The Quarkonium4AFTER Franco-Chinese collaboration

J.P. Lansberg

IPN Orsay – Paris-Sud U. – Paris Saclay U. –CNRS/IN2P3

12th France-China Particle Physics Laboratory Workshop

SJTU, Shanghai, China, April 24-27, 2019

Our FCPPL collaboration

Theory of quarkonia + fixed-target experiment at the LHC

	France	China
Leaders	J.P. Lansberg (IPNO)	J.X. Wang (IHEP)
Permanent	C. Hadjidakis (IPNO) I. Hrivnacova (IPNO) L. Massacrier (IPNO) C. Lorcé (CPhT-X) H.S. Shao (LPTHE)	B. Gong (IHEP) K.T. Chao (PKU) Y. Gao (PKU) Y.Q. Ma (PKU) Y. Mao (PKU) Z. Yang (Tsinghua) Z. Tang (USTC) J. He (UCAS) Y.J. Zhang (Beihang) H.F. Zhang (Guijang) Y. Feng (Chongqing) G.Z. Xu (Liaoning) Y.J. Li (Liaoning)
Non-permanent	N. Yamanaka (IPNO) S. Cotogno (CPhT-X) A. Trawinski (CPhT-X) M. Ozcelik (IPNO) F. Scarpa (IPNO - GU)	A.P. Chen (PKU)

Realisations (1)

LHC Fixed target mode: review and contributions to the European Strategy for Particle Physics

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LHC Fixed target mode: review and contributions to the European Strategy for Particle Physics

A Fixed-Target Programme at the LHC:
Physics Case and Projected Performances for Heavy-Ion, Hadron, Spin and Astroparticle Studies

C. Hadjidakis[a,1], D. Kikoła[b,1], J.P. Lansberg[a,1,*], L. Massacrier[a,1], M.G. Echevarria[c,2], A. Kusina[d,2], I. Schienbein[e,2], J. Seixas[f,g,2], H.S. Shao[h,2], A. Signori[i,2], B. Trzeciak[j,2], S.J. Brodsky[k], G. Cavoto[l], C. Da Silva[m], F. Donato[n], E.G. Ferreiro[o,p], I. Hřivnáčová[a], A. Klein[m], A. Kurepin[q], C. Lorcé[r], F. Lyonnet[s], Y. Makdisi[t], S. Porteboeuf[u], C. Quintans[g], A. Rakotozafindrabe[v], P. Robbe[w], W. Scandale[x], N. Topilskaya[q], A. Uras[y], J. Wagner[z], N. Yamanaka[a], Z. Yang[aa], A. Zelenski[t]

Abstract

We review the context, the motivations and the expected performances of a comprehensive and ambitious fixed-target program using the multi-TeV proton and ion LHC beams. We also provide a detailed account of the different possible technical implementations ranging from an internal wire target to a full dedicated beam line extracted with a bent crystal. The possibilities offered by the use of the ALICE and LHCb detectors in the fixed-target mode are also reviewed.

C.Hadjdakis, D. Kikola, JPL, L. Massacrier,*et al.* arXiv 1807.00603, submitted to Physics Reports

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    [150+ endorsers]

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ENDORSED BY [Affiliations in the appendix]:

