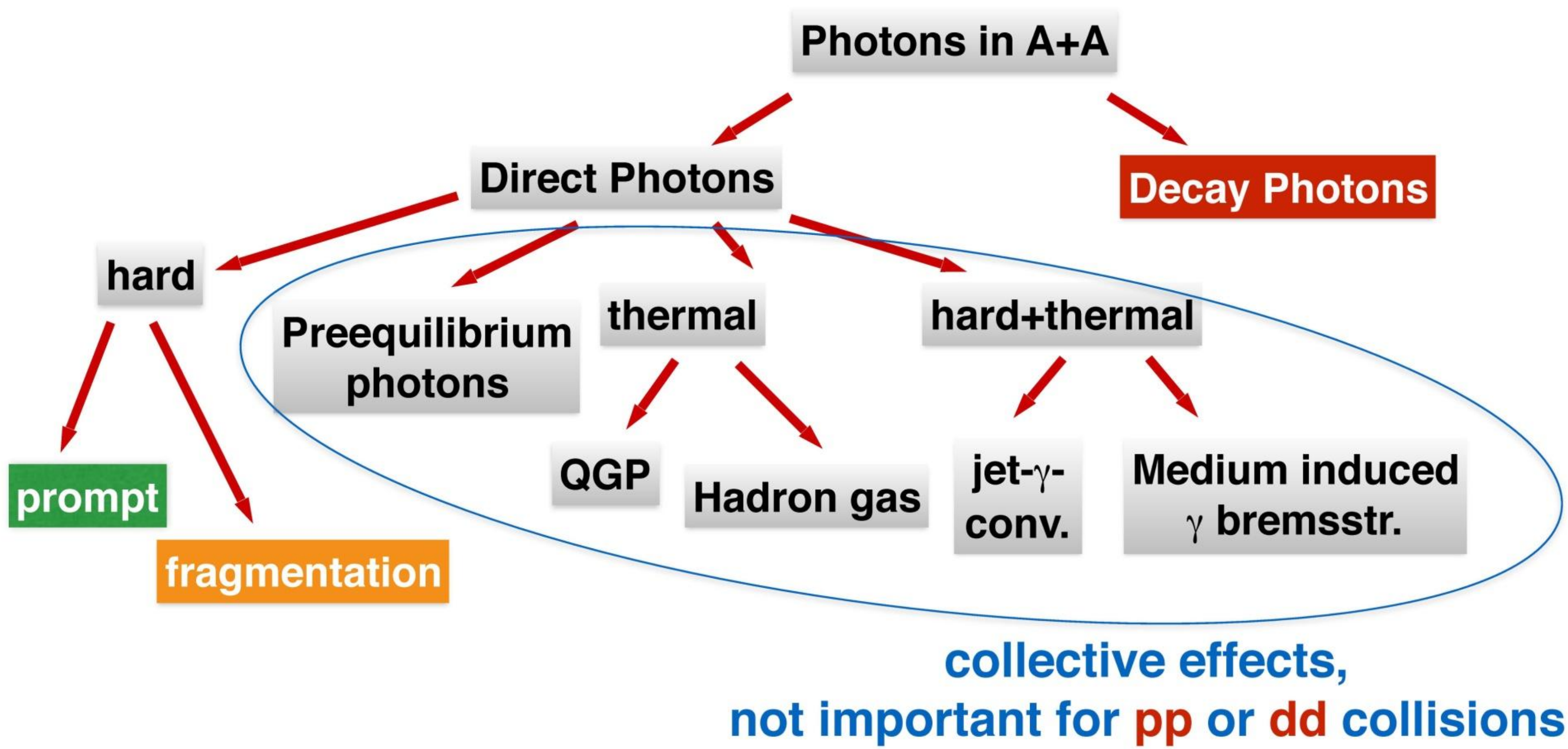
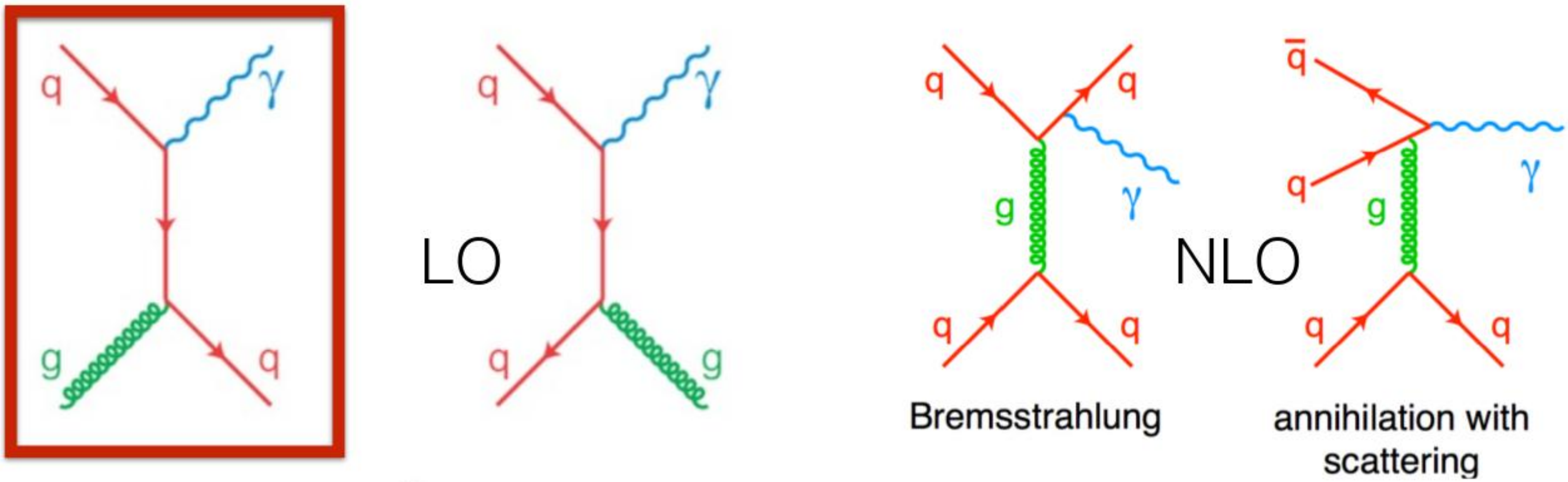
Prompt photons studies at SPD



