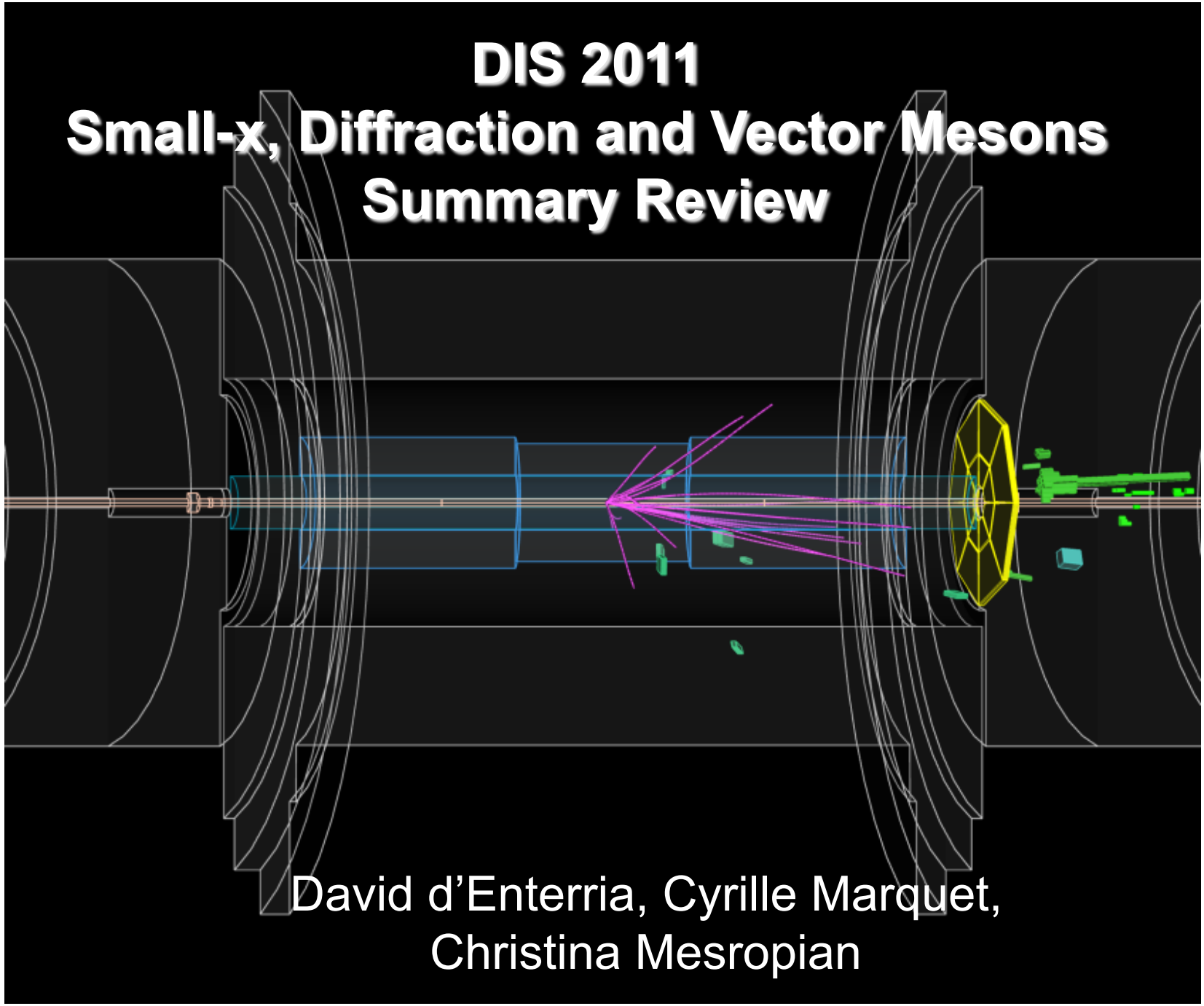
DIS 2011
Small-x, Diffraction and Vector Mesons
Summary Review



David d'Enterria, Cyrille Marquet,
Christina Mesropian

Summary of WG2

Small x, Diffraction and Vector Mesons

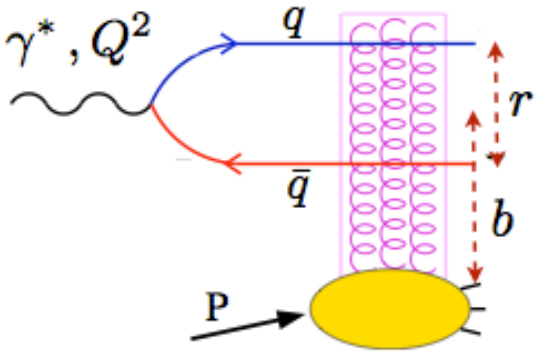
- 29 experimental talks
- 22 theory talks
- 3 joint sessions with
  - Structure functions
  - QCD and hadronic final states
  - Future of DIS

Theory Summary of WG2

Small x, Diffraction and Vector Mesons

- 22 theory talks
  - 13: Small x
  - 2: Diffraction
  - 2: Vector Mesons
  - 2: Central Exclusive Production
  - 2: Jets and Rapidity gaps
  - 1: AdS/CFT

Small x



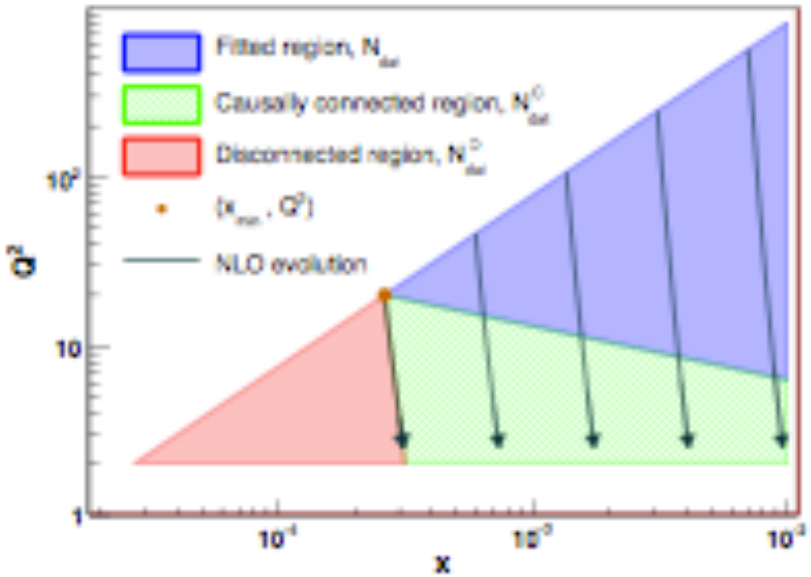
$$\sigma_{T,L}^{\gamma^* P}(x,Q^2) = \int_0^1 dz \int d^2\mathbf{r} \left| \Psi_{T,L}^{\gamma^* \to q\bar{q}}(z,Q,r) \right|^2 \sigma^{dip}(x,r)$$

$$\sigma^{dip}(x,r) = 2 \int d^2b \mathcal{N}(x,b,r) \rightarrow$$

Dipole cross section.
Strong interactions and x-dependence are here

Deviations from DGLAP

Juan Rojo



evidence for deviations from NLO DGLAP in inclusive HERA data

consistent with small-x resummations and non-linear dynamics not with NNLO corrections

general strategy

- cut out data in the "unsafe" region (small x and Q^2)
- determine PDFs in the "safe" region (large x and Q^2)
- evolve backwards and compare to data in causally connected region
- tension between data and back-evolution: deviations from NLO DGLAP

same analysis in e+A with pseudo-data

for a Pb nucleus, deviations from DGLAP would be identified within the x range of the full-energy EIC

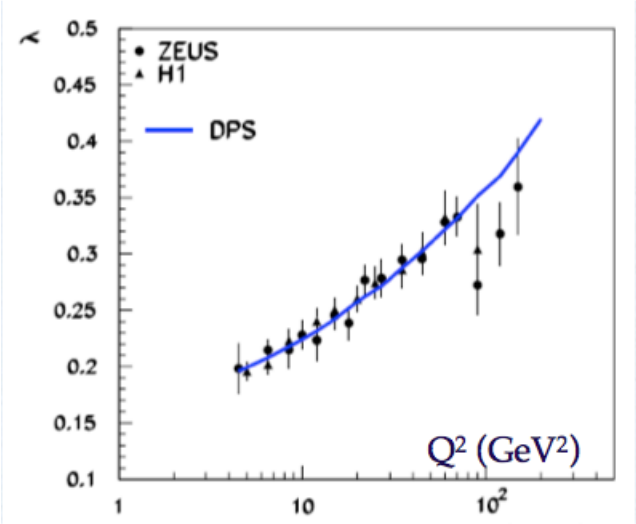
Alternative approaches at small-x

- Non-linear small-x QCD evolution next slides
- (first) pure BFKL description of the data, in particular of $\lambda(Q^2)$, $F_2 \sim (1/x)^\lambda$

  Henri Kowalski

  - based on discreet Pomeron solution (DPS) of NLL-BFKL with running coupling

  ~150 eigenfunctions needed with 3 parameters each (the precision of new data allows to find a unique solution)



- N=4 SYM model of confinement, using the AdS/CFT correspondence

$$F_2 = c\frac{Q}{Q'}\frac{(Q_0^2\frac{Q}{Q'}\frac{1}{x})^{1-\rho}}{\sqrt{\log(Q_0^2\frac{Q}{Q'}\frac{1}{x})}}\exp(-\frac{\log^2(\frac{Q}{Q'})}{\rho\log(Q_0^2\frac{Q}{Q'}\frac{1}{x})})$$

Chung-I Tan

strong and fixed coupling, nevertheless a good data descritption is obtained

- small x resummations Simone Marzani

F_2 not discussed, extension of the formalism to compute rapidity distributions

Running-coupling BK analysis

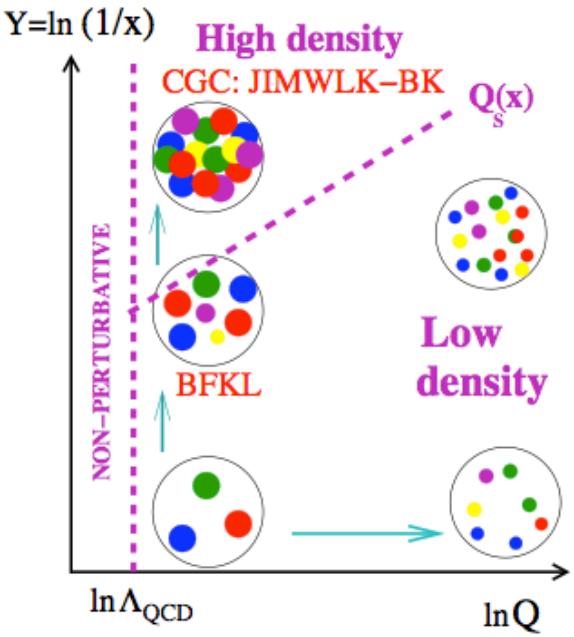
⇒ x-dependence: translational invariant (no b-dependence) running coupling BK using Balitsky's prescription

the most advanced practical non-linear evolution

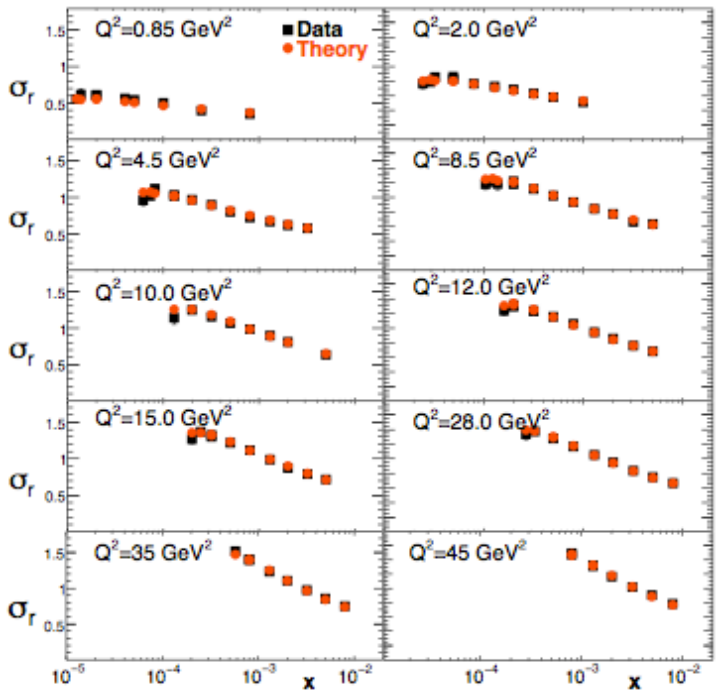
$$\frac{\partial \mathcal{N}(x,r)}{\partial \ln(x_0/x)} = \int d^2 r_1 \, K^{Bal}(\mathbf{r},\mathbf{r_1},\mathbf{r_2}) \left[\mathcal{N}(x,r_1) + \mathcal{N}(x,r_2) - \mathcal{N}(x,r) - \mathcal{N}(x,r_1)\mathcal{N}(x,r_2)\right]$$

$$K^{Bal}(\mathbf{r},\mathbf{r_1},\mathbf{r_2}) = \frac{N_c\,\alpha_s(r^2)}{2\,\pi^2}\left[\frac{r^2}{r_1^2\,r_2^2} + \frac{1}{r_1^2}\left(\frac{\alpha_s(r_1^2)}{\alpha_s(r_2^2)} - 1\right) + \frac{1}{r_2^2}\left(\frac{\alpha_s(r_2^2)}{\alpha_s(r_1^2)} - 1\right)\right]$$

Javier Albacete



fit parameters stable after the inclusion of the new data



The NLO photon impact factor

rcBK: first successful data description by the non-linear QCD evolution

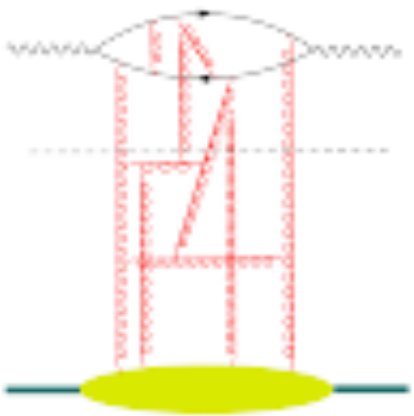
- previous successful descriptions are based on parameterization of the x dependence (dipole models)
- made possible by the running-coupling corrections (the most important corrections due to NLO evolution), but still using LO impact factors

- next step: full NLO calculation of F_2

Giovanni Chirilli

non-linear evolution at NLO: already known (Balitsky-Chirilli)

