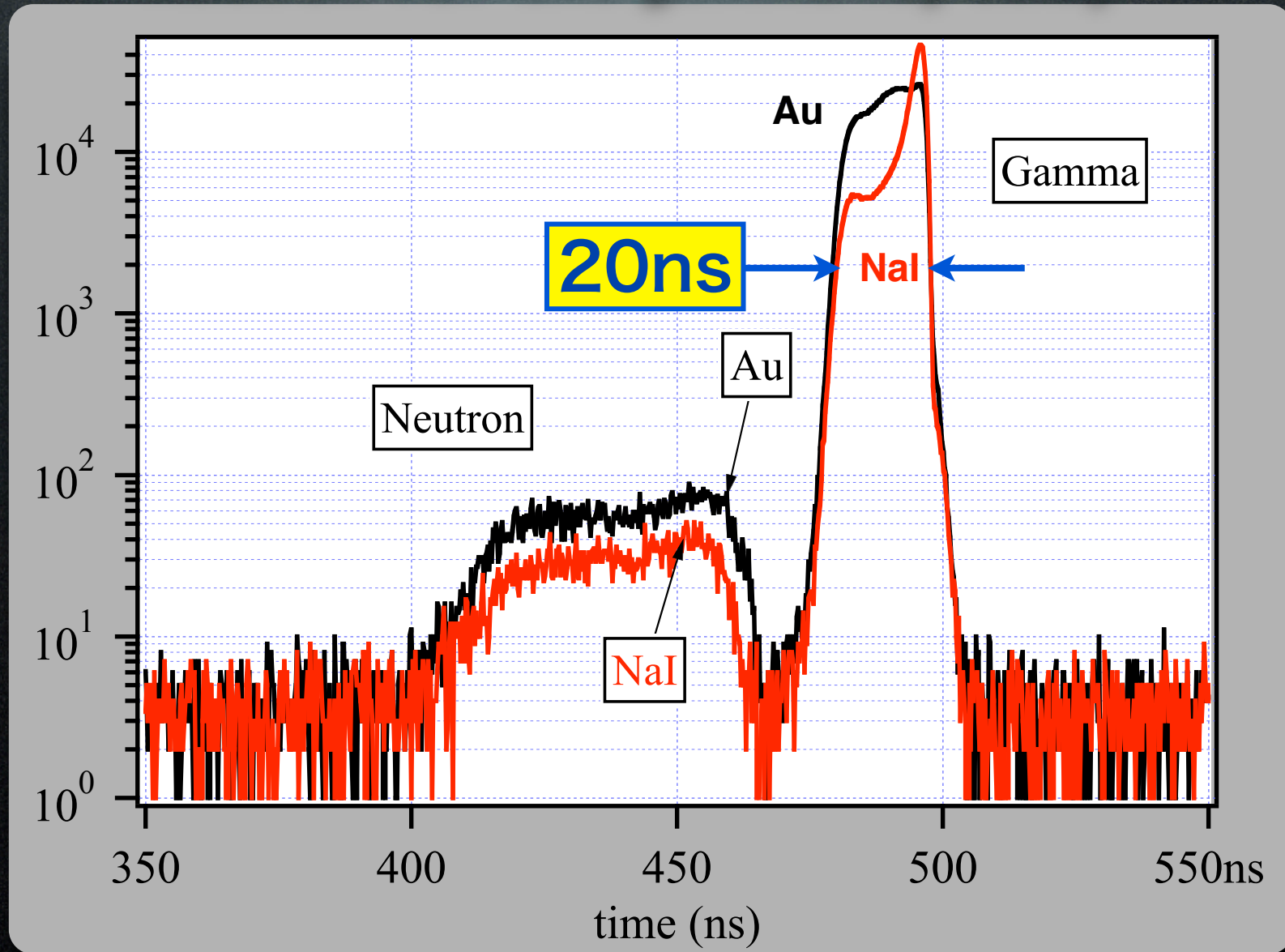


Neutron TOF spectrometer

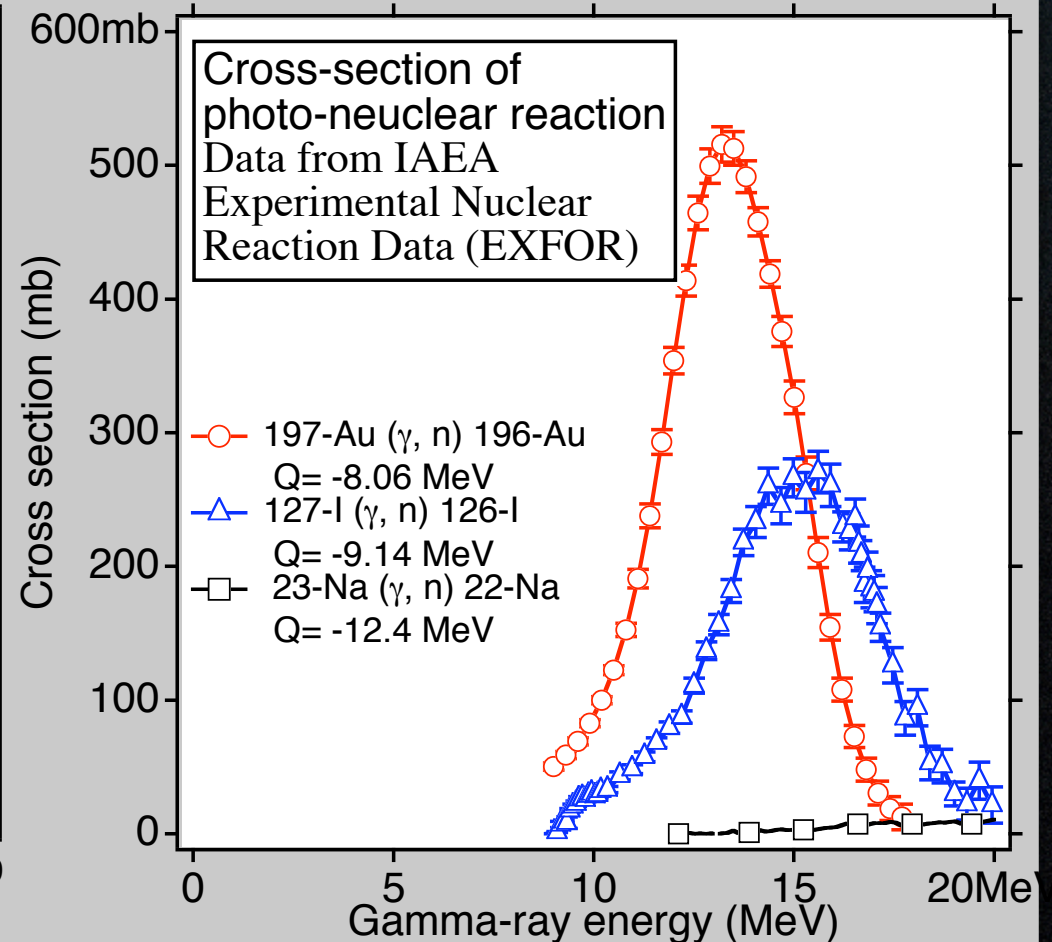
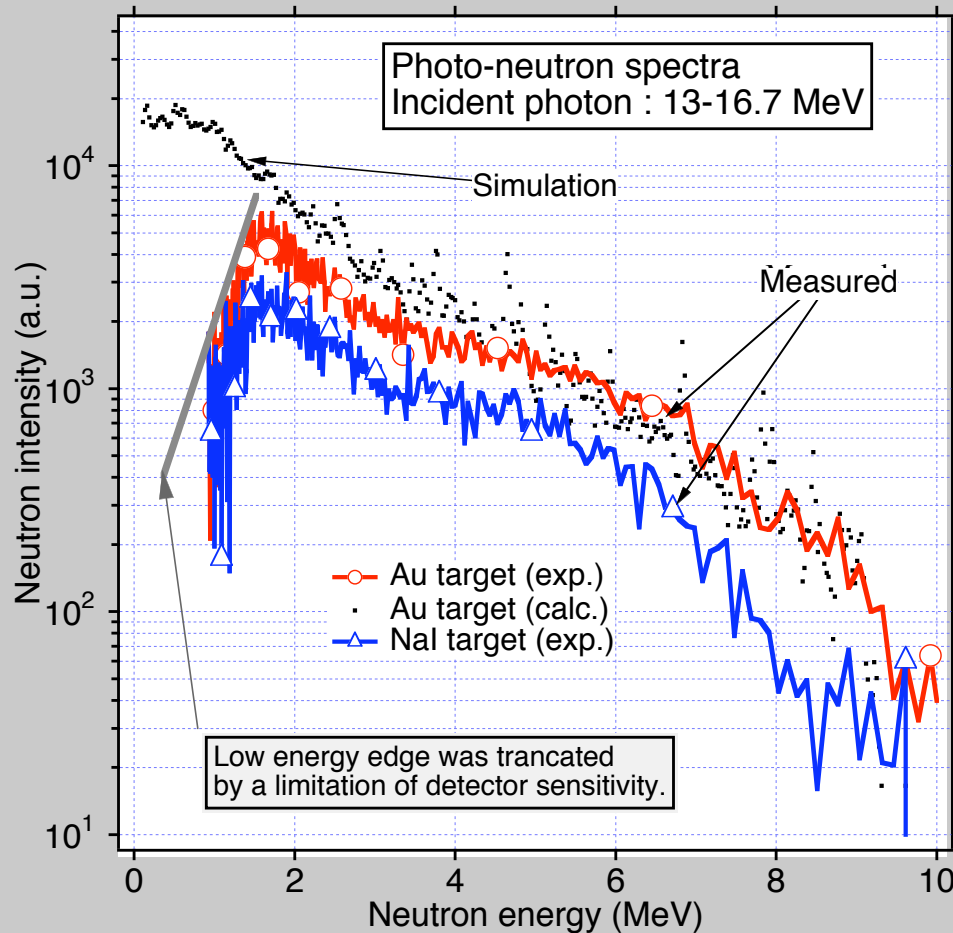


