Comparison of GK and KM20 in MILOU 3D

- We compare the generation of purely DVCS events in MILOU with GK and KM20 @ EIC beam energies
- Generation parameters as follows:

BASES integration parameters
& range to be optimized case by case

Number of x & Q^2 & t points in the amplitudes grid
NXGRID 60
NQGRID 60
NTGRID 60

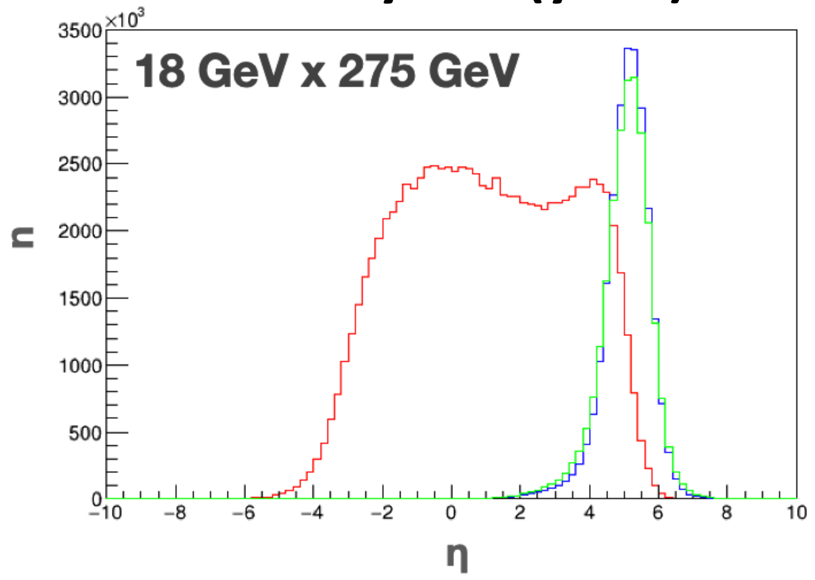
# of Generated Events: 500k /configuration

Kinematical cuts at generation level

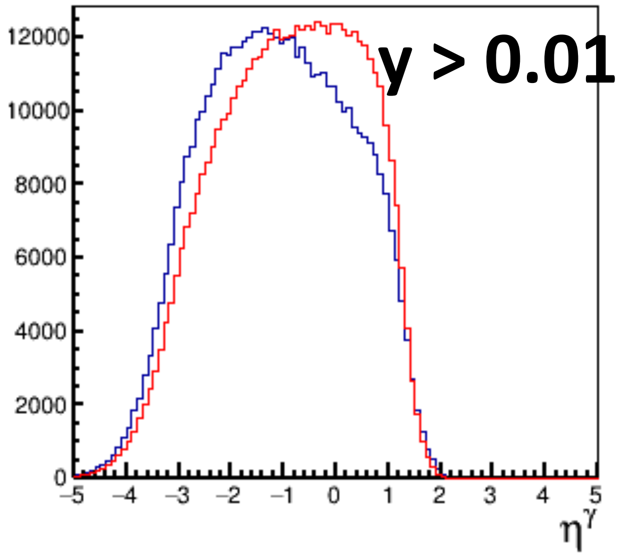
- $10^{-4} < x < 0.9$
- $1.0 < Q2 < 100$ GeV^2
- $0.01 < |t| < 1.6$ GeV^2
- $0.01 < y < 0.95$ [inelasticity]
- $E^{el}_{min} = 0.5$ GeV

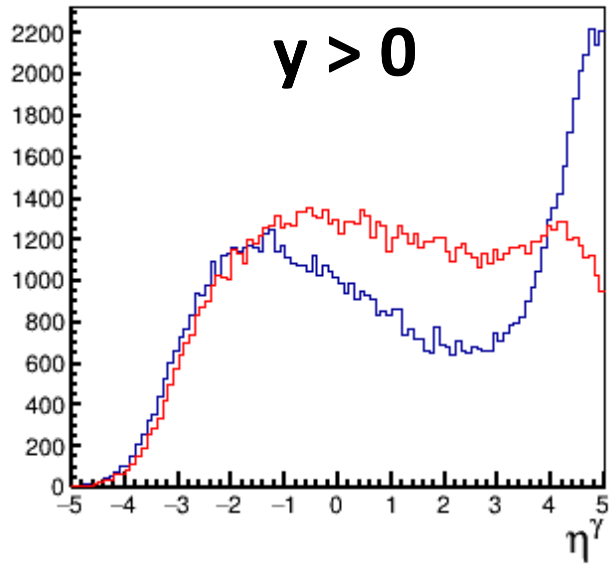
Photons at forward rapidity

Pawel's toy MC (y > 0)