S. Afonin, A. Ali, R. Arnaldi, E. Aschenauer, A. Bacchetta, A. Beraudo, D. Blaschke, G. Bodwin, G. Bozzi, V. Braun, G. Cavoto, K. T. Chao, L. Cifarelli, Z. Conesa Del Valle, M. Constantinou, J. Crkovska, M. Csanad, J. R. Cudell, U. D'Alesio, D. d'Enterria, B. Erazmus, T. Dahms, A. Dainese, K. T. Dehmelt, Y. Dokshitzer, K. J. Eskola, G. Feofilov, M. Finger, M. Finger, F. Fleuret, C. Flore, A. Francisco, L. Gamberg, M. Gameiro Munhoz, M. V. Garzelli, L. Gladilin, V. Goncalves, P. Gossiaux, V. Guzey, C. Hadjidakis, F. Halzen, P. Hoyer, T. Jezo, S. Joosten, V. Kartvelishvili, M. M. Khan, V. Khoze, D. Kikola, M. Kitazawa, C. Klein-Boesing, M. Knecht, S. Koshkarev, V. Kovalenko, P. Kroll, K. Kumeriki, A. Kurepin, D. Larsen, P. Lebiedowicz, Z. W. Lin, T. Liu, C. Lorce, C. Lourenco, V. Lyubovitskij, B. Q. Ma, J. P. Ma, Y. Q. Ma, M. Machado, V. Maisheev, F. Martinez Vidal, G. Martinez-Garcia, H. Marukyan, L. Massacrier, V. Mathieu, E. Maurice, A. Mukherjee, P. Mulders, F. Murgia, A. Napier, M. Neubert, E. M. Niel, F. Olness, M. A. Ozcelik, Pajares, B. Parsamyan, B. Pasquini, J. Pelaez, M. Petris, M. Petrovici, B. Pire, C. Pisano, A. Prokudin, J. Qiu, M. Radici, A. Rakotozafindrabe, J. Ralston, K. Rith, P. Robbe, J. Rojo, G. Salme, R. Sangem, E. Santopinto, H. Santos, S. Sapeta, P. Sasa, H. Sazdjian, W. Scandale, F. Scarpa, M. Schlegel, M. Schmelling, B. Schmidt, I. Scimemi, E. Scomparin, B. Seitz, J. Seixas, H. S. Shao, C. Shi, M. Siddikov, D. Sivers, J. Soffer, S. Spanier, N. Stefanis, D. Stocco, M. Strickland, E. Swanson, P. Taels, Z. Tang, D. Tapia Takaki, N. Topilskaya, S. Troshin, B. Trzeciak, I. Tserruya, L. Turko, N. Tyurin, U. Uggerhoej, A. Usachov, C. Van Hulse, V. Vechernin, I. Vitev, A. Vladimirov, R. Vogt, A. Vossen, S. Wallon, J. X. Wang, X. N. Wang, M. Winn, N. Yamanaka, Z. Yang, Y. J. Zhang

Abstract

This contribution aims at promoting the ground-breaking physics programme accessible with the multi-TeV LHC proton and ion beams used in the fixed-target mode. It can be realised in a parasitic mode for the LHC complex using existing detectors like those of the LHCb and ALICE collaborations or new dedicated systems during the LHC lifetime. It contains a brief description of the different technical implementations which are currently under investigation as well as the basic performances offered by the use of the ALICE and LHCb detectors in the fixed-target mode. In short, the multi-TeV LHC beams allow for the most energetic fixed-target experiment ever performed opening the way for unique studies of the nucleon and nuclear structure at high x, of the spin content of the nucleon and of the phases of the nuclear matter from a new rapidity viewpoint at seldom explored energies.

Contact: FTP4LHC-steering@ipno.in2p3.fr https://indico.cern.ch/event/765096/contributions/3295678/

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- Talk at the Granada Symposium next month

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2nd edition of the Quarkonium Satellite FCPPL workshop (FCPPLOnium)