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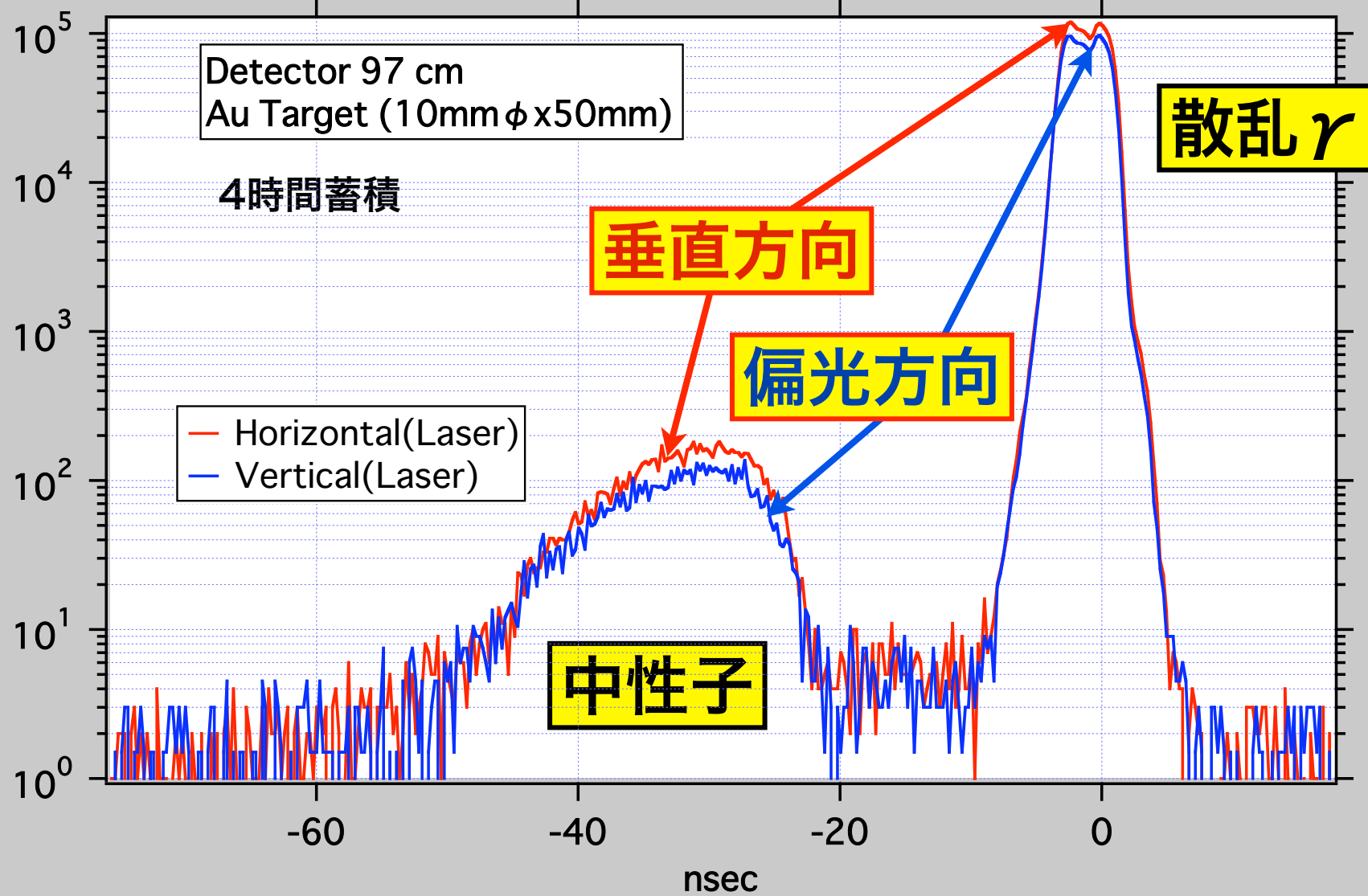
Neutron TOF and gamma-ray delay



