

TMDlib & TMDplotter and MCEG discussion

- TMDlib and TMDplotter
 - status
 - prospects
- Discussion on MC event generators
 - need for full particle (hadron) level MC generator
 - TMD distributions for use in MCEG
 - parton showers within TMD/PB framework
 - combining initial state radiation with TMD and (NLO) hard processes

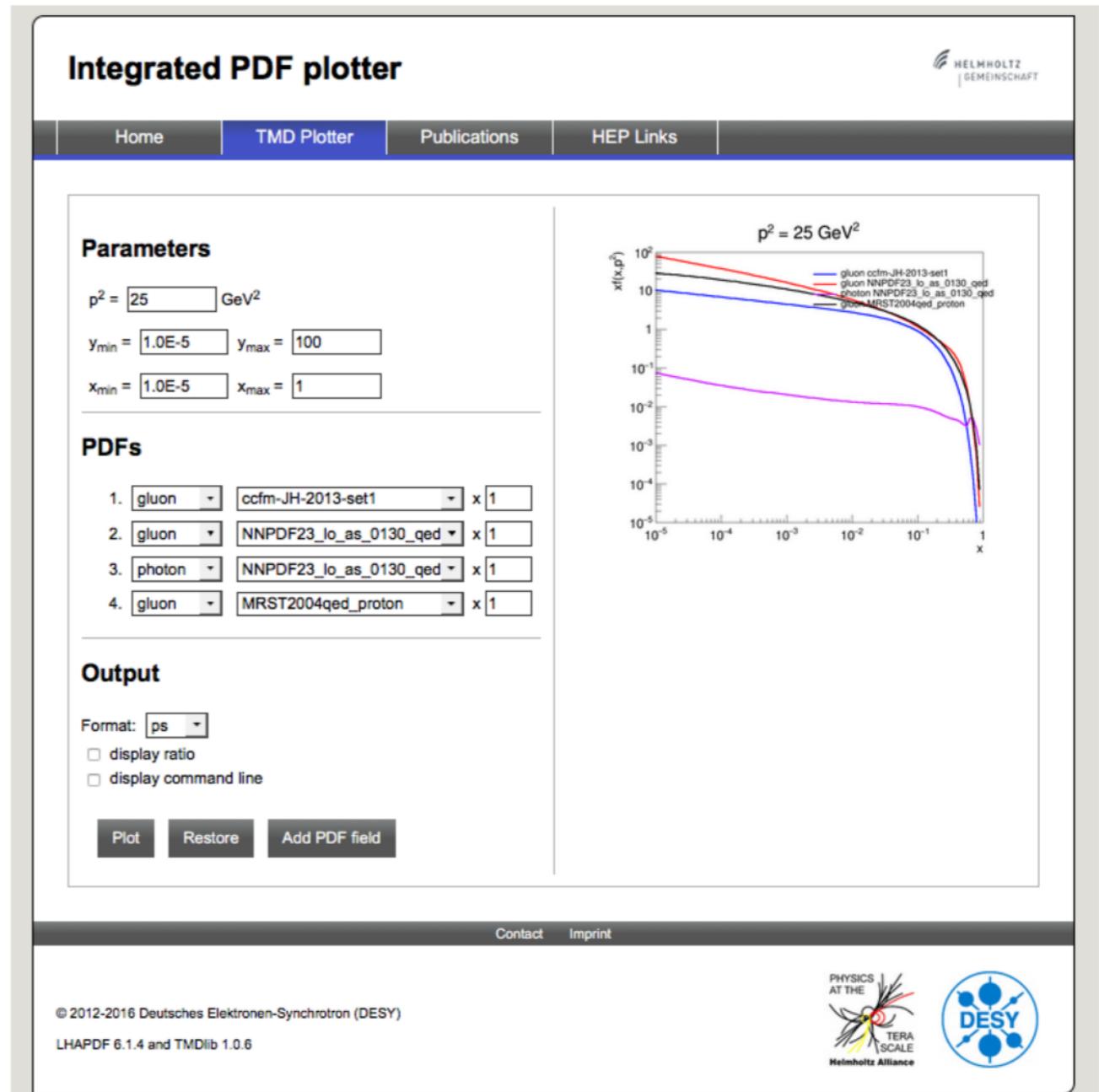
Where to find TMDs ? TMDlib and TMDplotter

- TMDlib proposed in 2014 as part of REF workshop and developed since
- combine and collect different ansaetze and approaches:

<http://tmd.hepforge.org/> and
<http://tmdplotter.desy.de>

- TMDlib: a library of parametrization of different TMDs and uPDFs (similar to LHAPdf)

