Short response to the presentation Electron Bug Fixes
by
Afroditi Papadopoulou

I. Kakorin, K. Kuzmin, V. Naumov

EMRES Spline Production Issue

We did not understand
the meaning
of this slide.

ReinSehgalRESXSecFast.xml

Why did one need to change default parameters?

Default Code

```
<param_set name="Default">
  <param type="string" name ="CommonParam">           Resonances  </param>
  <param type="double" name ="ESplineMax">                  500  </param>
  <param type="string" name ="gsl-integration-type">   adaptive  </param>
  <param type="int"    name ="gsl-max-eval">         1000000000  </param>
  <param type="double" name ="gsl-relative-tolerance">     1e-9  </param>
</param_set>
```

Modified Code

```
<param_set name="Default">
  <param type="string" name ="CommonParam">           Resonances  </param>
  <param type="double" name ="ESplineMax">                  500  </param>
  <param type="string" name ="gsl-integration-type">   adaptive  </param>
<!--<param type="int"    name ="gsl-max-eval">         1000000000  </param>
  <param type="double" name ="gsl-relative-tolerance">     1e-9  </param>-->
<!--apapadop-->
  <param type="int"    name ="gsl-max-eval">             500000  </param>
  <param type="double" name ="gsl-relative-tolerance">     0.01  </param>
</param_set>
```

as in GENIE v2.12.10

Why did this question arise?

Why such a significant difference ?

- Code crash or enter in an endless loop?
- Compute cross section too long?
- Something other?

To answer these questions we did some tests.
We calculated cross sections for EMRES-processes on carbon with several charged leptons:

```
gmkspl -n 500 -e 500 -p -11,-13,11,13 -t 1000060120 -o EMRES.xml --event-generator-list EMRES
```

Tests of the integrator for Rein-Sehgal with default parameters (ReinSehgalRESXSecFast)