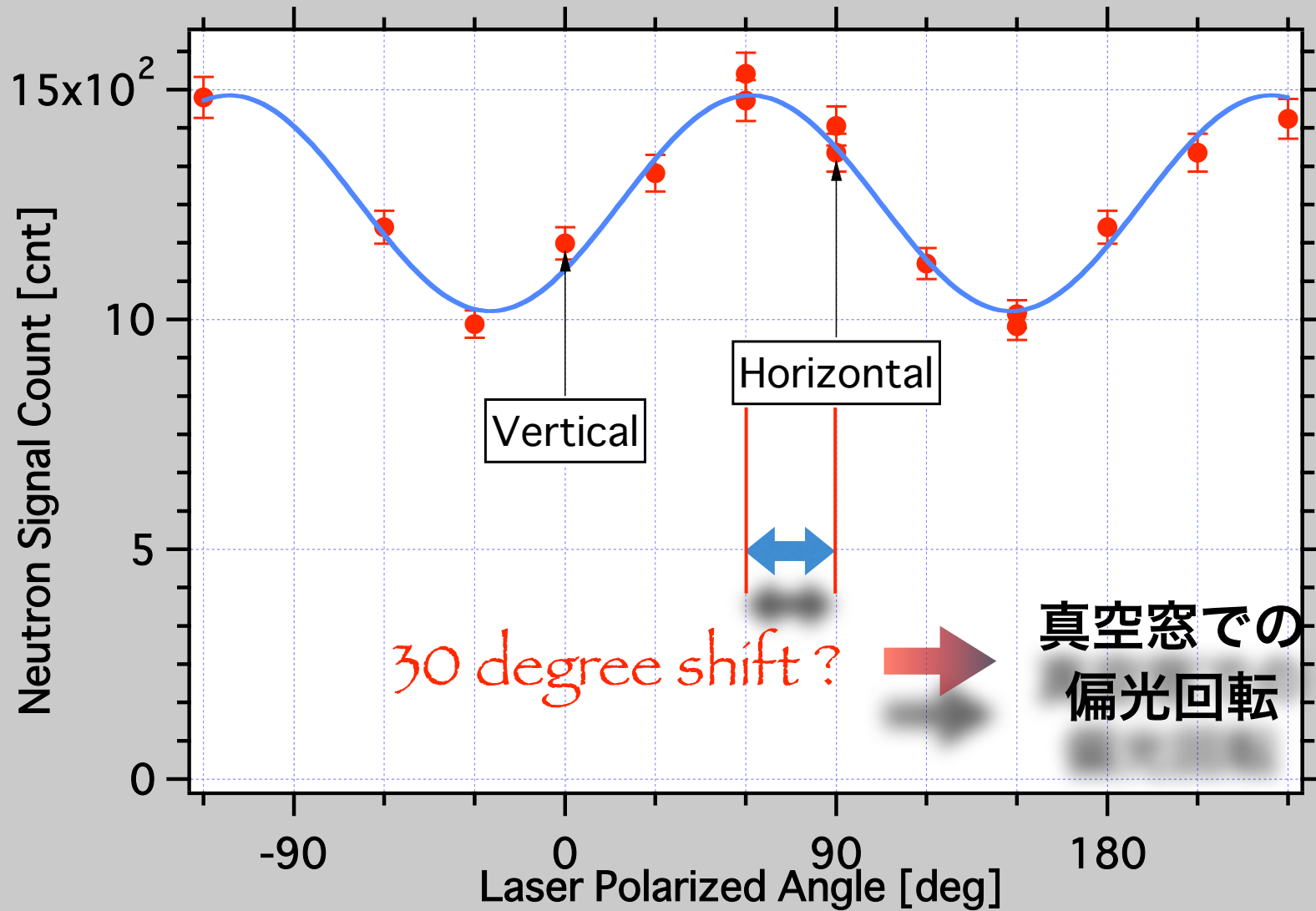
Neutron spectra of photo nuclear reaction



