Inclusive electron generator

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Introduction and motivation

- Motivation:
  - ➢To have an elegant inclusive electron generator including QE+RESONANCE+DIS
  - ➢Idea:
    - Christy & Peter Bosted fit for QE+RESONANCE… (Valid in W<3 GeV region)
    - W> 3GeV region, based on world pdf fits, like CTEQ etc.
  - ➢The real situation in the market
    - Many Fortran code or cross compile (Fortran&C) code exist in the market
    - No C/C++ code
- What I want and what I did
  - ➢Translate Peter Bosted's Fortran code to C code (QE+RESONANCE…)
    - Thanks to the efforts from Qweak and Moller (**Seamus, Ciprian**), many subroutines have been translated already
    - I contribute more so that the C code is now a direct translation of F1F209.f code:

    for A>=1 nucleus target, calculate the F1 and F2 structure functions, per nucleus, not per nucleon
  - ➢In DIS region, LHAPDF6, a C++ interface to access all kinds of PDF fits (migrated to C++ in 2015)

Introduction and motivation

- Motivation:

C/C++ code to calculate differential cross sections for inclusive electron scattering including QE + Resonance + DIS

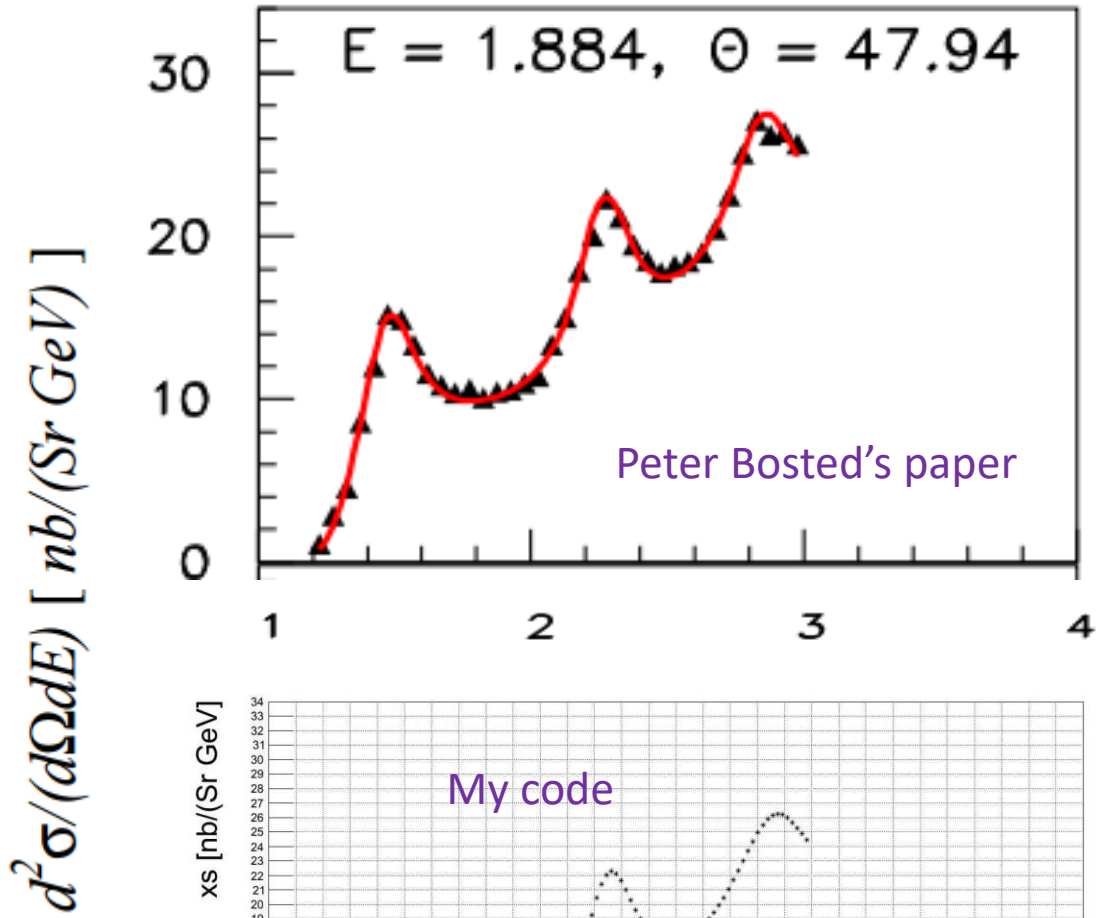
Cross checks

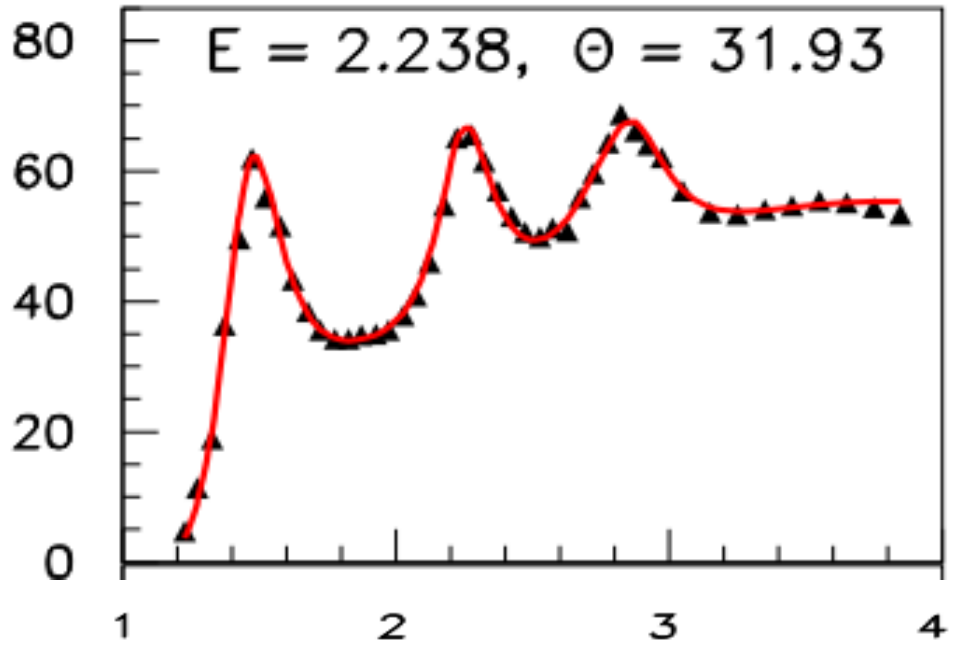
Calculations of neutron, proton, deuteron, Berilian F1 F2 structure functions
Refer to: https://userweb.jlab.org/~bosted/F1F209.f

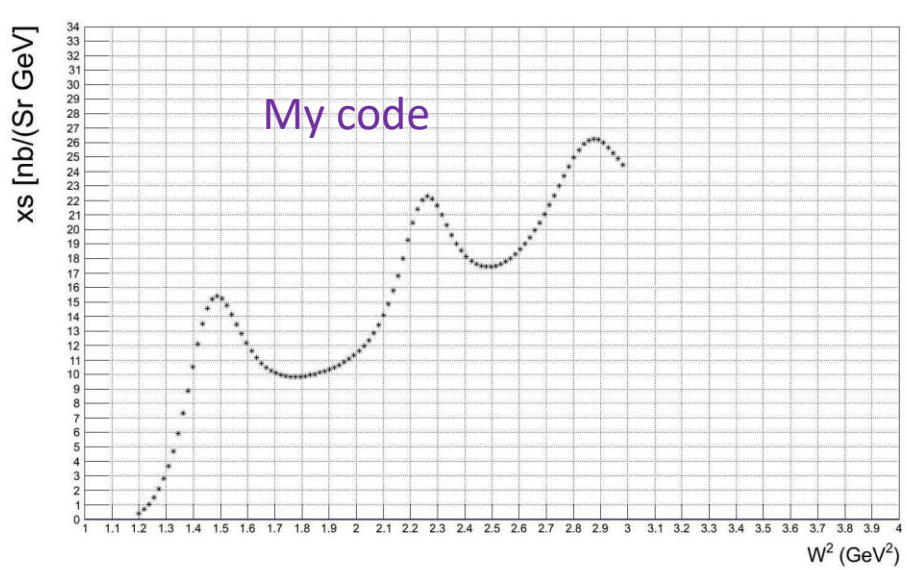
```
 1.000   1.500   0.617   0.204   0.231   0.312   0.410   1.644   0.072   0.102
 1.000   2.000   0.472   0.129   0.159   0.292   0.250   2.329   0.199   0.191
 1.000   2.500   0.382   0.169   0.227   0.417   0.360   2.973   0.241   0.292
 1.000   3.000   0.321   0.224   0.315   0.511   0.500   3.562   0.327   0.359
 1.000   3.500   0.276   0.218   0.309   0.517   0.521   4.060   0.348   0.387
 2.000   1.500   0.763   0.079   0.091   0.110   0.104   0.400   0.154   0.188
 2.000   2.000   0.641   0.058   0.091   0.157   0.104   0.764   0.184   0.216
 2.000   2.500   0.553   0.090   0.139   0.241   0.162   1.174   0.215   0.246
 2.000   3.000   0.485   0.137   0.214   0.324   0.252   1.558   0.233   0.270
 2.000   3.500   0.433   0.136   0.227   0.354   0.272   1.919   0.267   0.283
  1.000    0.747    0.432
  2.000    0.157    0.132
  3.000    0.048    0.049
```