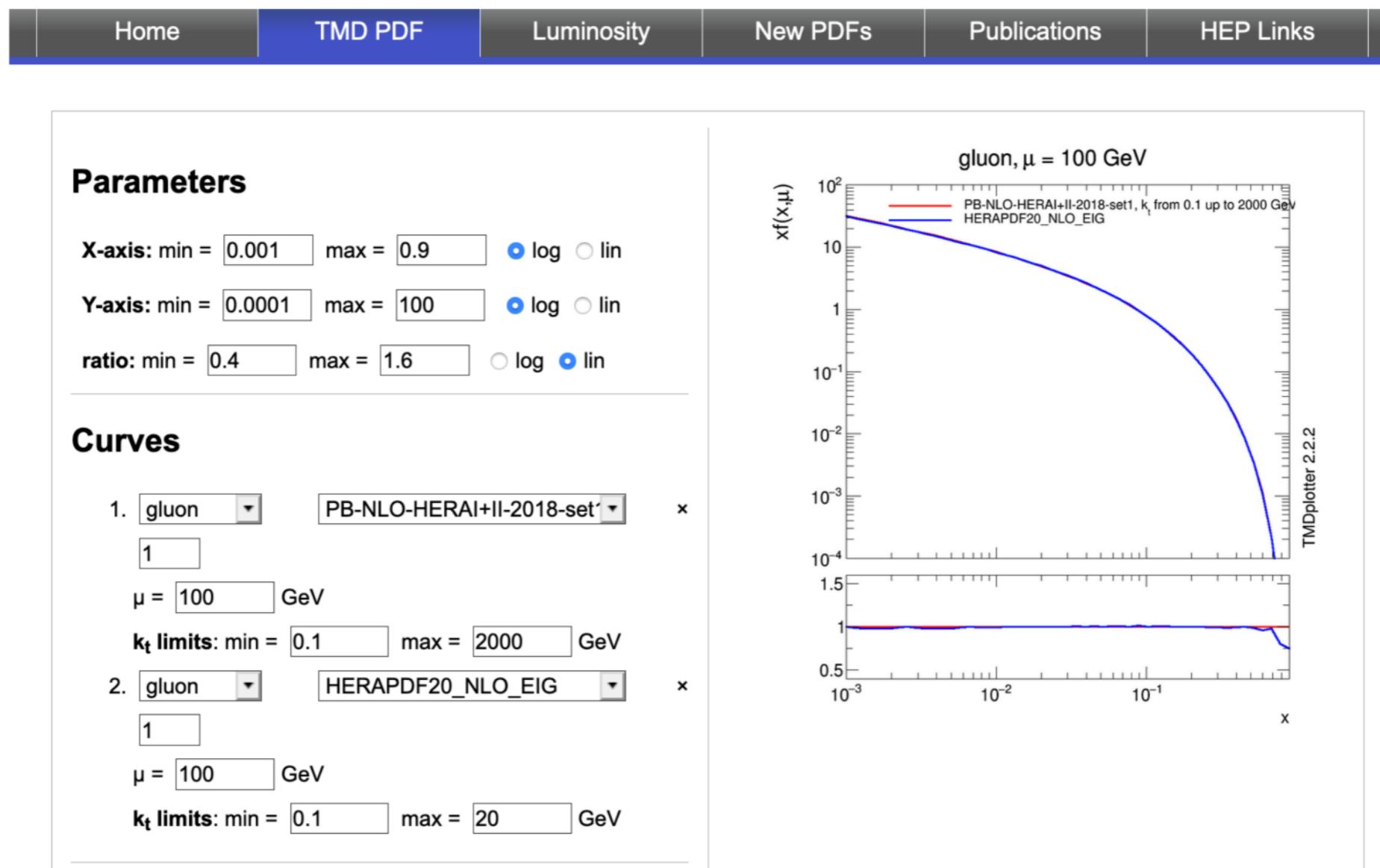
TMDlib and TMDplotter: library and plotting tools for transverse-momentum-dependent parton distributions, *F. Hautmann et al.* arXiv 1408.3015, Eur. Phys. J., C 74(12):3220, 2014.



