IPN INSTITUT DE PHYSIQUE NUCLÉAIRE ORSAY

ICA Division of International Comparative & Area Studies

The France-Stanford Center for Interdisciplinary Studies

cnrs IN2P3 Les deux infinis

AFTER @ LHC

A Fixed-Target ExpeRiment using the proton and lead LHC beams

Jean-Philippe Lansberg
IPN Orsay, Université Paris-Sud

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SPRING 2012 AFTER Meeting
LPSC, Grenoble

AFTER @ LHC

with the support of F. Fleuret (LLR), S.J. Brodsky (SLAC), C. Hadjidakis (IPN), R. Arnaldi (Torino), V. Chambert (IPN), J.P. Didelez (IPN), B. Genolini (IPN), E.G. Ferreiro (USC), A. Rakotozafindrabe (CEA), P. Rosier (IPN),E. Scomparin (Torino), and U.I. Uggerhøj (Aarhus)

Part I

A fixed-target experiment using the LHC beam(s): generalities

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- Expected luminosities with 5×10^8 *p*/s extracted (1cm-long target)

Target	ρ (g.cm^{-3})	A	$\mathcal{L}$ (μb^{-1}.s^{-1})	$\int\mathcal{L}$ (pb^{-1}.yr^{-1})
Sol. H_2	0.09	1	**26**	**260**
Liq. H_2	0.07	1	**20**	**200**
Liq. D_2	0.16	2	**24**	**240**
Be	1.85	9	**62**	**620**
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Part II

AFTER: a couple of flagships measurements

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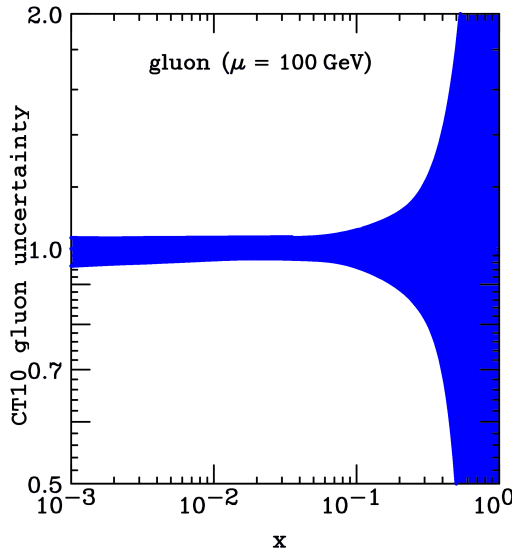

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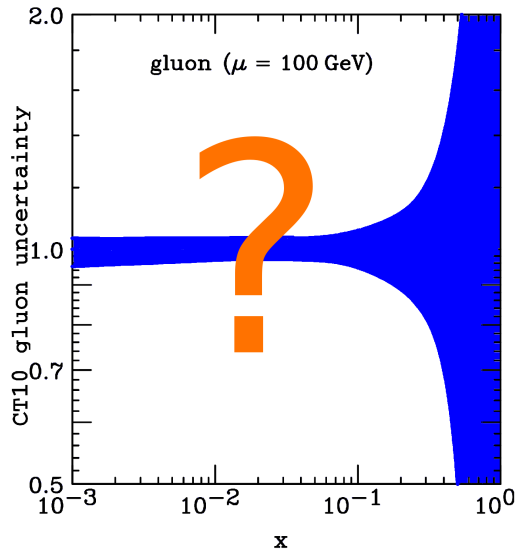

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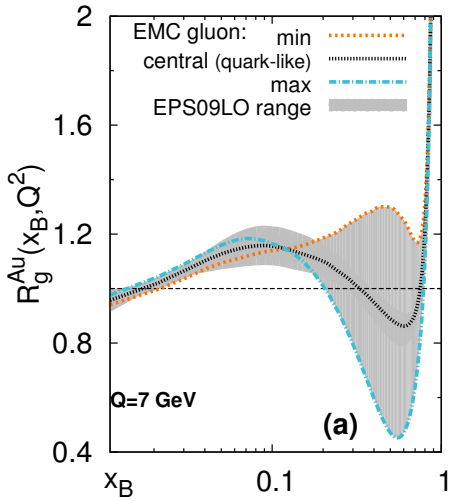

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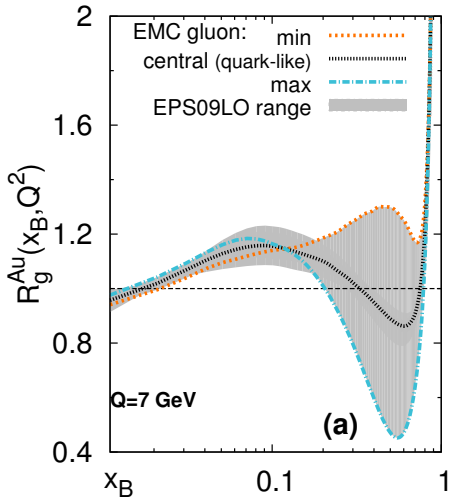

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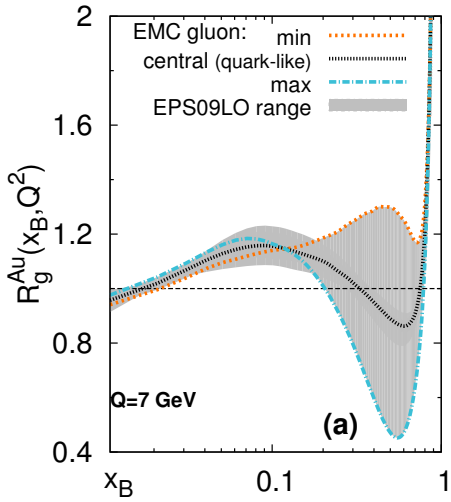

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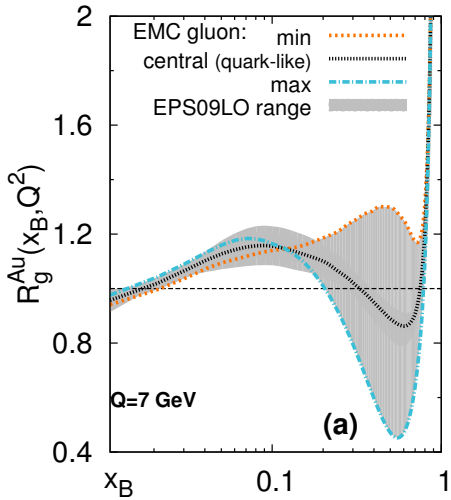

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- "high" P_T jets (we should access $P_T \in [20, 40]$ GeV)

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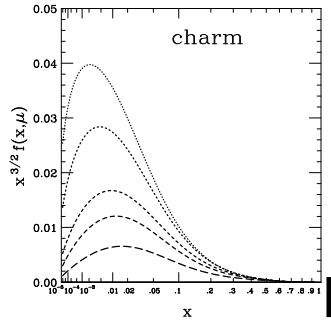