MILOU (GK, KM20)



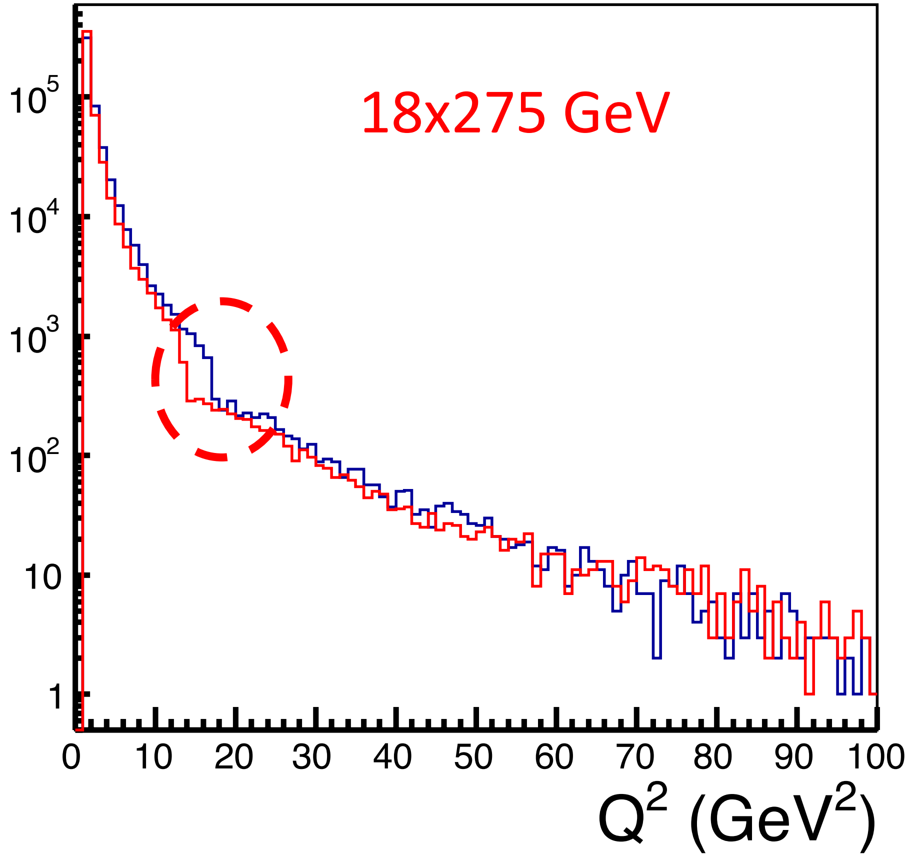


- In Pawel's plot DVCS photons extended to forward rapidity
- There was some discussion on this withing the Y.R., as it seemed to contrast with expectations from W.P. and plots with MILOU
- After investigation we found that this is driven by the lower inelasticity cuts (commonly assumed to be y>0.01)
- Optimizing the cut? See Pawel's update

Gaps in Q^2

- It was reported several times, e.g. see Jinlong's many updates, that MILOU plots often show weird gaps in the Q^2 (and large $|t|$) distribution
- This seems to be due to BASES/SPRING integration package

