

Reconfiguration of G4LowEPPhysics for Low Energy Polarised X-/gamma Ray Transport

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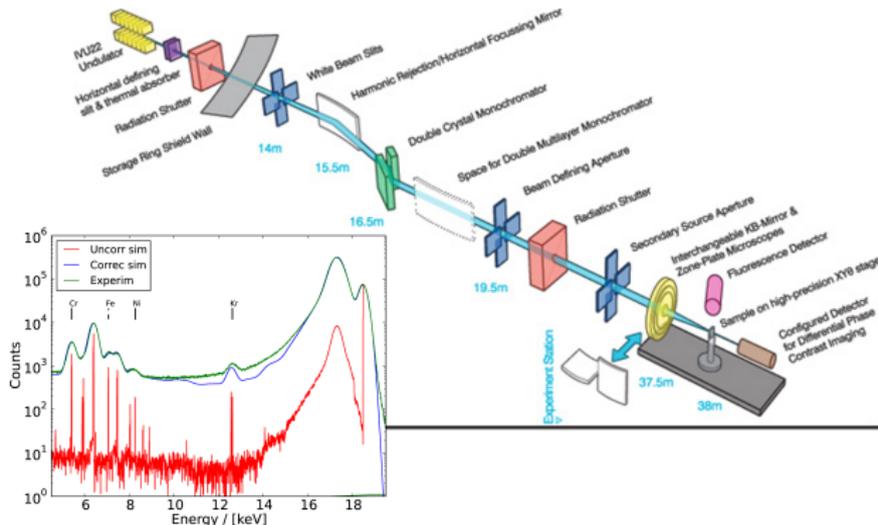
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J. M. C. Brown and M. R. Dimmock, NIMB 502 (2021)

Motivation

- + Increased interest in Geant4 polarised gamma ray studies:
 - Laser driven polarised x-ray sources
 - Synchrotron: MRT, XFM, etc.
 - X-ray/Gamma ray astronomy instruments
- + Targeted sub-10 MeV polarised gamma physics list