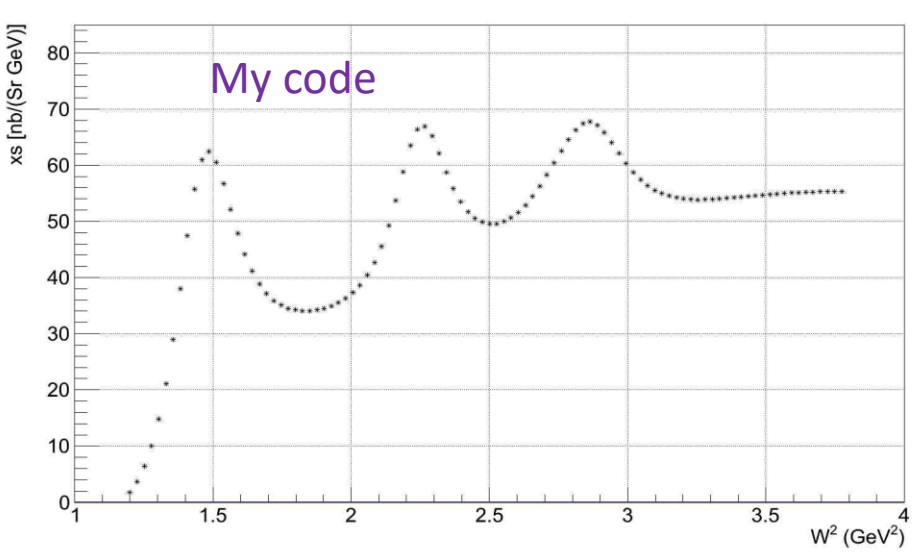
```
1       1.5     0.617439        0.20467 0.231455        0.313606        0.410837        1.64625 0.0725625       0.102152
1       2       0.471789        0.128945        0.159059        0.292669        0.24981 2.33041 0.199906        0.190772
1       2.5     0.381739        0.16906 0.227321        0.418129        0.360223        2.97465 0.241993        0.291878
1       3       0.320555        0.223661        0.314899        0.51173 0.500294        3.5634  0.327135        0.359038
1       3.5     0.276274        0.218134        0.309477        0.51765 0.521467        4.06104 0.347711        0.387278
2       1.5     0.763477        0.0789078       0.0910095       0.110661        0.104455        0.400304        0.153574        0.188463
2       2       0.641109        0.0581146       0.0906204       0.158258        0.104293        0.764416        0.184545        0.21588
2       2.5     0.552548        0.089614        0.139609        0.242122        0.162346        1.17498 0.215256        0.245659
2       3       0.485485        0.13717 0.213784        0.324658        0.251697        1.55908 0.233004        0.270411
2       3.5     0.432939        0.136178        0.227487        0.354578        0.271672        1.91999 0.267205        0.283075
1       0.746437        0.432598
2       0.156518        0.13154
3       0.0481432       0.0491918
```