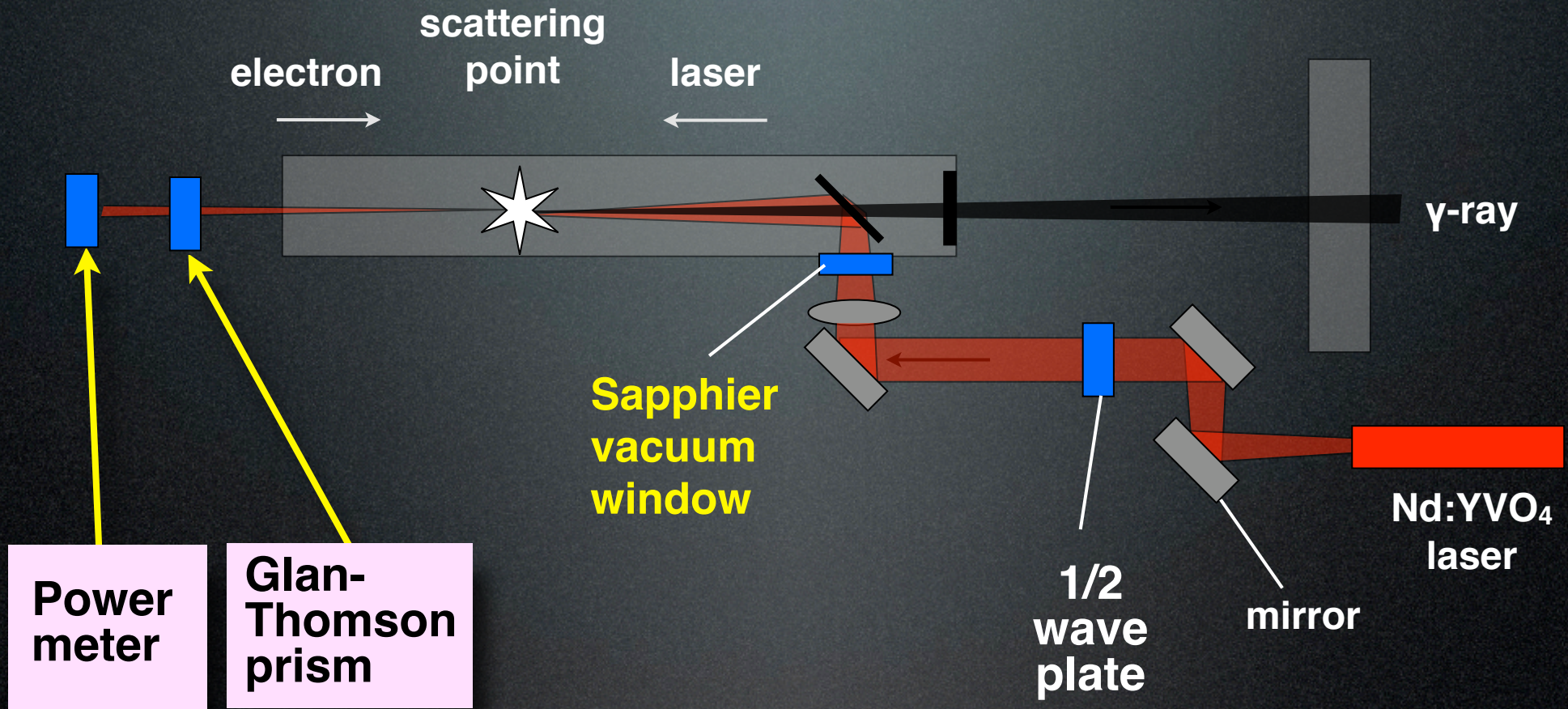
中性子および散乱ガンマ線の偏光依存



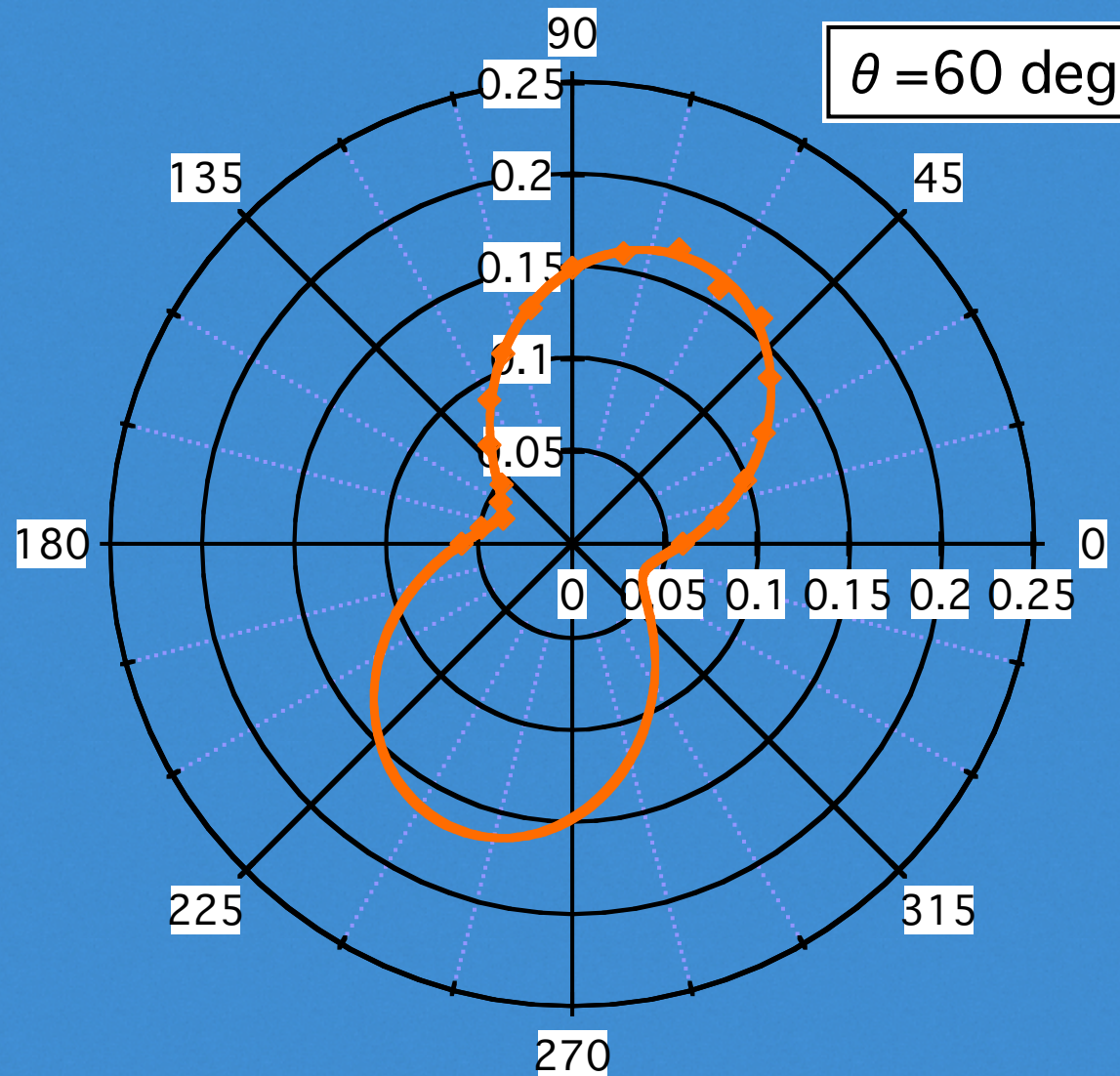
中性子発生分布のガンマ線偏光依存 (楕円偏光)