NLO impact factor:



$$
\begin{aligned}
I^{NLO}_{\mu\nu}(x,y) = {} & \frac{\alpha_s}{4\pi^7\Delta^4}\frac{\partial\kappa^\alpha}{\partial x^\mu}\frac{\partial\kappa^\beta}{\partial y^\nu}\int\frac{dz_1 dz_2}{z_{12}^4}\,\mathcal{U}(z_1,z_2)R^2\Bigg\{-\frac{2}{\kappa^2}\Big(g^{\alpha\beta}-2\frac{\kappa^\alpha\kappa^\beta}{\kappa^2}\Big) \\
& +\frac{\zeta_1^\alpha\zeta_2^\beta+\zeta_1\leftrightarrow\zeta_2}{(\kappa\cdot\zeta_1)(\kappa\cdot\zeta_2)}\Big[4\mathrm{Li}_2(1-R)-\frac{2\pi^2}{3}+\frac{2\ln R}{1-R}+\frac{\ln R}{R}-4\ln R+\frac{1}{2R}-2-4C-\frac{2C}{R} \\
& +2\Big(\ln\frac{1}{R}+\frac{1}{R}-2\Big)\Big(\ln\frac{1}{R}+2C\Big)\Big]+\Big(\frac{\zeta_1^\alpha\zeta_1^\beta}{(\kappa\cdot\zeta_1)^2}+\zeta_1\leftrightarrow\zeta_2\Big)\Big[\frac{\ln R}{R}-\frac{2C}{R}+2\frac{\ln R}{1-R}-\frac{1}{2R}\Big] \\
& +\Big[-2\frac{\ln R}{1-R}-\frac{\ln R}{R}+\ln R-\frac{3}{2R}+\frac{5}{2}+2C+\frac{2C}{R}\Big]\Big[\frac{\zeta_1^\alpha\kappa^\beta+\zeta_1^\beta\kappa^\alpha}{(\kappa\cdot\zeta_1)\kappa^2}+\zeta_1\leftrightarrow\zeta_2\Big] \\
& +\frac{g^{\alpha\beta}(\zeta_1\cdot\zeta_2)}{(\kappa\cdot\zeta_1)(\kappa\cdot\zeta_2)}\Big[\frac{2\pi^2}{3}-4\mathrm{Li}_2(1-R)-2\Big(\ln\frac{1}{R}+\frac{1}{R}+\frac{1}{2R^2}-3\Big)\Big(\ln\frac{1}{R}+2C\Big) \\
& +6\ln R-\frac{2}{R}+2+\frac{3}{2R^2}\Big]\Bigg\}
\end{aligned}
$$

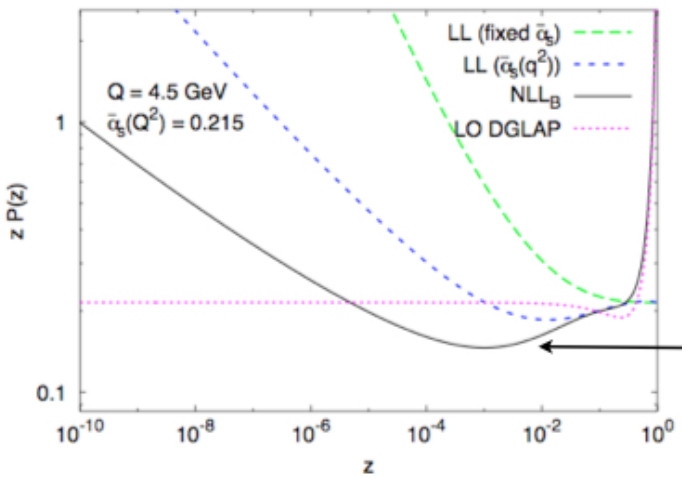
no numerical implementation yet

About collinear resummations

(linear) BFKL evolution suffers from spurious singularities
collinear resummations are needed to get meaningful results

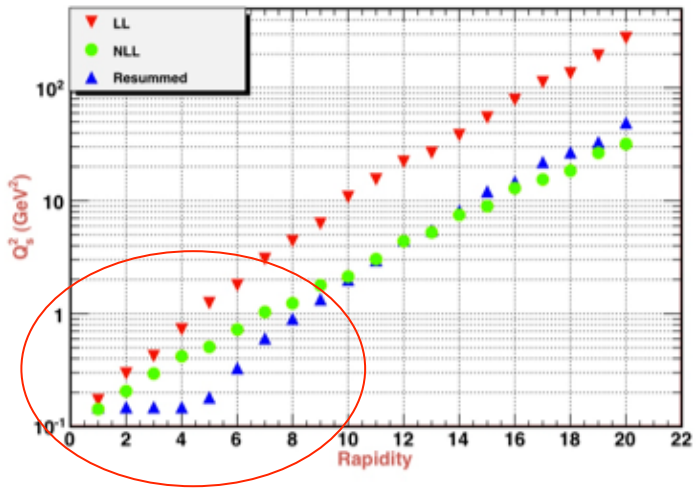
belief/hope: saturation cures the BFKL instabilities, no need for collinear resummations when non-linear effects are included

this is wrong, resummations are needed and may have sizable effects



Emil Avsar

the dip of the resummed splitting function delays the onset of saturation



analytic understanding of this phenomena developed using the traveling wave method to solve the BK (and higher-order) equations

Guillaume Beuf

BK evolution with impact parameter

the b dependence in the small x evolution is almost always neglected

- previous studies with LO BK

  - non-physical power-law tails at large b
  - non-trivial dynamics of large dipole sizes

Jeffrey Berger

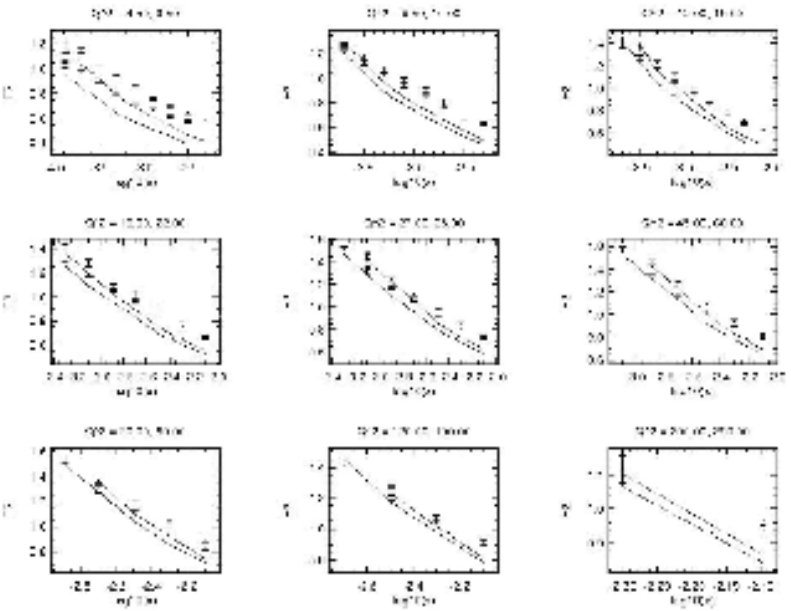
- the b dependence in the running coupling BK equation

  the IR regularization of the kernel becomes crucial

preliminary phenomenological analysis: with Balitsky's prescription one can get qualitative agreement with the data

however the agreement is perhaps accidental, due to the extreme sensitivity of the results to the regularization of

$$\alpha_s(x^2) = \frac{1}{b \ln\left(\frac{1}{\Lambda^2}\left(\frac{1}{x^2} + \mu^2\right)\right)}$$



Unintegrated gluon distributions

- the standard ugd, FT of the dipole amplitude

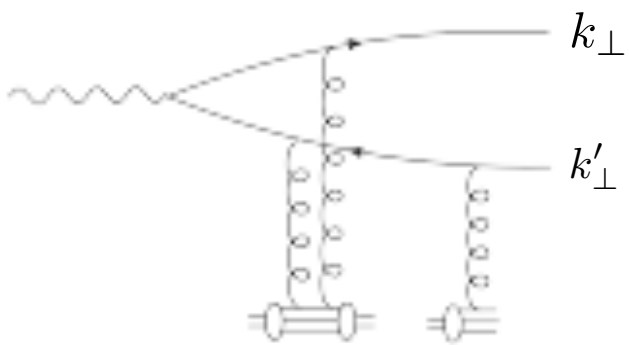
$$x_g G^{(2)}(x_g, q_\perp) = \frac{q_\perp^2 N_c}{2\pi^2 \alpha_s} S_\perp \int \frac{d^2 r_\perp}{(2\pi)^2} e^{-iq_\perp \cdot r_\perp} S^{(2)}_{x_g}(0, r_\perp)$$

Fabio Dominguez

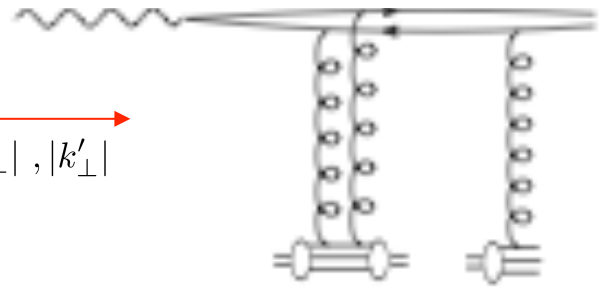
for instance used to calculate semi-inclusive DIS

- dijet production in DIS

$$\frac{d\sigma^{\gamma_T^* A \to q\bar{q}+X}}{dy_1 dy_2 d^2P_\perp d^2q_\perp} = \delta(x_{\gamma^*} - 1) x_g G^{(1)}(x_g, q_\perp) H_{\gamma_T^* g \to q\bar{q}}$$



$|k_\perp + k'_\perp| \ll |k_\perp|, |k'_\perp|$



no k_T or (TMD) factorization

no "naive" k_T factorization but "effective" k_T factorization

- dijet production in pA

depends on both gluons distributions through appropriate convolutions

Weizsäcker-Williams gluon distribution

$$x_g G^{(1)}(x_g, q_\perp) = -\frac{2}{\alpha_S} \int \frac{d^2v}{(2\pi)^2} \frac{d^2v'}{(2\pi)^2} e^{-iq_\perp \cdot (v - v')} \times \left\langle \mathrm{Tr}\left[\partial_i U(v)\right] U^\dagger(v') \left[\partial_i U(v')\right] U^\dagger(v) \right\rangle_{x_g}$$

Unintegrated sea quarks in CASCADE

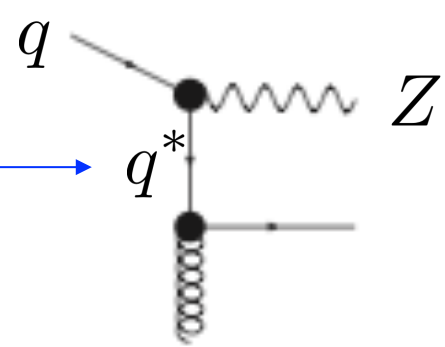
implementation necessary to deal with processes such as Z production

idea: use the Catani-Hautmann k_T-dependent splitting function as the last step of the CCFM evolution

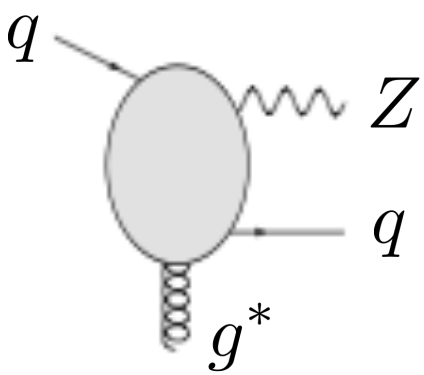
Martin Hentschinski

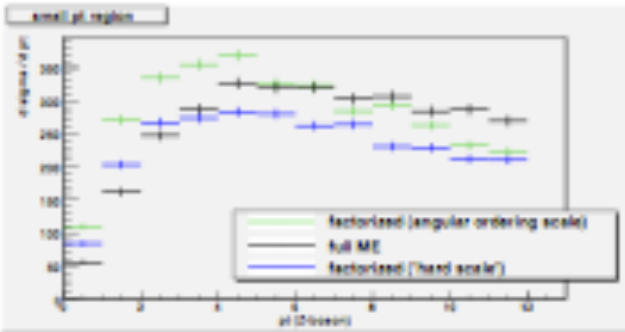
$$\mathcal{A}^{\text{sea}}(x, q^2, \mu^2) := \frac{1}{q^2} \int_x^1 dz \int_0^{\mu^2/z} d\boldsymbol{k}^2 P_{qg}^{\text{CH}}(z, \boldsymbol{k}^2, \boldsymbol{q}^2)\, \mathcal{A}_{\text{CCFM}}^{\text{gluon}}\left(\frac{x}{z}, \boldsymbol{k}^2, \bar{\mu}^2\right)$$

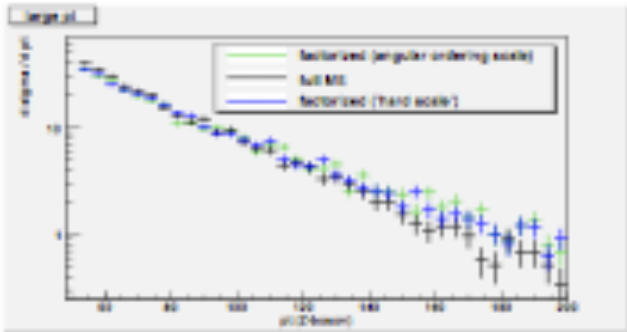
unintegrated quark distribution



comparison of k_T-factorized expression with full ME







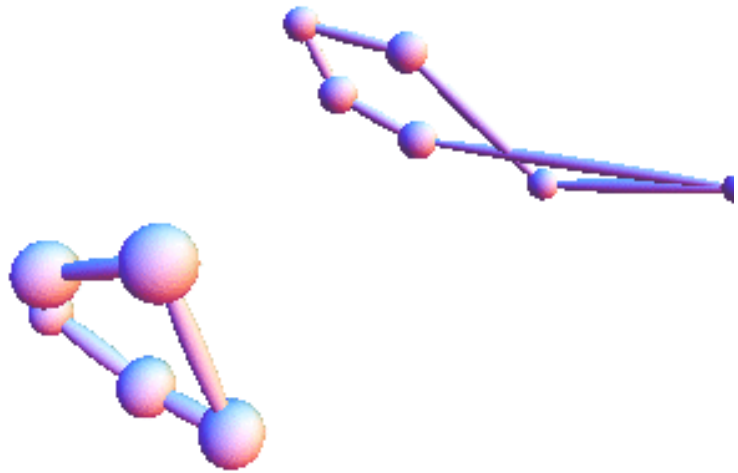
agreement best for large p_T region

The **DIPSY** event generator:

A BFKL-based dipole model in transverse space

(Christoffer Flensburg, Leif Lönnblad and Gösta Gustafson)

Christoffer Flensburg



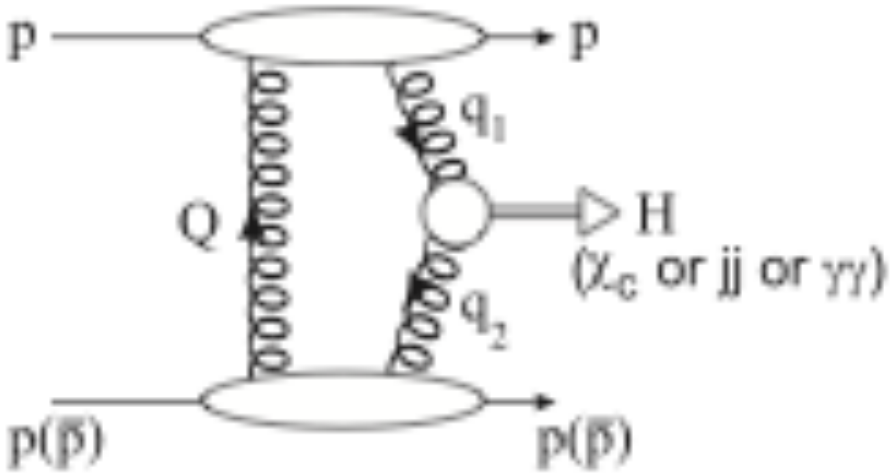
The model

- Based on LL BFKL
  - **NLL corrections**
  - Confinement
  - **Saturation**
- All **fluctuations** described!
- arXiv:1103:4321

