Geant4 simulation model of electromagnetic processes in oriented crystals for the accelerator physics

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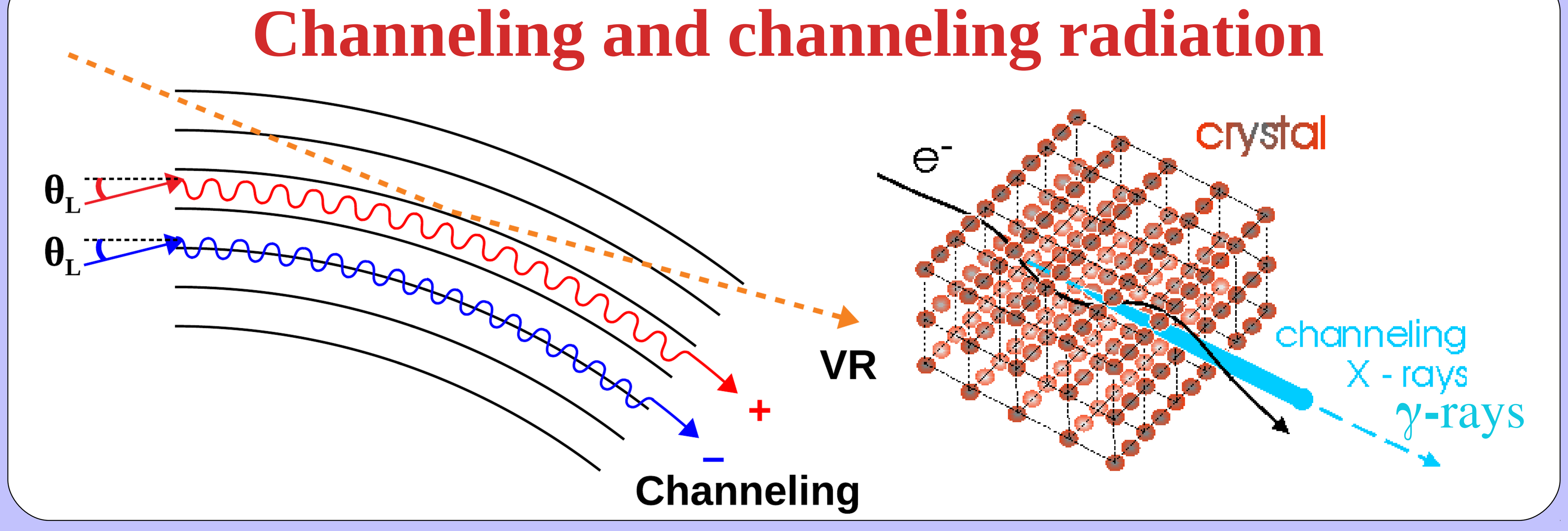
Introduction to TRILLION

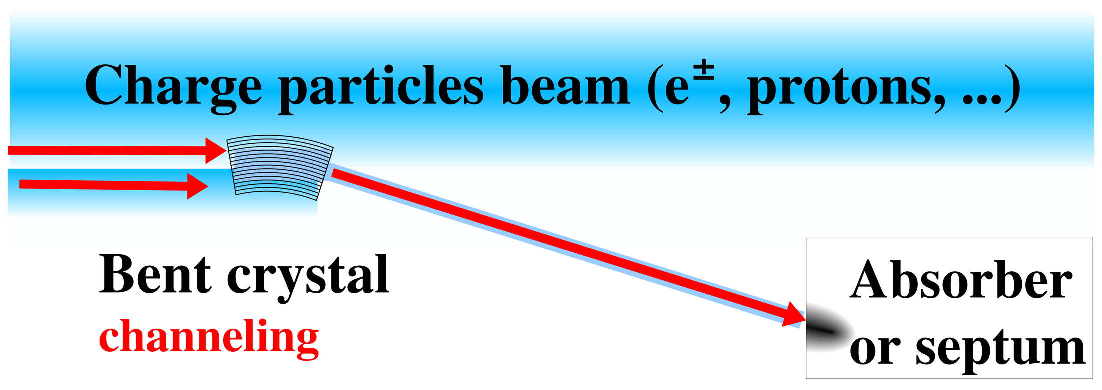
The **Marie Skłodowska-Curie Actions Global Fellowships** project **TRILLION** is dedicated to the implementation of both physics of **electromagnetic processes in oriented crystals** and the design of specific applications of crystalline effects into **Geant4 simulation toolkit**[1] as **Extended Examples** to bring them to a large scientific and industrial community and under a free Geant4 license. **Geant4** is a toolkit for the simulation of the passage of particles through matter.