1. Does not crash and does not enter in an endless loop.

```
|------------------------------> WeinbergAngle [double] [unlocked] [l] : 0.501628
|------------------------------> XSec-Integrator     [alg] [unlocked] [l] : genie::ReinSehgalRESXSecFast/NoPauliBlock
|------------------------------> minibooneGA    [bool] [unlocked] [l] : 1
|------------------------------> minibooneGV    [bool] [unlocked] [l] : 1

1549542338 NOTICE XSecSplLst : [s] <CreateSpline (188)> : Energy threshold for current interaction = 0.00115938 GeV
1549542338 WARN XSecSplLst : [s] <NSplines (255)> : No splines for tune G18_02a_00_000 were found!
1549542338 INFO ReinSehgalResTF : [n] <ReinSehgalRESXSecFast.cxx::Integrate (129)> : Finding cache branch with key:
genie::BergerSehgalRESPXSec2014/NoPauliBlock/ResExcitationXSec/R:P33(1232);nu:-11;int:EMp
1549542338 WARN ReinSehgalResTF : [n] <ReinSehgalRESXSecFast.cxx::Integrate (134)> : No cached RES v-production data for input neutrino (pdgc: -11)
1549542338 WARN ReinSehgalResTF : [n] <ReinSehgalRESXSecFast.cxx::Integrate (137)> : Wait while computing/caching RES production xsec first...
1549542338 NOTICE ReinSehgalResCF : [n] <ReinSehgalRESXSecWithCacheFast.cxx::CacheResExcitationXSec (127)> :
 ** Creating cache branch - key = genie::BergerSehgalRESPXSec2014/NoPauliBlock/ResExcitationXSec/R:P33(1232);nu:-11;int:EMp
1549542338 NOTICE ReinSehgalResCF : [n] <ReinSehgalRESXSecWithCacheFast.cxx::CacheResExcitationXSec (135)> : E threshold = 0.00115938
1549542338 INFO ReinSehgalResCF : [n] <ReinSehgalRESXSecWithCacheFast.cxx::CacheResExcitationXSec (166)> : *** Integrating d^2 XSec/dWdQ^2 for R: P33(1232) at Ev = 0.01
1549542338 INFO ReinSehgalResCF : [n] <ReinSehgalRESXSecWithCacheFast.cxx::CacheResExcitationXSec (169)> : {W}   = 0, 1
1549542338 INFO ReinSehgalResCF : [n] <ReinSehgalRESXSecWithCacheFast.cxx::CacheResExcitationXSec (171)> : {Q^2} = 0, 1
1549542338 NOTICE ReinSehgalResCF : [s] <CacheResExcitationXSec (192)> : RES XSec (R:P33(1232), E=0.01) = 0 x 1E-38 cm^2
1549542338 INFO ReinSehgalResCF : [n] <ReinSehgalRESXSecWithCacheFast.cxx::CacheResExcitationXSec (166)> : *** Integrating d^2 XSec/dWdQ^2 for R: P33(1232) at Ev = 0.0110641
1549542338 INFO ReinSehgalResCF : [n] <ReinSehgalRESXSecWithCacheFast.cxx::CacheResExcitationXSec (169)> : {W}   = 0, 1
1549542338 INFO ReinSehgalResCF : [n] <ReinSehgalRESXSecWithCacheFast.cxx::CacheResExcitationXSec (171)> : {Q^2} = 0, 1
1549542338 NOTICE ReinSehgalResCF : [s] <CacheResExcitationXSec (192)> : RES XSec (R:P33(1232), E=0.0110641) = 0 x 1E-38 cm^2

................................. some lines are missing .................................

1549557389 NOTICE XSecSplLst : [s] <CreateSpline (227)> : xsec(E = 483.255) = 43717.4 x 1E-38 cm^2
1549557389 INFO ReinSehgalResTF : [n] <ReinSehgalRESXSecFast.cxx::Integrate (129)> : Finding cache branch with key:
genie::BergerSehgalRESPXSec2014/NoPauliBlock/ResExcitationXSec/R:F17(1970);nu:13;int:EMn
1549557389 NOTICE ReinSehgalResTF : [s] <Integrate (156)> : XSec[RES/F17(1970)/free] (Ev = 491.556 GeV) = 7286.5 x 1E-38 cm^2
1549557389 NOTICE XSecSplLst : [s] <CreateSpline (227)> : xsec(E = 491.556) = 43719 x 1E-38 cm^2
1549557389 INFO ReinSehgalResTF : [n] <ReinSehgalRESXSecFast.cxx::Integrate (129)> : Finding cache branch with key:
genie::BergerSehgalRESPXSec2014/NoPauliBlock/ResExcitationXSec/R:F17(1970);nu:13;int:EMn
1549557389 NOTICE ReinSehgalResTF : [s] <Integrate (156)> : XSec[RES/F17(1970)/free] (Ev = 500 GeV) = 7286.72 x 1E-38 cm^2
1549557389 NOTICE XSecSplLst : [s] <CreateSpline (227)> : xsec(E = 500) = 43720.3 x 1E-38 cm^2
1549557389 NOTICE XSecSplLst : [s] <SaveAsXml (294)> : Saving XSecSplineList as XML in file: EMRES.xml
```

Tests of the integrator for Rein-Sehgal with default parameters (ReinSehgalRESXSecFast)

2. The calculation of resonance production
cross section for 18 resonances and 4 charged leptons
takes 254 minutes.
The calculation of resonance production cross
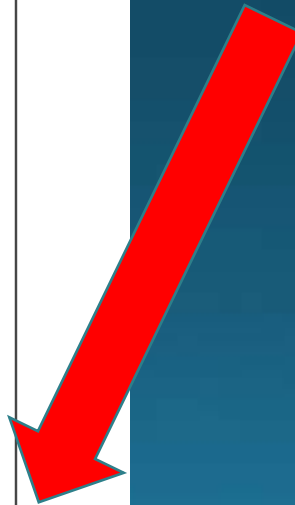section for 1 resonance and 1 charged lepton takes
1 minute 45 seconds.
(for 2.2 GHz CPU)