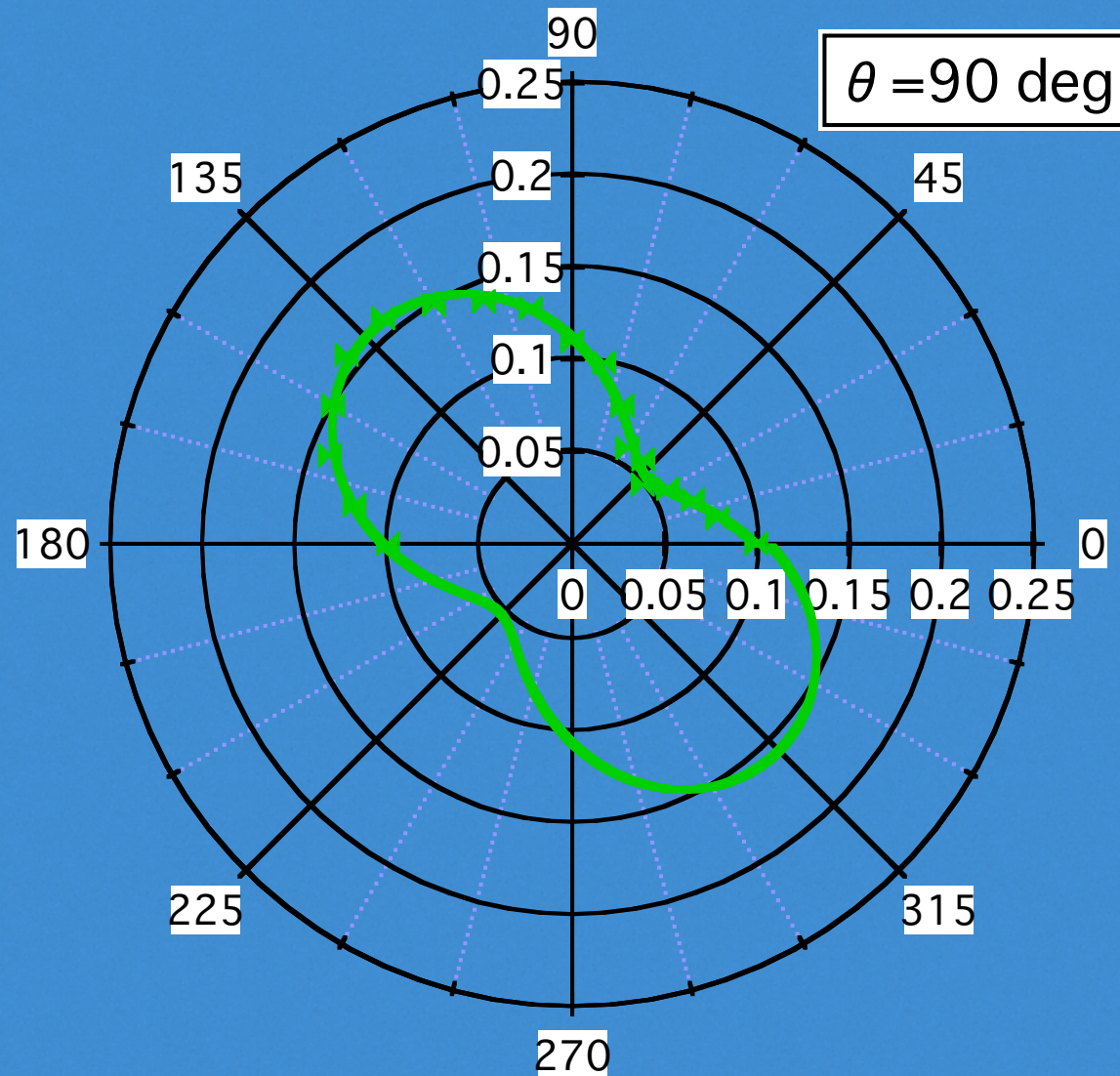
Glan-Thomson Prism で透過レーザーの偏光計測



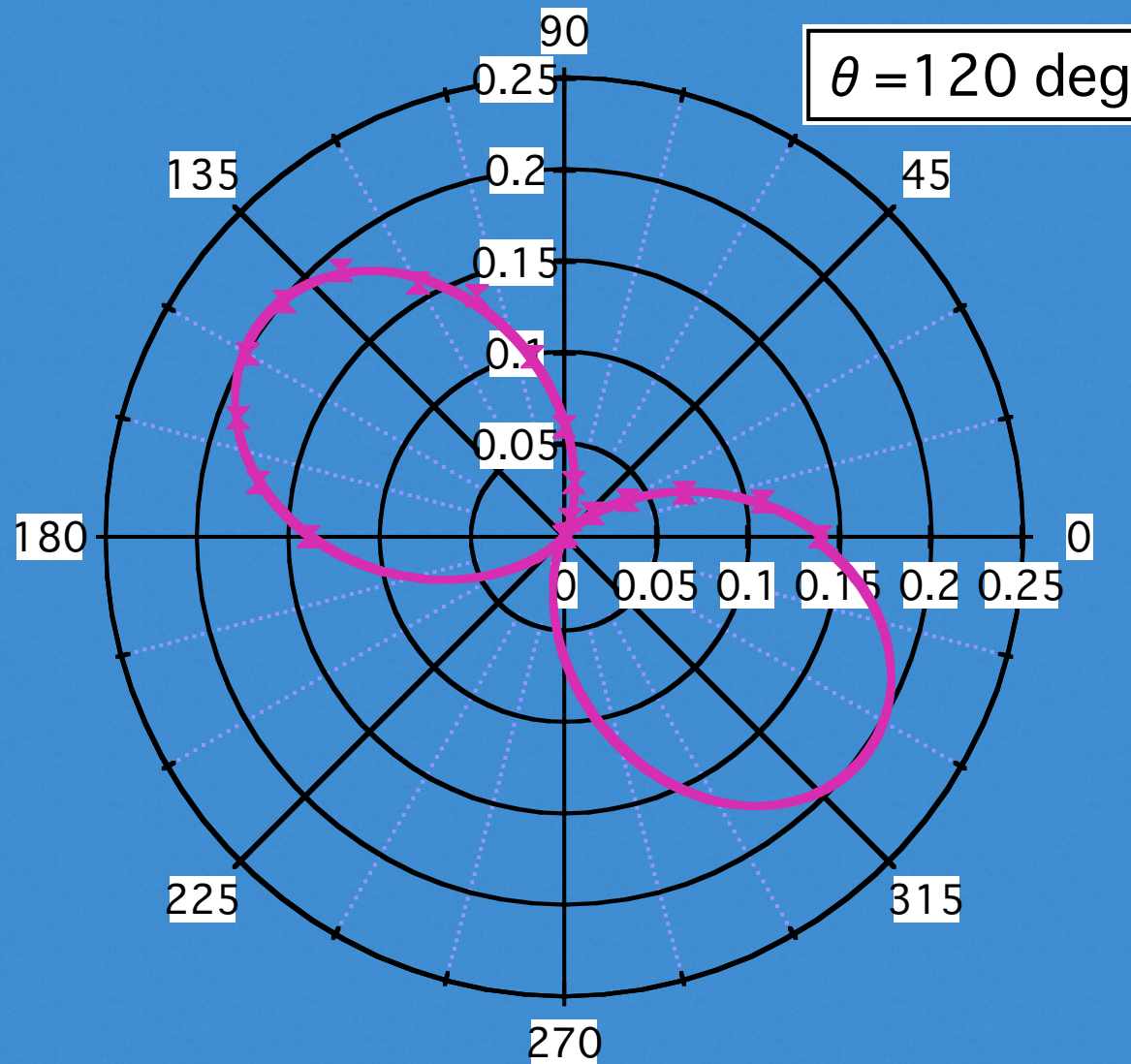
透過レーザーの偏光特性：60°入射（サファイア窓）



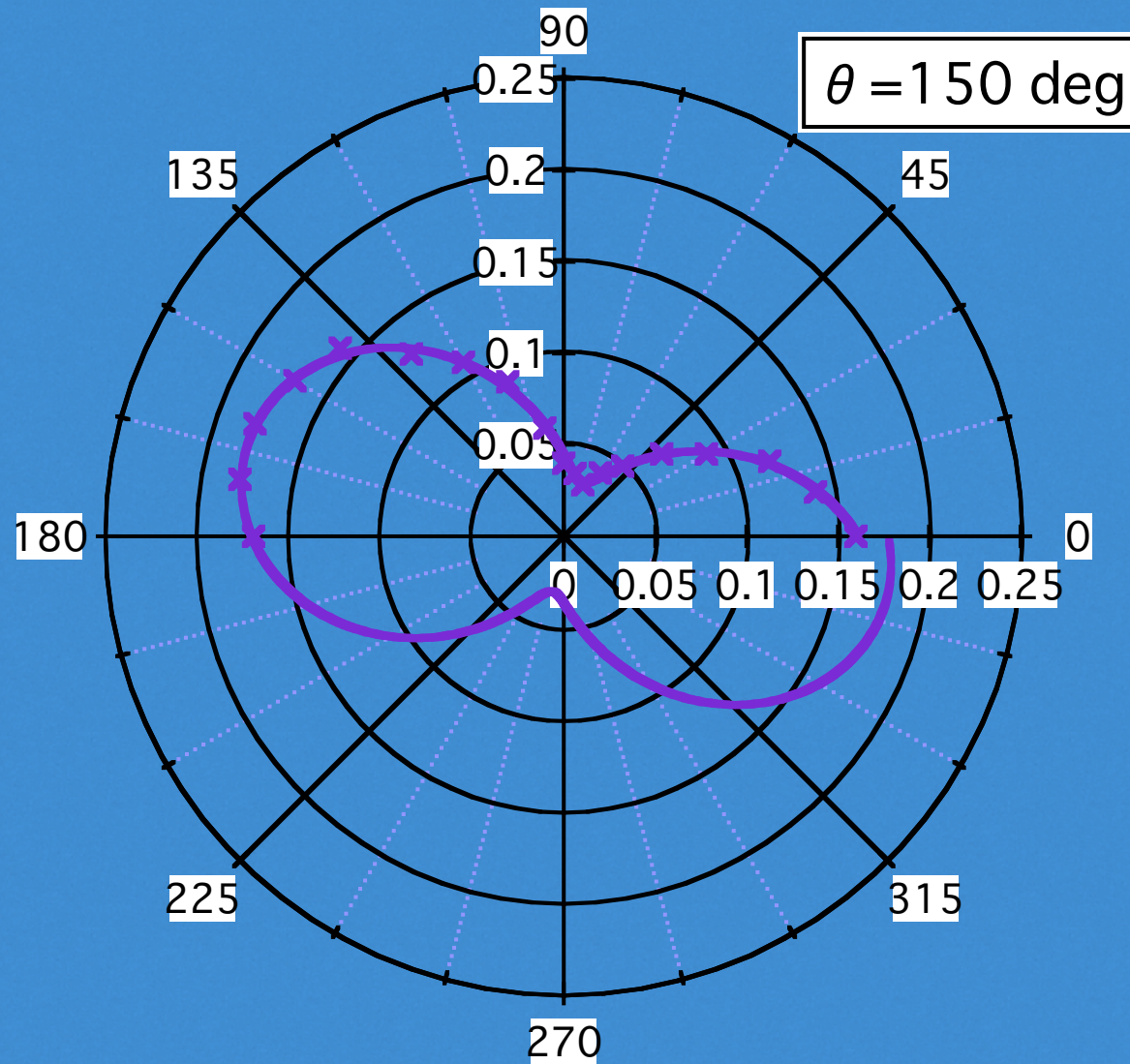