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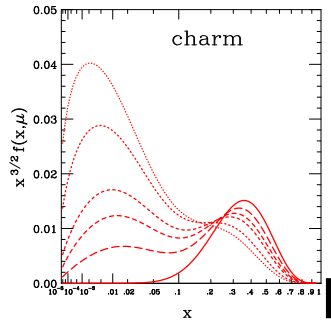

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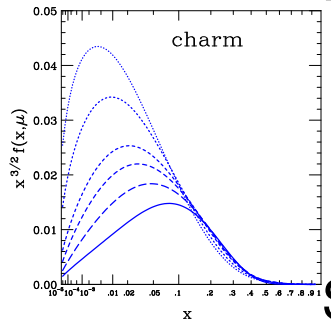

Sea-like

All 3 compatible with DIS data (Pumplin *et al.*)

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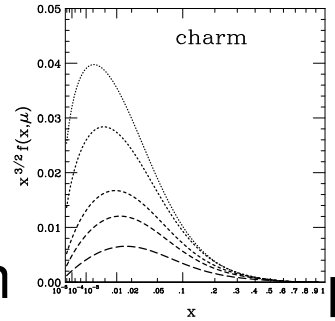

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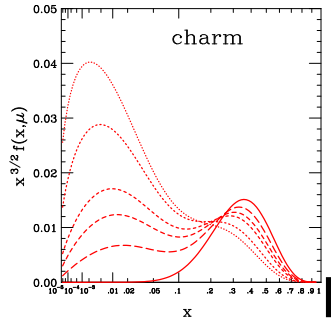

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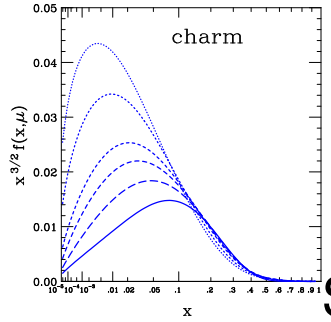

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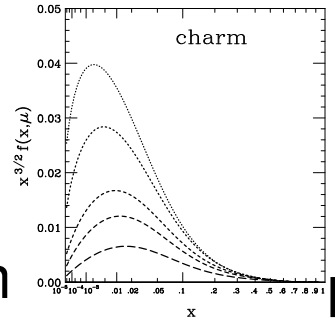

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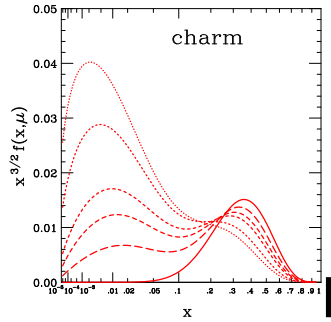

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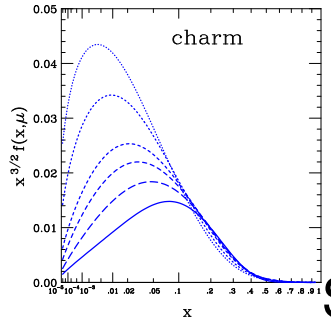

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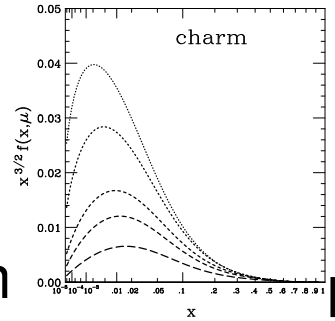

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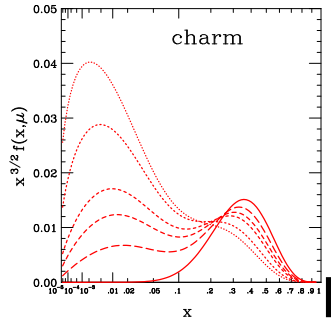

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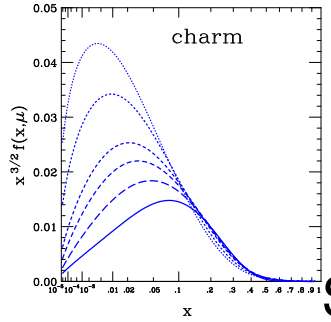

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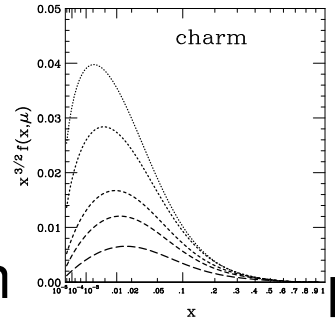

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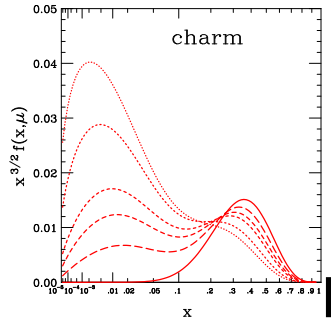

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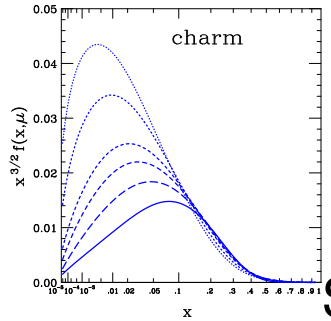

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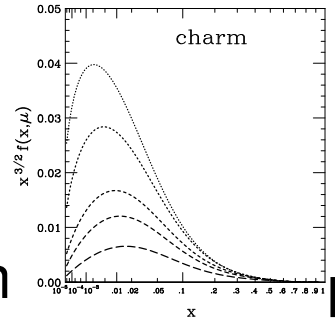

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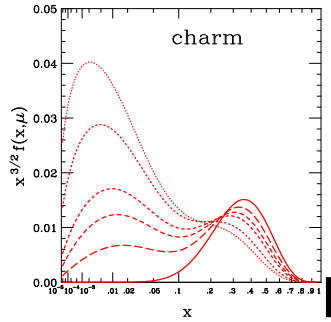

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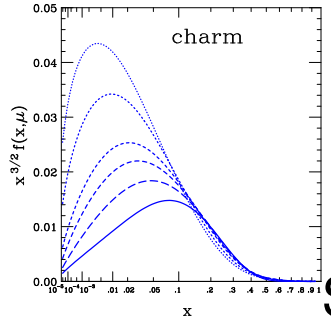

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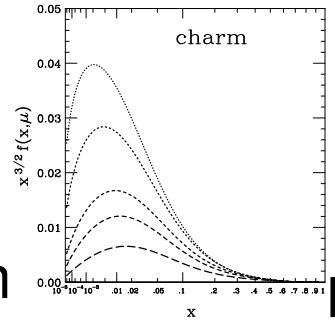

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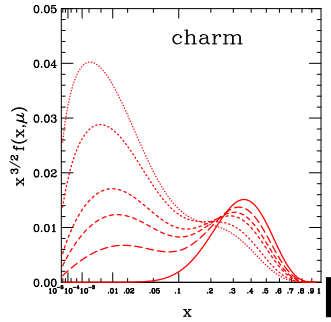