Tests of the integrator for Berger-Sehgal model with default parameters (ReinSehgalRESXSecFast)
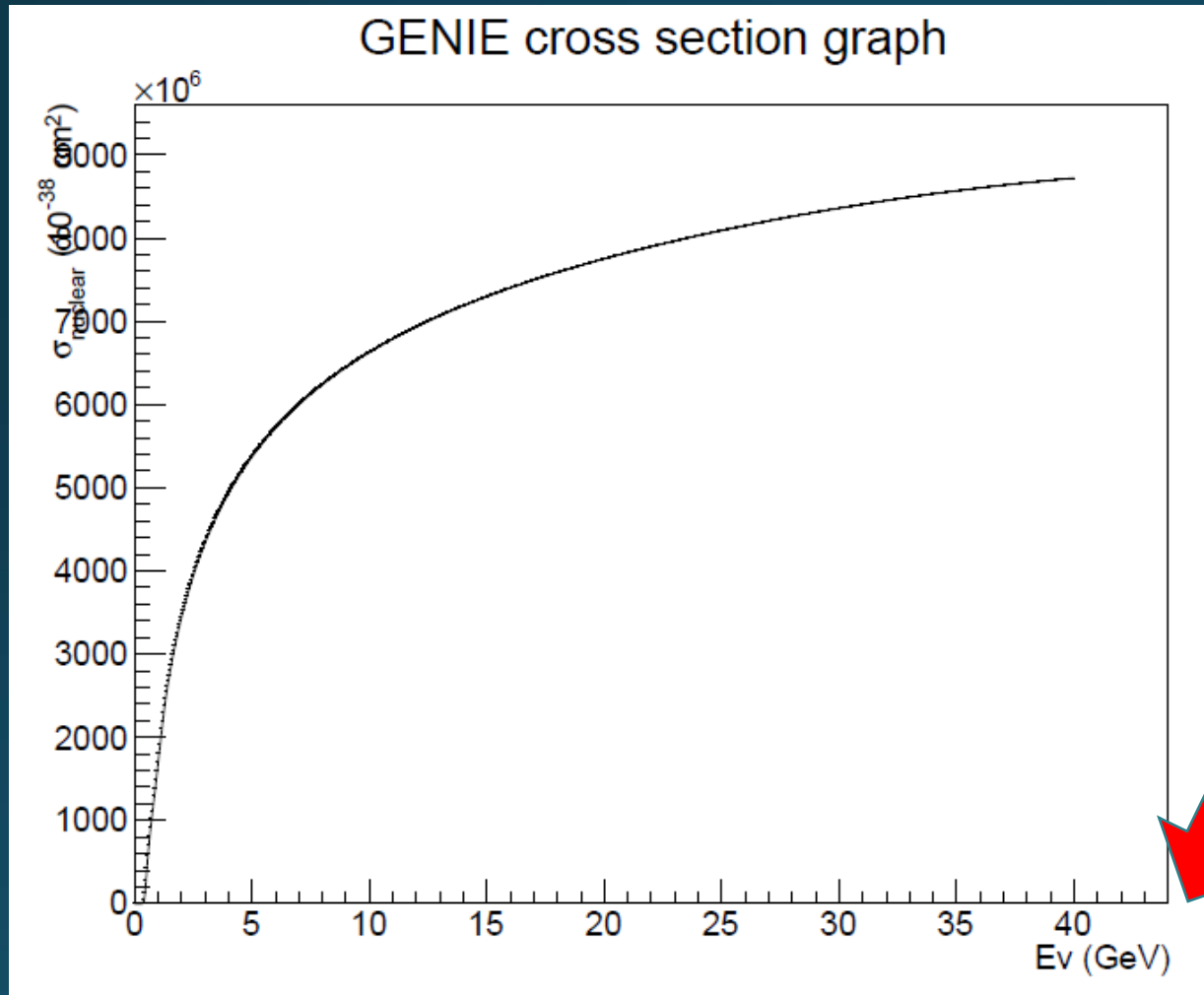
