

Checking elastic scattering in LAB

I modified G4ParticleHPElasticFS (changed frame flag to 1 and recalculated sampled cosTh from CMS to LAB using formulae from ENDF manual) in order to check the procedure for LAB. The problem is the same – neutron scatters elastically on carbon nuclei.

Neutron energy and momentum are taken from Pre and Post StepPoint, recoil energy and momentum – from the vector of secondaries. Kinetic energy and momentum of the target (with transformation back to lab) are taken from G4ParticleHPElasticFS.

Before the interaction:

	Kin. Energy, MeV	Momentum, MeV/c	Momentum.mag(), MeV/c
Neutron	8,66851E-08	-0.00579051, 0.0111418, 0.00228551	0,0127629
C-12 target	1,91023E-08	0.00676632, -0.0179413, 0.00770815	0,0206661
Total	1,05787E-07	0.00097581, -0.0067995, 0.0099937	0,0121268

After the interaction (Geant4 without any modifications):

	Kin. Energy, MeV	Momentum, MeV/c	Momentum.mag(), MeV/c
Neutron	8,94227E-08	0.00055911, 0.0071894, 0.010772	0,0129629
C-12 recoil	8,03266E-09	-0.0015435, -0.00865043, -0.0101151	0,0133988
Total	9,74554E-08	-0.0009844, -0.00146103, 0.0006569	0,0018802

After the interaction (with fix in G4HadronElasticProcess::PostStepDoIt described earlier):

	Kin. Energy, MeV	Momentum, MeV/c	Momentum.mag(), MeV/c
Neutron	8,94227E-08	0.00532512, 0.0109781, 0.0043774	0,0129629
C-12 recoil	8,03266E-09	-0.0051736, -0.0120319, -0.0028277	0,0133988
Total	9,74554E-08	0.00015155, -0.0010538, 0.0015498	0,0018802

After the interaction (added fix in G4ParticleHPElasticFS::ApplyYourself):

	Kin. Energy, MeV	Momentum, MeV/c	Momentum.mag(), MeV/c
Neutron	8,94228E-08	0.00532512, 0.0109781, 0.00437742	0,0129629
C-12 recoil	1,63982E-08	-0.00434927, -0.0177774, 0.0056162	0,0191441
Total	1,05821E-07	0.00097585, -0.0067993, 0.0099936	0,0121266

The last implemented fix:

```
if (frameFlag == 1)
```

```
{
```

```
    theNeutron.Lorentz(theNeutron, theTarget);
```

```
    G4double a = 1 + theTarget.GetMass() / theNeutron.GetMass();
```

```
    G4double b = -2 * theNeutron.GetTotalMomentum() * cosTh;
```

```
    G4double c = theNeutron.GetTotalMomentum() * theNeutron.GetTotalMomentum()
```

```
-2 * theTarget.GetMass() * (theNeutron.GetTotalEnergy() – theNeutron.GetMass());
```

```
    G4double en = (-b + std::sqrt(b * b – 4 * a * c)) / (2*a);
```

```
    if (en < 0) en = (-b - std::sqrt(b * b – 4 * a * c)) / (2*a);
```

```
    ...
```

```
    ...
```

```
// theTarget.SetTotalEnergy(theNeutron.GetTotalEnergy());
```

```
G4double tP = theTarget.GetTotalMomentum();
```

```
G4double tM = theTarget.GetMass();
```

```
theTarget.SetTotalEnergy(std::sqrt((tP+tM)*(tP+tM)-2*tP*tM));
```

```
    ...
```

```
    ...
```

```
}
```