透過レーザーの偏光特性：90°入射（サファイア窓）



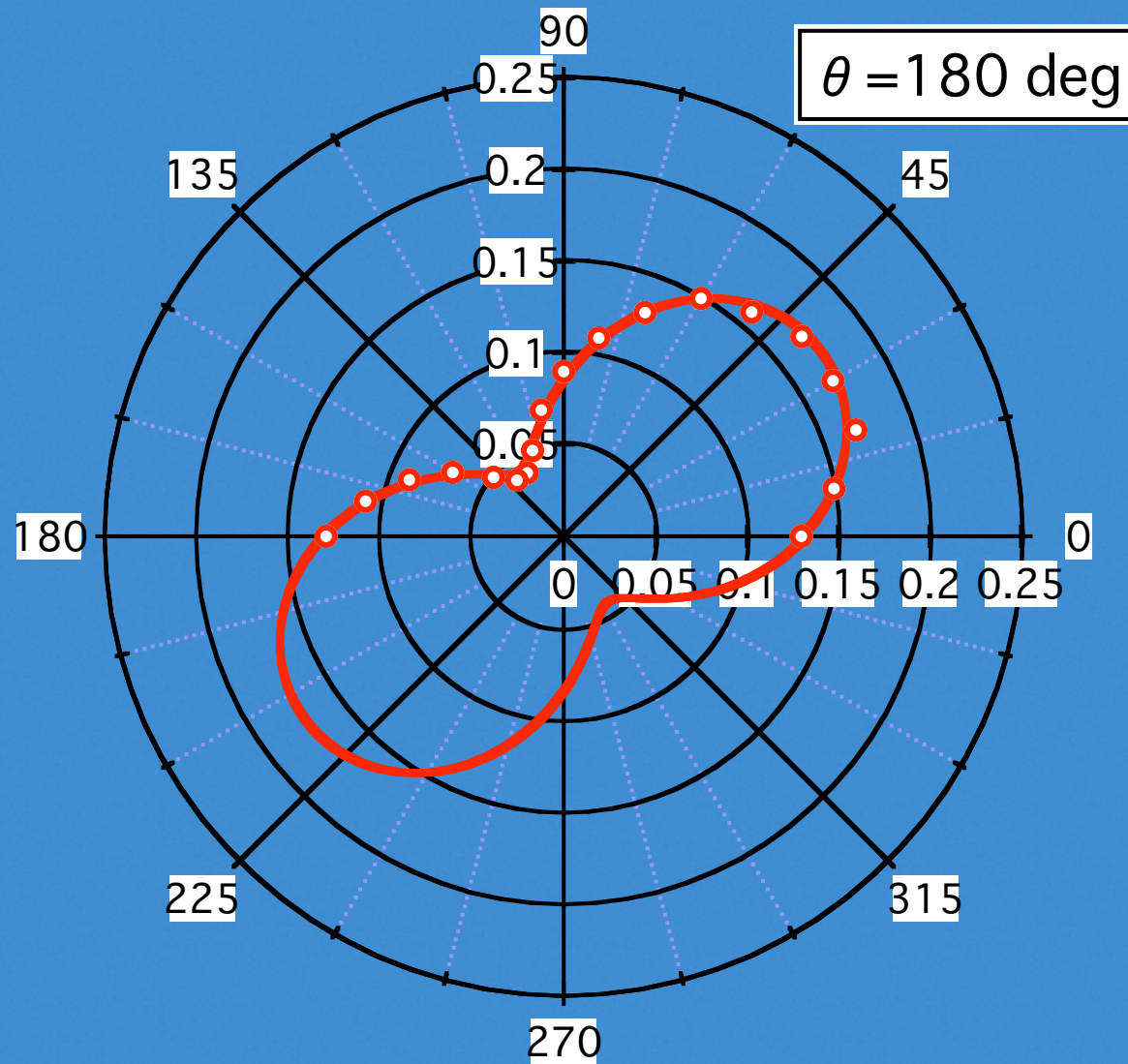
透過レーザーの偏光特性：120°入射（サファイア窓）



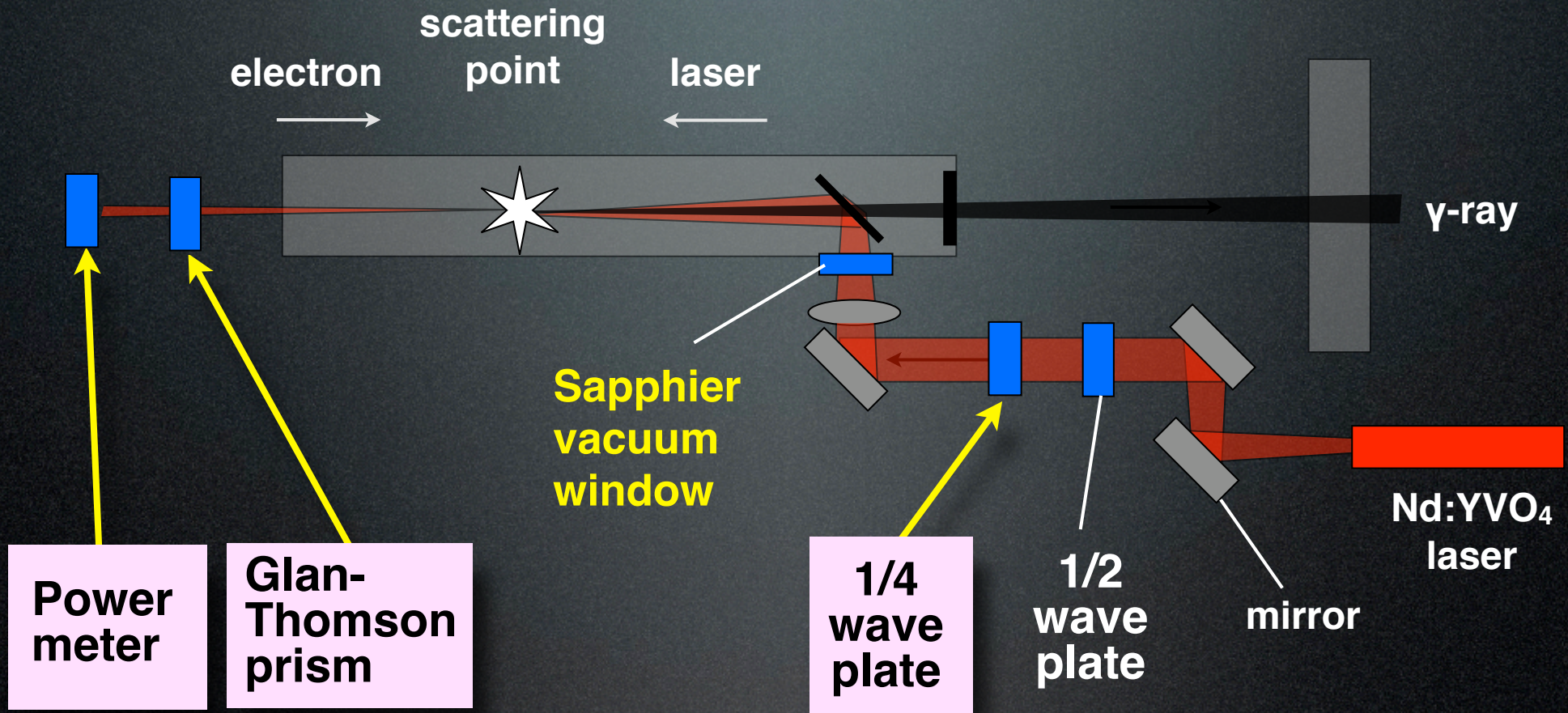
透過レーザーの偏光特性：150°入射（サファイア窓）