This report is prepared with plots and data taken from talks by A.Guskov

Prompt Photons

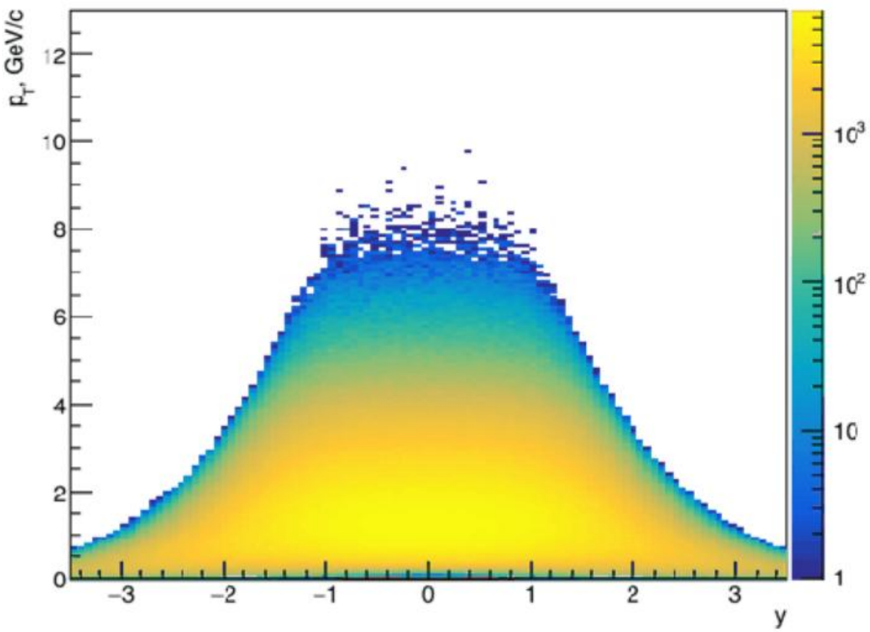


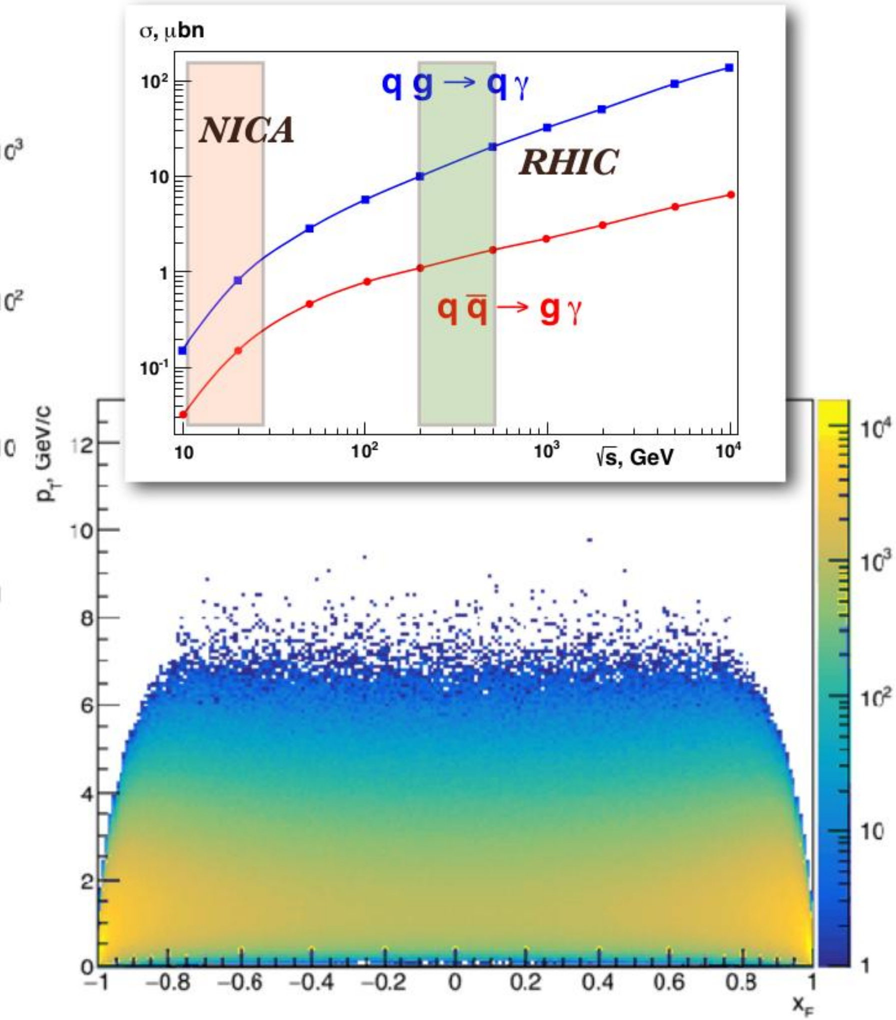
$$d\sigma_{AB} = \sum_{a,b=q,\bar{q},g} \int dx_a dx_b f_a^A(x_a,\mu^2) f_b^B(x_b,\mu^2) d\sigma_{ab\to\gamma X}(x_a,x_b,\mu^2).$$