3. The plots for (anti)electron created by gspl2root:
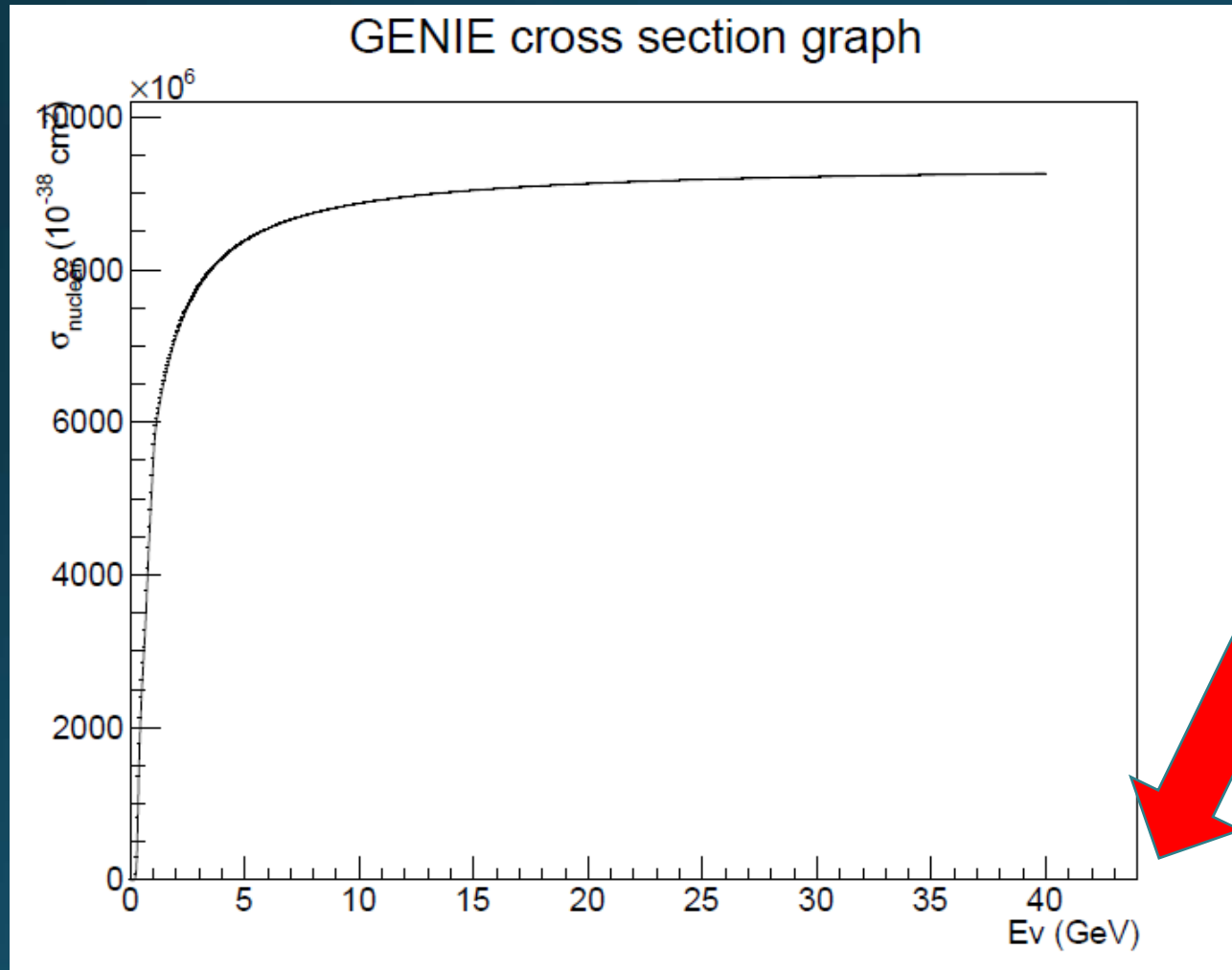
Indeed the curve is smooth till 500 GeV.