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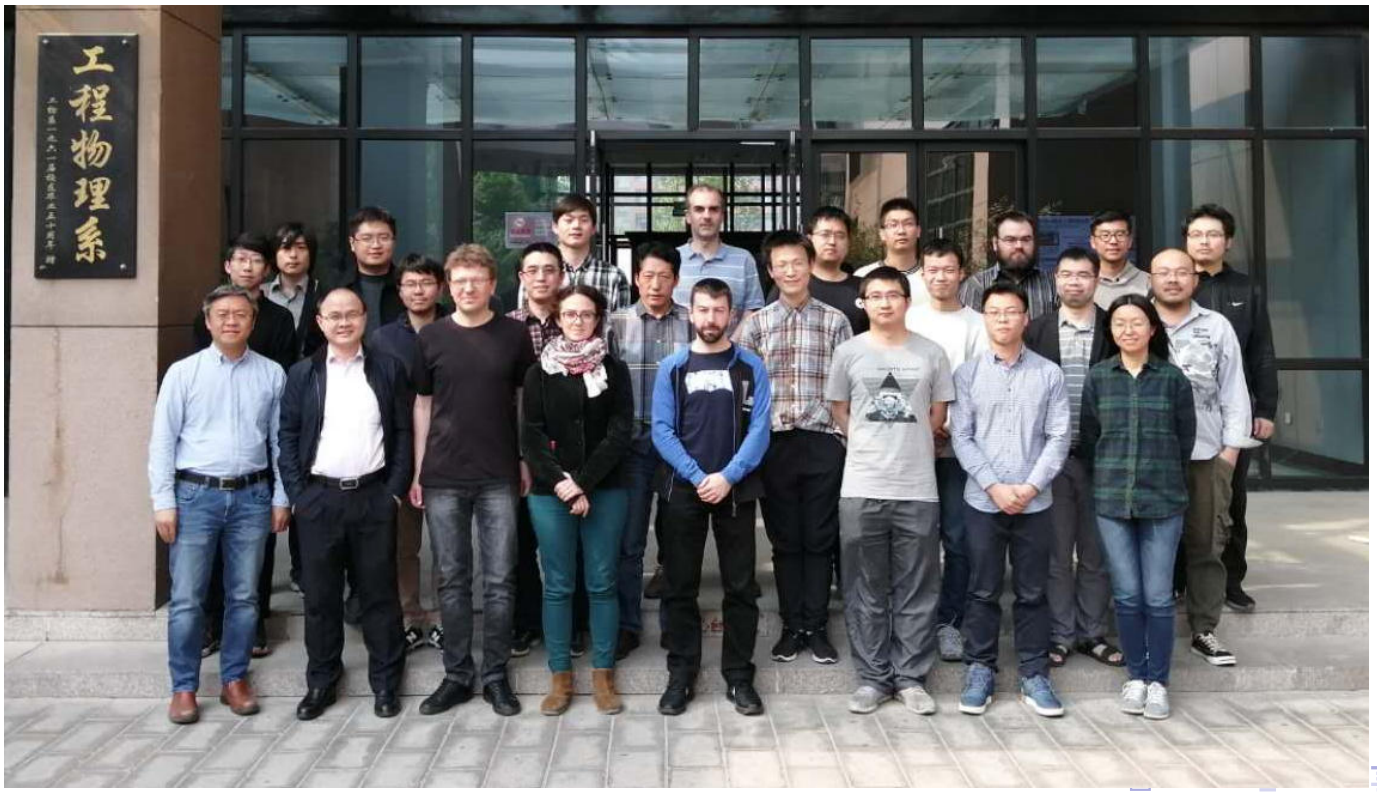

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Physics Letters B 786 (2018) 342–346

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η_c' hadroproduction at next-to-leading order and its relevance to ψ' production

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ABSTRACT

We proceed to the first phenomenological study of η_c' prompt hadroproduction at next-to-leading order in α_s. Based on heavy-quark-spin symmetry, which is systematically used in quarkonium-production phenomenology, we demonstrate that prompt η_c' can be studied at the LHC with the existing data. We emphasise its relevance to constrain ψ' production, in the same way as the first prompt η_c data at the LHC lately strongly impacted the phenomenology of J/ψ studies.

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- First LHC NLO $\eta_c(2S)$ production study published in PLB **[PLB 786 (2018) 342]**
- NLO predictions for $\eta_c(1S)$ production at $\sqrt{s}$ = 13 TeV submitted to NPB

[Y. Feng, J.He, JPL, H.S. Shao, A. Usachov, H.F. Zhang, 1901.09766]

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Phenomenological NLO analysis of η_c production at the LHC in the collider and fixed-target modes

Yu Feng[a], Jibo He[b,c], Jean-Philippe Lansberg[d], Hua-Sheng Shao[e], Andrii Usachov[b], Hong-Fei Zhang[f]