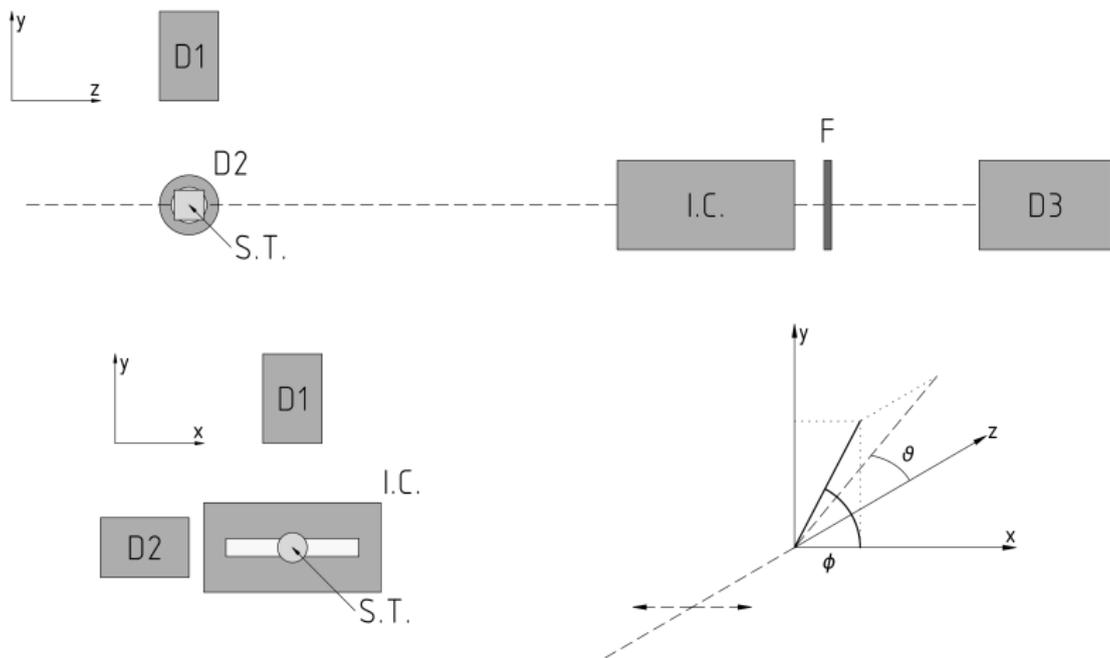


M. R. Dimmock et al., JSR 22 (2015)

G4LowEPPhysics Physics List

Physical Process	Model Class	Energy Range
X-/Gamma ray		
Photoelectric Absorption	G4LivermorePolarizedPhotoElectricModel	eV - TeV
Rayleigh Scattering	G4LivermorePolarizedRayleighModel	250 eV - TeV
Compton Scattering	G4LowEPPolarizedComptonModel	eV - TeV
Gamma Conversion	G4BetheHeitler5DModel	1.022 MeV - TeV
Electron		
Ionisation	G4LivermoreIonisationModel G4UniversalFluctuation	eV - 100 keV 100 keV - TeV
Bremsstrahlung	G4SeltzerBergerModel G4eBremsstrahlungRelModel	eV - GeV GeV - TeV
Multiple Scattering	G4GoudsmitSaundersonMscModel G4WentzelVIModel	eV - 100 MeV 100 MeV - TeV
Positron		
Annihilation	G4eplusAnnihilation	1.022 MeV - TeV
Ionisation	G4PenelopeIonisationModel G4UniversalFluctuation	eV - 100 keV 100 keV - TeV
Bremsstrahlung	G4SeltzerBergerModel G4eBremsstrahlungRelModel	eV - GeV GeV - TeV
Multiple Scattering	G4GoudsmitSaundersonMscModel G4WentzelVIModel	eV - 100 MeV 100 MeV - TeV

F. Tokanai et al., NIMA 530(3) (2004)



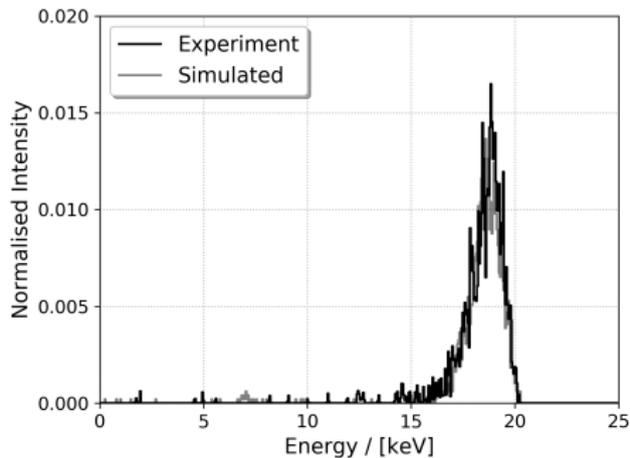
Geometry Parameters

Incident X-ray Energy	Polypropylene Scattering Target	Metal Filter Material	Metal Filter Thicknesses	Detector Azimuthal Angle Positions
20 keV	10 mm diameter, 10 mm length (S1)	Copper (Cu)	300 μm \pm 25, 50 μm	0°, 15°, 30°, ..., 180°
20 keV	5 mm diameter, 7 mm length (S2)	Copper (Cu)	300 μm \pm 25, 50 μm	0°, 15°, 30°, ..., 180°
40 keV	5 mm diameter, 7 mm length (S2)	Lead (Pb)	600 μm \pm 25, 50 μm	0°, 15°, 30°, ..., 180°

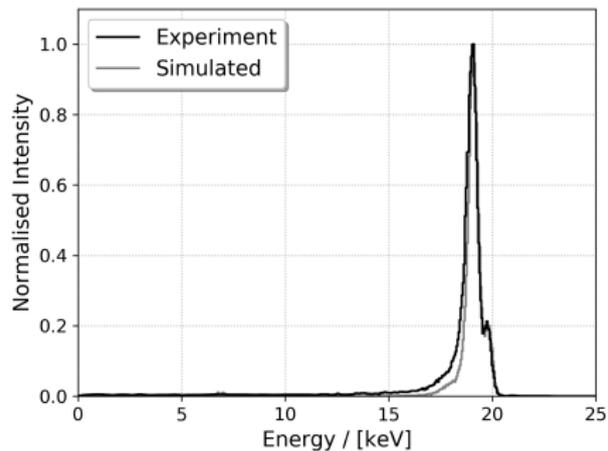
Physics Settings

- + Primary Per Geom. Config: 10^{10} horizontally polarised
- + Production Cut: 10 μm (gamma and electrons)
- + Low-energy Cut: 250 eV
- + De-excitation: X-ray fluo. and Auger on