$\mu \sim p_T/2$

Measurement with prompt photons is direct access to gluon distributions in nucleons

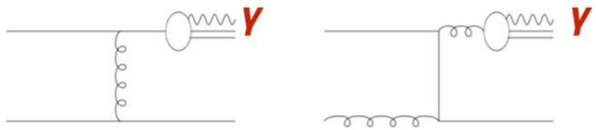
Gluon Compton Scattering

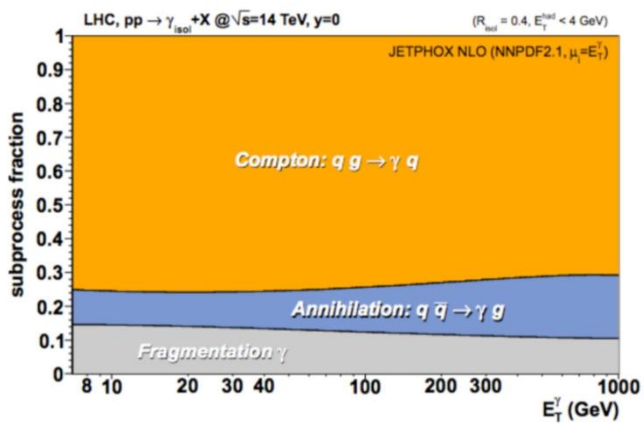




The region of **negative y** (or x_F) is the most sensitive for gluon content of beam meson