Applications

- **pp: tuned and published**.
- AA:
  - Implemented and running
  - t=0 state can be fed to final state models (hydro, jet quenching, etc)
- eA: implemented, not tuned
- DIS: implemented, not tuned

Central Exclusive Production



Estimating Model Uncertainties

Christophe Royon

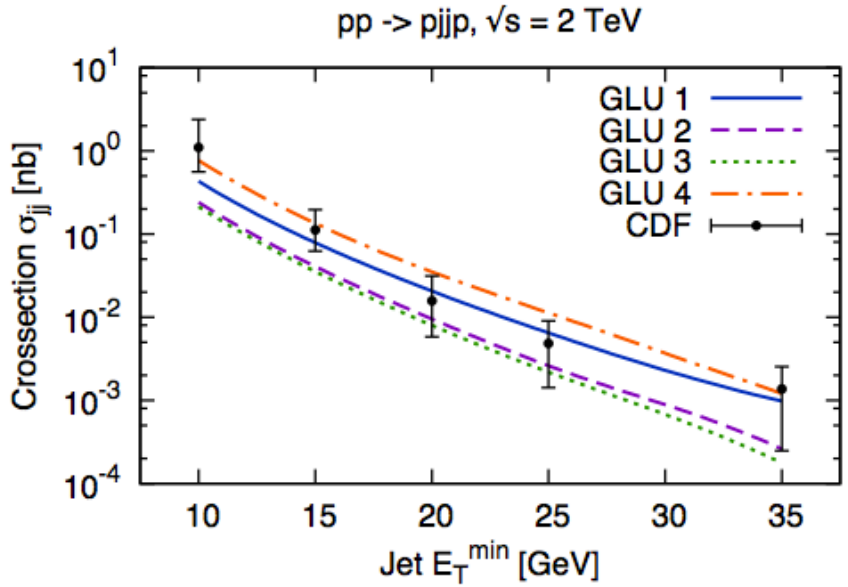
using the Forward Physics Monte-Carlo (FPMC)

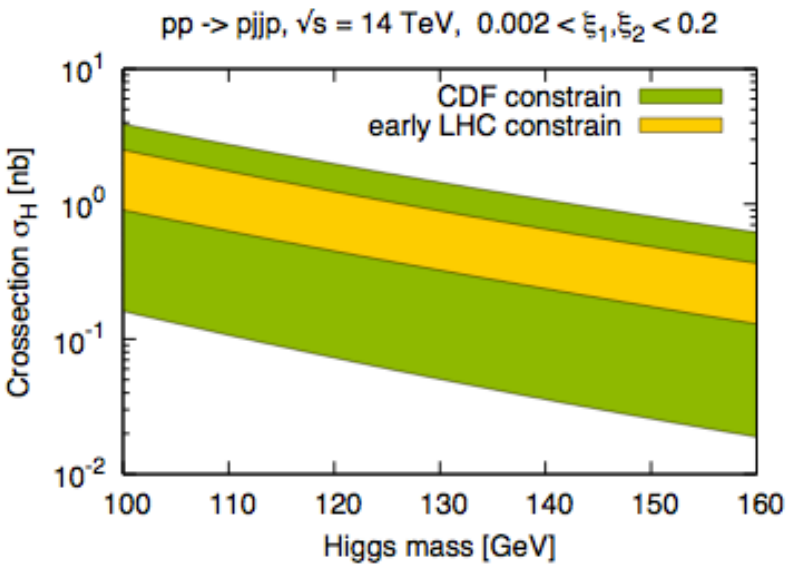
contains KMR and CHIDe model

uncertainties coming from:

- gap survival probability
- unintegrated gluon distributions
- Suddakov form factor

constrained by CDF data on diffractive di-jets ⇒ factor 10





Assume new measurement of exclusive jet production at the LHC: 100 pb-1, precision on jet energy scale assumed to be ~3% (conservative for JES but takes into account other possible systematics)

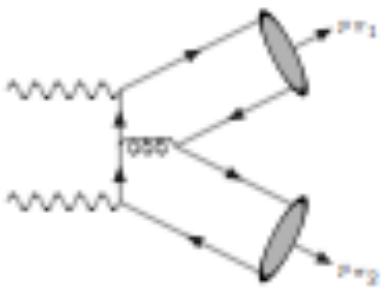
Meson pair production

Lucian Harland-Lang

novel QCD studies with the Khoze-Martin-Ryskin model

flavor non-singlet mesons

total amplitude given by convolution of parton level amplitude with non-perturbative wave functions



$$\mathcal{M}_{\lambda_1\lambda_2}(s,t) = \int_0^1 \mathrm{d}x\,\mathrm{d}y\,\phi(x)\phi(y)\,T_{\lambda_1\lambda_2}(x,y;s,t)$$

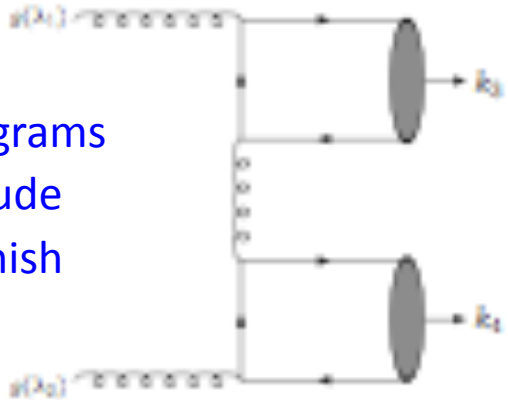
$J_z = 0$ rule $\pi^0\pi^0$ BG to $\gamma\gamma$ CEP is suppressed

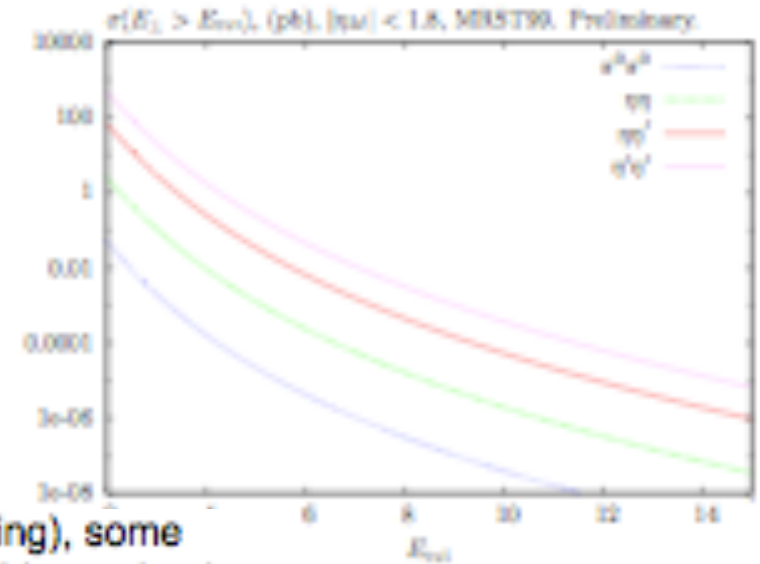
flavor singlet mesons

new set of diagrams

$J_z = 0$ amplitude

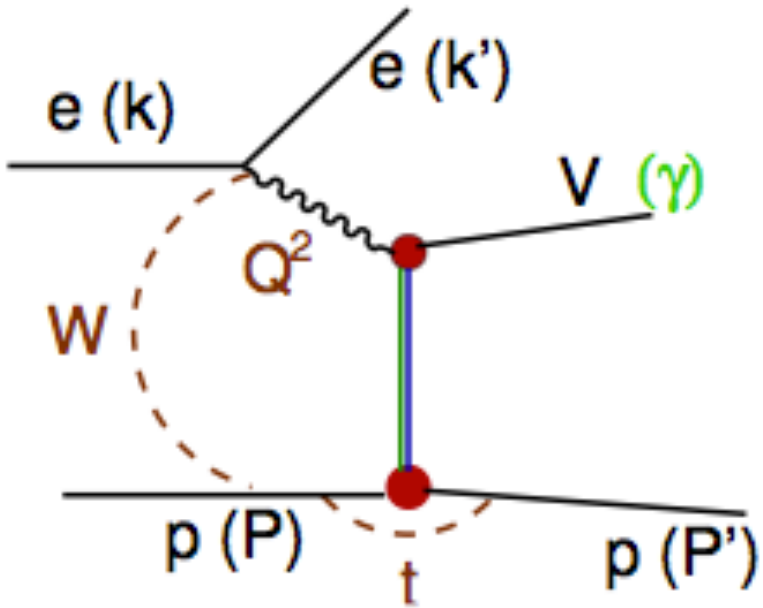
does not vanish





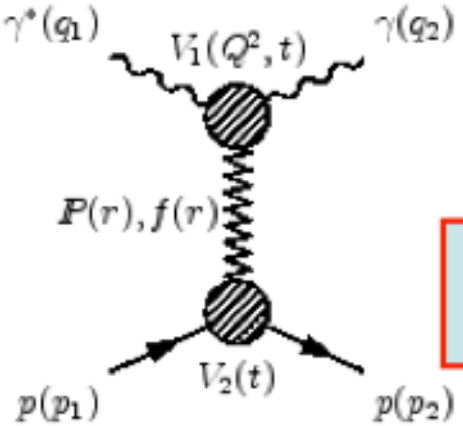
enhancement in $\eta'\eta'$ CEP rate' and (through η-η' mixing), some enhancement to $\eta\eta$ rate. $\eta\eta'$ CEP can also occur via this mechanism.

Vector Mesons and DVCS



A Regge-type model

Salvatore Fazio



$$V_1 = e^{b\beta(z)}$$

$$V_2 = e^{b\alpha(t)}$$

A new variable is introduced: $z = t - Q^2$

using a logarithmic Regge trajectory and a very few parameters

DVCS amplitude: $$A(s,t,Q^2)_{\gamma^* p \to \gamma p} = -A_0 V_1(t,Q^2)\, V_2(t)(-is/s_0)^{\alpha(t)}$$

the *t* dependence at the vertex *pIPp* is introduced by: $\alpha(t) = \alpha(0) - \alpha_1 \ln(1 - \alpha_2 t)$

the vertex *γ*IPγ* is introduced by the trajectory: $\beta(z) = \beta(0) - \beta_1 \ln(1 - \beta_2 z)$

good data description of $\sigma(Q^2)$ and $\frac{d\sigma}{dt}$ but room for improvement for $\sigma(W)$ at large Q^2, usual for soft Pomeron models

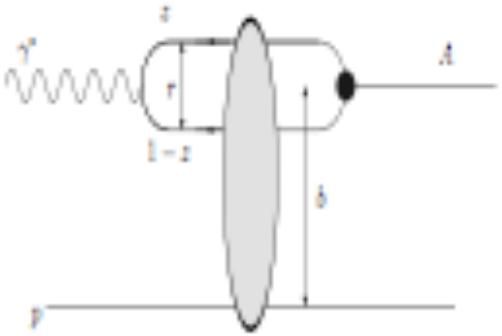
also presented an alternative to the Donnachie-Landshoff two-Pomeron model to describe **σ(W) in a large Q^2 domain**

New constraints on rho WF and DA

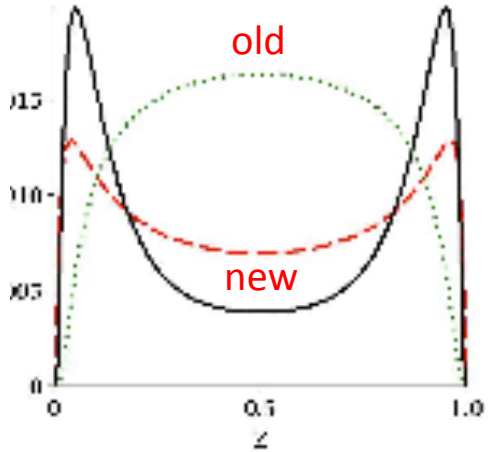
Ruben Sandapen

Current data require qualitatively different light-cone wavefunctions for transverse and longitudinal polarisation

especially σ_L/σ_T



- $A = \rho$
- r : transverse dipole size
- z : fraction of photon's light-cone momentum carried by quark



$$|\Psi_T(0,z)|^2$$

At high energy ($s \gg t, Q^2, M_\rho^2$), amplitude factorises

$$\Im m\mathcal{A}_\lambda(s,t;Q^2) = \sum_{h,\bar{h}} \int d^2\mathbf{r}dz\Psi^{\gamma^*,\lambda}_{h,\bar{h}}\Psi^{\rho,\lambda*}_{h,\bar{h}} e^{-iz\mathbf{r}.\mathbf{\Delta}}\mathcal{N}(x,\mathbf{r},\mathbf{\Delta})$$

a new distribution amplitude is also obtained

Twist-2

$$\phi_{||}(z,\mu) = \frac{1}{2\pi f_\rho}\int dr\mu J_1(\mu r)M_\rho\phi_L(r,z)$$