Cross checks

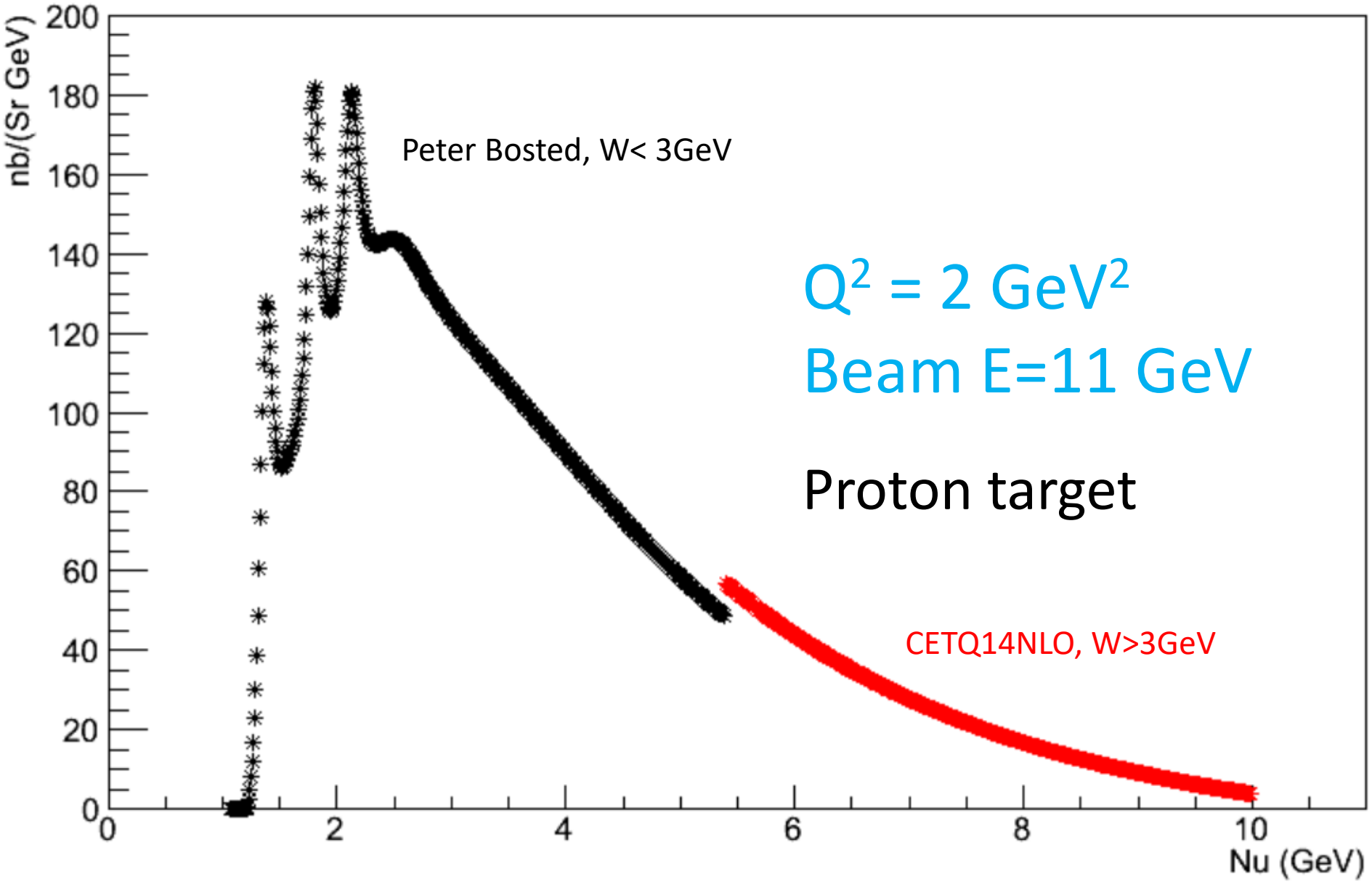








Combine QE + RESONANCE + DIS