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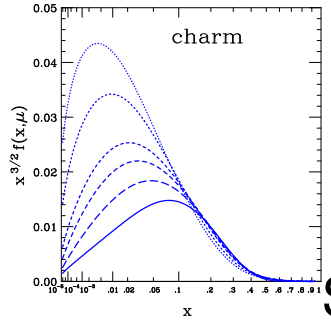

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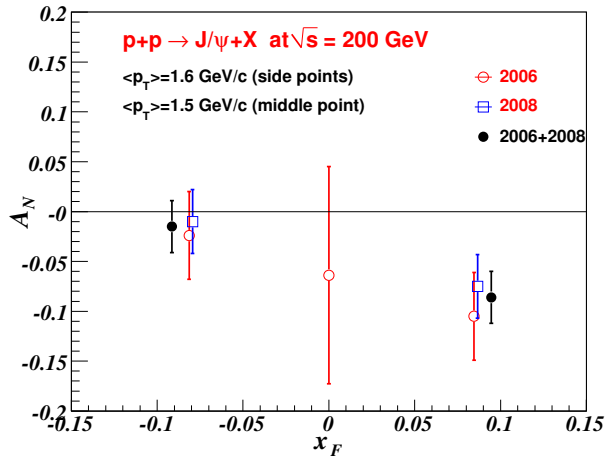

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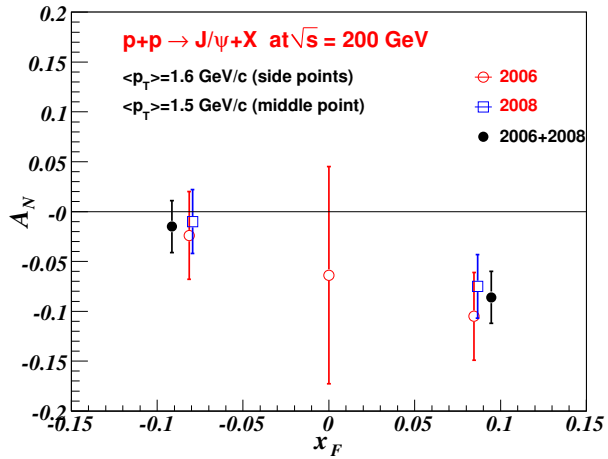

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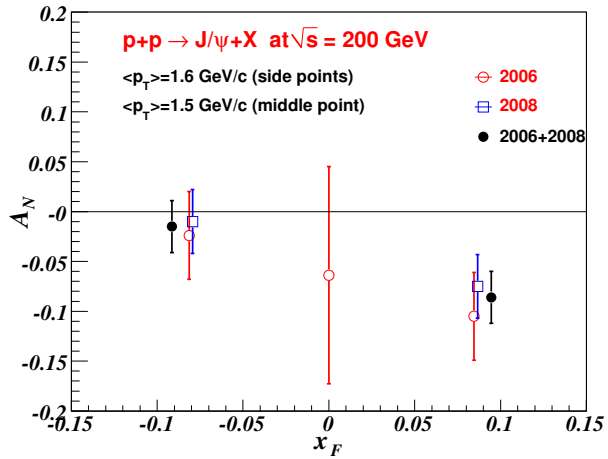

(**A. Bacchetta,** *et al.***Phys. Rev. Lett. 99 (2007) 212002)**

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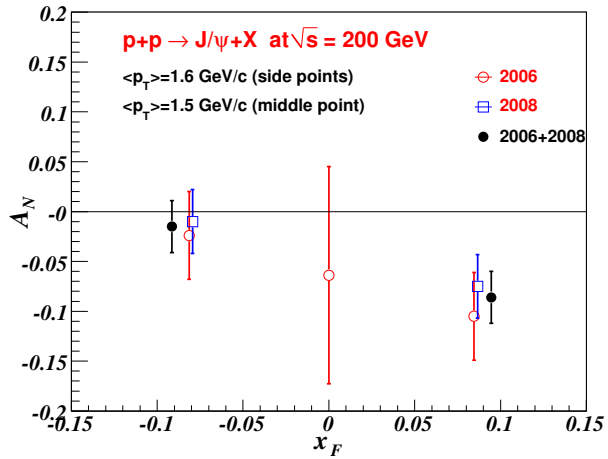

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  where the k_T-spin correlation is the largest

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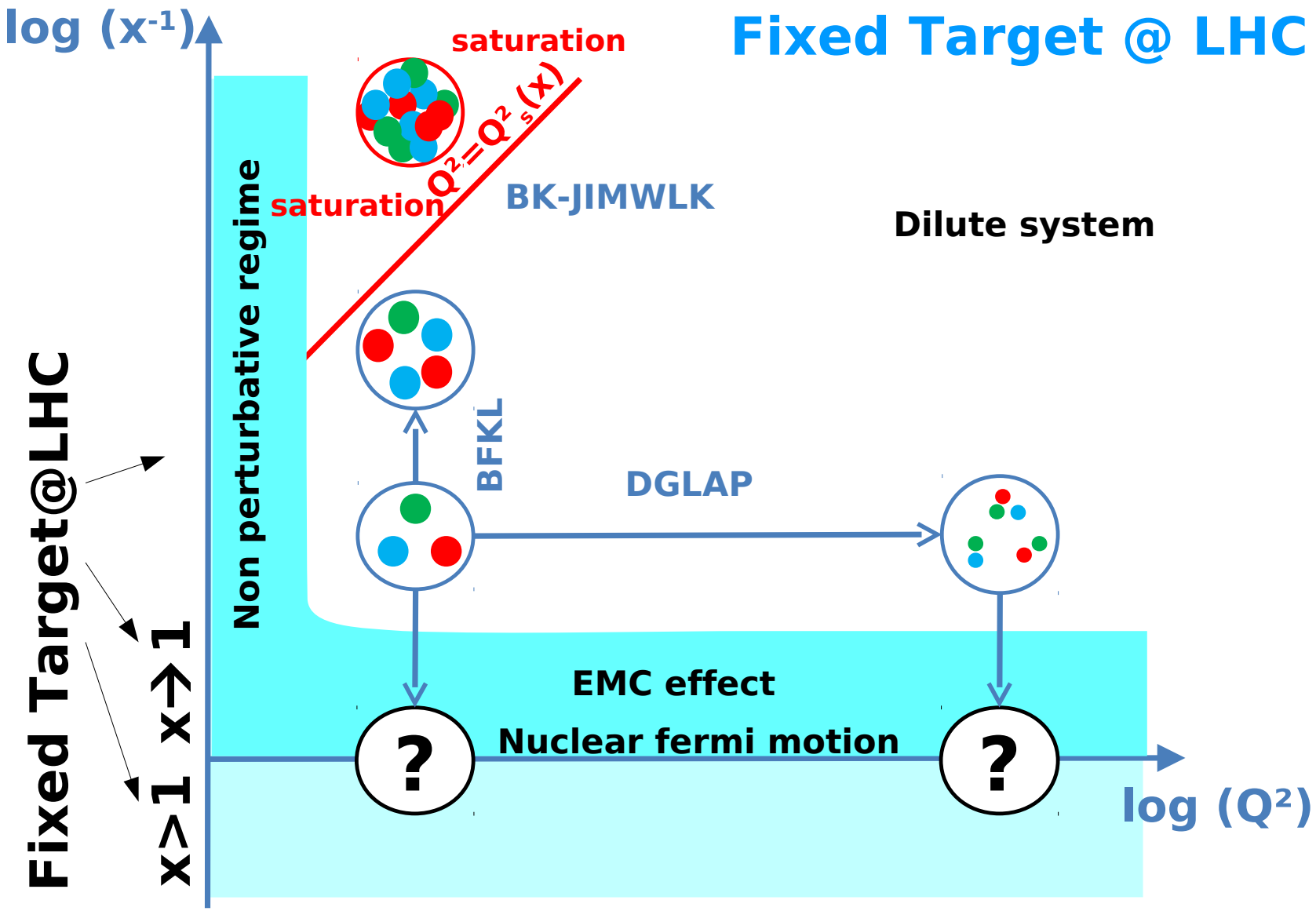
- Multiply heavy baryons: discovery potential ?
- Very forward (backward) physics:
  - semi-diffractive events
  - Ultra-peripheral collisions, etc.