Agrees with QCD Sum Rules and lattice predictions

What I did not cover

- Misha Gorshteyn

  Asymptotic behavior of pion form factors

- Marat Siddikov

  Diffractive neutrino production of pions in the color dipole model

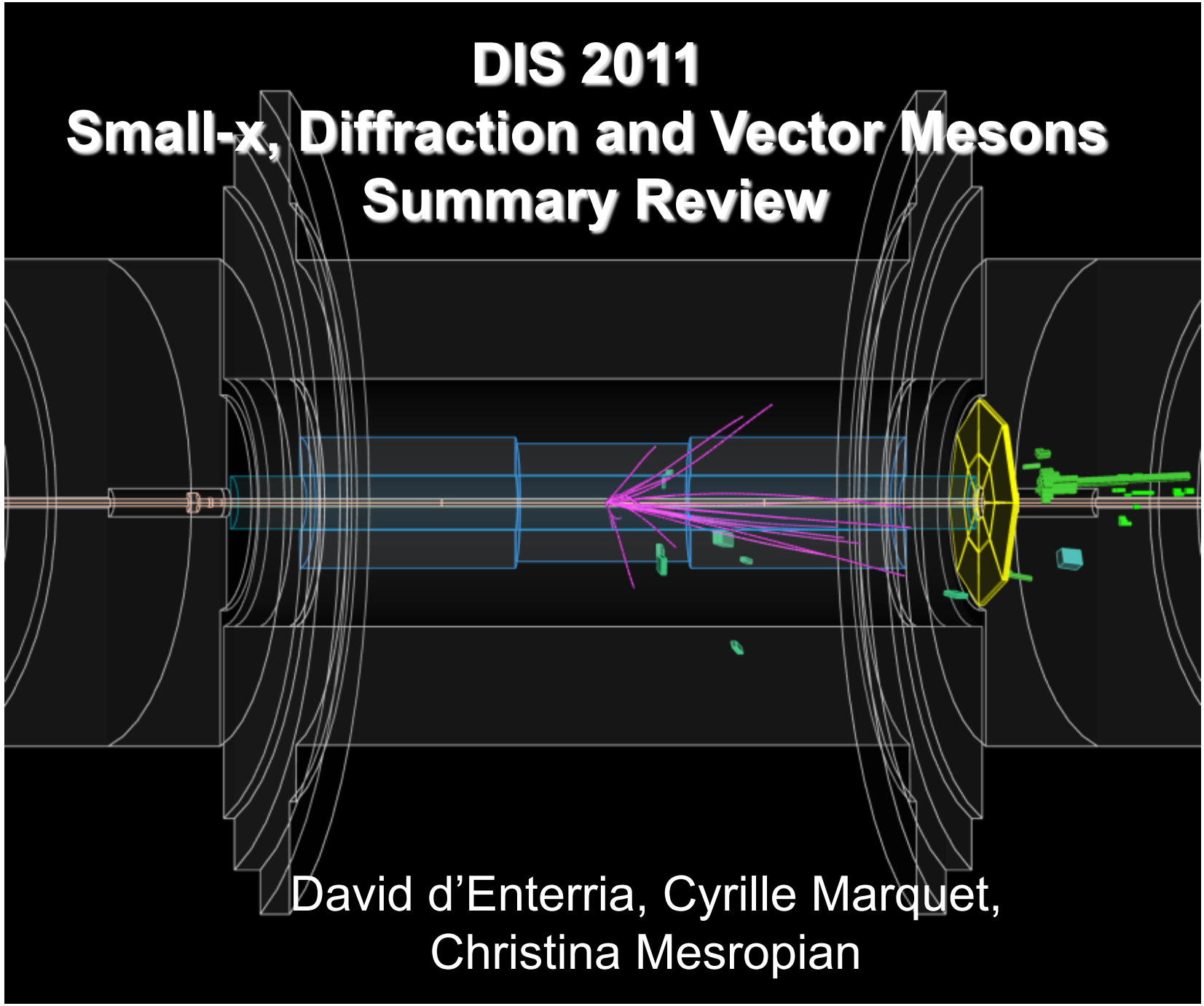
- Paolo Bolzoni

  Time-like small-x resummation for fragmentation functions

Thank you

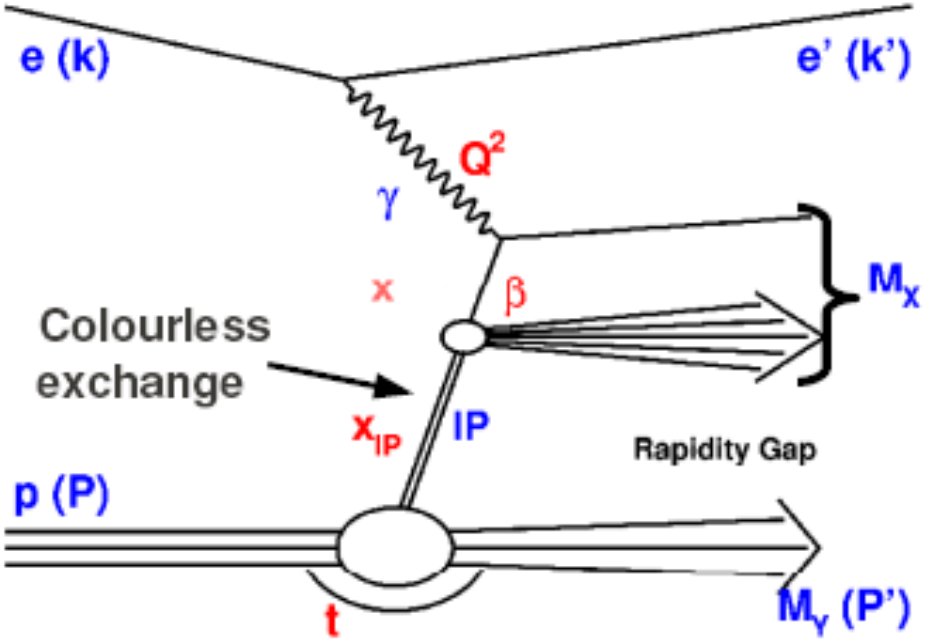
Thanks to the speakers

DIS 2011
Small-x, Diffraction and Vector Mesons
Summary Review



David d'Enterria, Cyrille Marquet,
Christina Mesropian

Diffraction (ep, HERA)



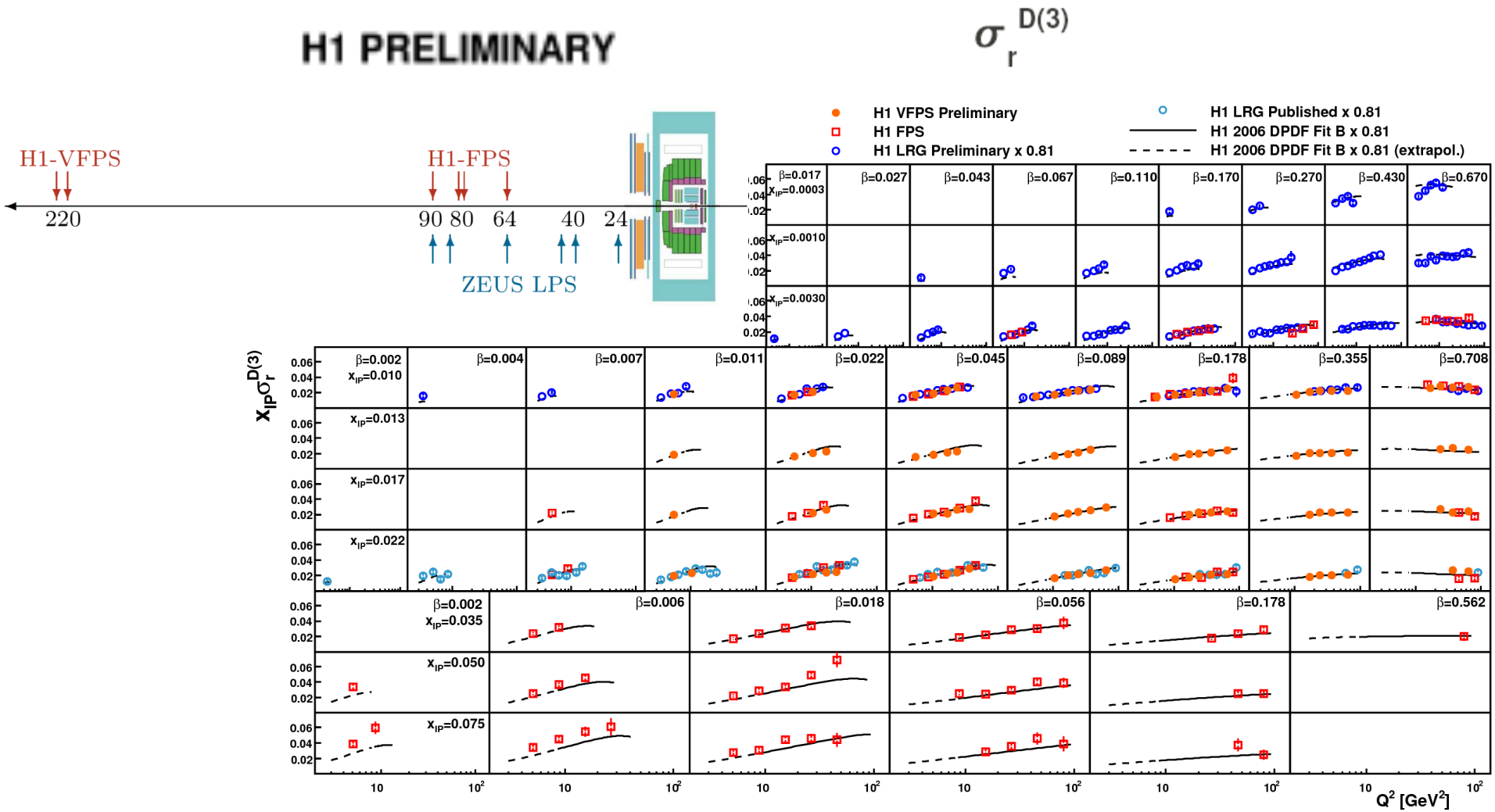
$$Q^2 = -q^2 = (k' - k)^2$$
$$x = Q^2/2Pq$$

$$x_{IP} = q(P' - P)/qP$$
$$= 1 - E_p/E'_p$$
$$\beta = x/x_{IP}$$
$$t = (P' - P)^2$$

Diffractive DIS kinematics

Inclusive Diffraction (ep, HERA)

H1
(R. Polifka)



3 different detectors (2 different methods)

very good agreement!

Diffractive Dijets (ep, HERA)

H1 (R. Polifka)
(J. Delvax)

•Forw. jets with leading ***p*** in DDIS

– search for physics beyond DGLAP

Selection of 1 cent.+ 1 forw.jet

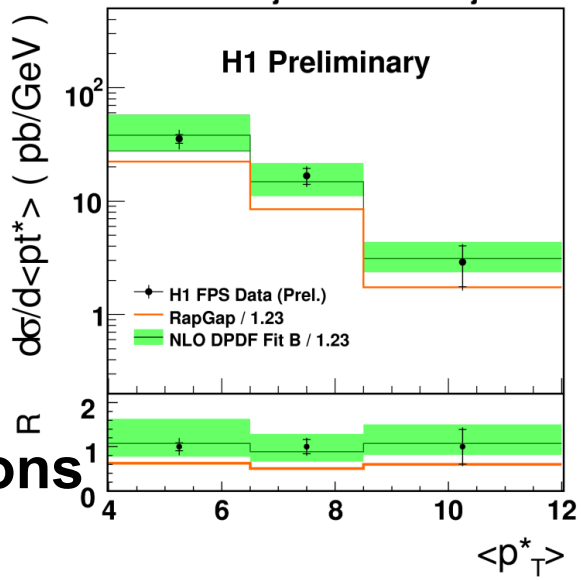
suppressing DGLAP phase space

Low x

Calculable in NLO (NLOJET++ with DPDF)

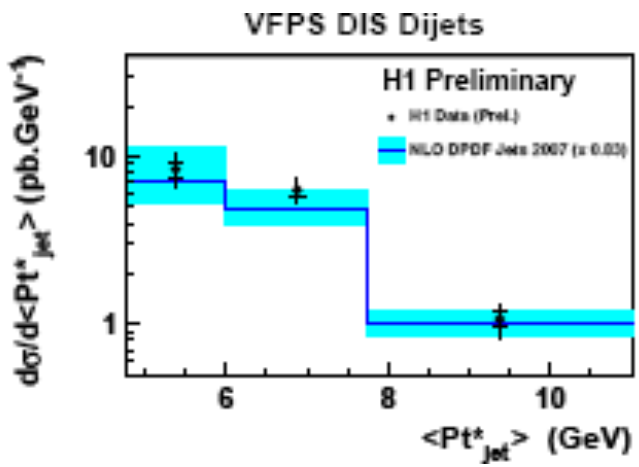
Good description by NLO QCD DGLAP predictions

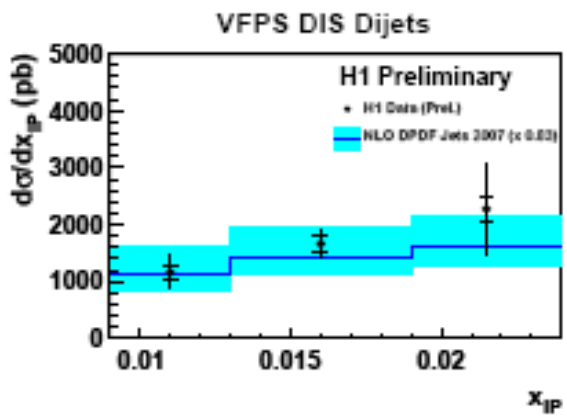
FPS 1 central jet + 1 forward jet



VFPS –
high accept. detector
⇓
high statistics

Good agreement
with NLO predictions





H1 VFPs Preliminary : 25.3±1.4(stat.) ± 6.5(syst.) pb
NLO DPDF Fit Jet 2007 : 19.9±7.4(4.4) ± 0.5(had.) pb

Forward Jets (ep, HERA)

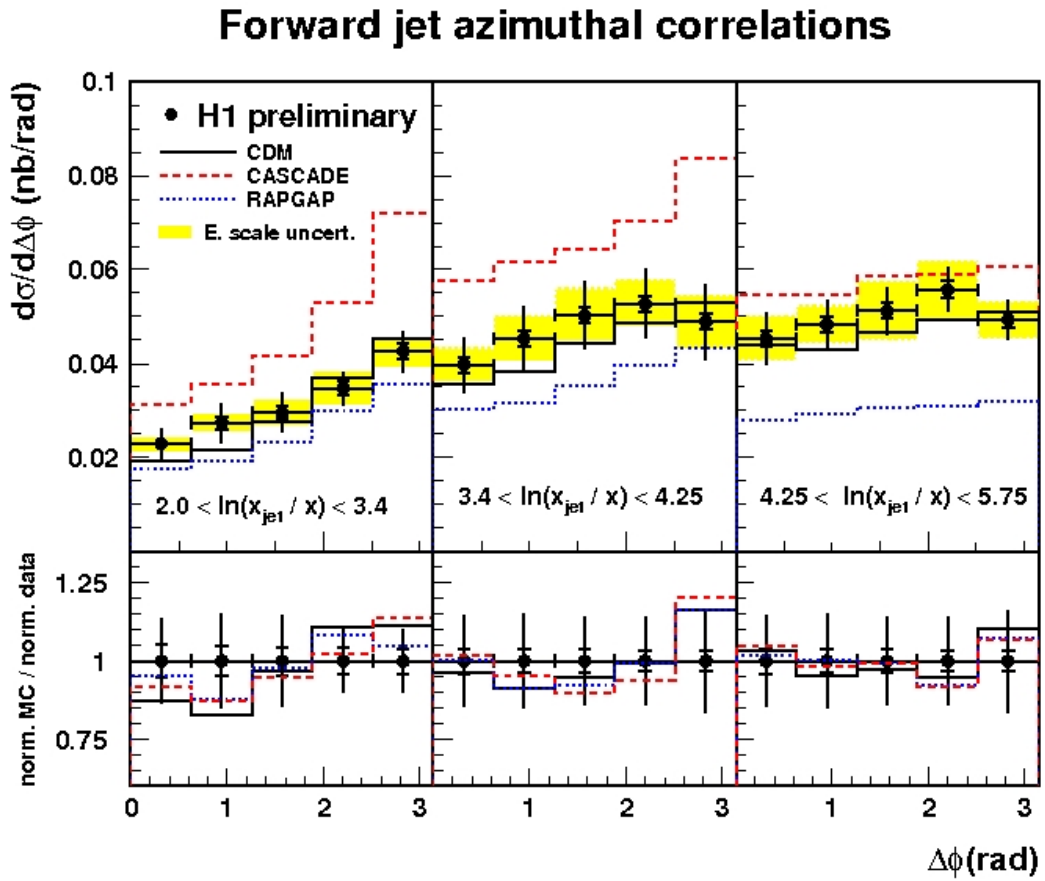
H1 (I. Milcewicz)

Look for observables that would be sensitive to underlying parton dynamics

▪The correlation in $\Delta\phi$ between scattered electron and the forward jet in DIS may be another signature of the BFKL dynamics

$x_{jet} = E_{jet}/E_p > 0.035$ enhancing phase space for BFKL

$0.5 < p_{t,je}^{t2}/Q^2 < 6.0$ suppressing phase space for DGLAP evolution



•At lower x forward jet is more decorrelated from the scattered electron

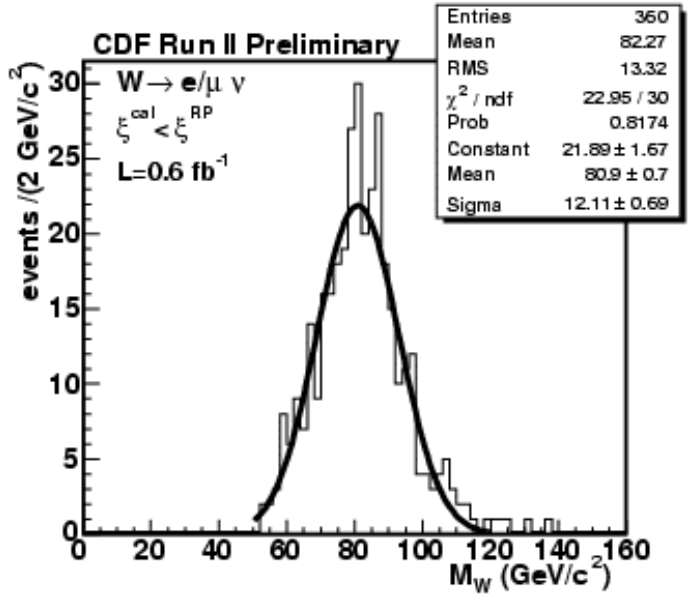
•Normalised shape distributions in $\Delta\phi$ don't discriminate between different QCD evolution schemes.