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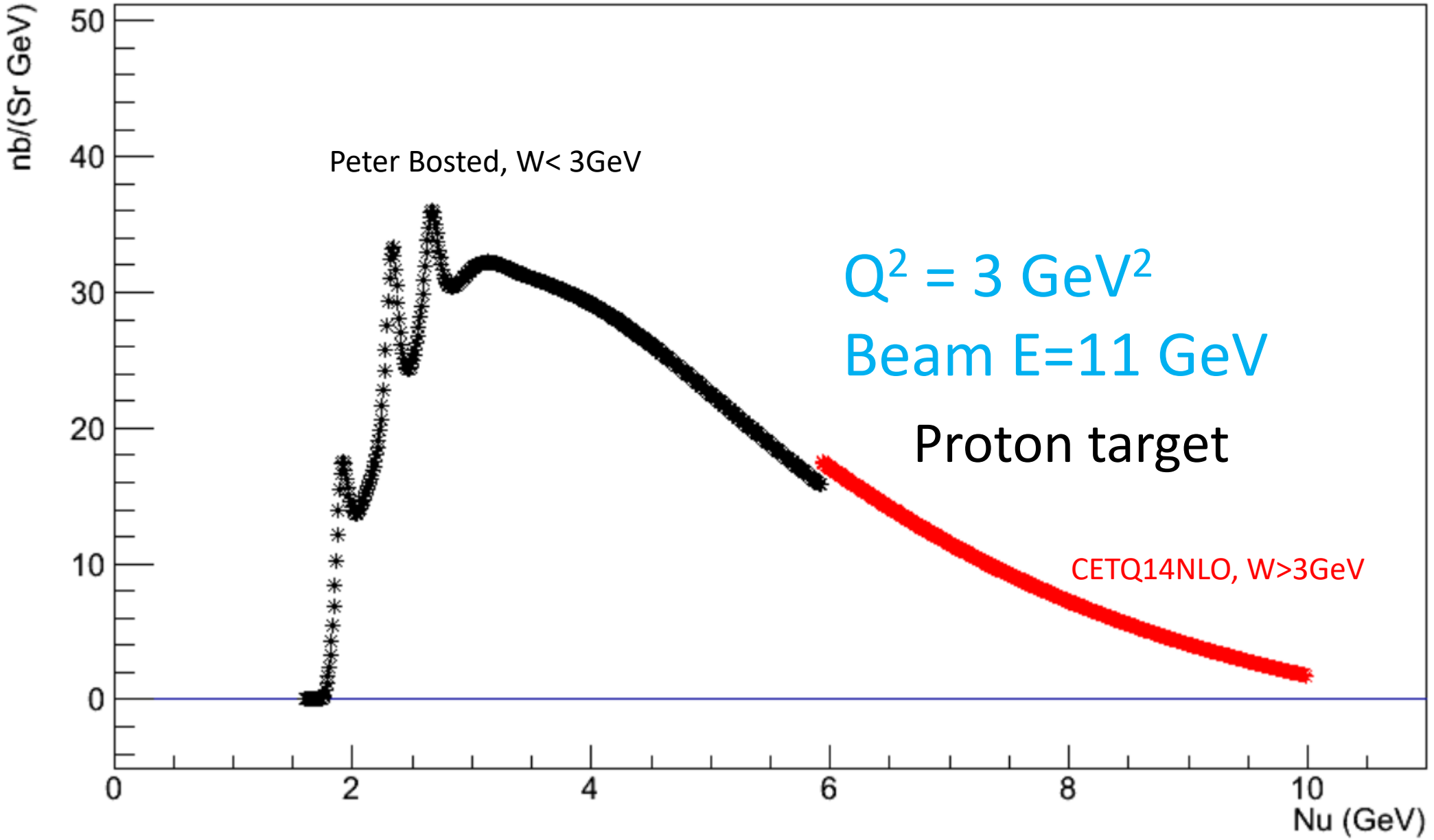