Overall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Fixed Target @ LHC
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Q2=Q2s(x)
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Dilute system
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BFKL
DGLAP
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EMC effect
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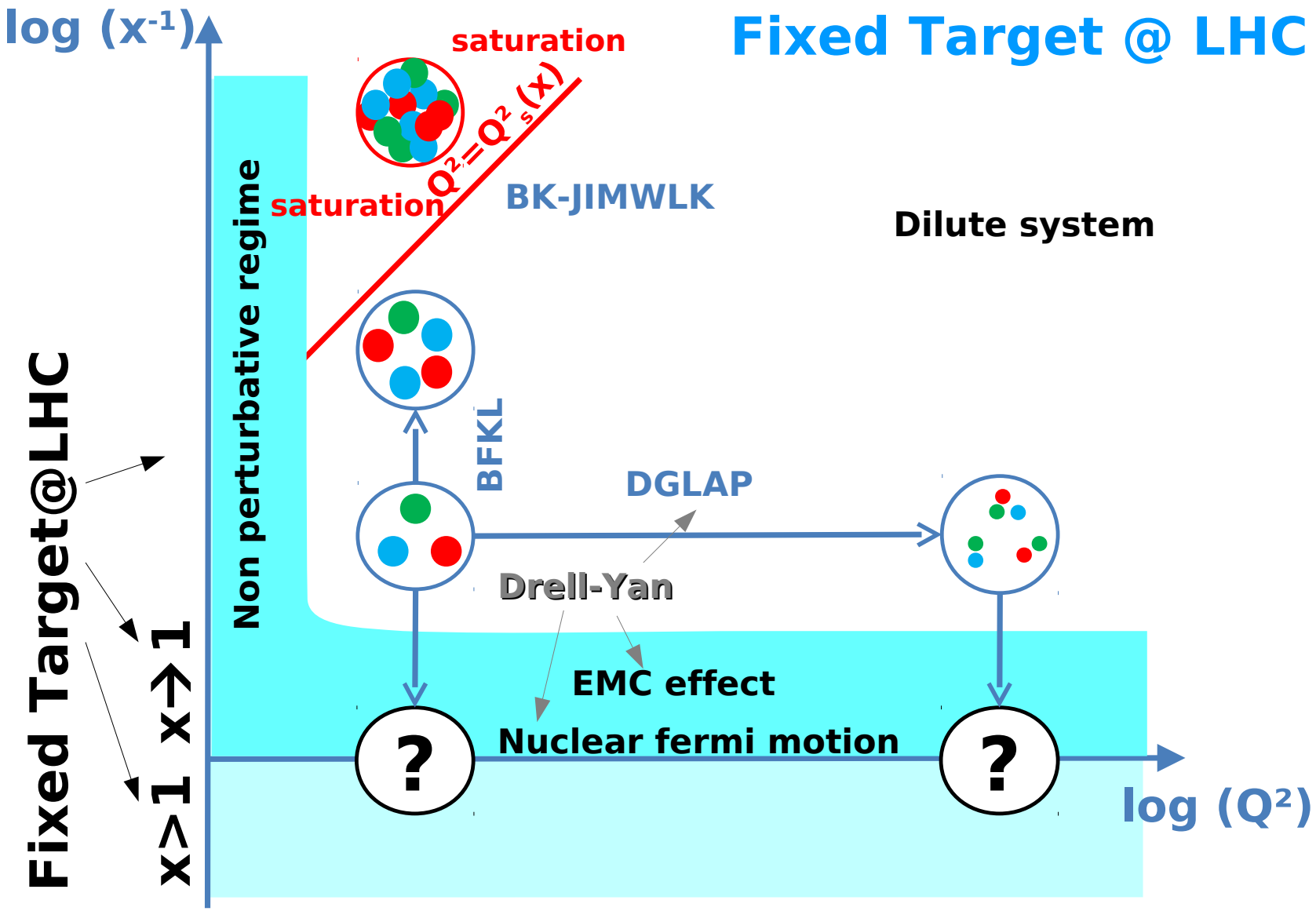