Photon virtuality




```
**********************************************************
*                                                        *
*     BBBBBBB     AAAA     SSSSSS   EEEEEE   SSSSSS      *
*     BB    BB   AA  AA   SS    SS  EE      SS    SS     *
*     BB    BB  AA    AA  SS        EE      SS           *
*     BBBBBBB   AAAAAAAA   SSSSSS   EEEEEE   SSSSSS      *
*     BB    BB  AA    AA        SS  EE            SS     *
*     BB    BB  AA    AA  SS    SS  EE      SS    SS     *
*     BBBB BB   AA    AA   SSSSSS   EEEEEE   SSSSSS      *
*                                                        *
*                BASES Version 5.1                       *
*          coded by S.Kawabata KEK, March 1994           *
**********************************************************

 <<   Parameters for BASES    >>

 (1) Dimensions of integration etc.
     # of dimensions :    Ndim    =        3   ( 50 at max.)
     # of Wilds      :    Nwild   =        3   ( 15 at max.)
     # of sample points : Ncall   =    18522(real)    20000(given)
     # of subregions    : Ng      =       42 / variable
     # of regions       : Nregion =       21 / variable
     # of Hypercubes    : Ncube   =     9261

 (2) About the integration variables
     ------+---------------+---------------+-------+-------
        i       XL(i)           XU(i)       IG(i)   Wild
     ------+---------------+---------------+-------+-------
        1    1.000000E-04    1.000000E-01     1      yes
        2    1.000000E+00    1.000000E+02     1      yes
        3   -1.600000E+00   -1.000000E-02     1      yes
     ------+---------------+---------------+-------+-------

 (3) Parameters for the grid optimization step
     Max.# of iterations: ITMX1 =        9
     Expected accuracy  : Acc1  =    0.0500 %

 (4) Parameters for the integration step
     Max.# of iterations: ITMX2 =       10
     Expected accuracy  : Acc2  =    0.0100 %
```

