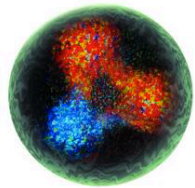


# EMP- PANDA simulations and data analyses

Alaa Dbeyssi, Manuel Zambrana, Iris Zimmermann, Maria Carmen Mora-Espi, Dmitry Khanfekt and Frank Maas

# Nucleon Structure



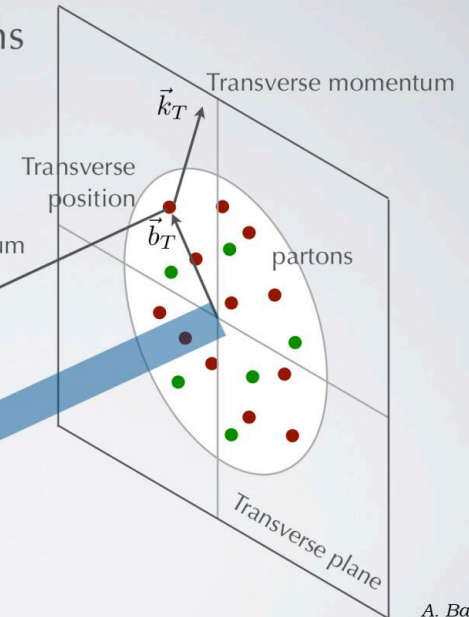
*Wigner function:*  
*full phase space parton*  
*distribution of the nucleon*  
 Generalised Transverse Momentum  
 Distributions (GTMDs)

Wigner distributions

$$\rho(x, \vec{k}_T, \vec{b}_T)$$

*intuitive relation to*  
*experimental observables*

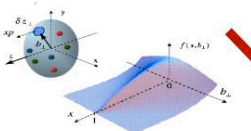
Longitudinal momentum  
 $k^+ = xP^+$   
 $x$ : longitudinal  
 momentum  
 fraction carried by  
 struck parton



A. Bacchetta

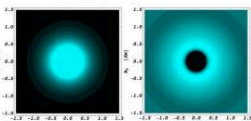
$ep \rightarrow epy$

Generalised Parton  
 Distributions (GPDs)



$$\int dx$$

Form Factors  
 eg:  $G_E, G_M$



$$\int d^2 k_T$$

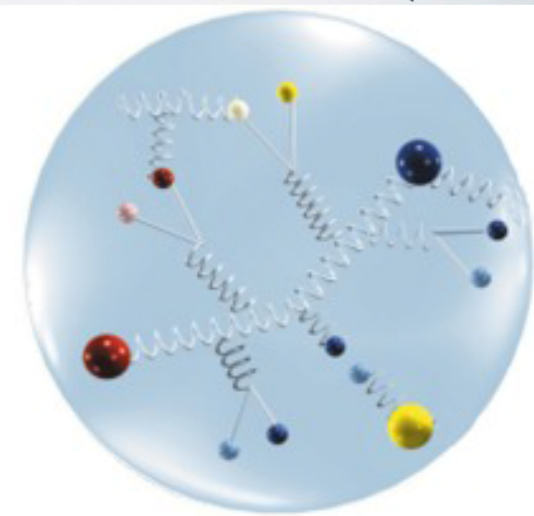
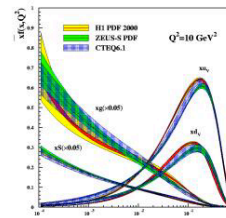
$$\int d^2 b_T$$

Transverse  
 Momentum  
 Distributions  
 (TMDs)