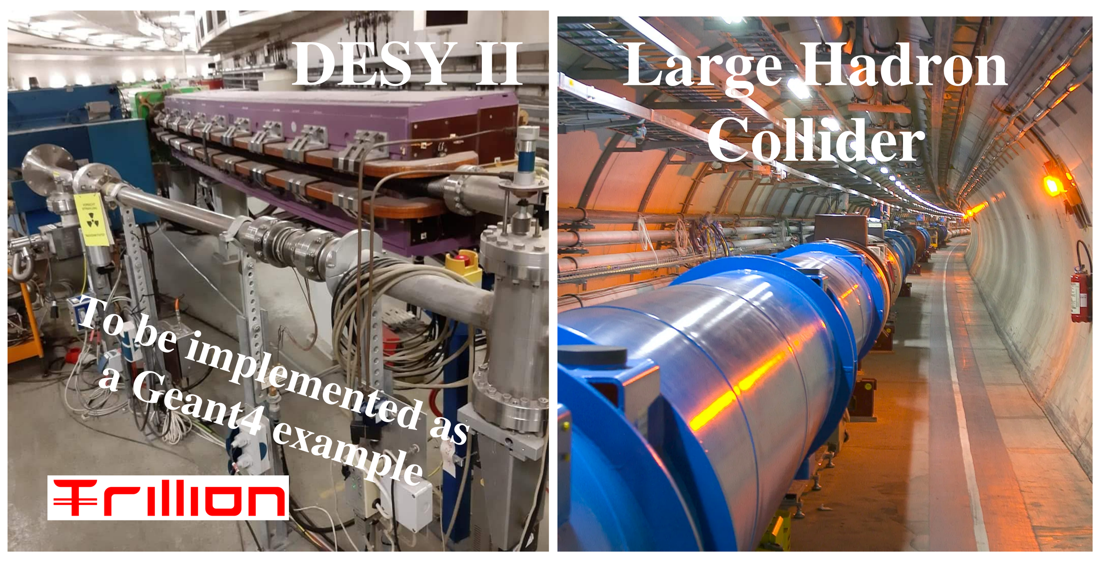
Channeling and channeling radiation



Applications of a crystal

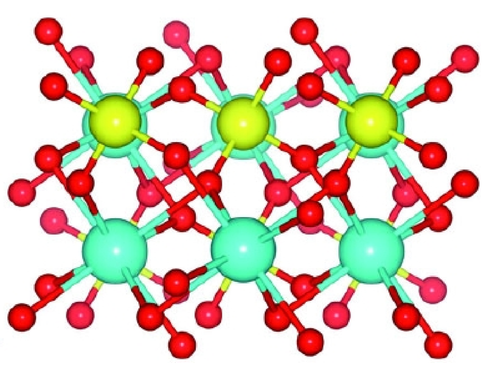
Crystal-based collimation and extraction[2] of charged particles from an accelerator