- Also integrated pdfs (including photon pdf are available via LHAPDF)

TMDplotter - examples

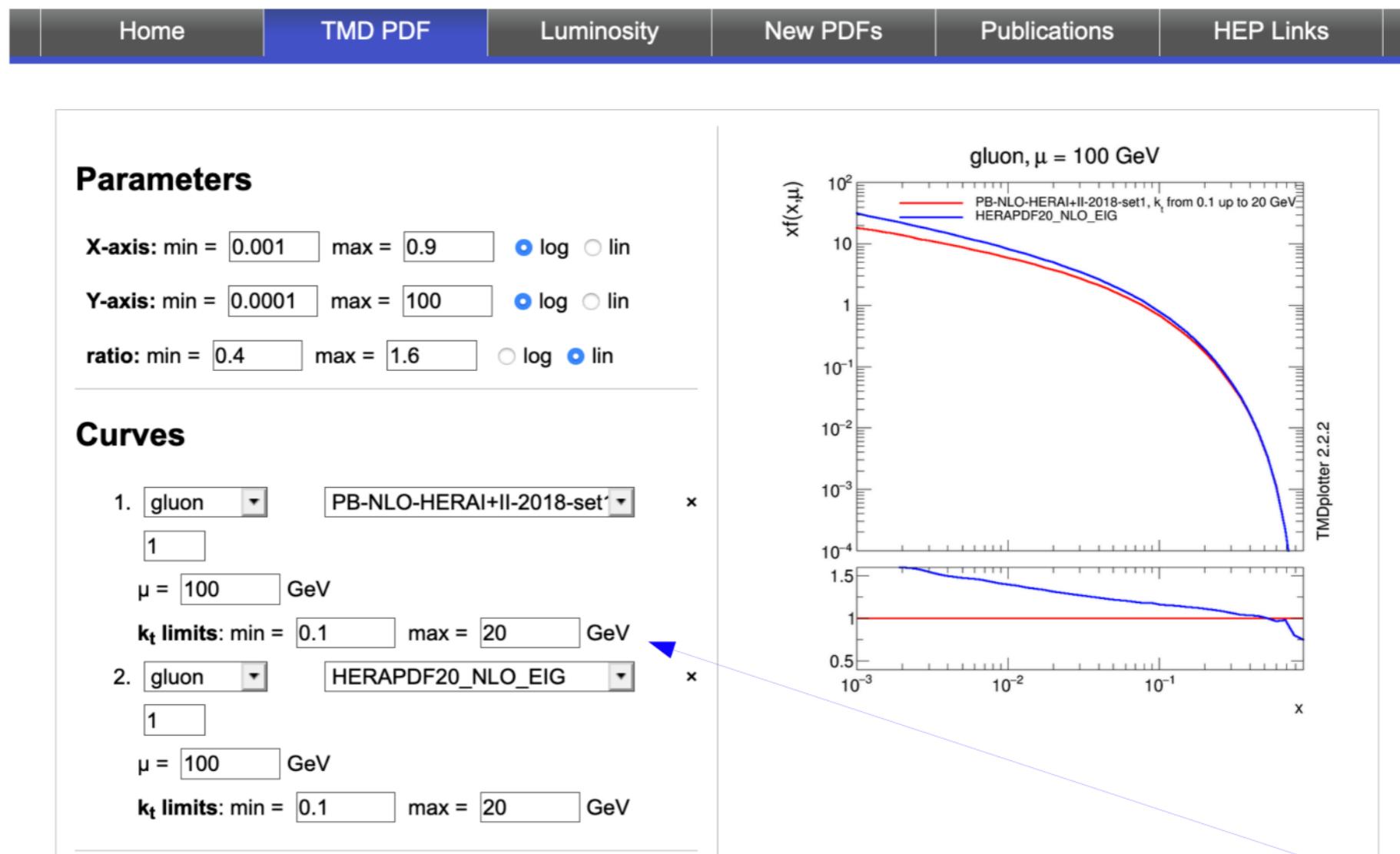
TMD plotter — Integrated density as a function of x



- Compare HERAPDF2.0 (as in LHAPDF) with PB-TMD set1
 - integrated PB-TMD set1 agrees with HERAPDF2.0 NLO (as it should)