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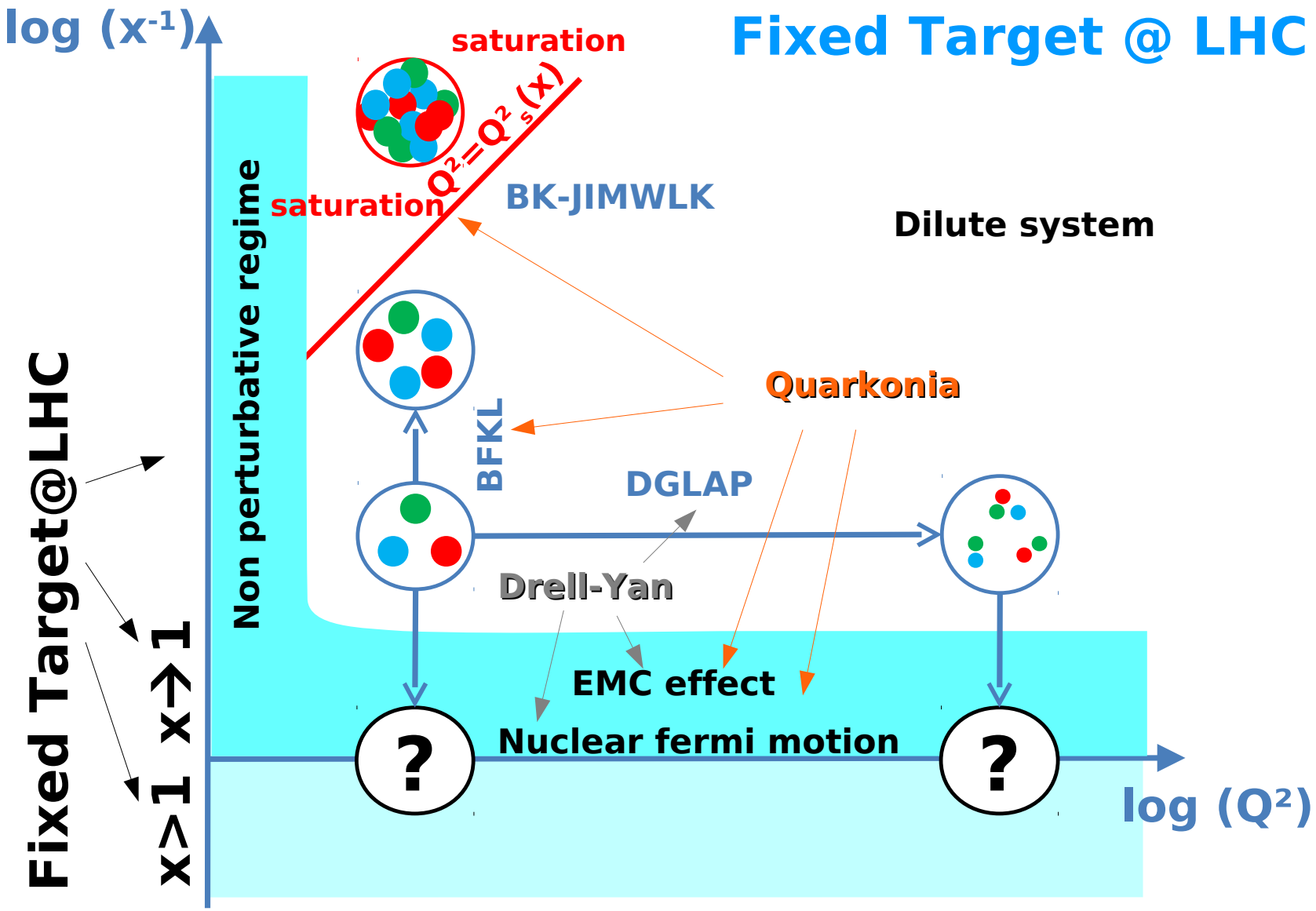
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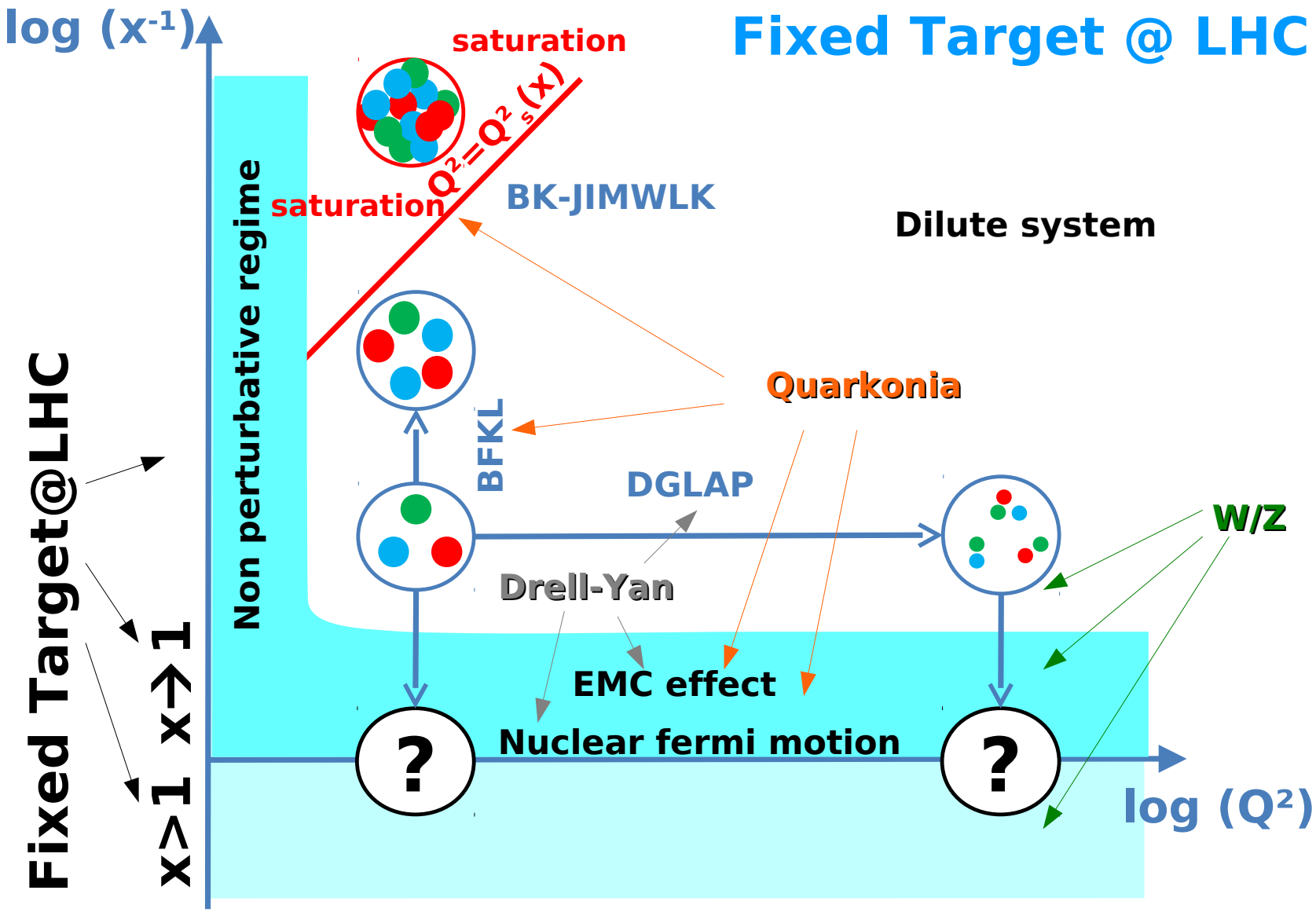
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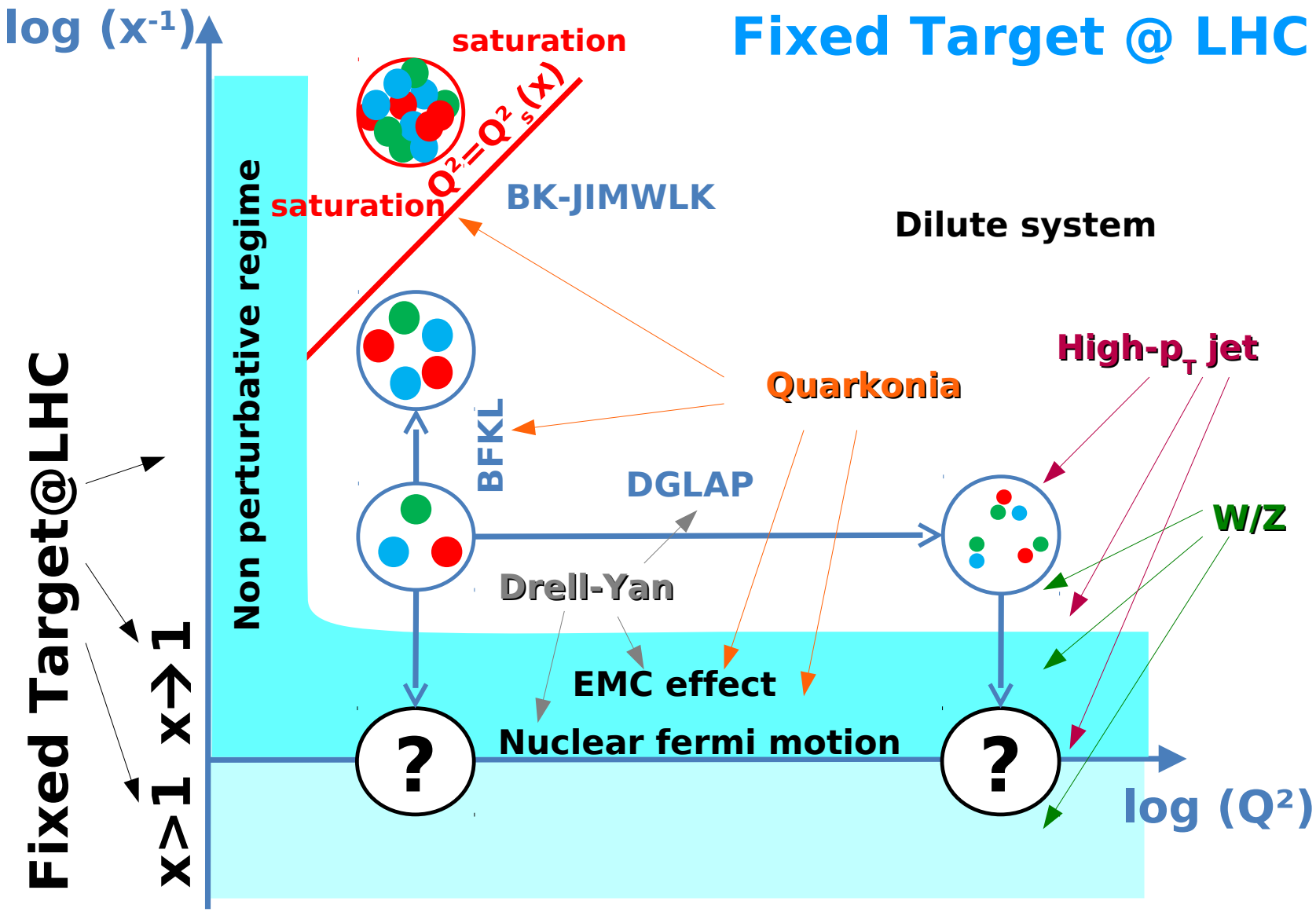
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More details in arxiv:1202.6585