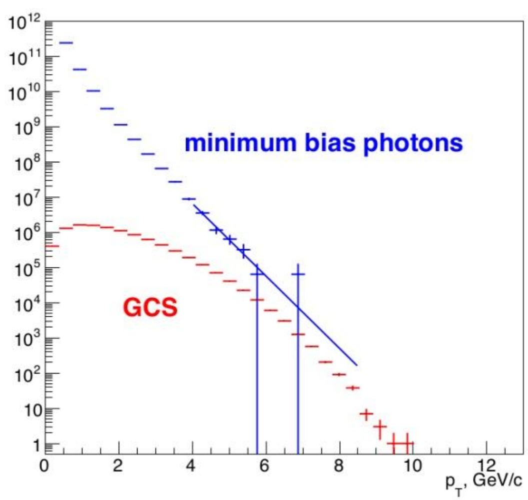
Fragmentation and Decay Photons

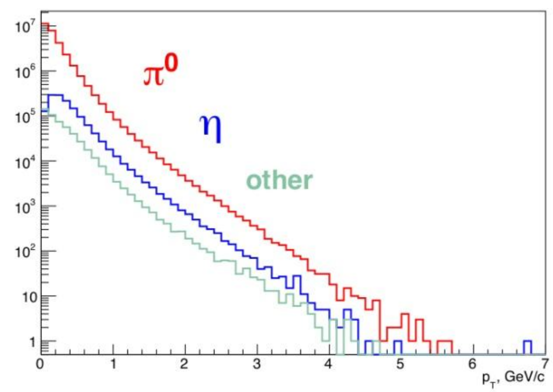




Relative contribution of fragmentation photons is below 15% even at much higher energies.

It can be calculated in LO and NLO





Even at very high p_T signal will dominate over background !

Spin asymmetries with Prompt Photons

$$A_N = \frac{\sigma^\uparrow - \sigma^\downarrow}{\sigma^\uparrow + \sigma^\downarrow}$$

Single transverse spin asymmetry

I. Shmidt, J. Soffer, J.J. Yang, Phys. Lett. B 612 (2005)

gluon Sivers function

$$\sigma^\uparrow - \sigma^\downarrow = \sum_i \int_{x_{min}}^1 dx_a \int d^2\mathbf{k}_{Ta} d^2\mathbf{k}_{Tb} \frac{x_a x_b}{x_a - (p_T/\sqrt{s})\, e^y} [q_i(x_a, \mathbf{k}_{Ta}) \Delta_N G(x_b, \mathbf{k}_{Tb}) \times \frac{d\hat\sigma}{d\hat t}(q_i G \to q_i \gamma) + G(x_a, \mathbf{k}_{Ta}) \Delta_N q_i(x_b, \mathbf{k}_{Tb}) \frac{d\hat\sigma}{d\hat t}(G q_i \to q_i \gamma)]$$

where $q(x_{a,b}, k_{Ta,b})$ and $G(x_{a,b}, k_{Ta,b})$ are quark and gluon distribution functions and $\Delta_N q(x_{a,b}, k_{Ta,b})$

$$A_{LL} = \frac{(\sigma_{++} + \sigma_{--}) - (\sigma_{+-} + \sigma_{-+})}{(\sigma_{++} + \sigma_{--}) + (\sigma_{+-} + \sigma_{-+})}$$

Double longitudinal spin asymmetry

G. Bunce et. al. Ann.Rev.Nucl.Part.Sci. 50:525-575,2000

gluon polarization

$$A_{LL} \approx \frac{\Delta g(x_1)}{g(x_1)} \cdot \left[\frac{\sum_q e_q^2 [\Delta q(x_2) + \Delta \bar q(x_2)]}{\sum_q e_q^2 [q(x_2) + \bar q(x_2)]}\right] + (1 \leftrightarrow 2)$$