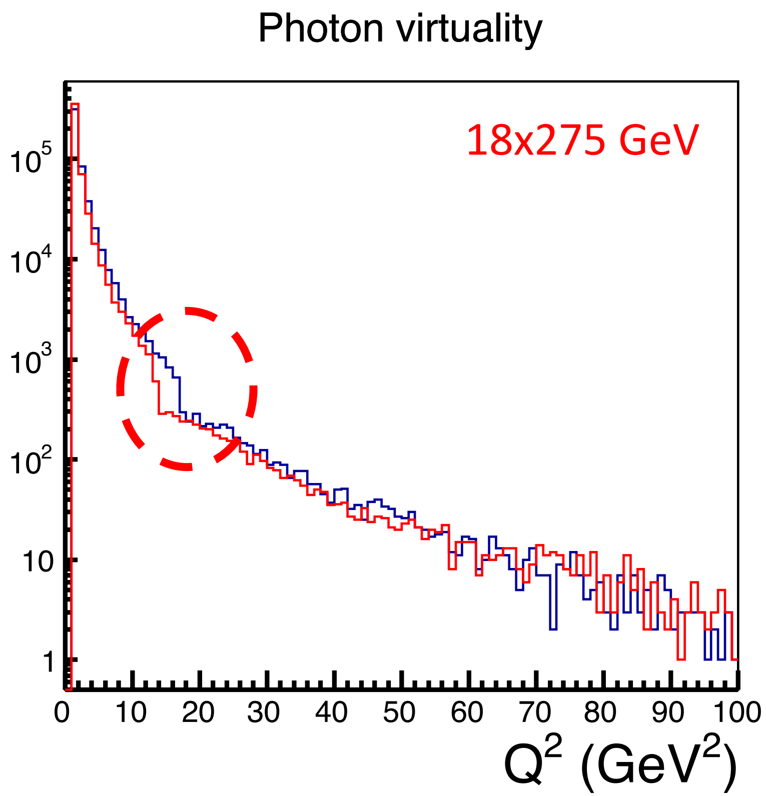
Optimization of BASES grid

```
                                                          Date: 2020/ 9/25   18:11
              Convergency Behavior for the Grid Optimization Step
 ------------------------------------------------------------------------------
 <- Result of  each iteration ->  <-      Cumulative Result     -> < CPU  time >
  IT Eff R_Neg   Estimate  Acc %  Estimate(+- Error )order  Acc % ( H: M: Sec )
 ------------------------------------------------------------------------------
   1  88  0.00  1.930E-01 17.864  1.929769(+-0.344729)E-01 17.864   0:16:54.40
   2  71  0.00  3.999E-01  1.225  3.957869(+-0.048508)E-01  1.226   0:28:59.84
   3  80  0.00  4.138E-01  0.215  4.132092(+-0.008751)E-01  0.212   0:43:27.87
   4  82  0.00  4.158E-01  0.246  4.142973(+-0.006648)E-01  0.160   0:57:25.92
   5  81  0.00  4.145E-01  0.217  4.143823(+-0.005349)E-01  0.129   1:10:55.50
   6  81  0.00  4.149E-01  0.236  4.145101(+-0.004693)E-01  0.113   1:25: 4.36
   7  81  0.00  4.162E-01  0.231  4.148287(+-0.004218)E-01  0.102   1:38:50.89
   8  81  0.00  4.163E-01  0.285  4.149889(+-0.003975)E-01  0.096   1:52:32.91
   9  80  0.00  4.137E-01  0.210  4.147629(+-0.003614)E-01  0.087   2: 6:41.37
 ------------------------------------------------------------------------------
^L
                                                          Date: 2020/ 9/25   18:11
              Convergency Behavior for the Integration Step
 ------------------------------------------------------------------------------
 <- Result of  each iteration ->  <-      Cumulative Result     -> < CPU  time >
  IT Eff R_Neg   Estimate  Acc %  Estimate(+- Error )order  Acc % ( H: M: Sec )
 ------------------------------------------------------------------------------
   1  81  0.00  4.138E-01  0.252  4.138218(+-0.010420)E-01  0.252   2:20:12.01
   2  81  0.00  4.151E-01  0.239  4.145102(+-0.007181)E-01  0.173   2:33:51.18
   3  81  0.00  4.154E-01  0.238  4.148119(+-0.005810)E-01  0.140   2:47:26.93
   4  81  0.00  4.160E-01  0.252  4.150840(+-0.005084)E-01  0.122   3: 1: 8.49
   5  81  0.00  4.150E-01  0.242  4.150684(+-0.004536)E-01  0.109   3:15:25.60
   6  81  0.00  4.163E-01  0.241  4.152770(+-0.004135)E-01  0.100   3:29:39.94
   7  81  0.00  4.143E-01  0.229  4.151176(+-0.003791)E-01  0.091   3:43:39.38
   8  81  0.00  4.157E-01  0.273  4.151712(+-0.003595)E-01  0.087   3:57:55.32
   9  81  0.00  4.163E-01  0.239  4.153046(+-0.003382)E-01  0.081   4:11:32.34
  10  81  0.00  4.135E-01  0.235  4.151063(+-0.003194)E-01  0.077   4:25:47.40
 ------------------------------------------------------------------------------
^L
```

```
-
Histogram (ID =  1 ) for x
                              Linear Scale indicated by "*"
    x      d(Sigma)/dx     0.0E+00      3.8E+01      7.5E+01     1.1E+02
+-------+-----------------+------------+------------+-----------+-----------+