Tests of the integrator for Berger-Sehgal model with default parameters (ReinSehgalRESXSecFast)
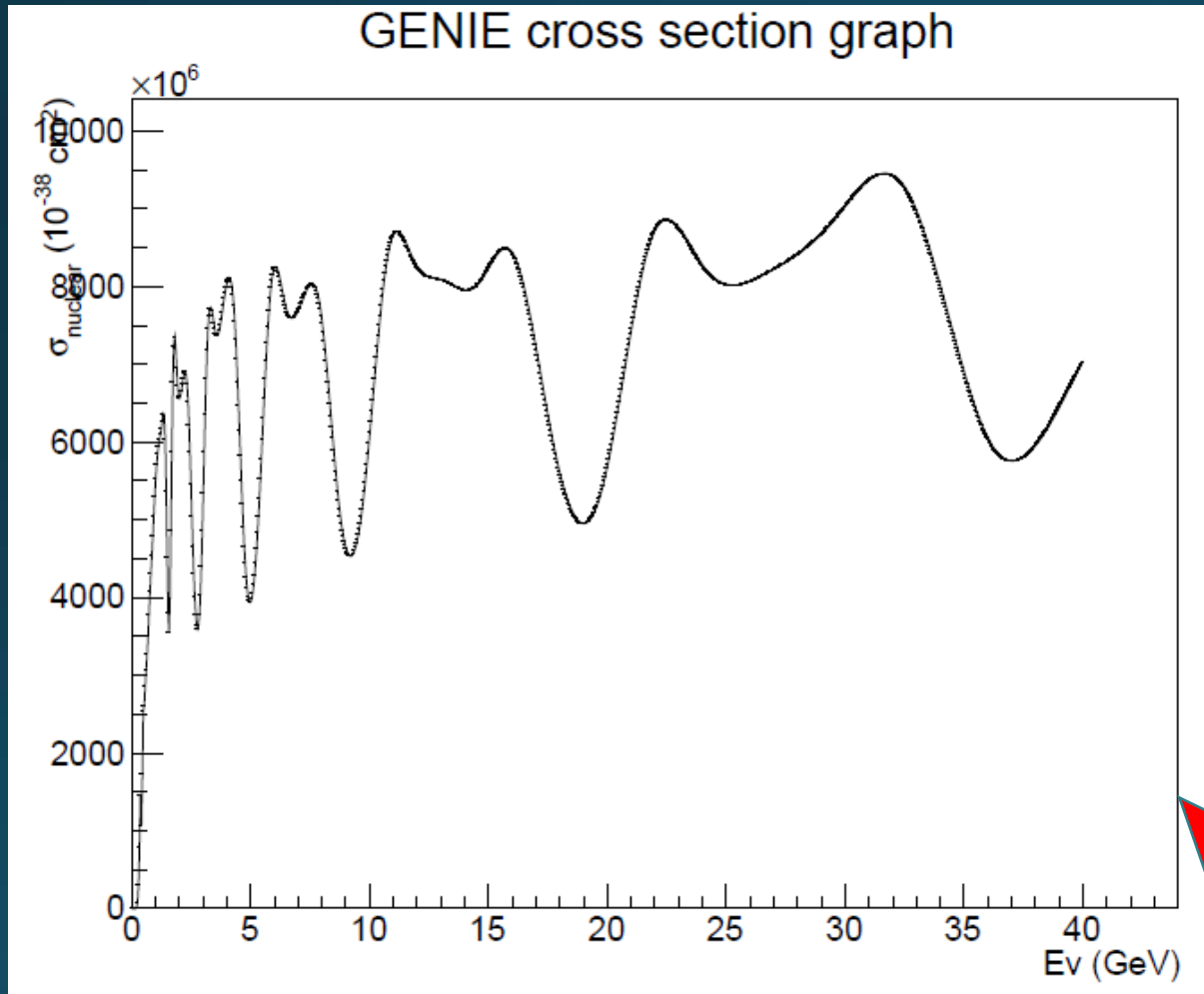
3. The plots for (anti)muon created by gspl2root:

Indeed the curve is smooth till 500 GeV.

Tests of the integrator for Berger-Sehgal model with parameters from Afroditi (ReinSehgalRESXSecFast)
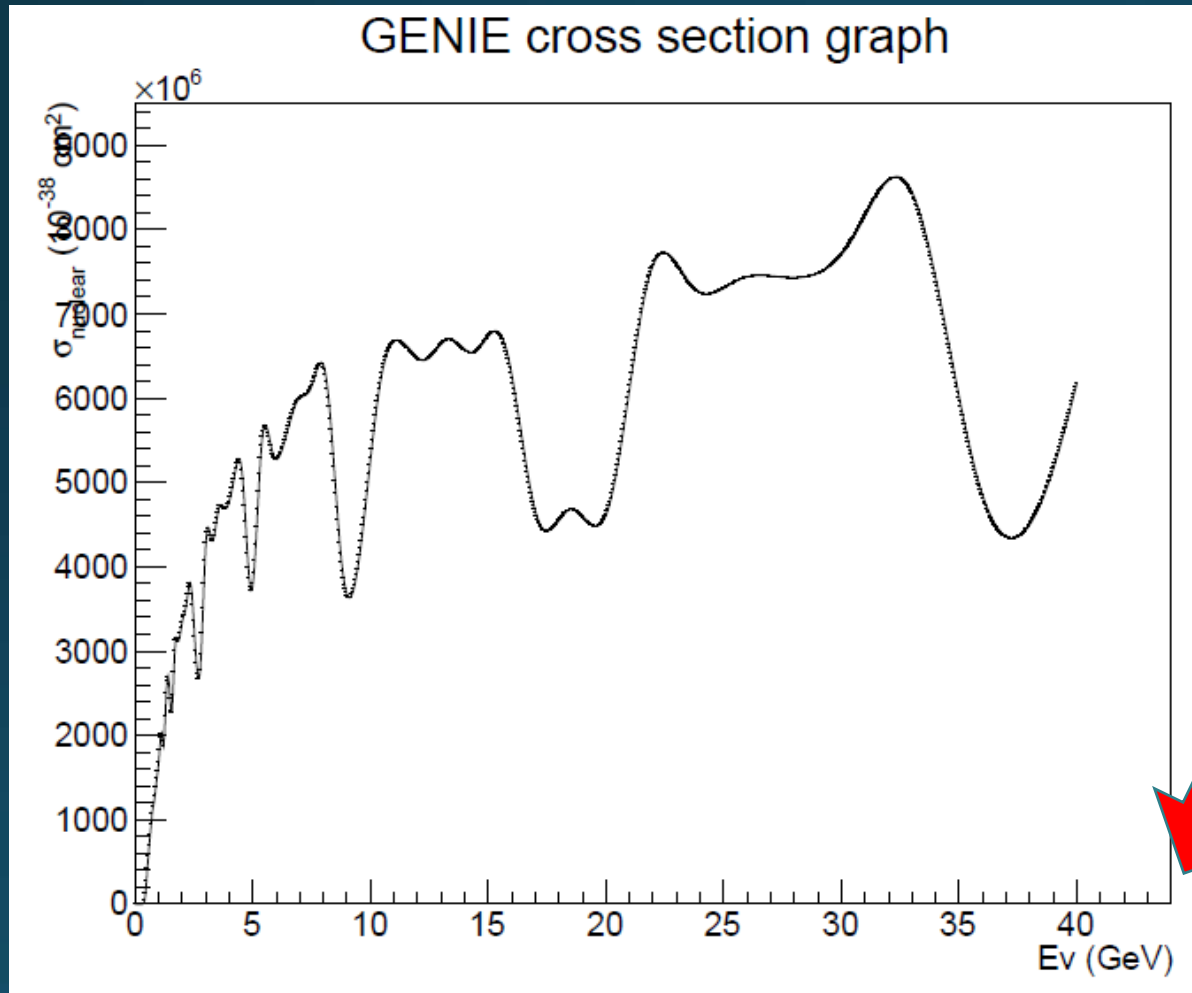
3. The plots for (anti)electron created by gspl2root:

The line is wavy till 500 GeV.

Tests of the integrator for Berger-Sehgal model with parameters from Afroditi (ReinSehgalIRESXSecFast)

3. The plots for (anti)muon created by gspl2root:

The line is wavy till 500 GeV.

Conclusions

We do not see any reasons to change default parameters of the integrator (ReinSehgalRESXSecFast) for Rein-Sehgal based models also for EMRES processes, because now the good accuracy is achieved in a reasonable time.