Diffraction (ppbar, Tevatron)

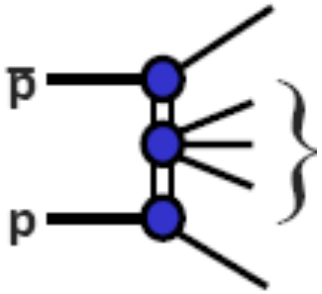
CDF (K. Goulianos)

Hard Diffraction - jets, W

Fraction of diffractive W
(measured with tagged pbar)
R_W (0.03<ξ<0.10, |t|<1)=
[0.97 ±0.05(stat) ±0.10(syst)]%
consistent with Run I result (LRG)

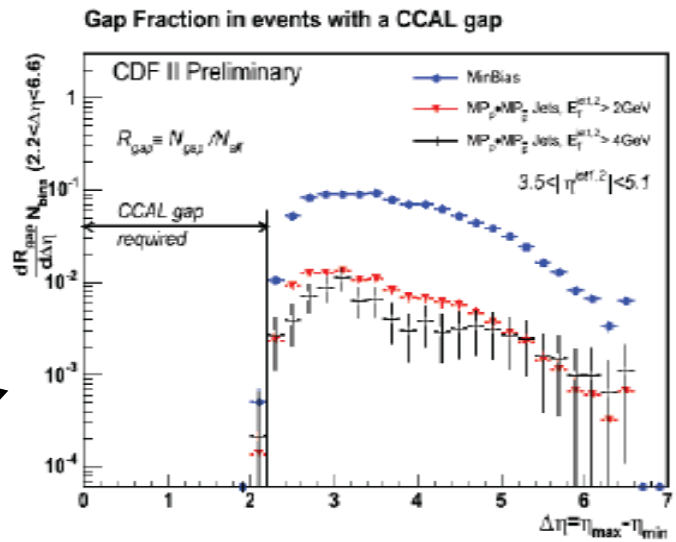


Central Exclusive Production



JJ - PRD 77, 052004 (2008)
γγ - PRL 99, 242002 (2007)
χ_c - PRL 242001 (2007)

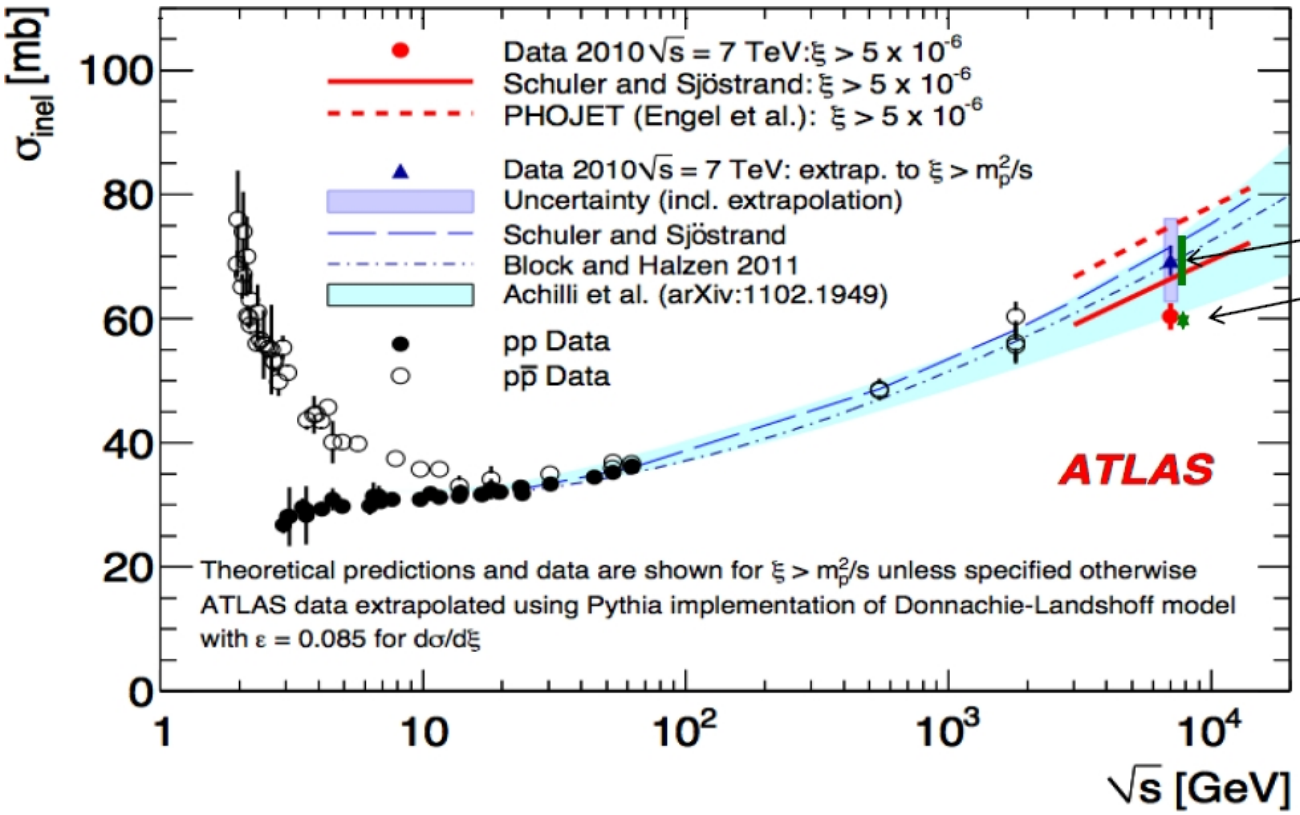
Forward Jets with Rapidity Gap



Inelastic cross section (pp, LHC)

- ATLAS: Single-sided events
- CMS: Vertex counting in pileup evts:

$$P(n_{pileup}) = \frac{(L\cdot\sigma)^{n_{pileup}}}{n_{pileup}!}\cdot e^{-(L\cdot\sigma)}$$



$\sigma_{visible}$ = 60.33 ± 2.3 mb

σ_{inel} = 69.4 ± 2.4 ± 6.9 mb

CMS

$\sigma_{visible}$ = 59.7 ± 2.6 mb

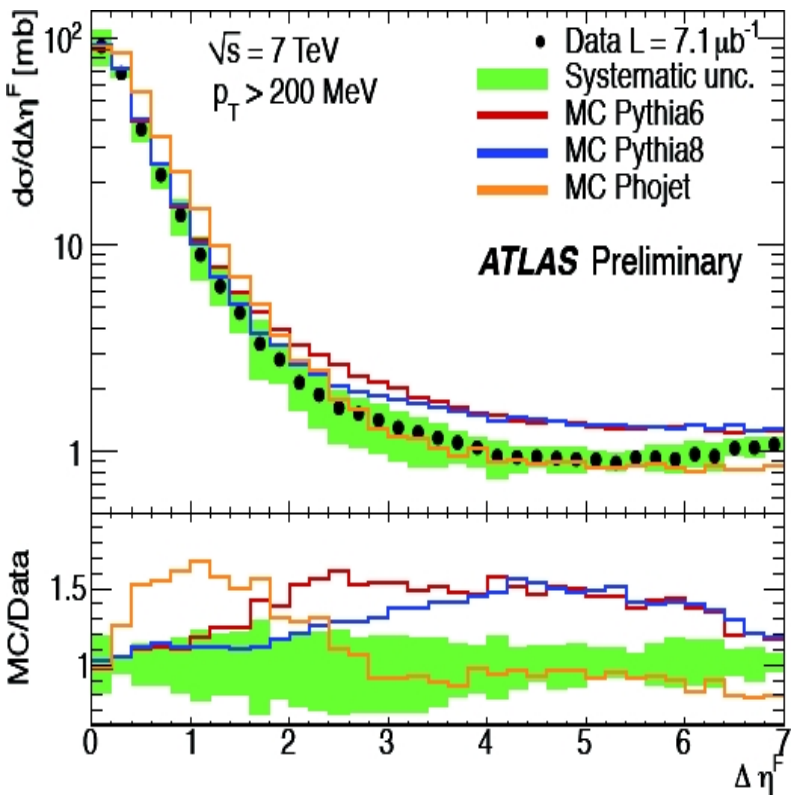
σ_{inel} = 66.8 – 74.8 mb

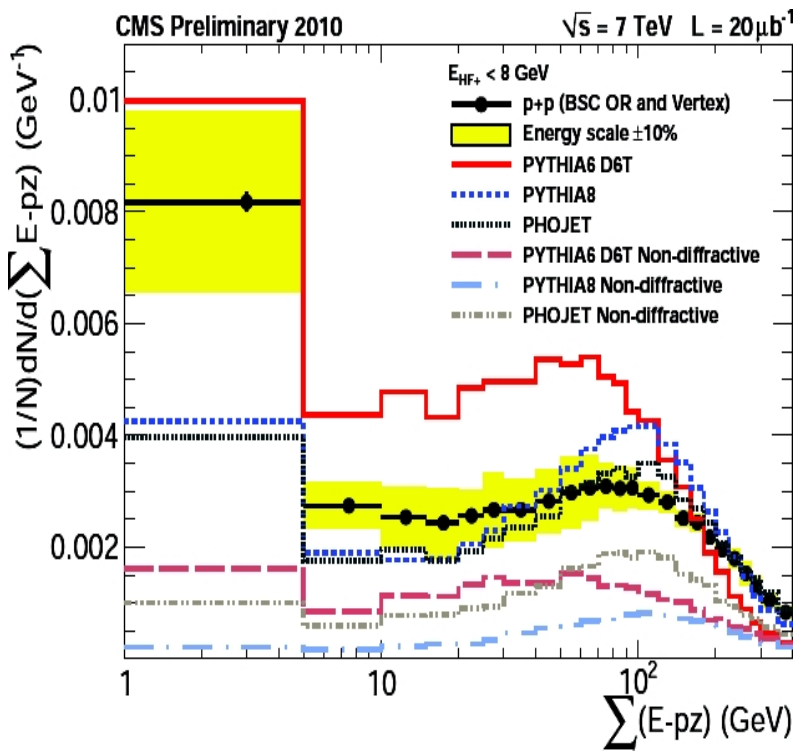
ATLAS (S. Tompkins)
CMS (M. Marone)

Diffraction (pp, LHC)

ATLAS (M. Kayl)
CMS (A-K. Sanchez)

- ATLAS: x-section as function of forward rapidity gap $\Delta\eta^F$
- CMS: Observation in single-side trigger ($\Delta\eta$~2 rap-gap, $\xi \sim E - p_z$)



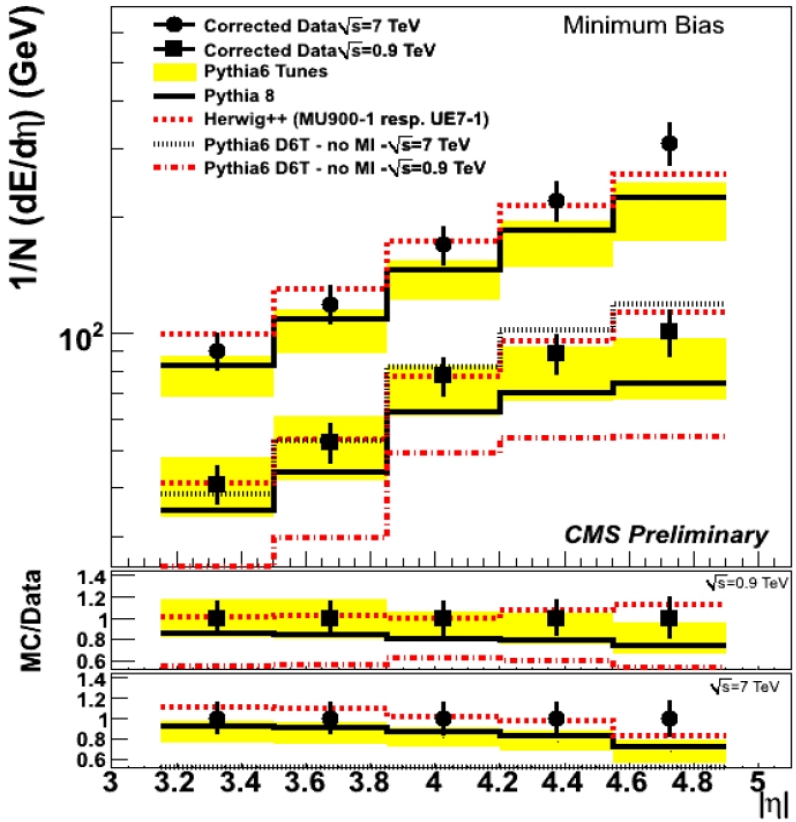


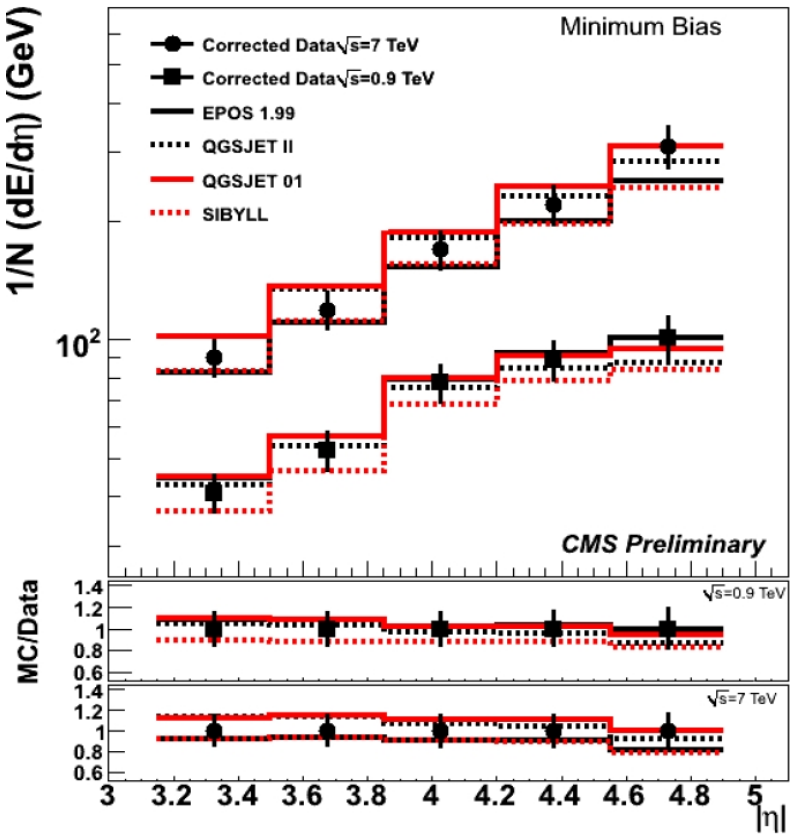
- PYTHIA8 describes data best at low $\Delta\eta^F$
  PHOJET at high $\Delta\eta^F$
- Evidence of diffraction at high $\Delta\eta^F$
- Diffractive x-section ~ 1mb per unit $\Delta\eta^F$ at high $\Delta\eta^F$

- No PYTHIA tune reproduces all data
  PHOJET ....