Results: 20 keV and S1 (D=10mm, L=10mm)

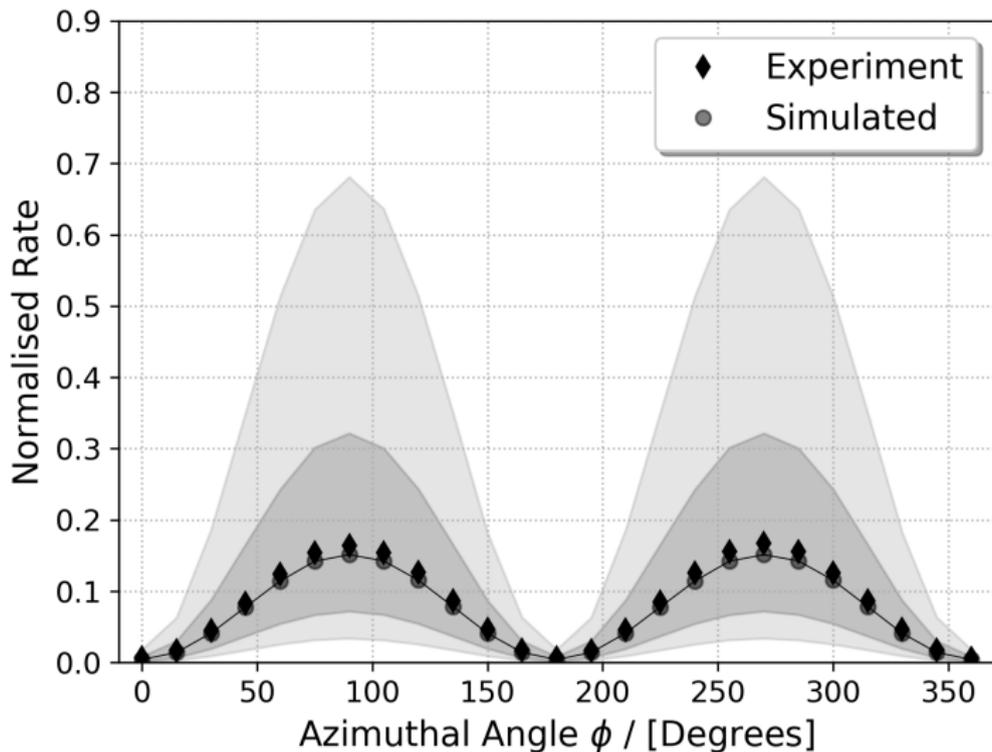


$\phi = 0^\circ$

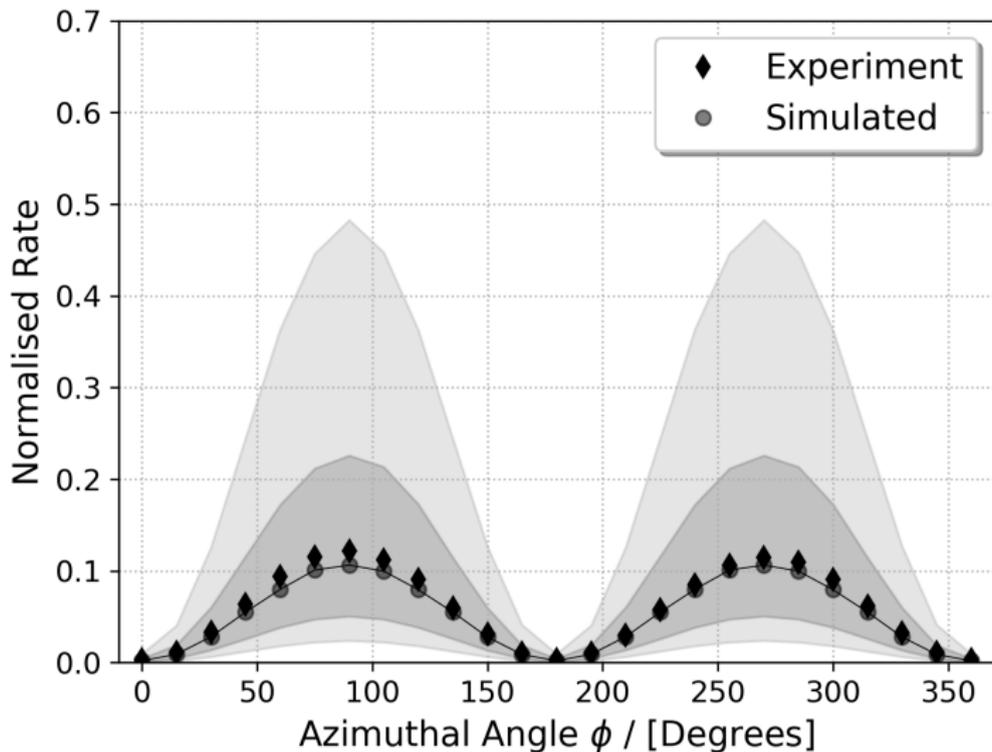


$\phi = 90^\circ$

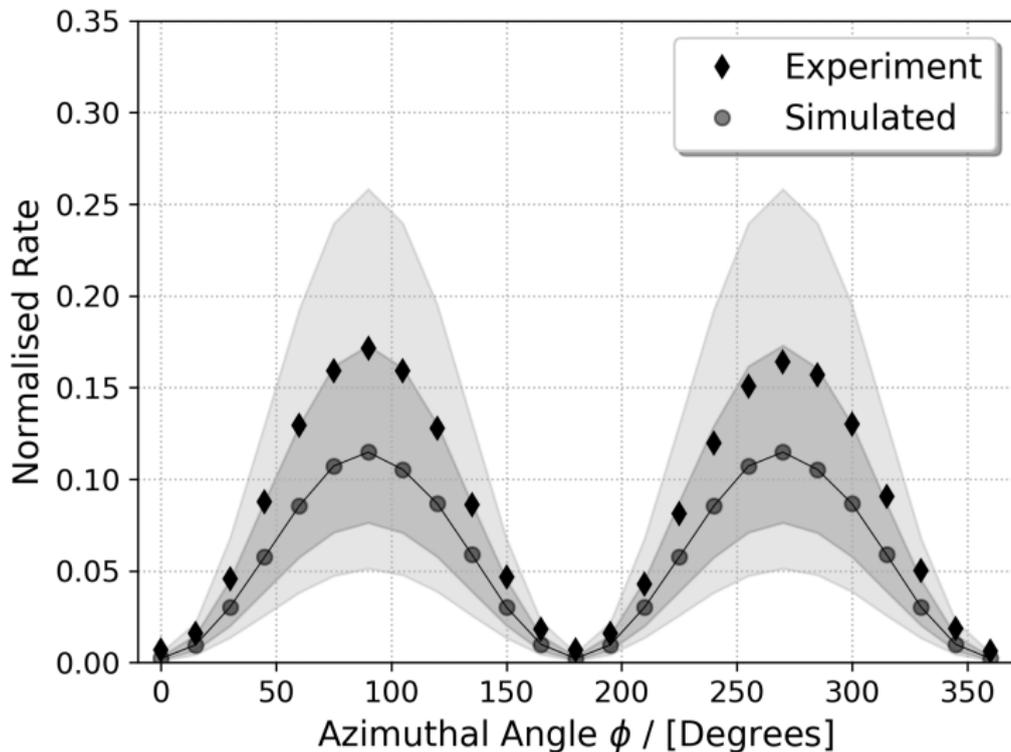
Results: 20 keV and S1 (D=10mm, L=10mm)



Results: 20 keV and S2 (D=5mm, L=7mm)



Results: 40 keV and S2 (D=5mm, L=7mm)



- + G4LowEPPysics reconfigured for sub-10 MeV polarised gammas
- + Validation w.r.t experimental X-ray polarimeter at SPring-8:
 - 20 keV: High correlation between energy spectra (\approx stat. variance)
 - 20 keV: High correlation between normalised rates ($> \pm 5\%$)
 - 40 keV: High correlation between normalised rate ($> \pm 5\%$)
- + Differences on the order of Geant4 gamma cross-section uncertainties
- + J. M. C. Brown and M. R. Dimmock, NIMB 502 (2021)

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