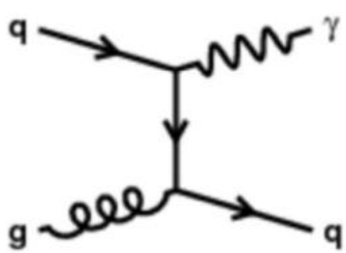
A_1^P - known from DIS

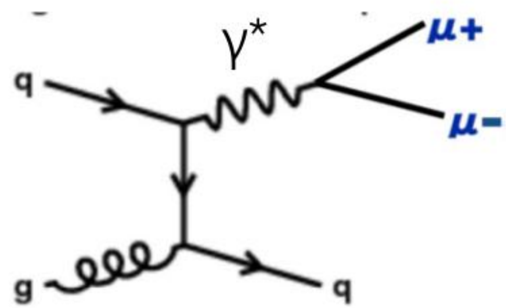
Prompt Photons and DY

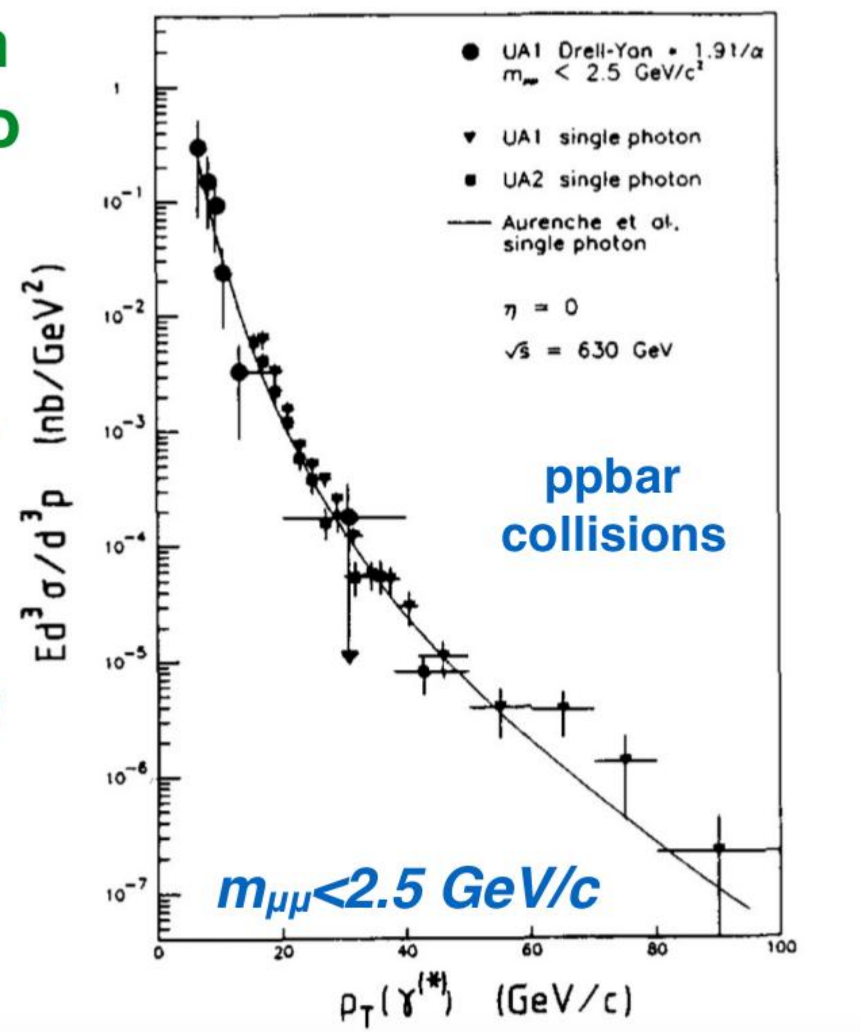
Phys.Lett. B209 (1988) 397-406 (1988)

Comparison of Drell-Yan and single photon cross sections

Production of low-mass dimuon pairs is a process very similar to prompt photon production







— **two orders of magnitude smaller cross section**

— **possibility to achieve low-p_T region**

Prompt Photons at SPD

Estimations of direct photon production rates.

Estimation of the direct photon production rates based on PYTHIA6 Monte-Carlo simulation for two values of colliding proton energies. Event rates are given for all and for leading processes of direct photon production considered in PYTHIA.
Statistical accuracies of A_N and A_{LL} measurements at NICA, have been estimated assuming the beam polarizations (both transversal and longitudinal) equal to P = ± 0.8 and overall detector efficiency (acceptance, efficiency of event reconstruction and selection criteria) of about 50%.
To minimize systematic uncertainties, precision of luminosity and beam polarization should be under control, as well as accuracy of π^0 and other background rejection.

$\sqrt{s}$=24 GeV $L = 1.0 \times 10^{32},\ cm^{-1}s^{-1}$	σ_{tot}, nbarn	$\sigma_{P_T>4\ GeV/c}$, nbarn	Events/year, 10^6	Events/year, 10^6 $(P_T > 4\ GeV/c)$
All processes	1290	42	3260	105
$qg \to q\gamma$	1080	33	2730	84
$q\bar{q} \to g\gamma$	210	9	530	21
$\sqrt{s}$=26 GeV $L = 1.2 \times 10^{32},\ cm^{-1}s^{-1}$	σ_{tot}, nbarn	$\sigma_{P_T>4\ GeV/c}$, nbarn	Events/year, 10^6	Events/year, 10^6 $(P_T > 4\ GeV/c)$
All processes	1440	48	4340	144
$qg \to q\gamma$	1220	38	3680	116
$q\bar{q} \to g\gamma$	240	10	660	28

Summary on Prompt Photons Proposal

- Unpolarized and polarized physics with prompt photons looks very attractive
- All the measurements at energy scale ~20 GeV were performed with pion and proton beams only 20-30 years ago It is a good time to come back with new level of experimental techniques and theoretical understanding
- We have good chance to perform such kind of measurements at SPD detector
- Background conditions for studies with prompt photons are quite hard. So the SPD detector should be really optimized.