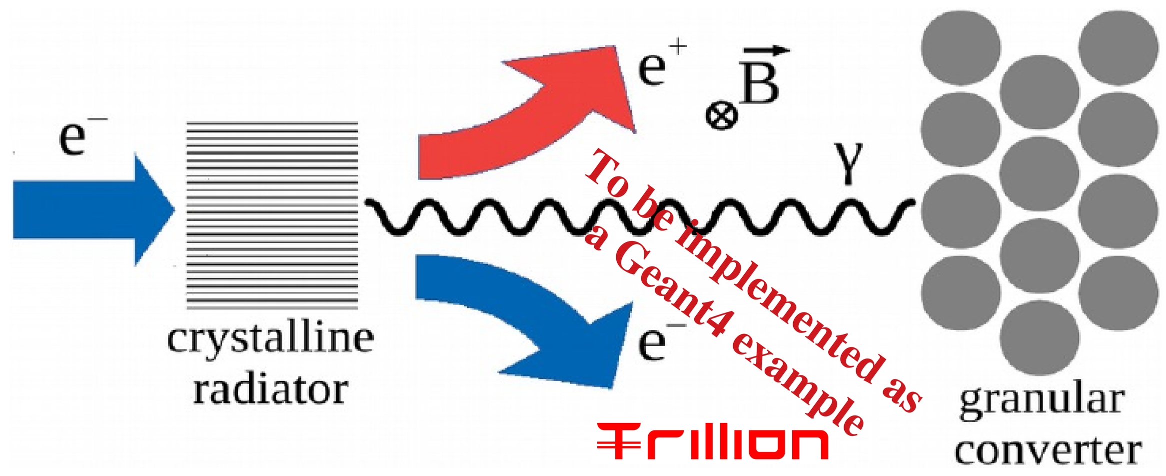


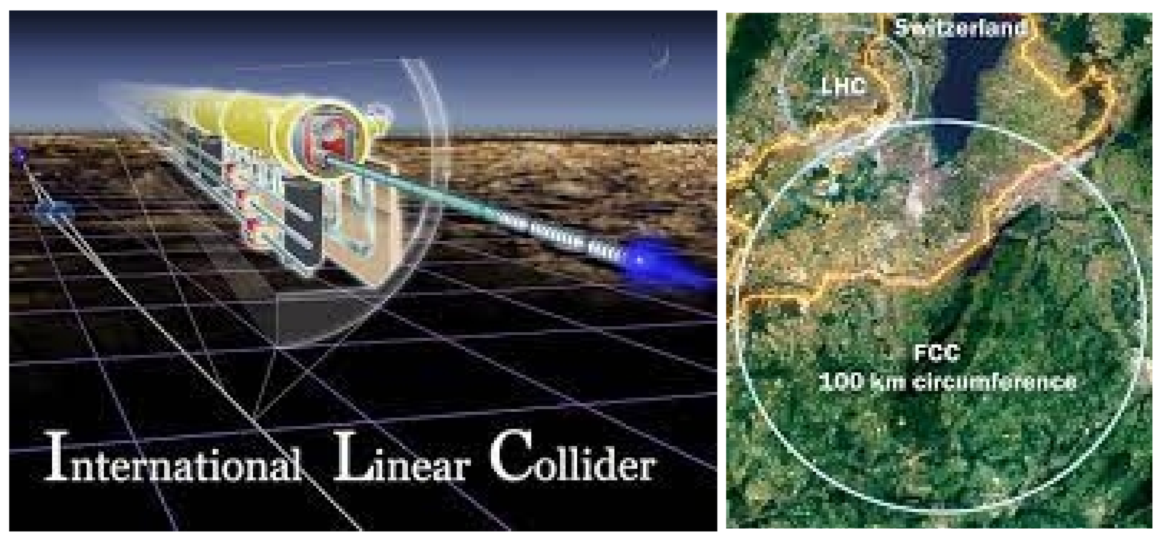
Gamma-ray Space Telescope[3]