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[e]*LPTHE, UMR 7589, Sorbonne Universités & CNRS, F-75252, Paris Cedex 05, France*
[f]*College of Big Data Statistics, Guizhou University of Finance and Economics, Guiyang 550025, China*

Abstract

In view of the good agreement between the LHCb prompt-η_c data at $\sqrt{s} = 7$ and 8 TeV and the NLO colour-singlet model predictions –*i.e.* the leading v^2 NRQCD contribution–, we provide predictions in the LHCb acceptance for the forthcoming 13 TeV analysis bearing on data taken during the LHC Run2. We also provide predictions for $\sqrt{s} = 115$ GeV for proton-hydrogen collisions in the fixed-target mode which could be studied during the LHC Run3. Our predictions are complemented by a full theoretical uncertainty analysis. In addition to cross section predictions, we elaborate on the uncertainties on the $p\bar{p}$ branching ratio –necessary for data-theory comparison– and discuss other usable branching fractions for future studies.

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Triple prompt J/ψ hadroproduction as a hard probe of multiple-parton scatterings

Hua-Sheng Shao[1] and Yu-Jie Zhang[2,3]

[1] *Laboratoire de Physique Théorique et Hautes Energies (LPTHE), UMR 7589, Sorbonne Université et CNRS, 4 place Jussieu, 75252 Paris Cedex 05, France*
[2] *School of Physics and Nuclear Energy Engineering, Beihang University, Beijing 100083, China*
[3] *Center for High Energy Physics, Peking University, Beijing 100871, China*

(Dated: February 14, 2019)

We propose the process of triple prompt J/ψ hadroproduction is a very clean hard probe of multiple-parton scatterings at high-energy hadron colliders, especially the least known triple-parton scattering. A first complete study is carried out by considering single-, double- and triple-parton scatterings coherently. Our calculation shows that it is a golden channel to probe double- and triple-parton scatterings as the single-parton scattering is strongly suppressed. The predictions of the (differential) cross sections in proton-proton collisions at the LHC and the future higher-energy hadron colliders are given. Our study shows that its measurement is already feasible with the existing data collected during the period of LHC Run2. A method is proposed to extract the triple-parton scattering contribution, and therefore it paves a way to study the possible triple-parton correlations in a proton.

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- First study of J/ψ-pair production at NLO in the CEM being finalised

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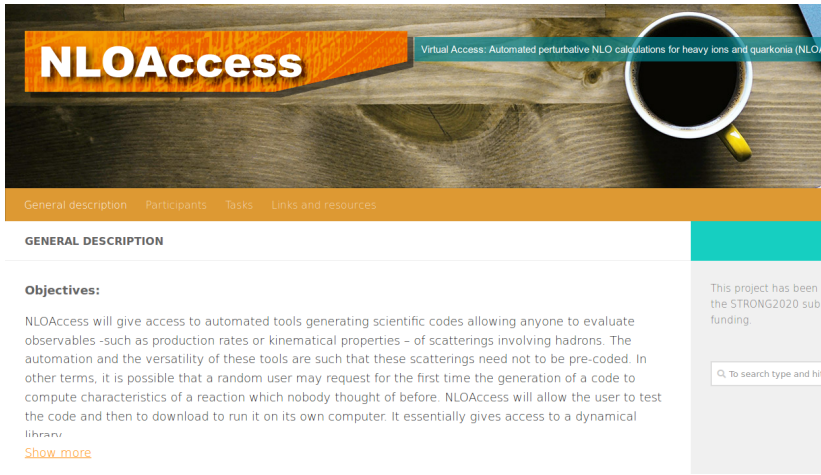