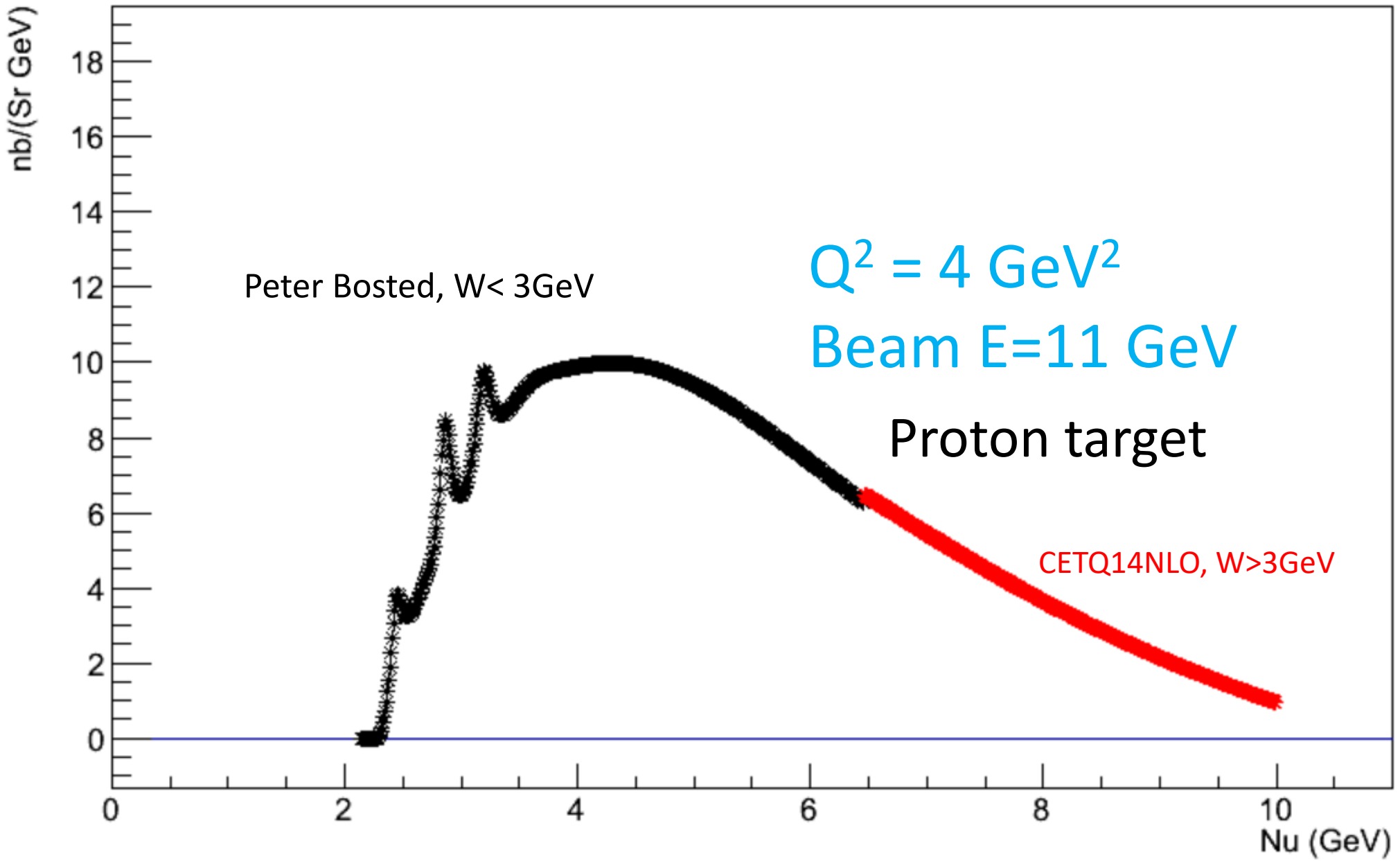
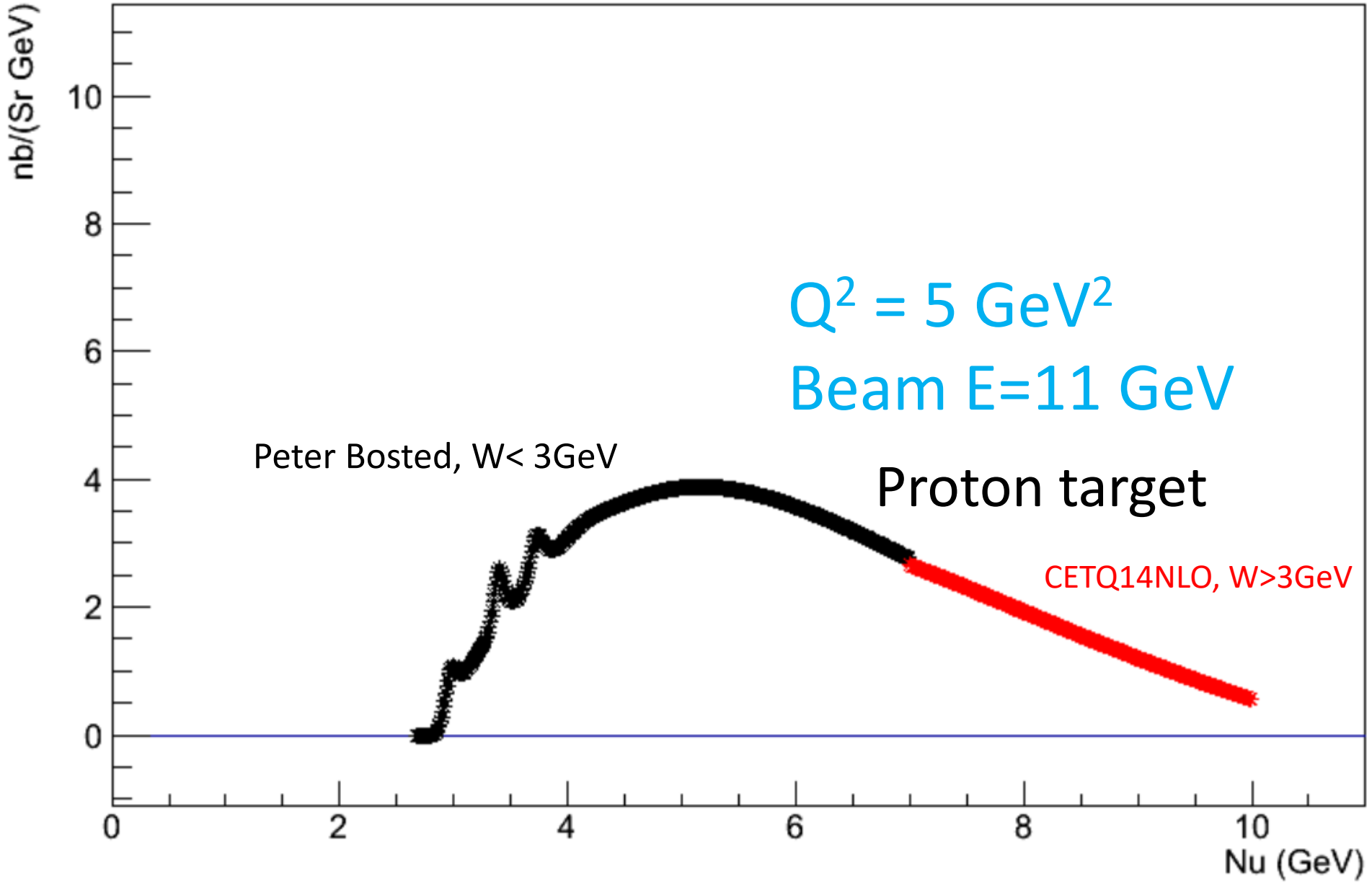