Forward hadrons (|η|=3-5, pp, LHC)

- Probe Underlying-Evt modeling (MPI, beam remnants) in MCs:
  - Data between HERWIG and PYTHIA
- Constraints for cosmic-rays MCs: Good agreement





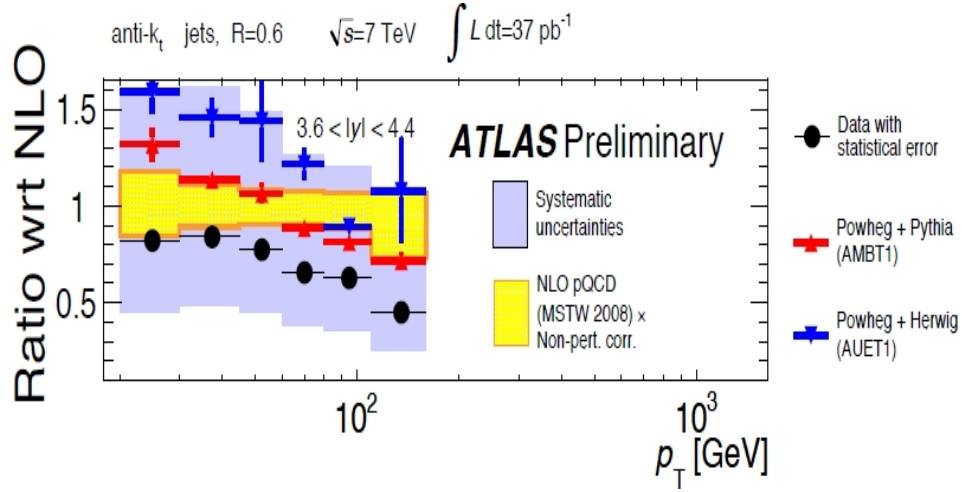
CMS (A. Knutson)

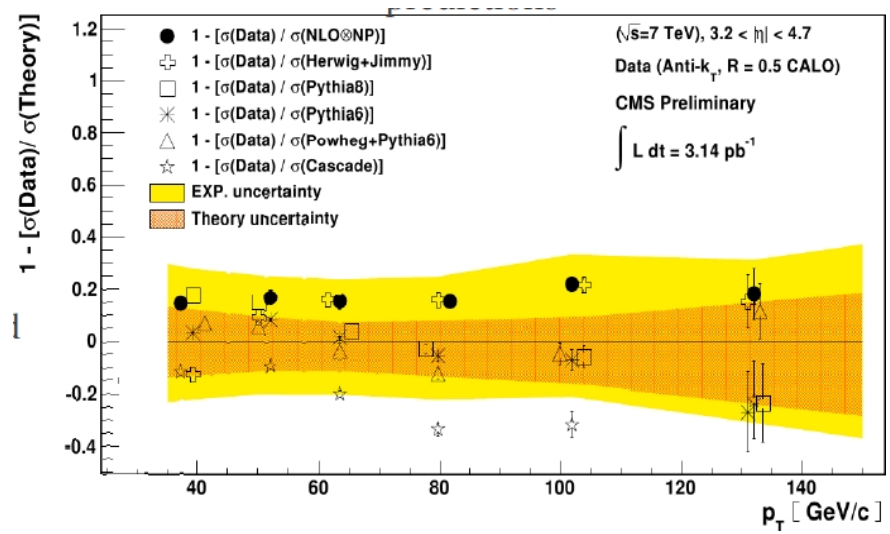
Forward jets (|y|=3-5, pp, LHC)

- Probe PDFs down to $x \sim p_T/\sqrt{s}\, e^{-y} \sim 10^{-4}$
- DGLAP vs BFKL dynamics

- ATLAS data (±50% uncert) < parton-shower+POWHEG (NLO)

- CMS data (±30% uncert) agrees with TH predictions

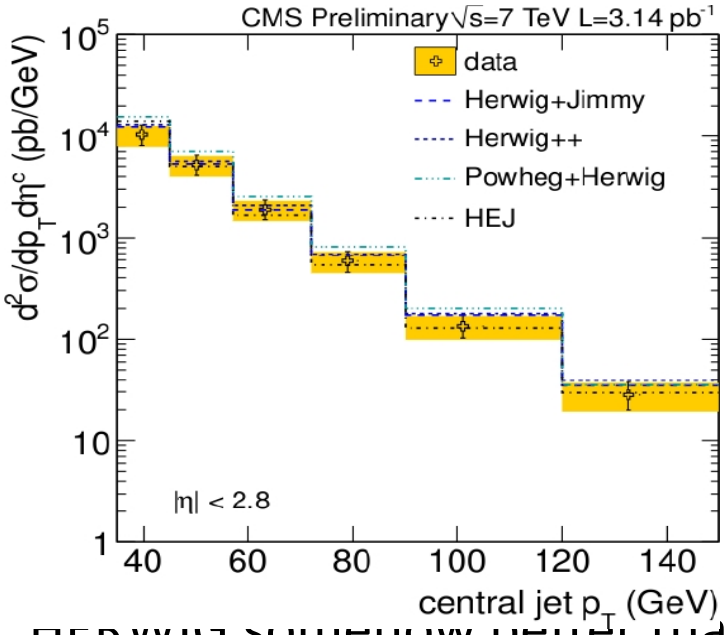


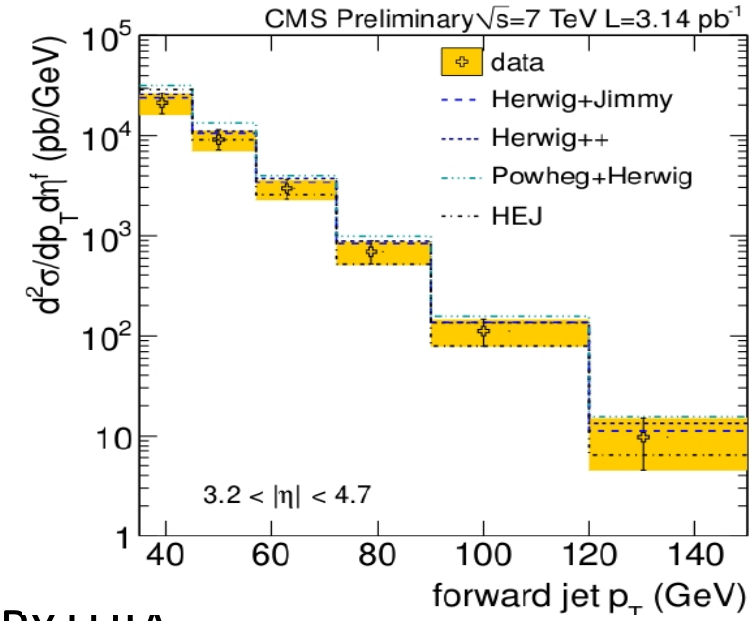


ATLAS (D. Gillberg)
CMS (A. Massironi)

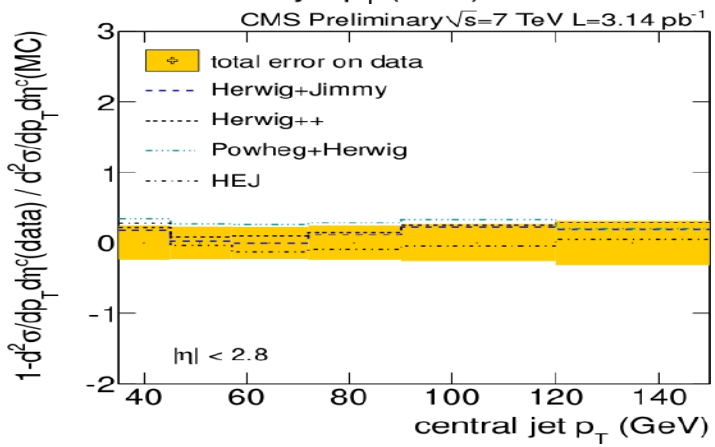
Forward-central jets (pp, LHC)

- Constrains multi-jets production & DGLAP vs BFKL dynamics





- HERWIG somehow better than PYTHIA.
- POWHEG (NLO) does not help.
- HEJ (BFKL-multijets) best agreement.



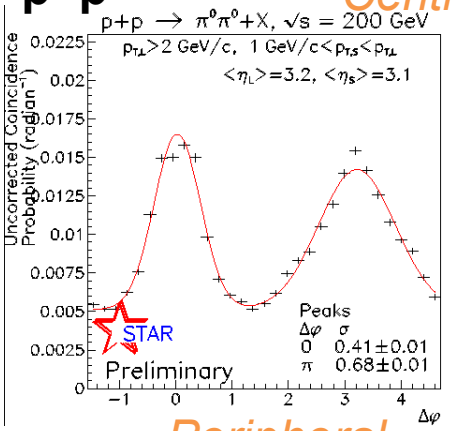
CMS (A. Massironi)

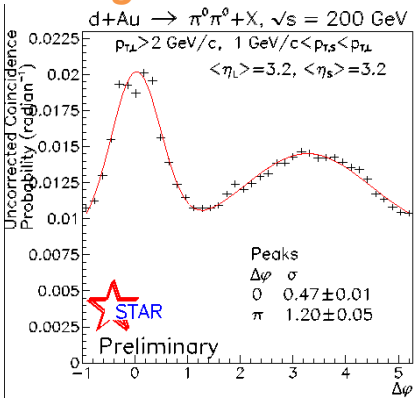
Small x Physics (RHIC)

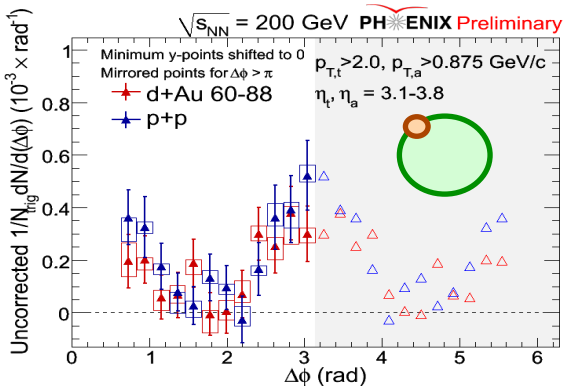
STAR (C. Perkins)
PHENIX (J. Lajoie)

Measuring correlations between two forward π_0 probes a limited, smaller *x* range