I  E -2 I 0.000         E  0I                                               I
I 0.010 I 1.250+-0.001 E  2I******************************************00000 I
I 0.260 I 2.231+-0.003 E  1I********0000000000000000000000000000000000      I
I 0.510 I 9.149+-0.028 E  0I****00000000000000000000000000000000000         I
I 0.759 I 3.839+-0.025 E  0I**0000000000000000000000000000000000            I
I 1.009 I 1.979+-0.024 E  0I*000000000000000000000000000000000              I
I 1.259 I 1.256+-0.024 E  0I*0000000000000000000000000000000                I
I 1.509 I 7.428+-0.171 E -1I*00000000000000000000000000000                  I
I 1.758 I 4.911+-0.232 E -1I*0000000000000000000000000000                   I
I 2.008 I 2.524+-0.193 E -1I*00000000000000000000000000                     I
I 2.258 I 3.037+-0.178 E -1I*00000000000000000000000000                     I
I 2.508 I 2.030+-0.143 E -1I*0000000000000000000000000                      I
I 2.757 I 1.200+-0.103 E -1I*00000000000000000000000                        I
I 3.007 I 9.444+-0.839 E -2I*0000000000000000000000                         I
I 3.257 I 7.481+-0.692 E -2I*0000000000000000000000                         I
I 3.507 I 3.492+-0.584 E -2I*0000000000000000000                            I
I 3.756 I 3.378+-0.648 E -2I*0000000000000000000                            I
I 4.006 I 6.158+-1.924 E -2I*000000000000000000000                          I
I 4.256 I 7.091+-1.435 E -2I*000000000000000000000                          I
I 4.506 I 2.333+-0.712 E -2I*000000000000000000                             I
I 4.755 I 4.548+-1.532 E -2I*00000000000000000000                           I
I 5.005 I 1.389+-0.761 E -2I*0000000000000000                               I
I 5.255 I 1.729+-0.503 E -2I*00000000000000000                              I
I 5.505 I 1.098+-0.392 E -2I*000000000000000                                I
I 5.754 I 9.939+-0.870 E -3I*000000000000000                                I
I 6.004 I 1.966+-0.533 E -2I*00000000000000000                              I
I 6.254 I 5.538+-1.434 E -3I*0000000000000                                  I
I 6.504 I 1.371+-0.409 E -2I*0000000000000000                               I
I 6.753 I 2.333+-0.859 E -2I*000000000000000000                             I
I 7.003 I 4.075+-1.127 E -3I*000000000000                                   I
I 7.253 I 7.760+-2.381 E -3I*00000000000000                                 I
I 7.503 I 8.198+-2.912 E -3I*00000000000000                                 I
I 7.752 I 8.436+-1.753 E -3I*00000000000000                                 I
I 8.002 I 3.242+-1.321 E -3I*00000000000                                    I
I 8.252 I 3.775+-1.165 E -3I*000000000000                                   I
I 8.502 I 5.408+-1.364 E -3I*0000000000000                                  I
I 8.751 I 2.698+-0.752 E -3I*00000000000                                    I
I 9.001 I 2.517+-1.765 E -3I*0000000000                                     I
```