Combine QE + RESONANCE + DIS



Combine QE + RESONANCE + DIS



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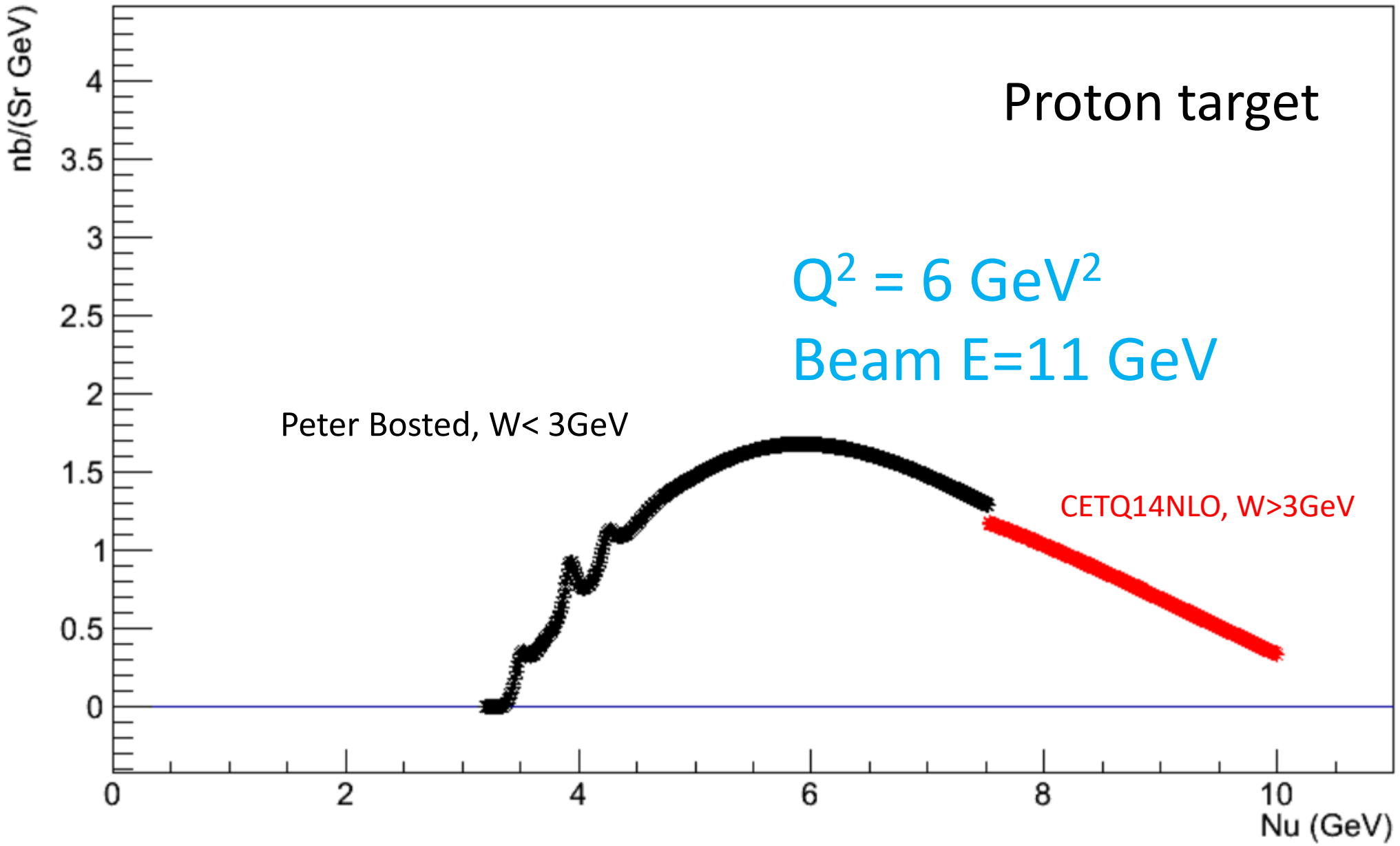