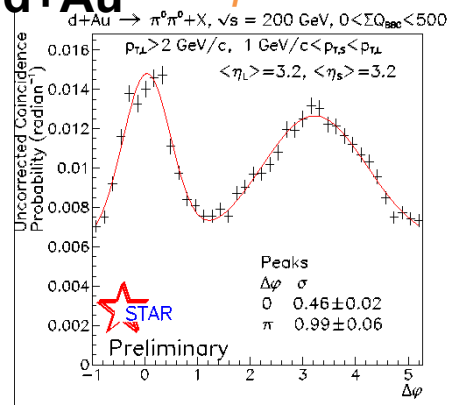
p+p *Centrality averaged* **d+Au**



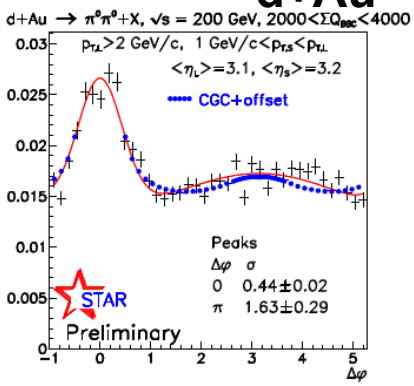


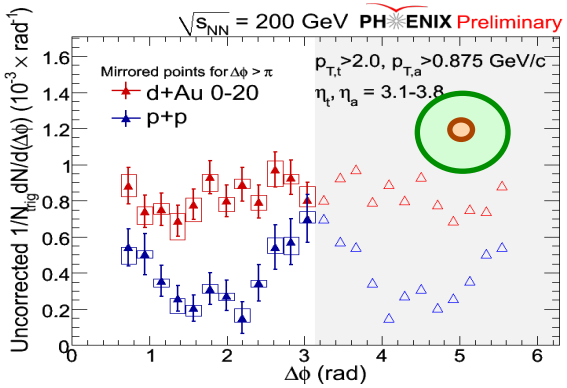


d+Au *Peripheral*



Central **d+Au**

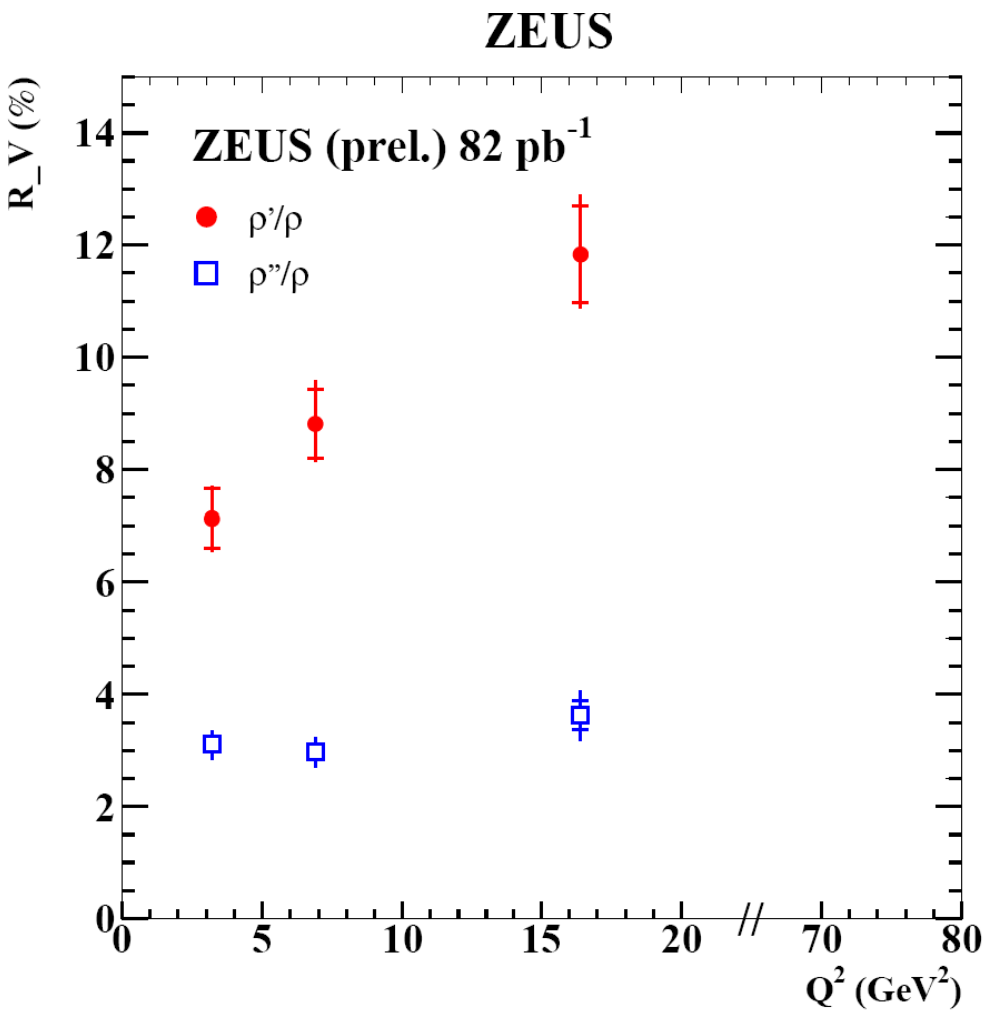


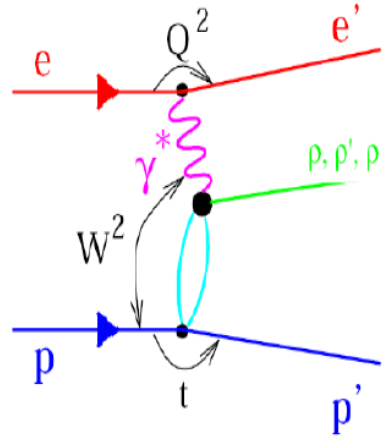


- Near-side peak is similar in p+p and d+Au
- Significant broadening from p+p to d+Au in the away side peak
- Agreement with CGC (?), MPI contributions(?)

Exclusive electroproduction of pions (ep, HERA)

ZEUS
(V. Aushev)





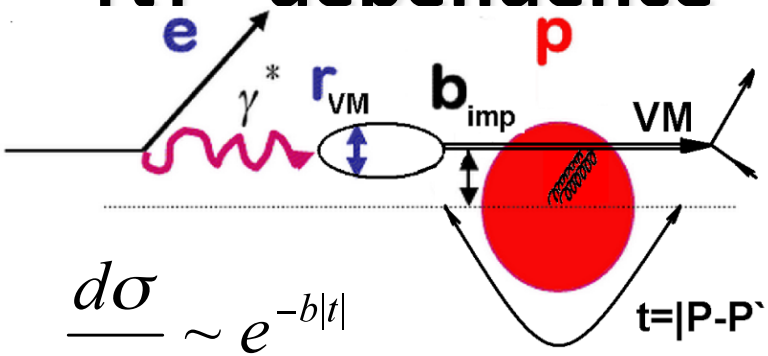
$0.4 < M_{\pi\pi} < 2.5$ GeV,
$2 < Q^2 < 80$ GeV^2,
$32 < W < 180$ GeV
$|t| \leq 0.6$ GeV^2

contribution of the three vector mesons *ρ^0, ρ` and ρ``*

compare their Q^2 dependence to QCD predictions

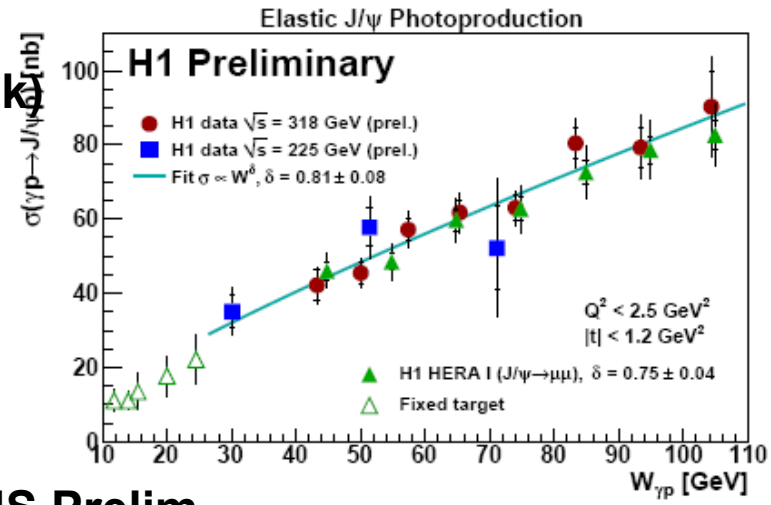
Exclusive VM production (ep, HERA)

|t| - dependence



$$\frac{d\sigma}{dt} \sim e^{-b|t|}$$

ZEUS (G. Grzelak)
H1 (F. Huber)



b - sensitive to the transverse size of the interaction region

Geometric picture - transverse size:

$b = b_V + b_p$

Transverse size:

Vector Meson : $b_V \sim 1/(Q^2+M^2_V)$

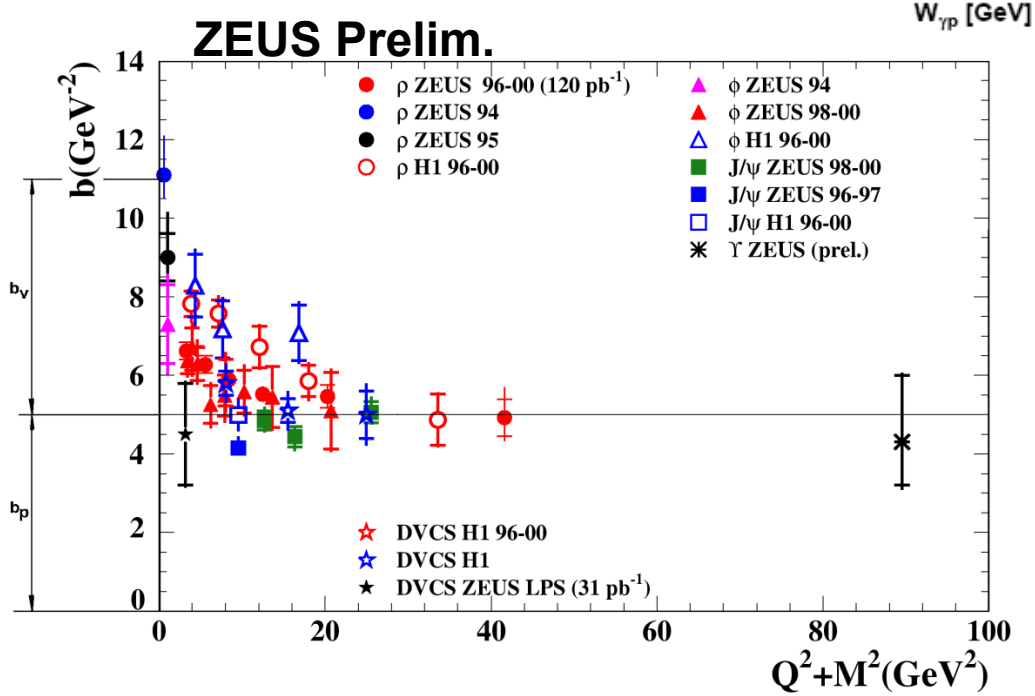
Target (proton) : $b_p \approx 5\text{GeV}^{-2}$

b_p can be interpreted as

$r_{gluons} \approx 0.6$ fm

charge radius of the proton

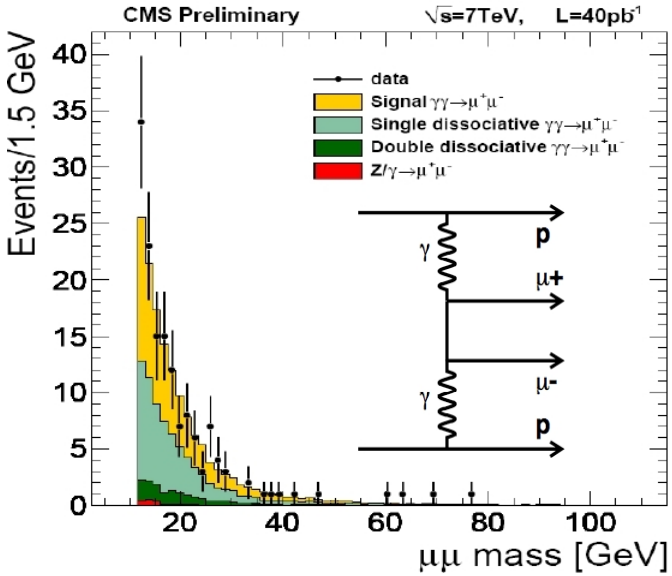
$r_{em} \approx 0.8$ fm

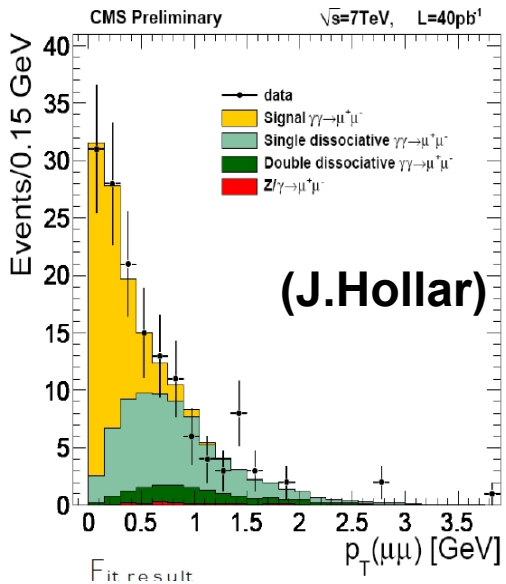


New ZEUS measurement of ϒ(1S) consistent with hard regime VM production.

Exclusive photoproduction $\gamma\,\gamma \rightarrow \mu\,\mu$ (pp, LHC)

- CMS: Rap-gap, $p_T(\mu) > 4$ GeV, $\eta(\mu) < 2.1$, $m(\mu\mu) > 11.5$ GeV





Clear signal measured

$\sigma(pp \rightarrow p\mu\mu p)_{exp}$ = 3.35±0.5±0.2 pb

Agreement with LPAIR:

$\sigma_{exp}/\sigma_{QED}$ = 0.82±0.14±0.04

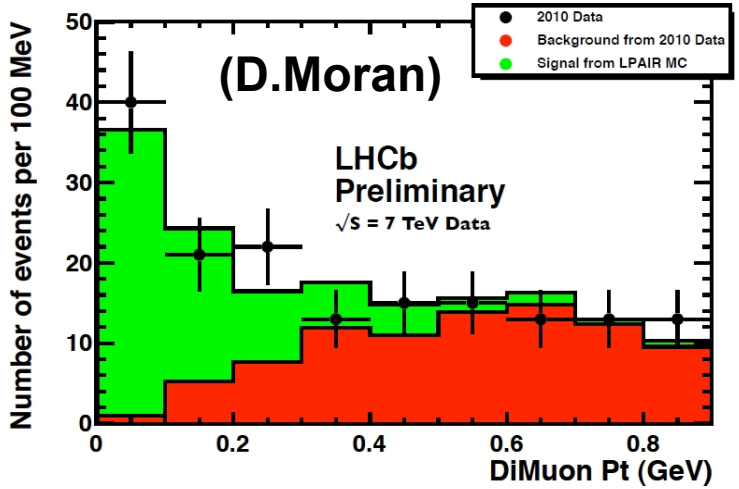
Uncertainties in inelastic contributions (proton taggers needed)

- LHCb:

$m(\mu\mu) > 2.5$ GeV (not J/psi,psi')
Exclusivity: no backward tracks, no γ, N>2 forward tracks

Agreement with LPAIR elastic

σ_{exp} = 67±19 pb, σ_{QED} = 42 pb

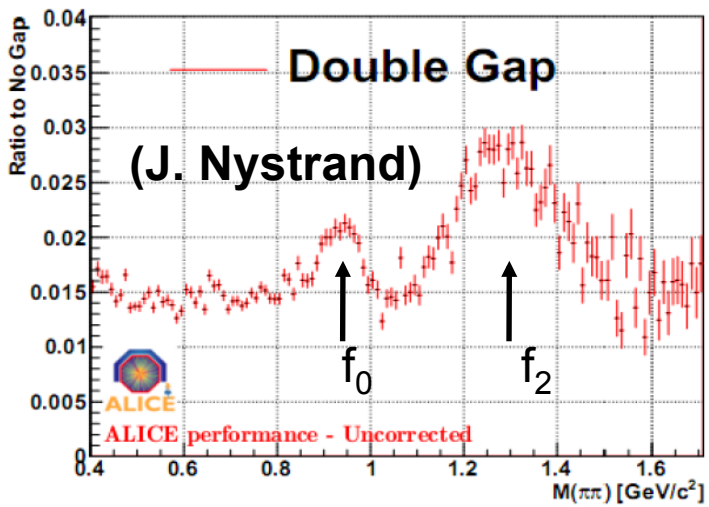


Central Exclusive IP+IP → X (pp, LHC)

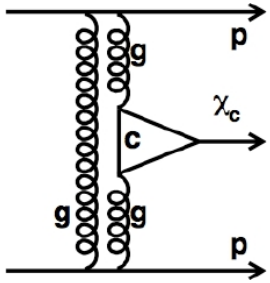
- ALICE: IP+IP → f_0 , f_2 mesons.

  2-track events with gaps on both sides over events without gaps.