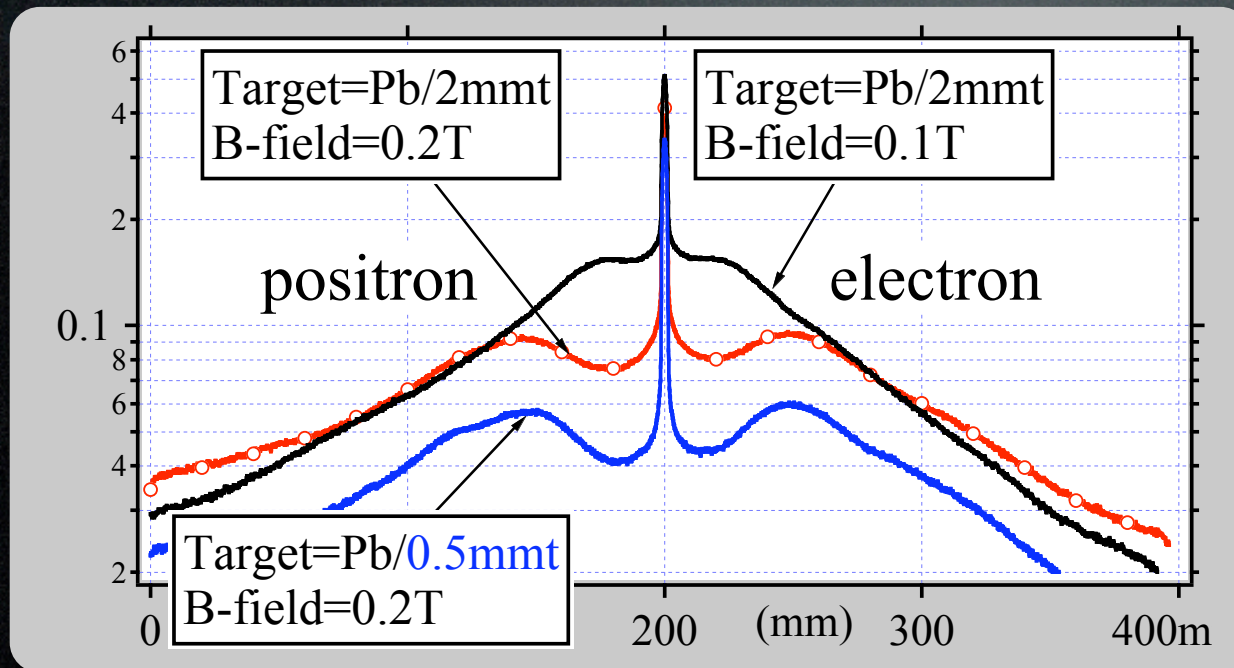
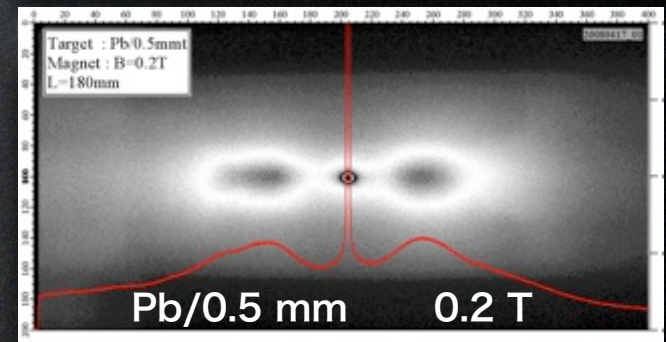
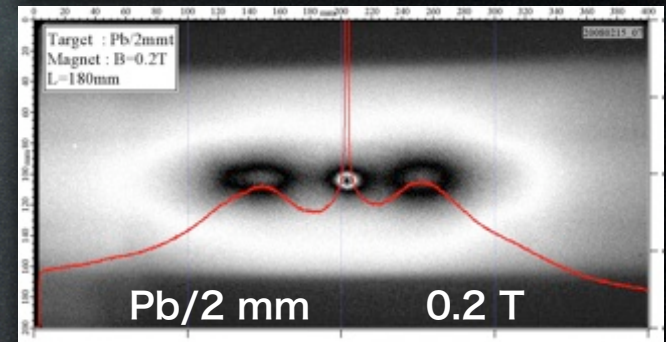
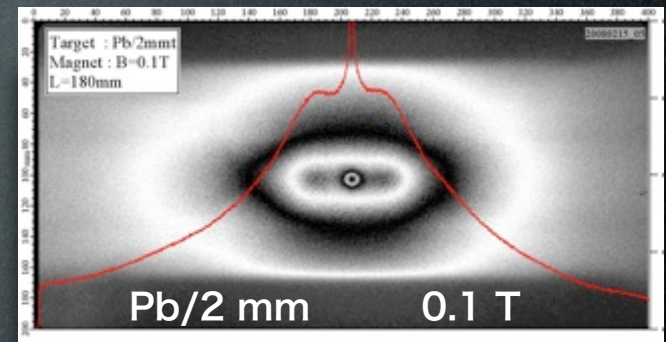