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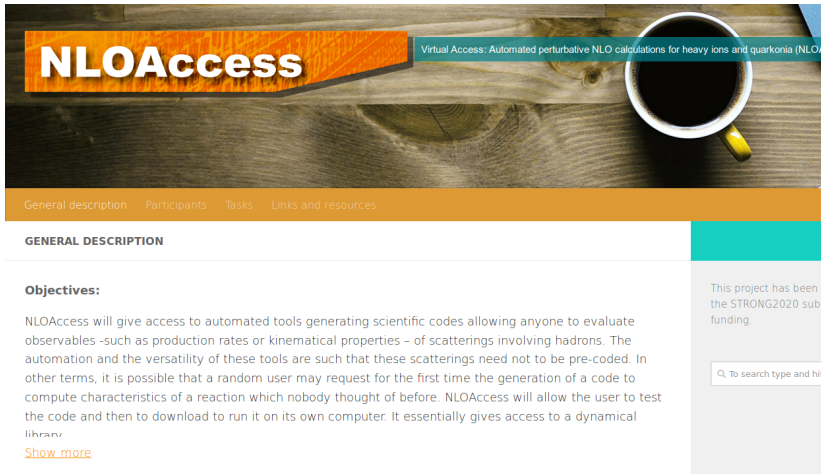

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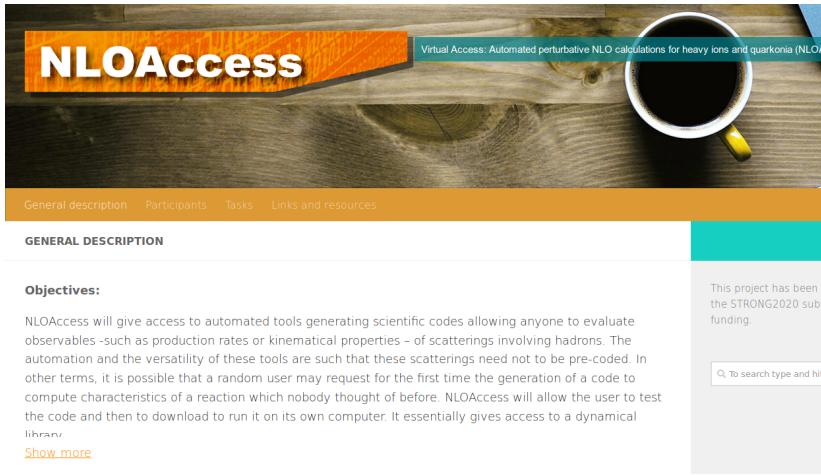

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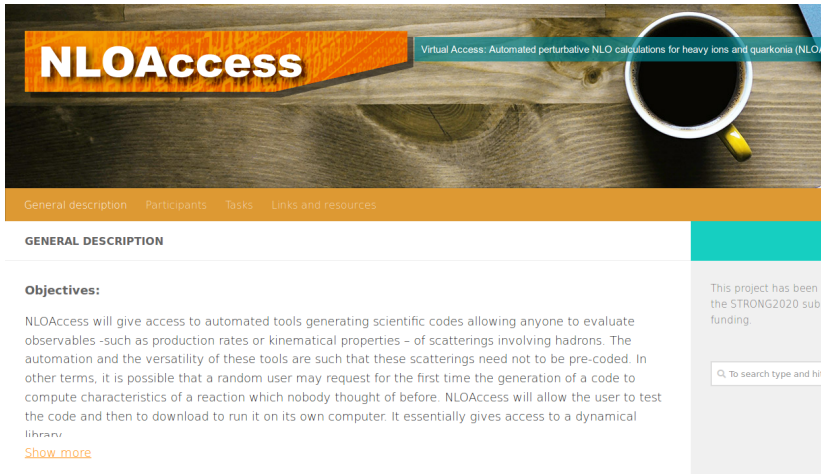

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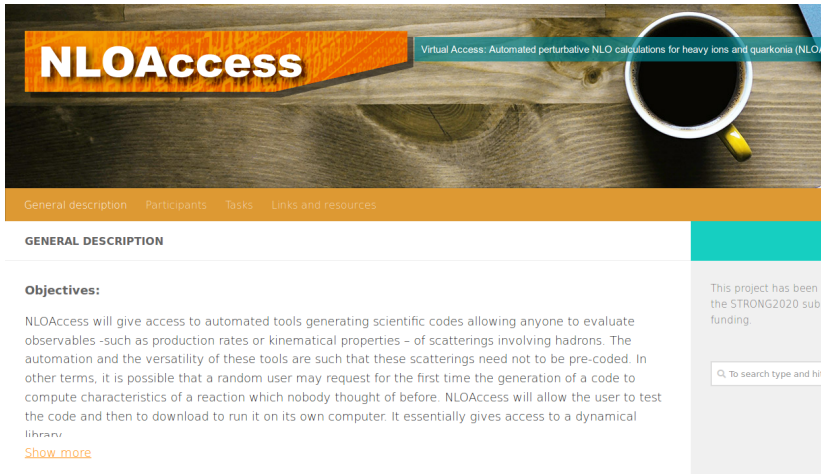