SLAC-PUB-14878

Physics Opportunities of a Fixed-Target Experiment using the LHC Beams

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[3]*IPNO, Université Paris-Sud, CNRS/IN2P3, 91406 Orsay, France*

Abstract

We outline the many physics opportunities offered by a multi-purpose fixed-target experiment using the proton and lead-ion beams of the LHC extracted by a bent crystal. In a proton run with the LHC 7-TeV beam, one can analyze pp, pd and pA collisions at center-of-mass energy $\sqrt{s_{NN}} \simeq 115$ GeV and even higher using the Fermi-motion of the nucleons in a nuclear target. In a lead run with a 2.76 TeV-per-nucleon beam, $\sqrt{s_{NN}}$ is as high as 72 GeV. Bent crystals can be used to extract about 5×10^8 protons/sec; the integrated luminosity over a year would reach 0.5 fb^{-1} on a typical 1 cm-long target without nuclear species limitation. We emphasize that such an extraction mode does not alter the performance of the collider experiments at the LHC. By instrumenting the target-rapidity region, gluon and heavy-quark distributions of the proton and the neutron can be accessed at large x and even at x larger than unity in the nuclear case. Single diffractive physics and, for the first time, the large negative-x_F domain can be accessed. The nuclear target-species versatility provides a unique opportunity to study nuclear matter versus the features of the hot and dense matter formed in heavy-ion collisions, including the formation of the Quark-Gluon Plasma (QGP), which can be studied in PbA collisions over the full range of target rapidities with a large variety of nuclei. The polarization of hydrogen and nuclear targets allows an ambitious spin program, including measurements of the QCD lensing effects which underlie the Sivers single-spin asymmetry, the study of transversity distributions and possibly of polarized parton distributions. We also emphasize the potential offered by pA ultra-peripheral collisions where the nucleus target A is used as a coherent photon source, mimicking photoproduction processes in ep collisions. Finally, we note that W and Z bosons can be produced and detected in a fixed-target experiment and in their threshold domain for the first time, providing new ways to probe the partonic content of the proton and the nucleus.

Keywords: LHC beam, fixed-target experiment

More details in arxiv:1202.6585

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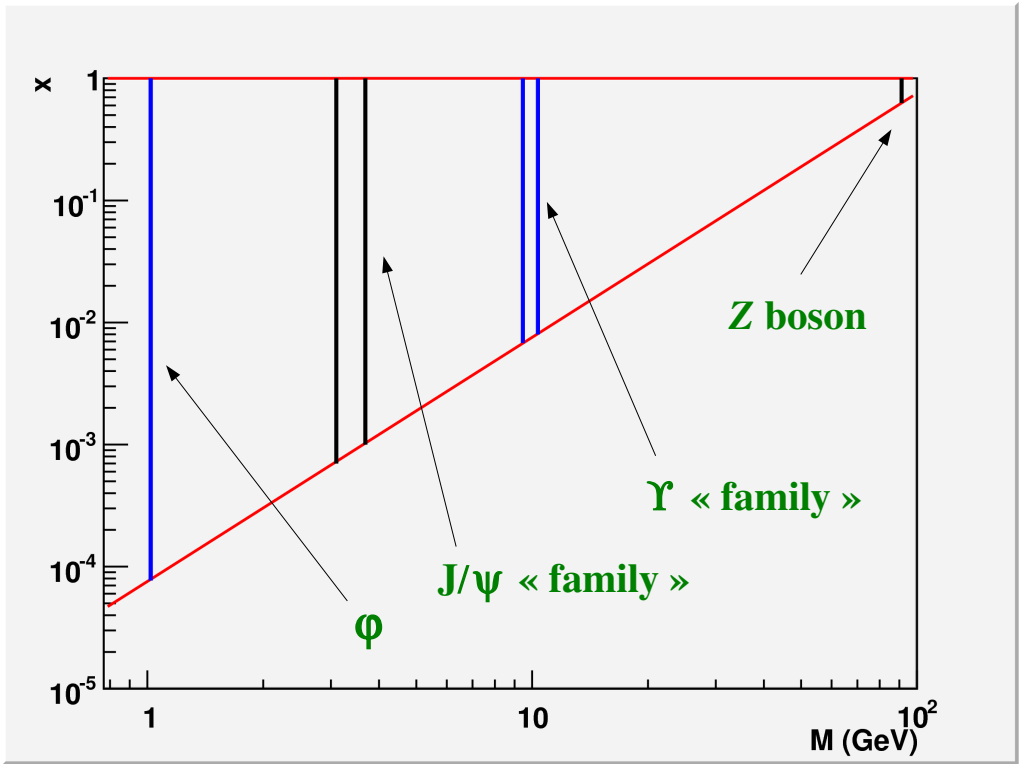