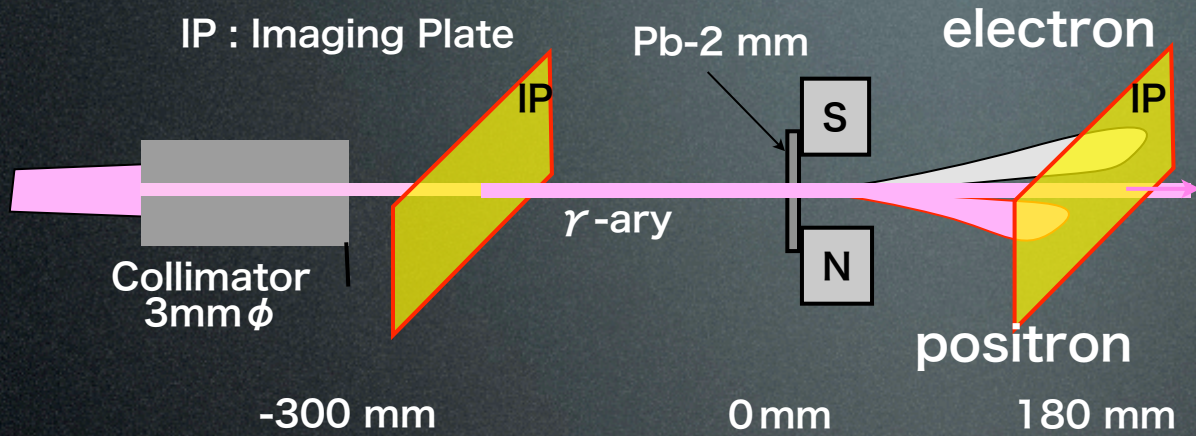
透過レーザーの偏光特性：180°入射（サファイア窓）



透過レーザーの偏光をモニターしながら1/4波長板で補正



17MeVガンマ線による電子対生成



Thank you.

Lasti  

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