Optimization of BASES grid

- The integration variables (x, Q2, t) bust be samples properly (right interval in the steering cards)
- Number of calls and number of steps for grid optimization must yield an acceptable accuracy
- Tuned grids (bases.data files) can be later reused for generation



Parameters varied:

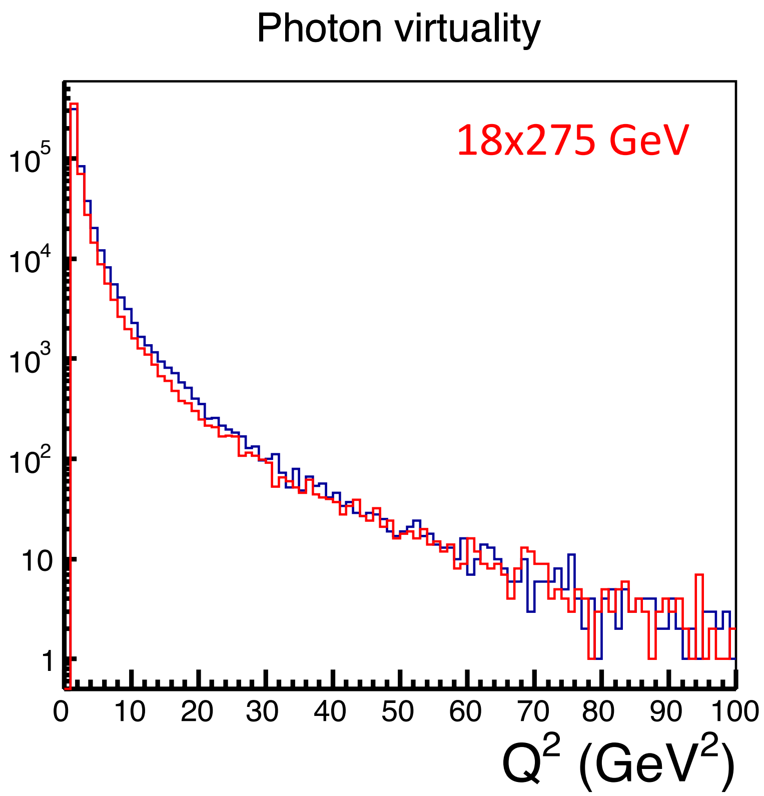
Upper x limit x < 0.9 → 0.1

Ncall 10k → 20k