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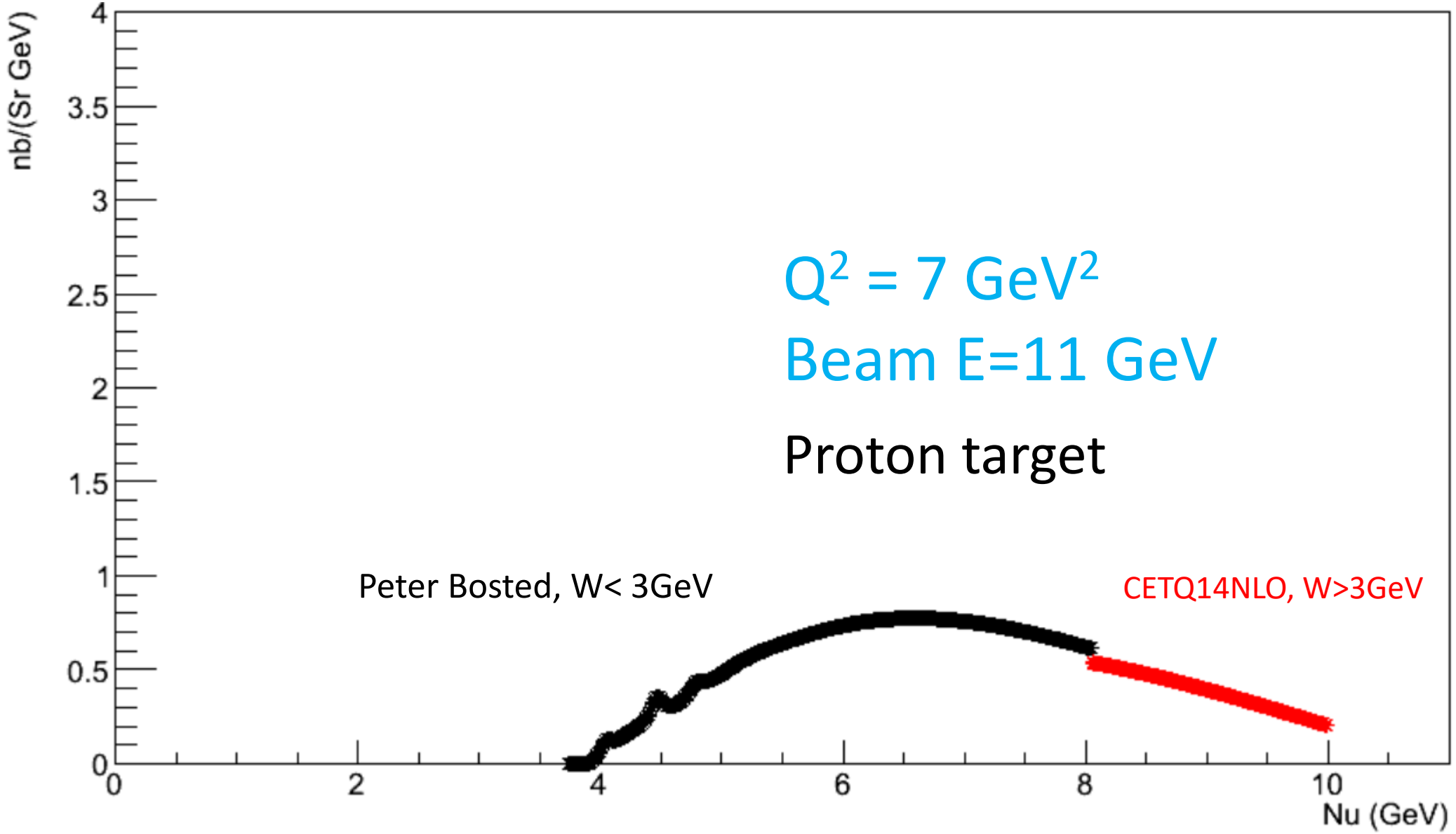