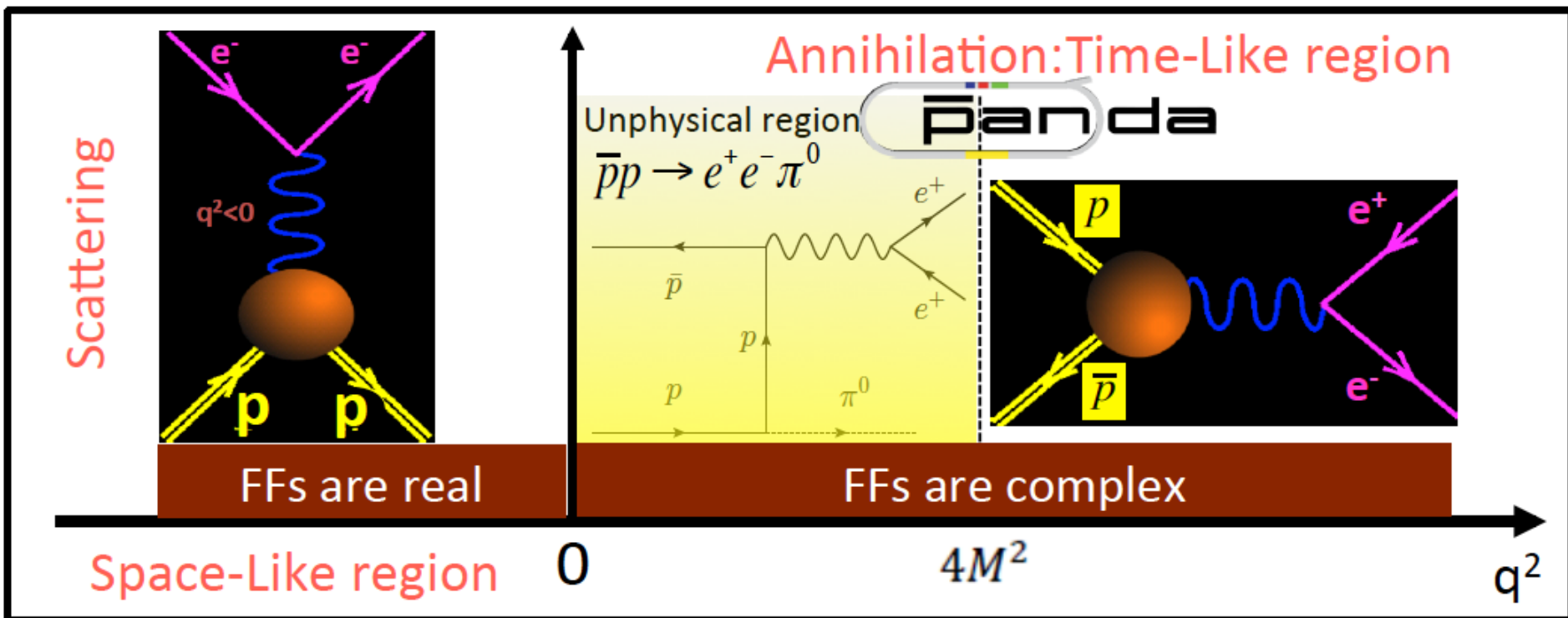
$$\int d^2 b_T$$

$$\int d^2 k_T$$

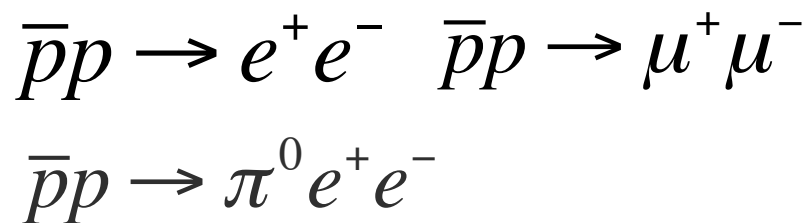
Parton Distribution  
 Functions (PDFs)



# Proton electromagnetic form factors $G_E$ and $G_M$



- Antiproton beams (1.5 – 15 GeV/c)
- Antiproton-proton annihilations



# Feasibility studies – Simulations with PANDARoot

Simulation framework: PANDARoot



- Reconstruction of signal channels: good detection efficiency, large acceptance
- Background studies: optimize signal efficiency versus background suppression
- Precise measurements of experimental observables, e.g. cross sections; optimize the time of measurements (PANDA Phases 1, 2, 3)
- Next-to PANDARoot analyses: extraction of physics quantities e.g. form factors; statistical and systematic uncertainties, input/output check, ....

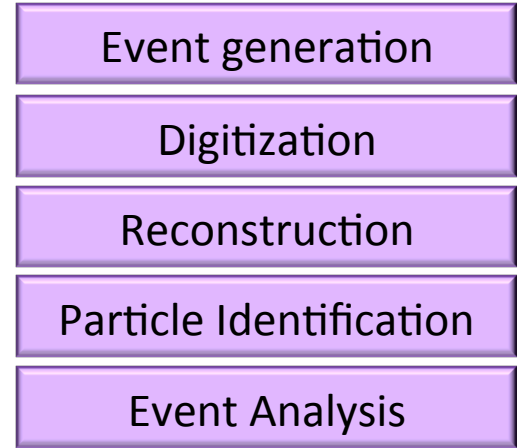
# Feasibility studies (e<sup>+</sup>e<sup>-</sup>/mu<sup>+</sup>mu<sup>-</sup>)

- Development of event generators for signal and background processes (implemented in PANDARoot)

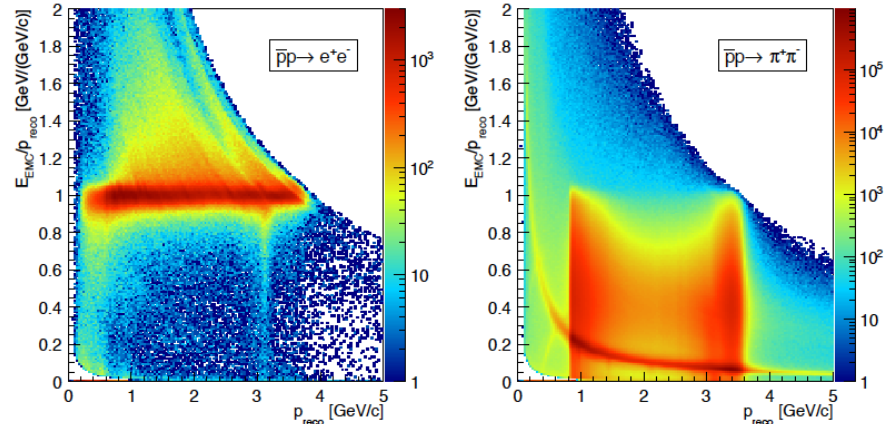
```
//-----User Settings:-----  
// gDebug=5;  
TString parAsciiFile = "all.par";  
TString prefix      = "evtcomplete";  
TString options     = "";  
// TString inputGenerator =  
// EvtGen -> "xxxxxxx.dec" (parses dec-file for initial particle) or "xxxxxxx.dec:initial_particle"  
// DPM    -> "dpm_xxxxxx"  
// FTF    -> "ftf_xxxxxx"  
// BOX    -> "box:type(pdgcode,mult):p(min,max):tth(min,max):phi(min,max)"  
// PIPI   -> "pipi:cosTheta(min,max)"  
// LEP    -> "leplep:pid(value):gegm(value):cosTheta(min,max)"
```

- Development of event selection codes (kinematics, sub-detector PID, TMVA analysis):

## Simulation & Analysis chain with PANDARoot



$$\frac{\sigma(\bar{p}p \rightarrow \pi^+ \pi^-)}{\sigma(\bar{p}p \rightarrow l^+ l^-)} \sim 10^6$$



- Simulations on HIMSTER I and II (Singularity containers): (20 submissions \* 500 jobs \* 10<sup>4</sup> events) \* 4 energy points ~ 2-3 months)