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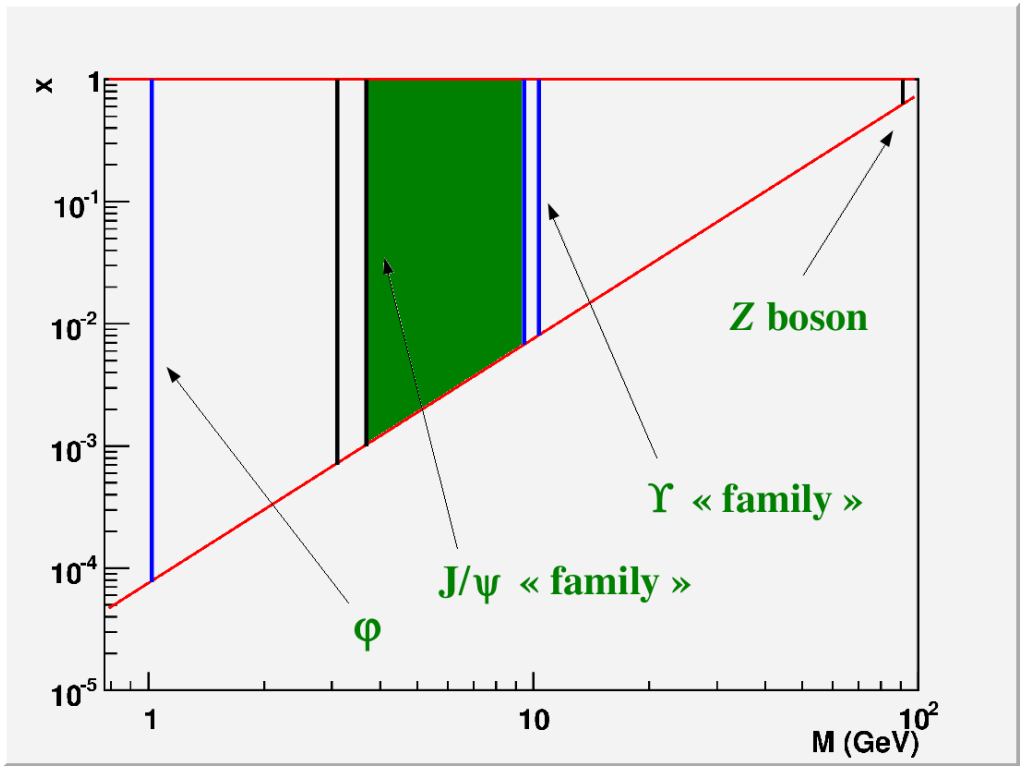

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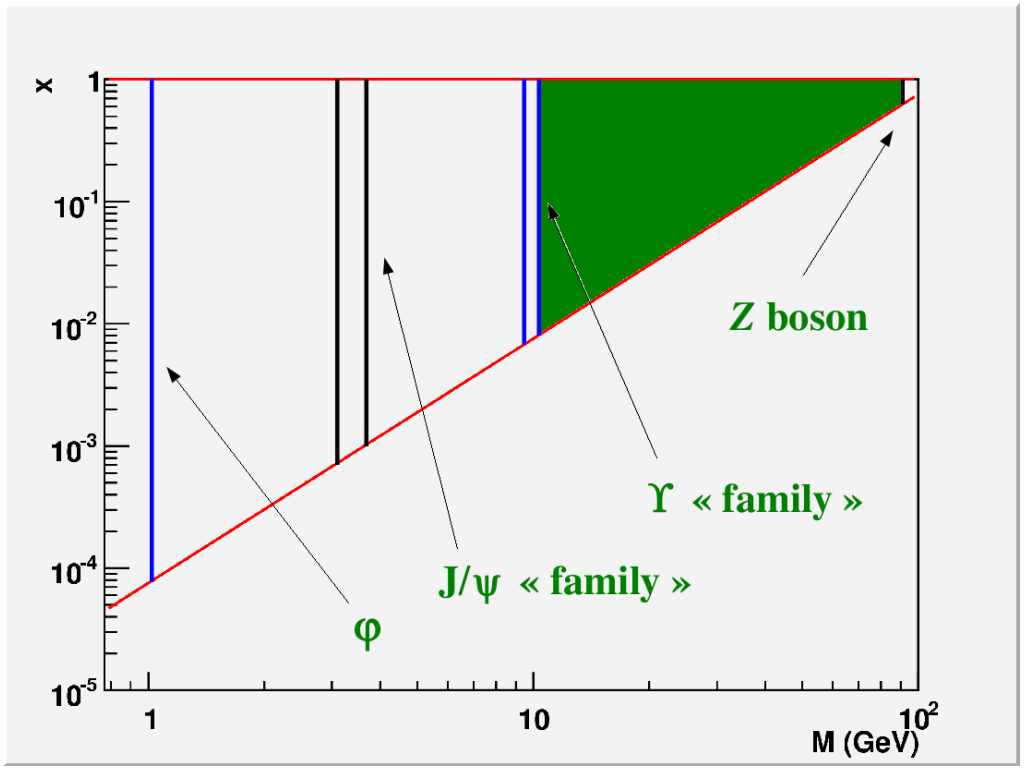