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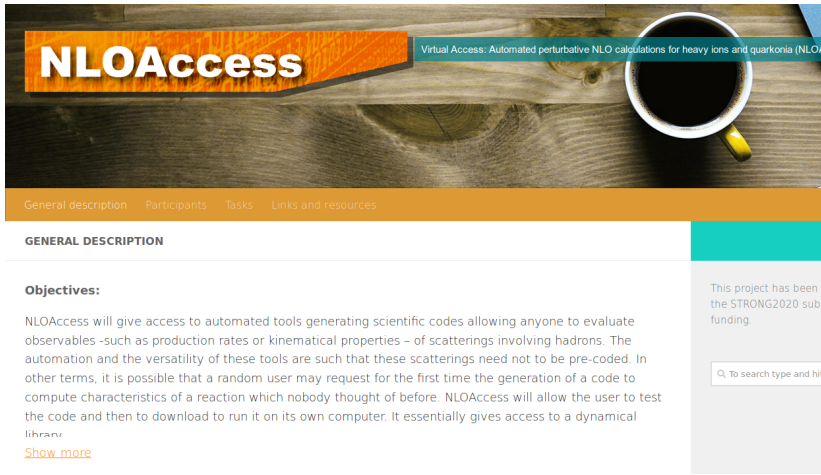

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- Predictions for pion beams [preliminary studies]

Theory and experiment prospects for associated-quarkonium production

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See section 3 of JPL, arXiv:1903.09185 [hep-ph] (submitted to Phys.Rept.)

Observables	Experiments	CSM	CEM	NRQCD	Interest
J/ψ+J/ψ	LHCb, CMS, ATLAS, D0 (+NA3)	NLO, NNLO*	LO ?	LO	Prod. Mechanism (CS dominant) + DPS + gluon TMD
J/ψ+D	LHCb	LO	LO ?	LO	Prod. Mechanism (c to J/psi fragmentation) + DPS
J/ψ+ϒ	D0	(N)LO	LO ?	LO	Prod. Mechanism (CO dominant) + DPS
J/ψ+hadron	STAR	LO	--	LO	B feed-down; Singlet vs Octet radiation
J/ψ+Z	ATLAS	NLO	NLO	Partial NLO	Prod. Mechanism + DPS
J/ψ+W	ATLAS	LO	NLO	NLO (?)	Prod. Mechanism (CO dominant) + DPS
J/ψ vs mult.	ALICE,CMS (+UA1)	--	--	--	Initial vs Final state effects ?
J/ψ in jet.	LHCb, CMS	LO	--	LO	Prod. Mechanism (?)
J/ψ(ϒ) + jet	--	--	--		Prod. Mechanism (QCD corrections)
Isolated J/ψ(ϒ)	--	--	--	--	Prod. Mechanism (CS dominant ?)
J/ψ+b	--	--	--	LO	Prod. Mechanism (CO dominant) + DPS
ϒ+D	LHCb	LO	LO ?	LO	DPS
ϒ+γ	--	NLO, NNLO*	LO ?	LO	Prod. Mechanism (CO LDME mix) + gluon TMD/PDF
ϒ vs mult.	CMS	--	--	--	
ϒ+Z	--	NLO	LO ?	LO	Prod. Mechanism + DPS
ϒ+ϒ	CMS	NLO ?	LO ?	LO ?	Prod. Mechanism (CS dominant ?) + DPS + gluon TMD

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- New possible collaboration on NLOAccess