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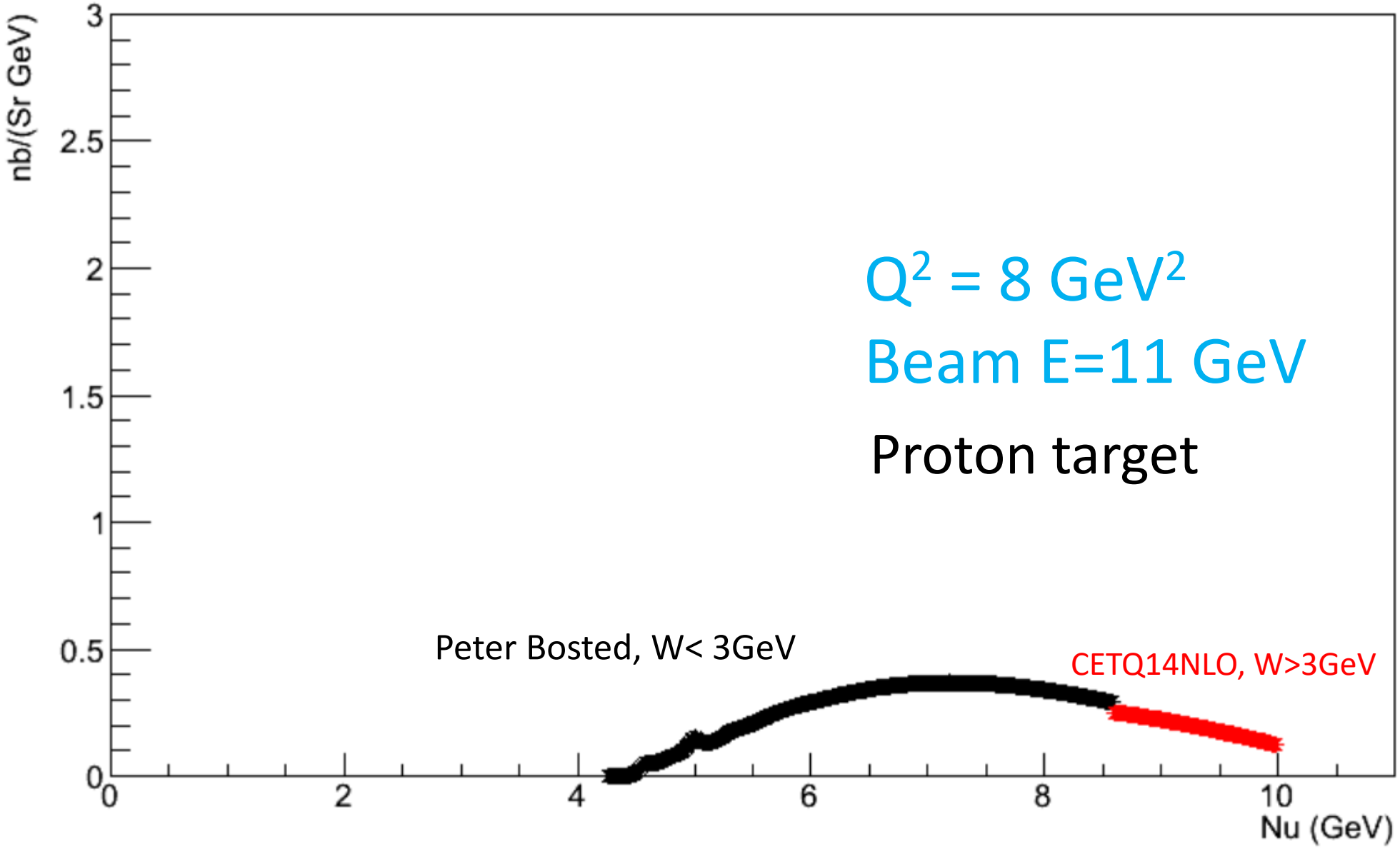

A glance at the code structure

```
yxzhao@yxzhao-dellpc:~/workarea/SoLID/Inclusive_electron/inclusive_electron$ ls
analysis_code  build  cmake  CMakeLists.txt  include  main.C  readme  src  use_LHAPDF6.sh
```

Christy_bosted_inelastic_QE.h
proton_DIS.h

```
//proton structure functions
double calculate_proton_g1gz(PDF* pol_pdf, double x, double Q2);
double calculate_proton_g5gz(PDF* pol_pdf, double x, double Q2);
double calculate_proton_g3gz(PDF* pol_pdf, double x, double Q2);
double calculate_proton_g5z(PDF* pol_pdf, double x, double Q2);
double calculate_proton_g3z(PDF* pol_pdf, double x, double Q2);
double calculate_proton_F2g(PDF* unpol_pdf, double x, double Q2);
double calculate_proton_F1g(PDF* unpol_pdf, double x, double Q2);

//---proton asymmetries
double calculate_proton_AL(PDF* unpol_pdf, PDF* pol_pdf, double x, double Q2, double y);
double calculate_proton_AL_g1gz(PDF* unpol_pdf, PDF* pol_pdf, double x, double Q2, double y);
double calculate_proton_AL_g5gz(PDF* unpol_pdf, PDF* pol_pdf, double x, double Q2, double y);
```

Select a PDF set in LHAPDF6 and use the functions in the head file to calculate structure functions and differential cross sections…

As simple as it is !

Summary

- A C/C++ code is ready to use for the inclusive electron generators
- Including QE + RESONANCE + DIS
  - Christy Bosted + LHAPDF6
- Any nucleus targets