- LHCb: IP+IP → χ_c



$m(\mu\mu)$ = m(J/psi)±65 MeV, $p_T(\mu\mu)$ < 900 MeV, 1 γ
Exclusivity: no backward tracks, N>2 fwd tracks



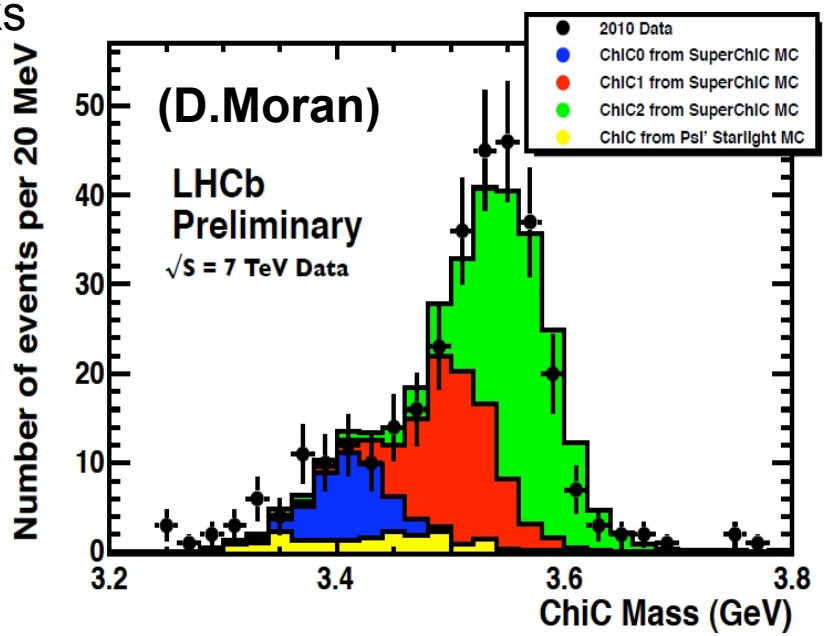
σ_{chic0} = 9.3±4.5 pb (σ_{TH} = 14 pb)

σ_{chic1} = 16.4±7.1 pb (σ_{TH} = 10 pb)

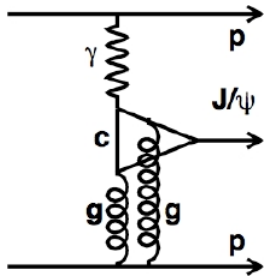
σ_{chic2} = 28±12.3 pb (σ_{TH} = 3 pb)

Consistent with TH: SuperChic, Starlight (but large TH/EXP uncertainties)

ChiC0:ChiC1:ChiC2 = 1:2.2±0.8:3.9±1.1

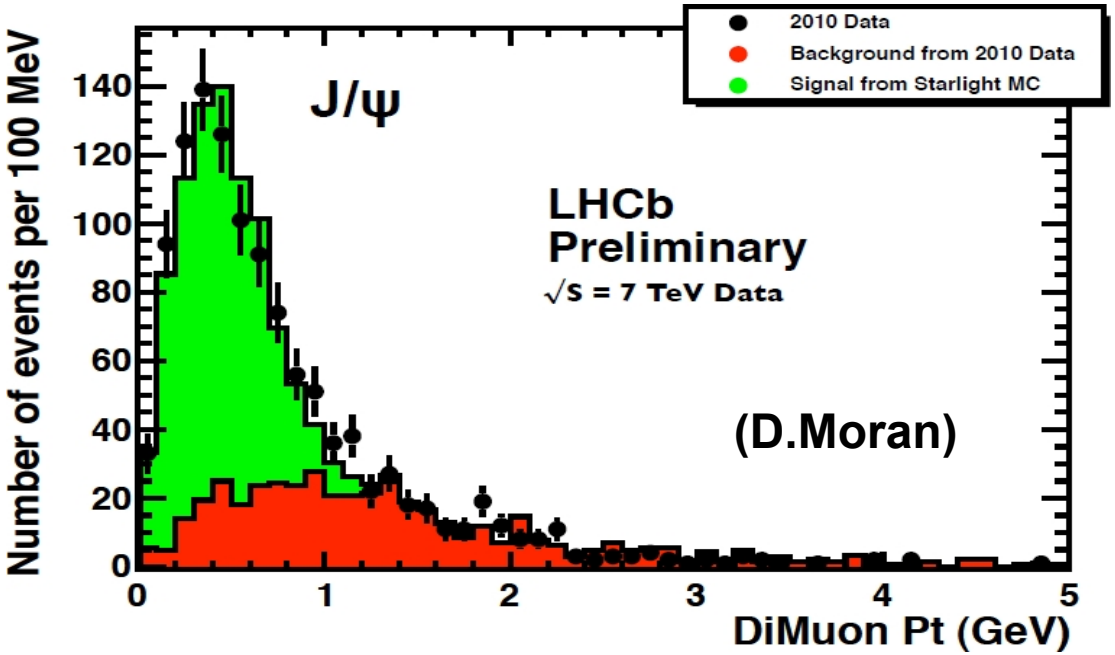


Exclusive photoproduction γ IP $\rightarrow$X (pp, LHC)



- LHCb: γ IP –> J/Psi, Psi'

m($\mu\mu$) = m(J/psi)±65 MeV, $p_T(\mu\mu)$ < 900 MeV, No γ
Exclusivity: no backward tracks, N>2 fwd tracks



Consistent with Starlight/SuperChic
(but large TH/EXP uncertainties)

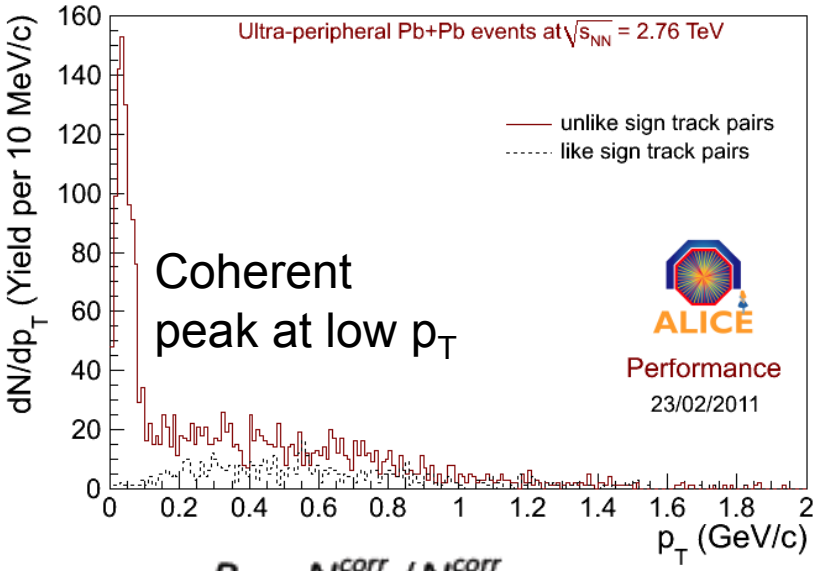
$\sigma_{J/psi}$ = 474 ± 103 pb (σ_{TH} = 292-330 pb)

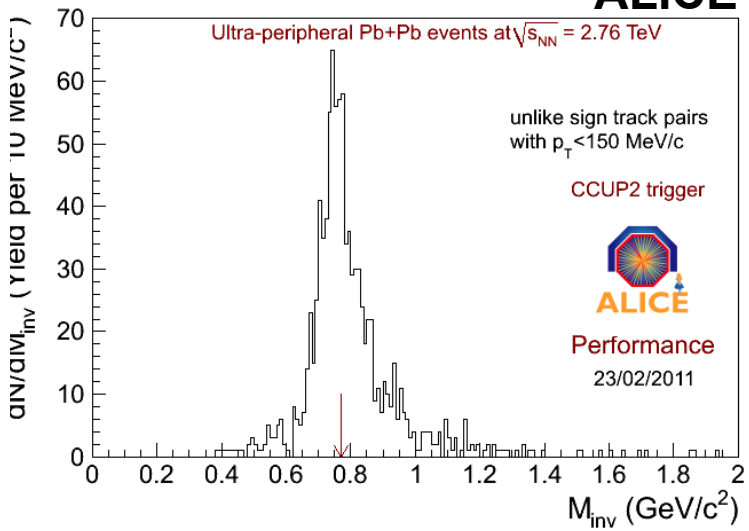
$\sigma_{psi'}$ = 12.2 ± 3.2 pb (σ_{TH} = 6.1 pb)

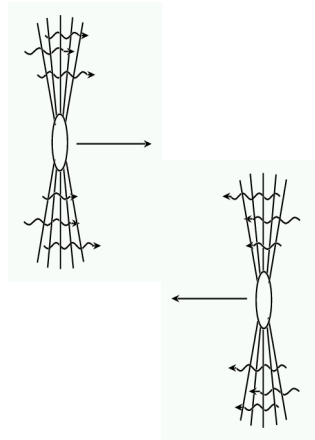
Vector Meson Production (PbPb, LHC)

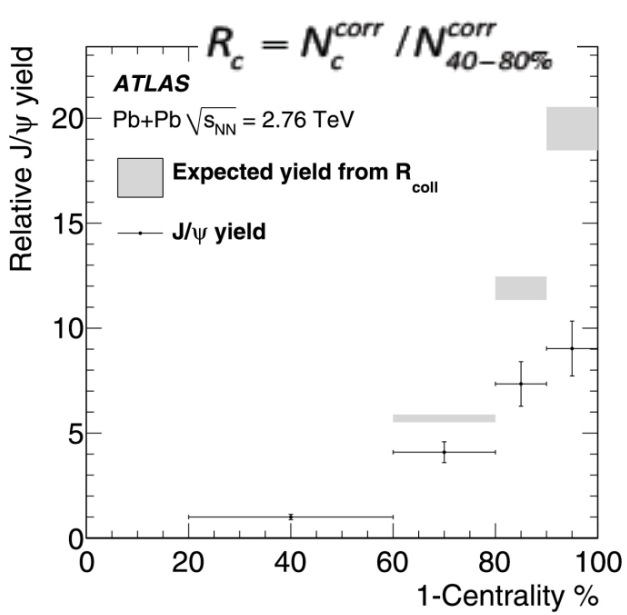
- ALICE observed: PbPb → Pb+Pb+ ρ^0

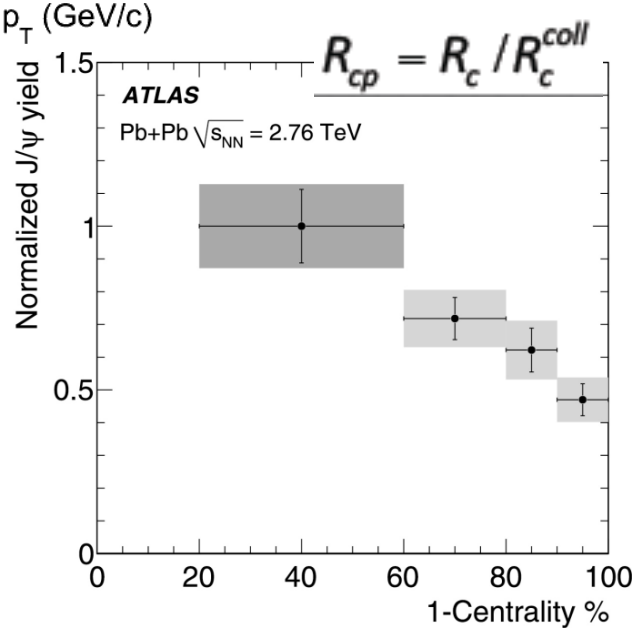
ATLAS (G. Pasztor)
ALICE (L. Massacrier)









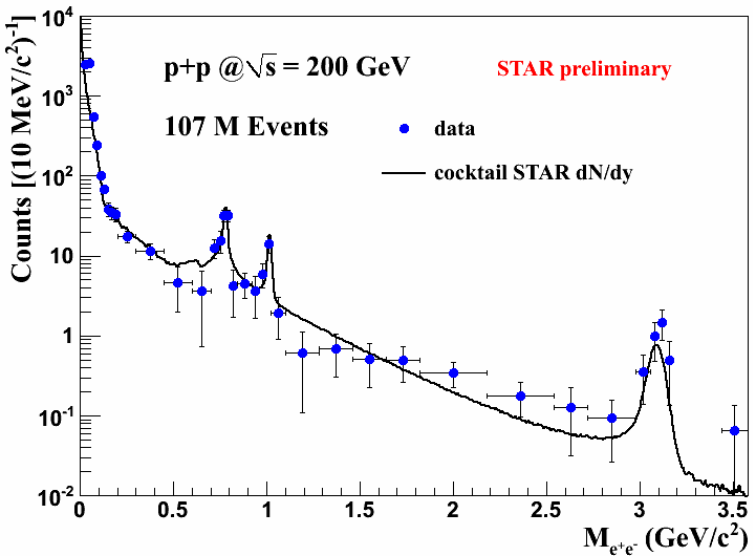


Centrality dependent J/ψ suppression observed at ATLAS

(M. Naglis)

Vector Meson production (RHIC)

Motivation:
•More than 10% of bulk meson production in HI collisions.
•Lifetime comparable to QGP.
•Vector mesons (ρ, ω, f, J/ψ, ψ' , Y) have // decay channels
bring information → about medium properties directly to the detector .



- Low mass vector mesons
  - PHENIX: Low mass e+e- pair enhancement in Au+Au
  - STAR: Similar analysis is ongoing. Stay tuned.
- Y
  - PHENIX, STAR: cross-section measured in p+p, dAu,AuAu
- J/ψ
  - PHENIX: High statistic measurement in p+p: spectra.
    Ψ' and χc feed-down on p+p
    High statistic measurement in d+Au
  - STAR: High statistic p+p data-sample is being analyzed.

M. Tasevsky

Central Exclusive Production (pp, LHC)

1)CED Higgs production in SM

- provides a moderate signal yields but it is attractive because

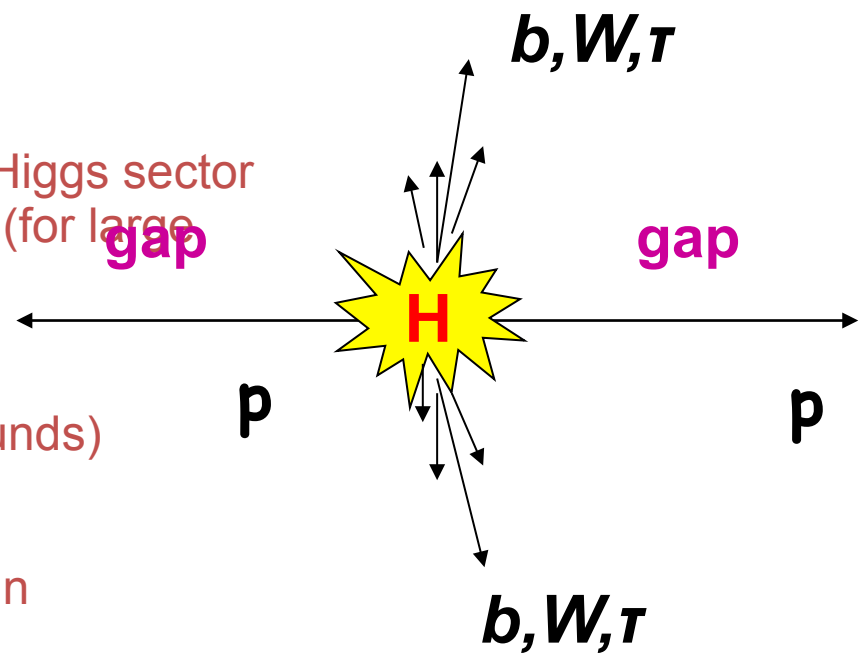
- gives information about Hbb Yukawa coupling – which is difficult in standard searches

2) CED Higgs production in MSSM

- the signal yields are greatly enhanced
- it gives complementary information about Higgs sector
- the Higgs width may be directly measured (for large tanβ)

Update of the 2007 analysis:

- background NLO CED gg→bb
- LEP/Tevatron exclusion regions (HiggsBounds)



- improved theory calculations (as included in FeynHiggs)
- new CDM benchmark planes (similar results as for Mhmax and no-mixing benchmarks)

3) CED Higgs production in 4th Generation Model

- LEP/Tevatron searches: 112 < M_H < 130 GeV allowed

What I did not cover

- Vitaliy Dodonov

  Forward neutron p_T distribution and forward photon spectra measured in H1 FNC

- Heiner Wollny

  Vector Meson & DVCS measurements in COMPASS

- Valery Kubarovsky

  Vector meson production & DVCS at J-Lab

- Anastasia Grebeniuk

  Transverse momentum spectra of charged particles at low Q^2

Thank you

Thanks to the speakers