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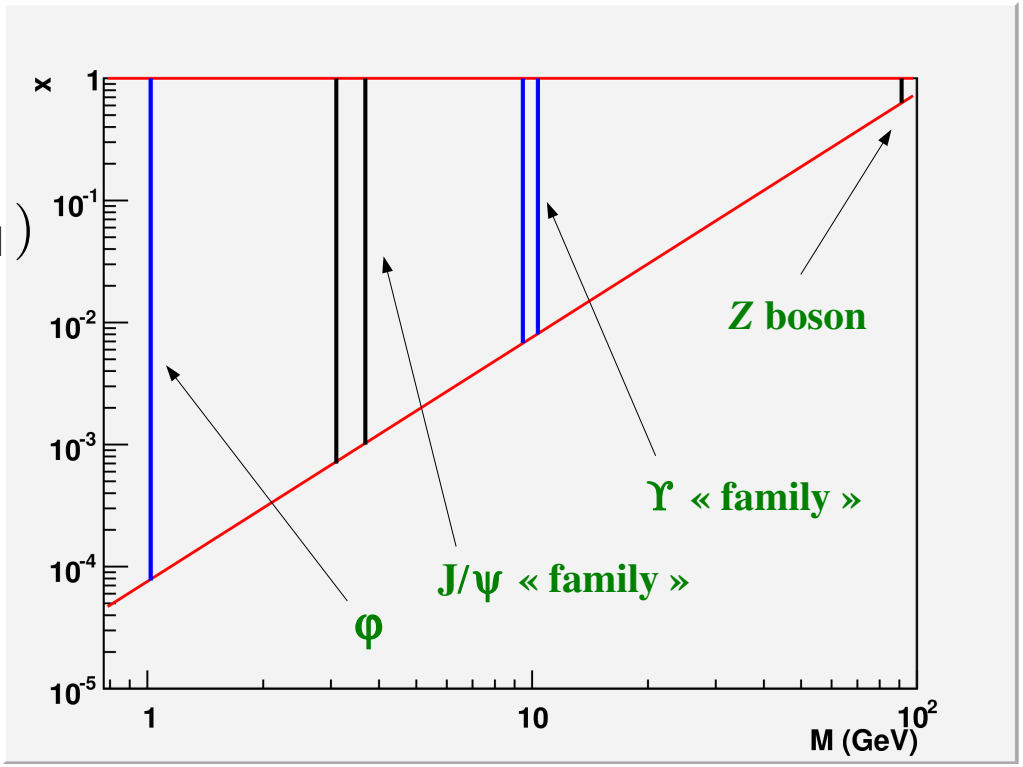

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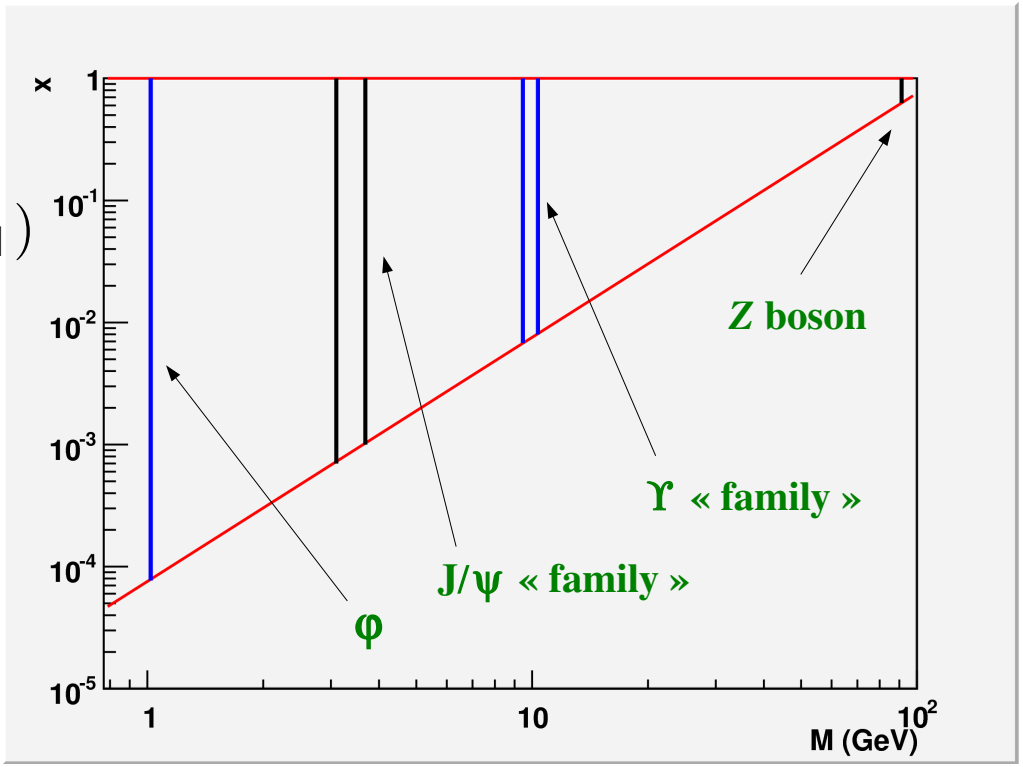

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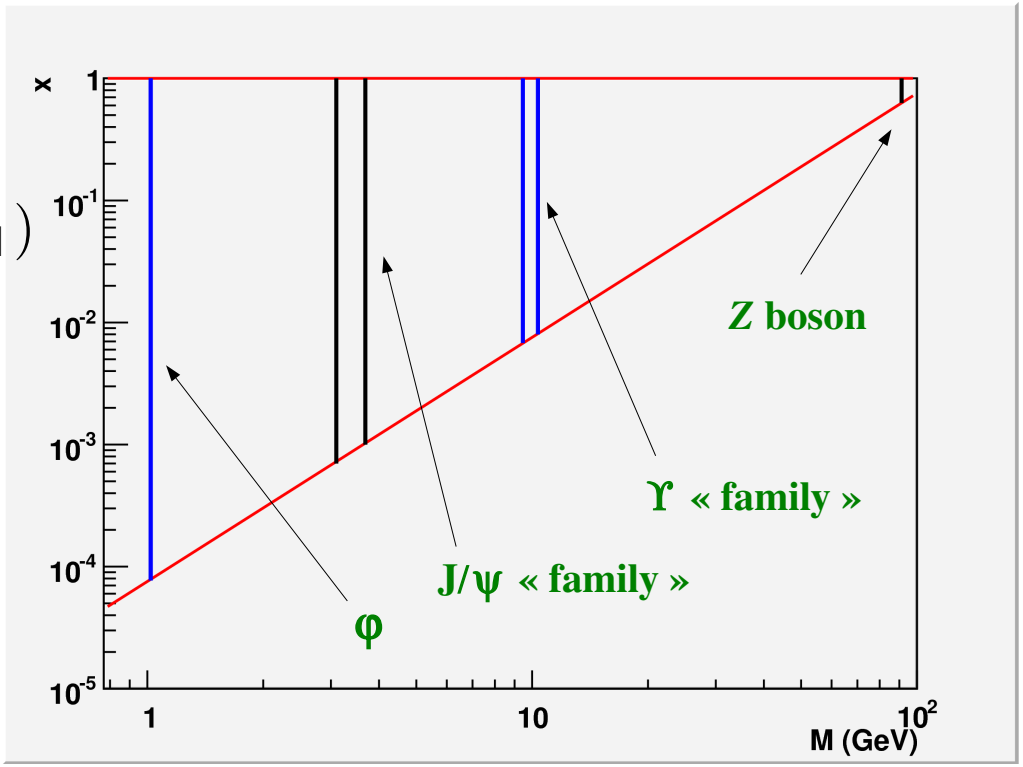

➠ To do: to look at the rates to see how competitive this will be

Part III

Conclusion and outlooks

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- A wealth of possible measurements:
  DY, Open b/c, jet correlation, UPC... (not mentioning secondary beams)