



UPDATE ON CHANNELING

ENRICO BAGLI

INFN DIVISION OF FERRARA



IMPLEMENTATION STATUS

- Model:
 - The simulation model behind the Geant4 channeling process was not changed with respect to the latest modification presented during last Geant4 Collaboration Meetings.
 - The latest development (spin precession) is not yet in the release.
- Release:
 - Geant4 channeling process was added to the “solidstate” process directory. It is now possible to add it without copying the process classes from the ”channeling” example.
 - In order to use the channeling process, the biasing helper has to be used to modify the cross section of the e.m. and hadronic processes:

CODE TO BE ADDED

- **main**

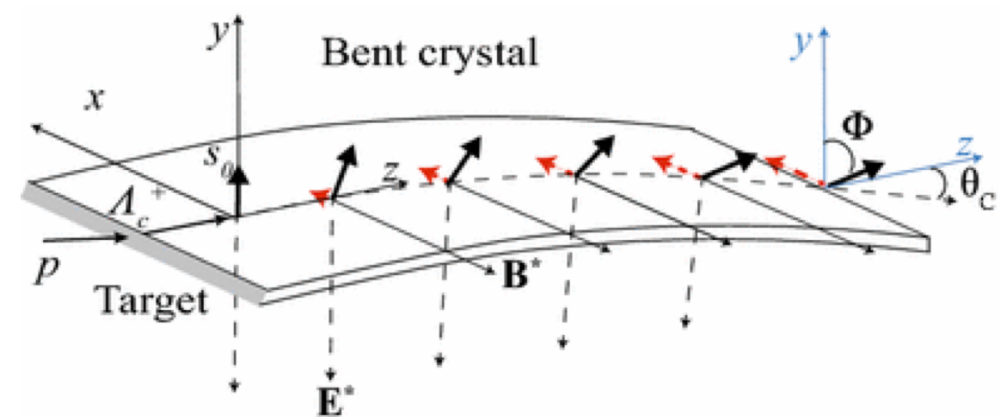
```
PhysicsList* Physlist = new PhysicsList()  
G4GenericBiasingPhysics* biasingPhysics = new G4GenericBiasingPhysics();  
physlist->RegisterPhysics(new G4ChannelingPhysics());  
biasingPhysics->PhysicsBiasAllCharged();  
physlist->RegisterPhysics(biasingPhysics);
```

- **DetectorConstruction**

```
G4LogicalVolume* crystalLogic = G4LogicalVolumeStore::GetInstance()->GetVolume("crystal.logic");  
G4ChannelingOpPtrMultiParticleChangeCrossSection* testMany =  
    new G4ChannelingOpPtrMultiParticleChangeCrossSection();  
testMany->AttachTo(crystalLogic);
```

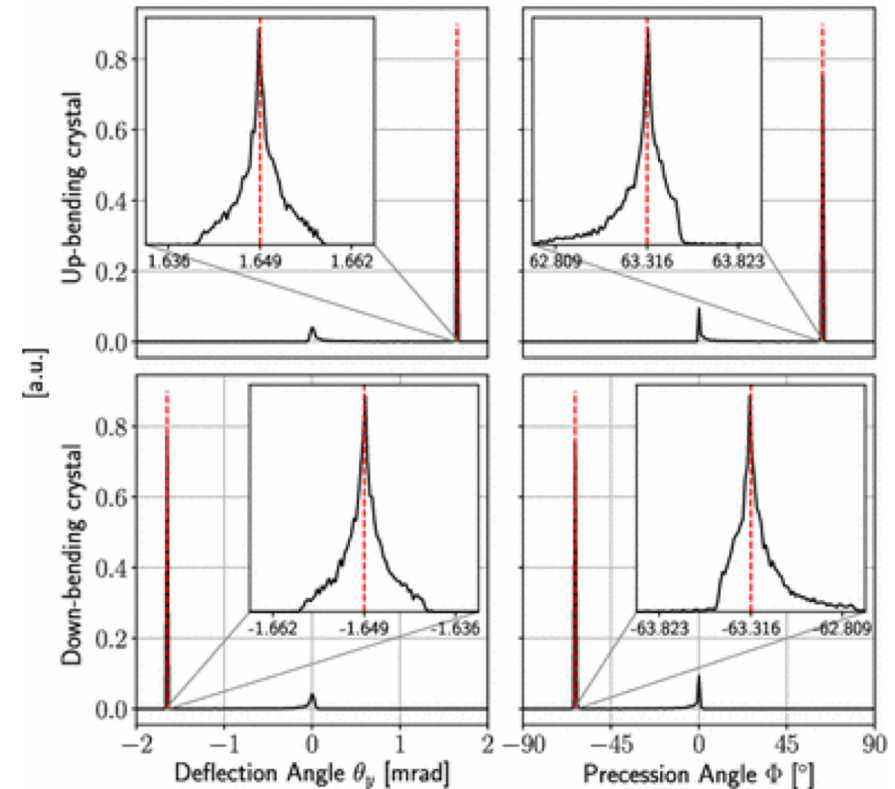
SPIN PRECESSION UNDER CHANNELING

- The spin precession of a charged particle is induced by the interaction of its electromagnetic dipole moments, e.g. MDM and EDM, with external electromagnetic fields.
- The possibility to measure MDM using channeling in bent crystals was firstly pointed out by V. G. Baryshevsky in 1979.
- The method is based on the interaction of the MDM of the channeled particles with the intense electric field between crystal atomic planes.



SPIN PRECESSION UNDER CHANNELING

- The numerical integration of the classical equations of motion allows to introduce the modification of the particle spin under the effect of the strong electric field generated by the crystalline lattice.
- The step-by-step variation of the spin is tracked by numeric integration of the T-BMT equation.
- The process for spin precession has been validated against the solely available experimental data provided by the E761 experiment at FNAL. The average of experimental values 60 ± 17 degrees is consistent with the predicted value of 62 ± 2 degrees.



E. Bagli et al., “*Electromagnetic dipole moments of charged baryons with bent crystals at the LHC*”, Eur. Phys. J. C77 (2017), 828

Geant4 simulated distributions of the deflection angle and spin precession angle for Σ^+ baryons of 375 GeV/c momentum interacting with 4.5 cm long (top) up-bent and (bottom) down-bent crystals.

TO DO

- Open issues:
 - Biasing weight of channeled particles are changed by the biasing processes.
 - Channeling needs single-scattering: the usage of a different EM physics list for a `G4Region` which contains crystals would allow to reduce computation time (see `MicroElec` and `DNA`)
 - Some inelastic hadronic models seem to modify the channeling efficiency for negative particles. To be investigated.
- Desiderata:
 - Create a «biased» EM physics list for channeling which is automatically to `G4ExtendedMaterial` with crystals.