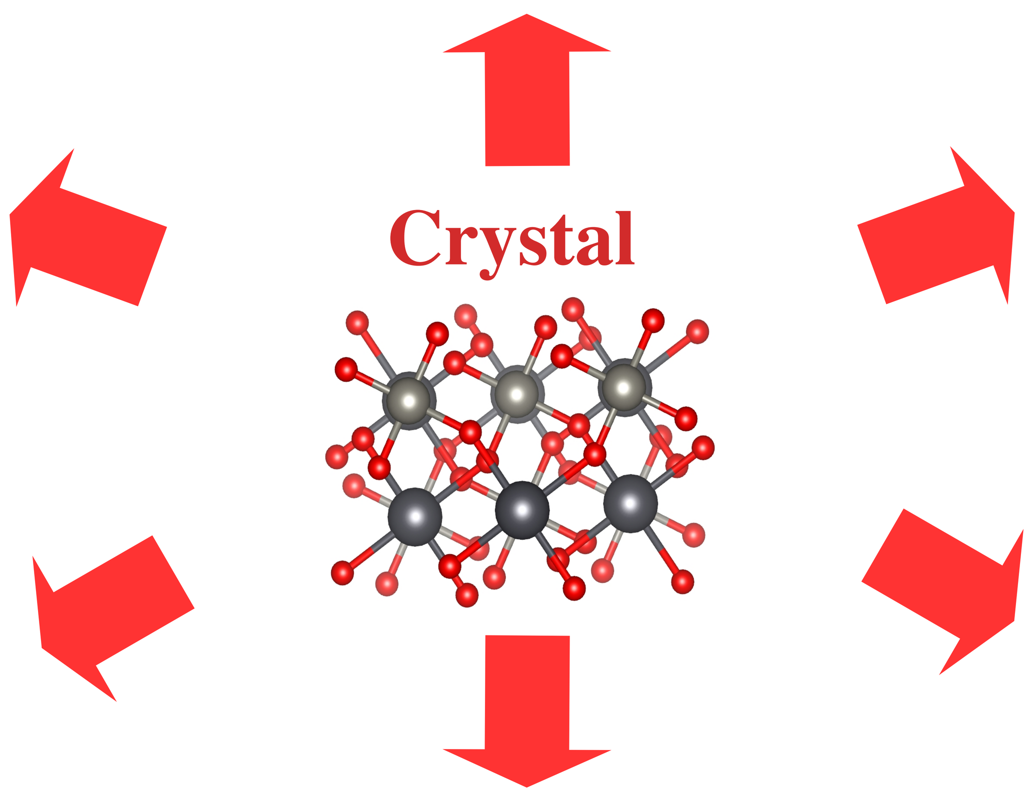
Compact EM calorimeter to detect γ-rays



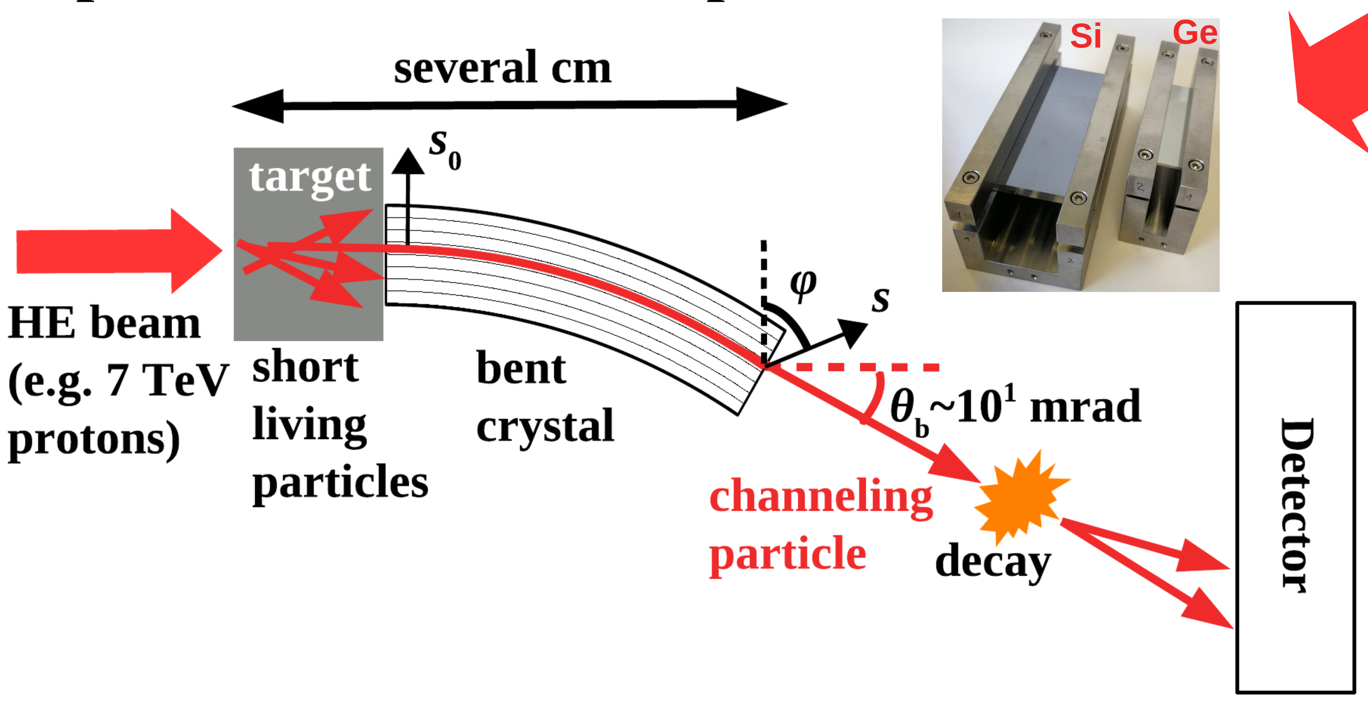
Crystal-based hybrid positron source for future e⁺e⁻ and muon colliders[4]