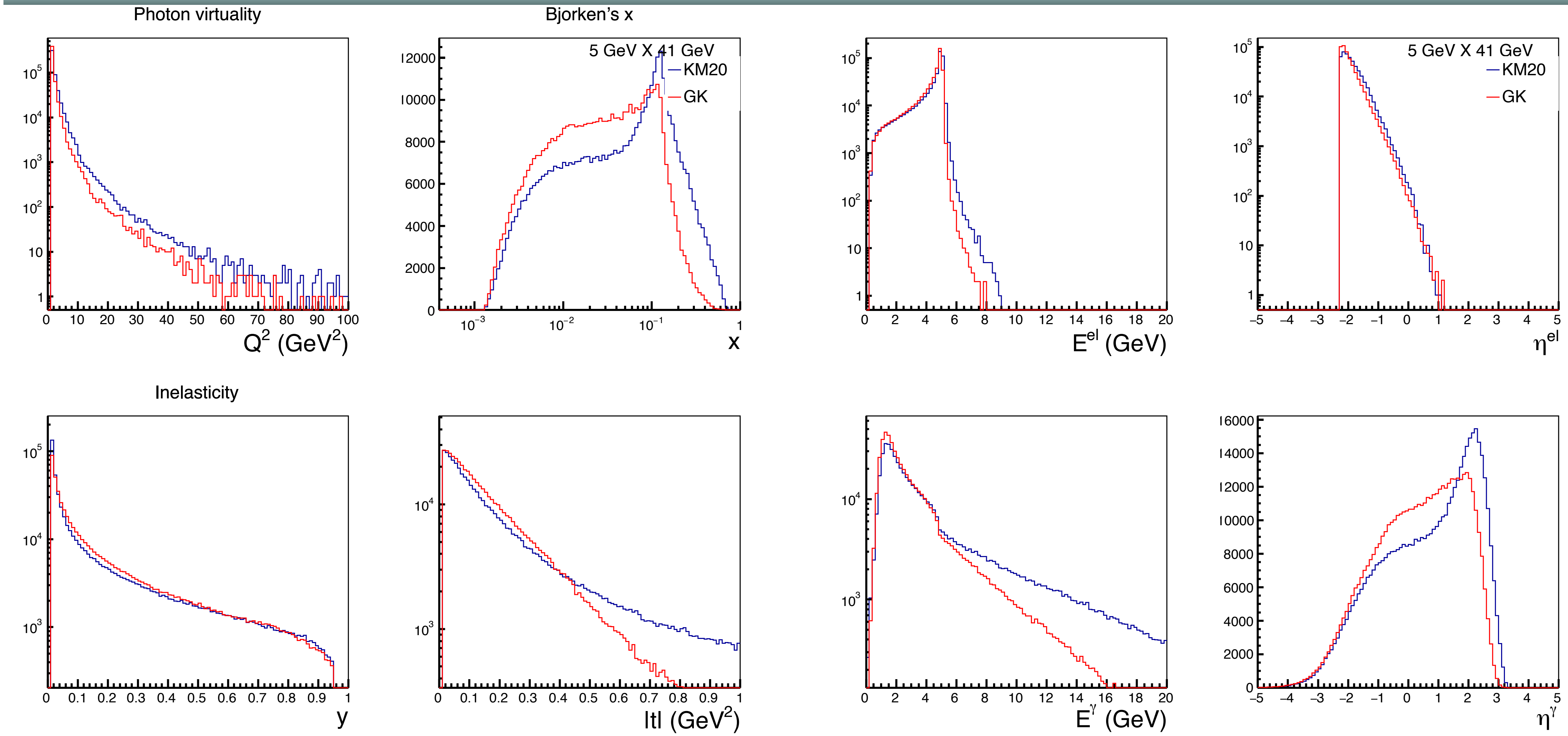
ITMX1 = 3 → 9

ITMX2 = 3 → 10

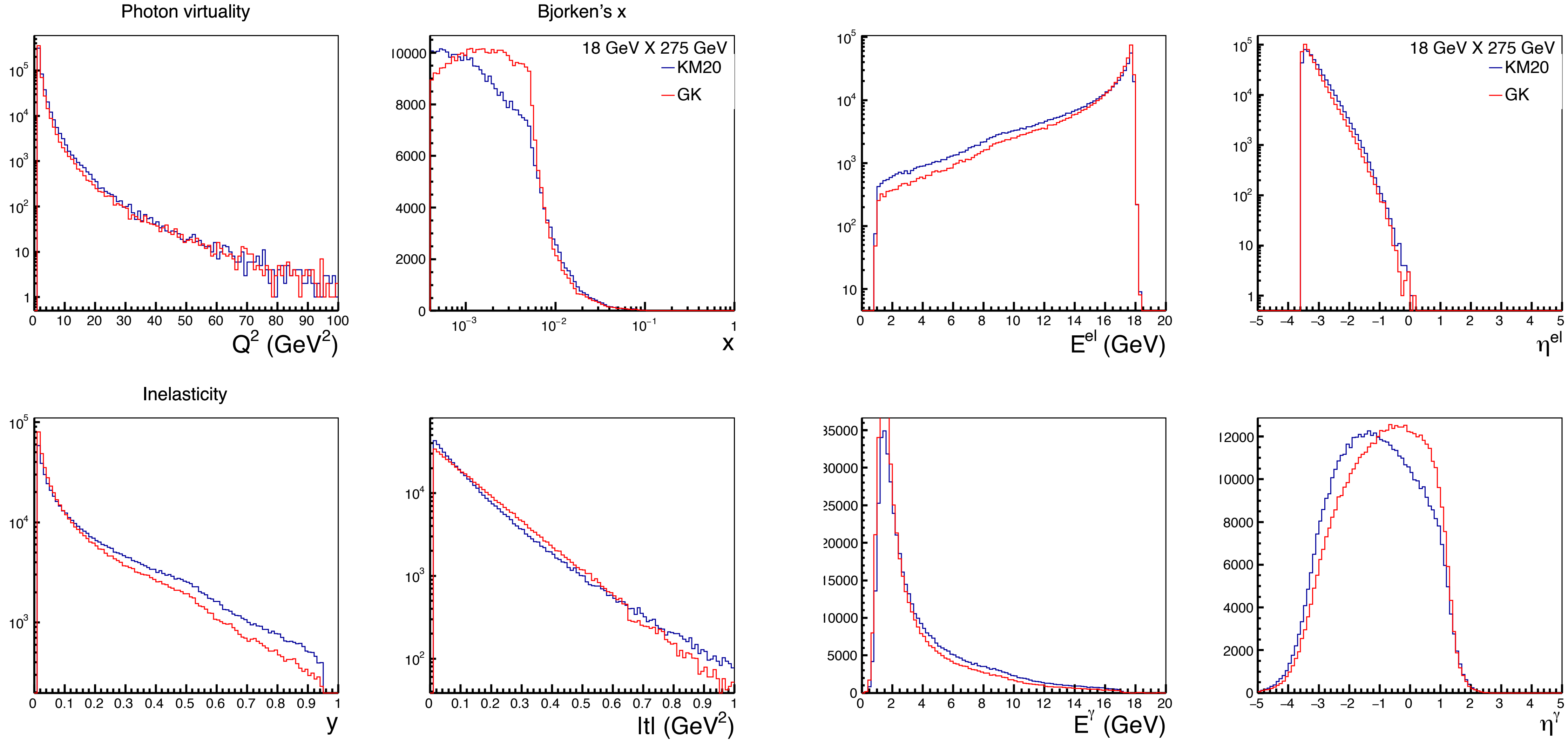
After BASES grid optimization



Comparison: (5 x 41) GeV

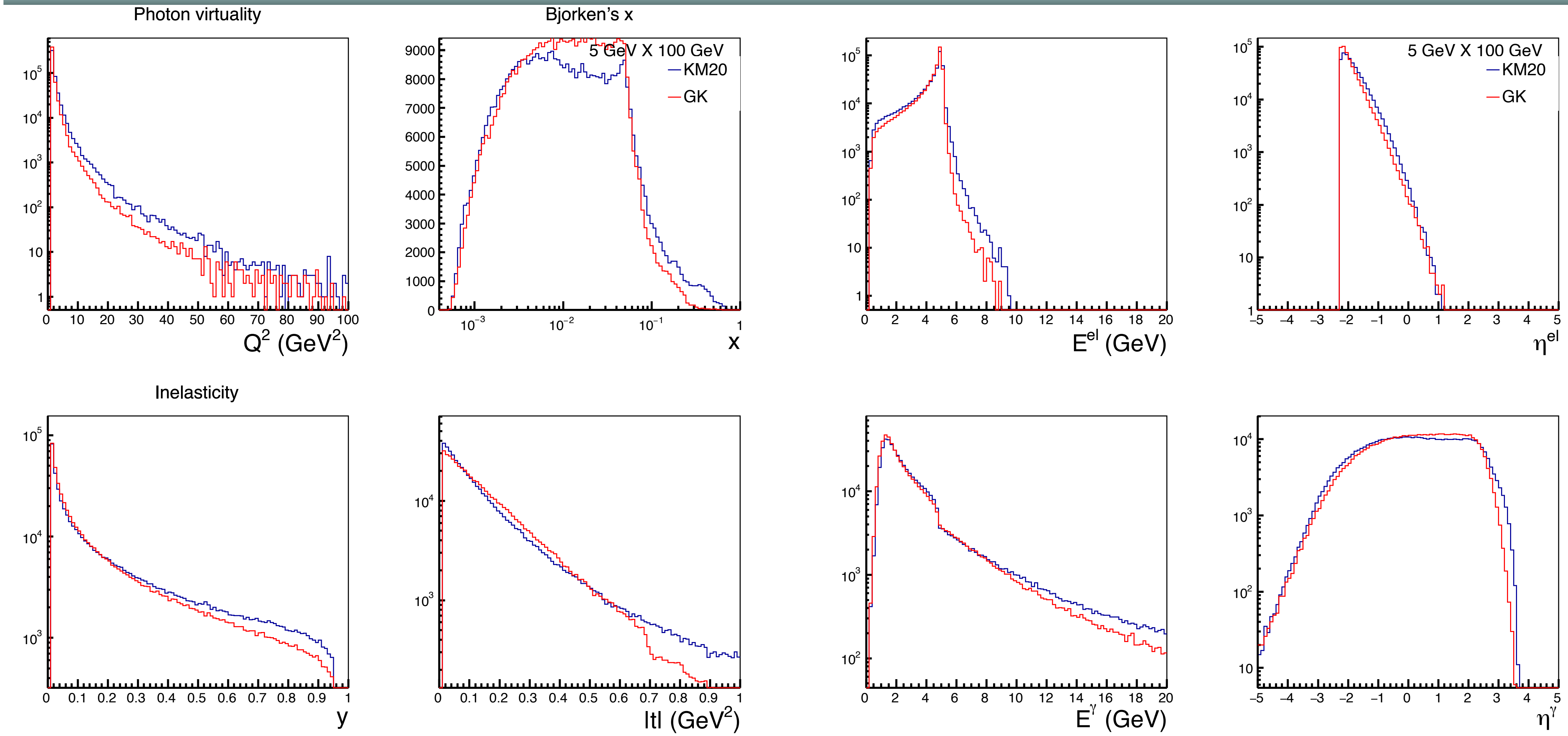


Comparison: (18 x 275) GeV



- **Deep in Q^2 and t distribution:** related to optimization of BASES integration grid/parameters
- **Different behavior vs Bjorken's x** of GK and KM20

Comparison: (5 x 100) GeV



- **Deep in Q^2 distribution disappears**.
- Very different t-dependences at large |t|> 0.65 GeV2 for GK (exponential) and KM20 (dipole-like)
- **Behavior vs Bjorken's x** of GK and KM20 becames more similar in the tails

Outlook

- The code is now in good shape, ready to be used for impact and detector studies

In the near term, we should consider to:

- Include CFFs of light nuclei
- Include polarization (beam helicity)