TMDplotter - examples

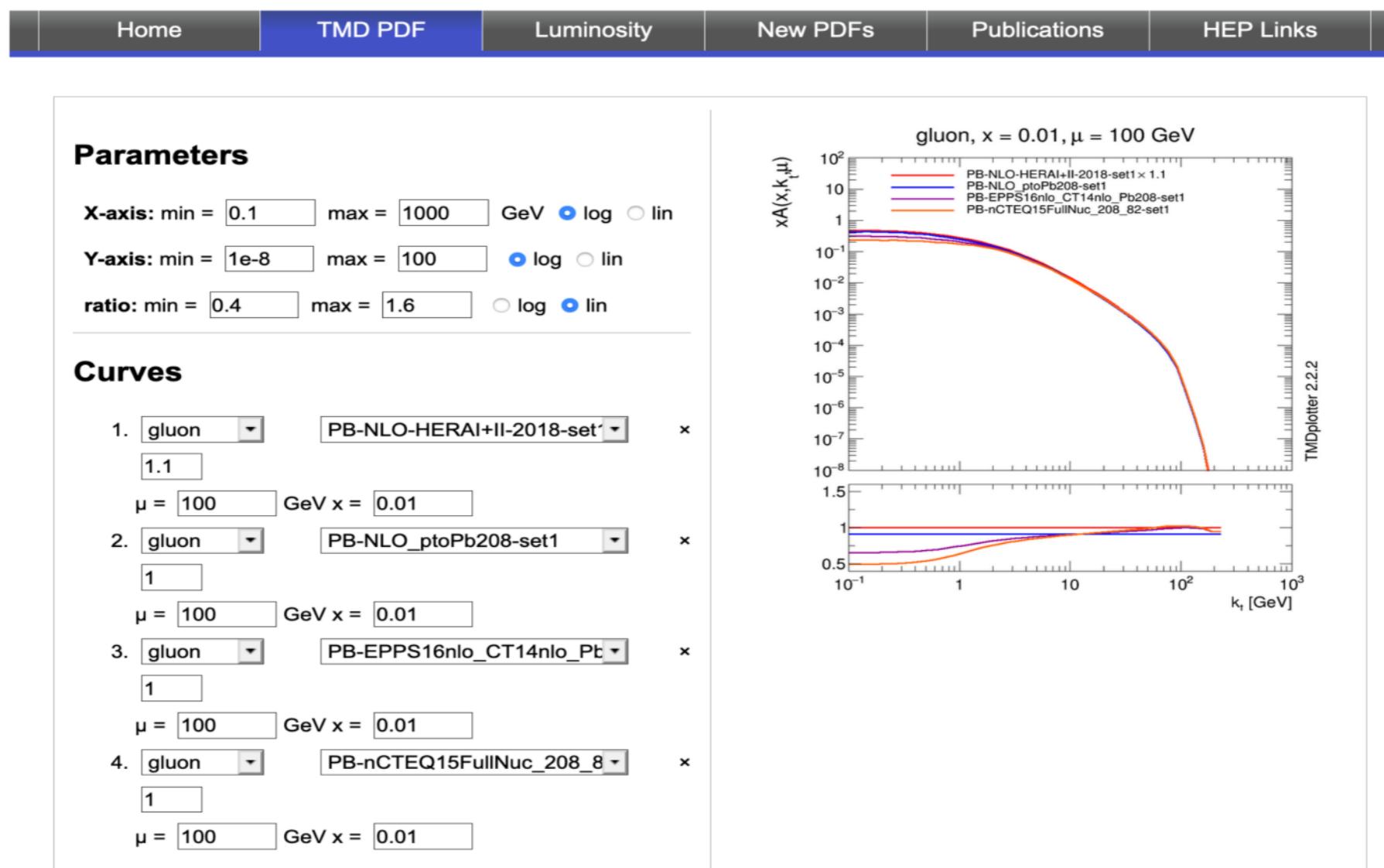
TMD plotter — Integrated density as a function of x



- Compare HERAPDF2.0 (as in LHAPDF) with PB-TMD set1 (limited kt integration)
 - differences observed (as it should be !)

TMDplotter - examples

TMD plotter — Density as a function of k_t



- Compare k_t distributions of different sets: Pb-TMDs and p-TMDs

TMDlib: implemented TMD sets

- TMDlib version 1.0.31 - implemented TMDs:

Parton	uPDF/TMD set	identifier	Sets	$\Lambda_{qcd}^{(4)} (\alpha_s(M_Z))$	k_t^{cut} [GeV]	Q_0 [GeV]	Ref.
all flavors	EKMP	500001	1	0.35	-	-	[87]
	PB-NLO-HERAI+II-2018-set1	102100	35	$\alpha_s = 0.118$	0.01	1.378	[88]
	PB-NLO-HERAI+II-2018-set2	102200	37	$\alpha_s = 0.118$	0.01	1.183	[88]
	PB-NLO-HERAI+II-2018-set1-q0	102140	2	$\alpha_s = 0.118$	0.01	1.378	[88]
	PB-NLO-HERAI+II-2018-set2-q0	102240	2	$\alpha_s = 0.118$	0.01	1.183	[88]
	PB-NLO_ptoPb208-set1	10904300	1	$\alpha_s = 0.118$	0.01	1.378	[89]
	PB-NLO_ptoPb208-set2	10904400	1	$\alpha_s = 0.118$	0.01	1.183	[89]
	PB-EPPS16nlo_CT14nlo_Pb208-set1	10901300	1	$\alpha_s = 0.118$	0.01	1.378	[89]
	PB-EPPS16nlo_CT14nlo_Pb208-set2	10901400	1	$\alpha_s = 0.118$	0.01	1.183	[89]
	PB-nCTEQ15FullNuc_208_82-set1	10902300	1	$\alpha_s = 0.118$	0.01	1.378	[89]
	PB-nCTEQ15FullNuc_208_82-set2	10902400	1	$\alpha_s = 0.118$	0.01	1.183	[89]
	MRW-CT10nlo	410001	1	-	-	-	[90]
Gluon	ccfm-JS-2001	101000	1	0.25	0.25	1.4	[79]
	ccfm-setA0	101010	3	0.25	1.3	1.3	[79]
	ccfm-setB0	101020	3	0.25	0.25	1.3	[79]
	ccfm-JH-set 1	101001	1	0.25	1.33	1.33	[91]
	ccfm-JH-set 2	101002	1	0.25	1.18	1.18	[91]
	ccfm-JH-set 3	101003	1	0.25	1.35	1.35	[91]
	ccfm-JH-2013-set1	101201	1	0.2	2.2	2.2	[75]
	ccfm-JH-2013-set2	101301	1	0.2	2.2	2.2	[75]
	GBWlight	200001	1	-	-	-	[80]
	GBWcharm	200002	1	-	-	-	[80]
	KS-2013-linear	400001	1	0.3	-	-	[81]
	KS-2013-non-linear	400002	1	0.35	-	-	[81]
	Kutak-linear-scale	400003	1	0.35	-	-	[82]
	Kutak-nonlinear-scales	400004	1	0.35	-	-	[82]
	GLLZ	600001	1	0.2	1.1	1.1	[92]
Quark	ccfm-setA0	-	1	0.25	1.3	1.3	
	ccfm-JH-2013-set1	-	1	0.2	2.2	2.2	[75]
	ccfm-JH-2013-set2	-	1	0.2	2.2	2.2	[75]
	SBRS-2013-TMDPDFs	300001	1	-	-	1.55	[52]
	SBRS-2013-TMDPDFs-par	300001	1	-	-	1.55	[52]

Table 1: Available uPDF/TMD parton sets in TMDlib.

TMDlib: status & prospects

- **TMDlib version 1.0.31** (production version)
 - all TMD sets (including nuclear TMDs)
- **new version 2.0.0-beta** (to be released in the next days)
 - TMDset data files are separated (and can be downloaded separately)
 - new structure of TMDlib, allowing to load several TMDsets simultaneously (important for pA calculation):

```
TMD tmd1;  
name ="PB-NLO-HERAI+II-2018-set1";  
tmd1.TMDinit(name);  
tmd1.TMDpdf(x,xbar,kt,mu, up,ubar,dn, dbar, strange, sbar, charm, cbar, bottom, bbar, gluon);
```

- version 2.0.0 (to be ready in < month)
 - new structure of data files:
 - info file gives details on TMDset, like α_s , x , k_t , μ - ranges, type of grid and interpolation method etc.
 - code can handle new TMDsets (without changing source by hand)

TMDlib & TMDplotter

- We to find TMDlib and TMDplotter:
 - <http://tmd.hepforge.org/> and <http://tmdplotter.desy.de>
- TMDlib depends that TMD fitters/produces/authors will provide the parametrization/code:
 - format is very flexible, any way to calculate TMDs can be implemented
 - easiest is to provide a grid in $\log x, \log k_t, \log \mu$
 - A citation from: Collins/Rogers in Phys.Rev. D91 (2015) 074020:

If results of a global fit were presented for evolved Q -dependent TMD densities (as is routine for collinear parton densities), then users would not even have to use (16), (18), or (22); they could just use the simple parton-model-like form (15). (See Ref. [TMDlib] for recent efforts in this direction.)
- PLEASE provide your favorite TMD for TMDlib (otherwise it cannot be used)

Discussion on TMDs and MC EG

- Need for full particle (hadron) level MC generator
 - Why do we need a MCEG ?
- Need to go from qualitative to quantitative predictions with realistic uncertainties !
- Why do we need a (or more) MCEG based on TMDs ?
 - which TMDs are needed for a MCEG ?
 - perturbative region for parton showers, but also small k_t region is needed
 - can one combine efforts i.e. PB-TMD for large k_t and traditional TMD for “intrinsic” k_t ?
 - parton showers within TMD/PB framework
 - combining initial state radiation with TMD and (NLO) hard processes
- How to proceed with predictions for EIC and LHeC and FCC (and not forget LHC):
 - going beyond the small q_t in DY production