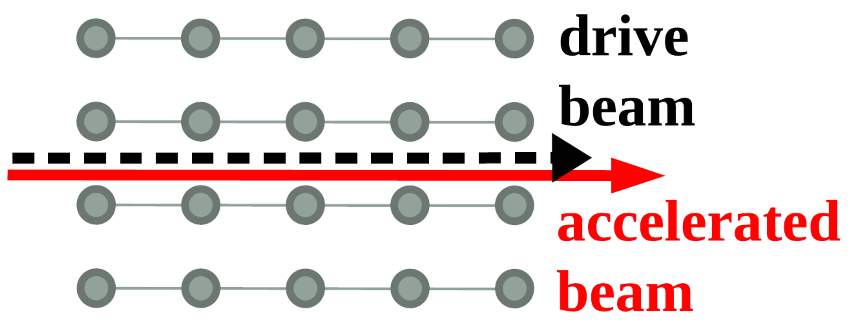




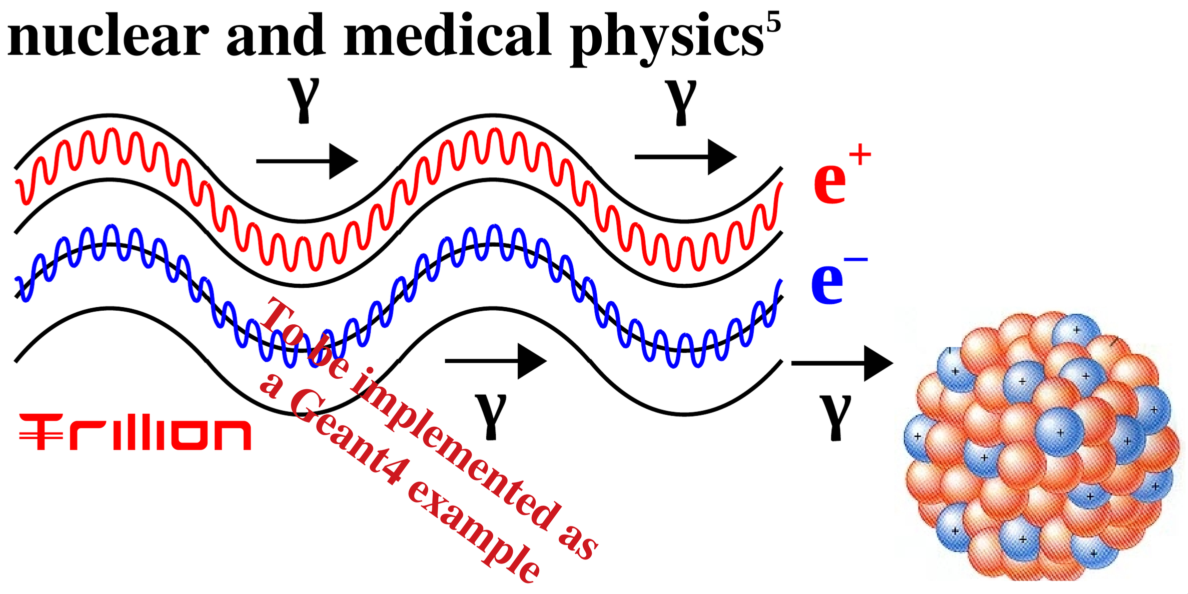
Measurement of magnetic and electric dipole moments of exotic particles[6]



Wakefield acceleration[7]



Crystalline source of intense coherent hard X-ray and gamma radiation, for nuclear and medical physics[5]



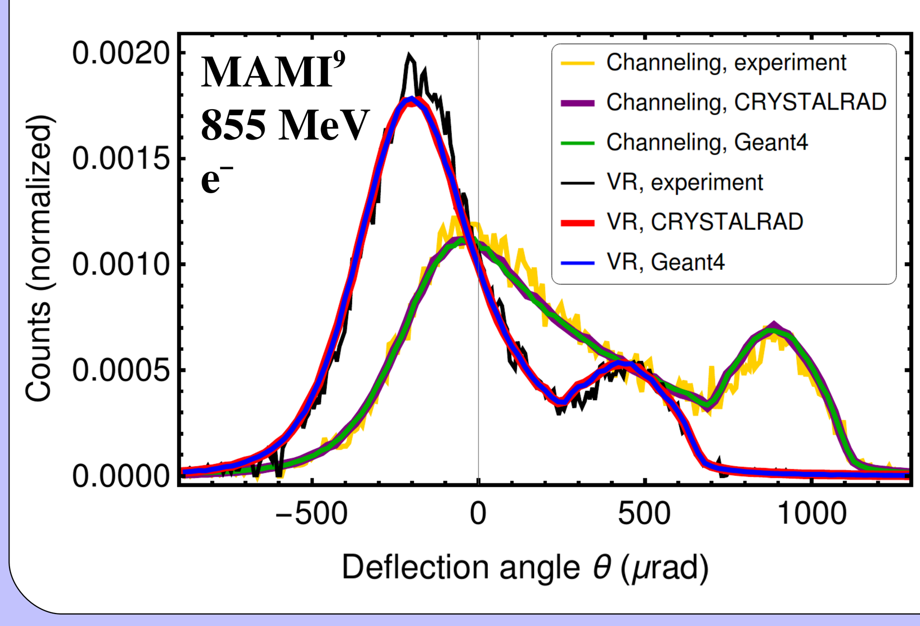
Implementation of channeling model into Geant4

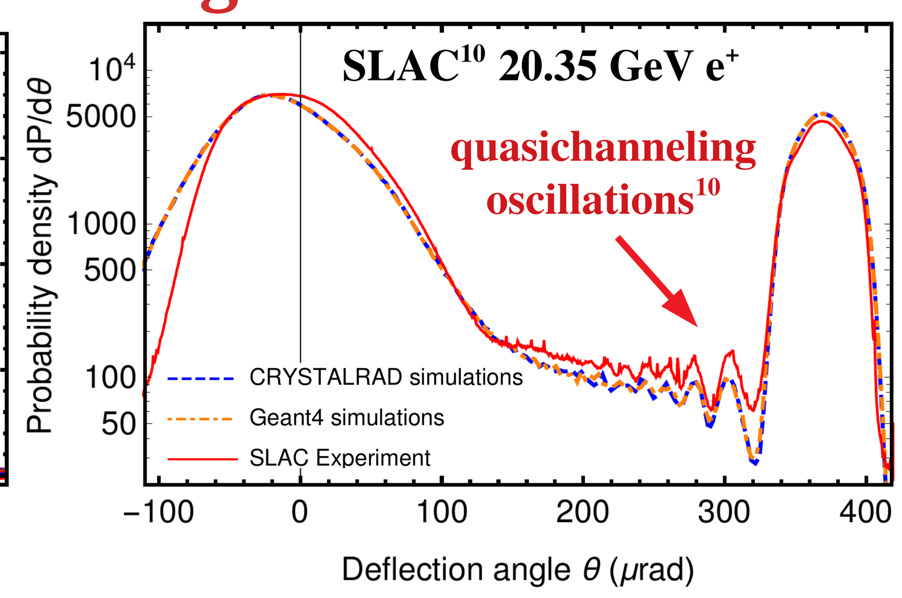
CRYSTALRAD simulation code[8] designed for tracking of charged particles in a crystal and for calculation of radiation spectra is a **baseline code** for channeling and channeling radiation model implementation into Geant4.

The implementation mechanism is **Geant4 FastSim interface**, which is a **PhysicsList independent** model and is activated only in a certain **G4Region**, at a certain **condition** (*ModelTrigger*) and for certain **particles** (*IsApplicable*).

```
G4bool ChannelingModel::IsApplicable(const G4ParticleDefinition& particleType)
G4bool ChannelingModel::ModelTrigger(const G4FastTrack& fastTrack)
void ChannelingModel::DoIt(const G4FastTrack& fastTrack,G4FastStep& fastStep)
```

Validation of Geant4 channeling model with data[9,10]





Conclusions

Channeling model has been implemented into Geant4 using FastSim interface and validated with experimental data and CRYSTALRAD simulations.

TRILLION GEANT4 examples can be applied in nuclear and medical physics (X- and γ-ray source), for e-e+ synchrotrons and colliders (positron source; beam extraction).

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References:

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