

The 9th China LHC Physics Workshop (CLHCP2023)

SUMMARY

Yuanning Gao
(Peking University)



A bit of history

1990

2000

2010

2020

2030

Chinese physicists participated
LEP experiments (ALEPH,L3)

MoU's for LHC experiments

A bit of history

1990

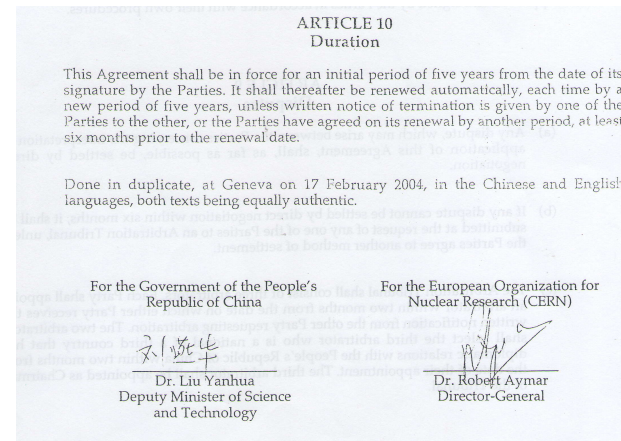
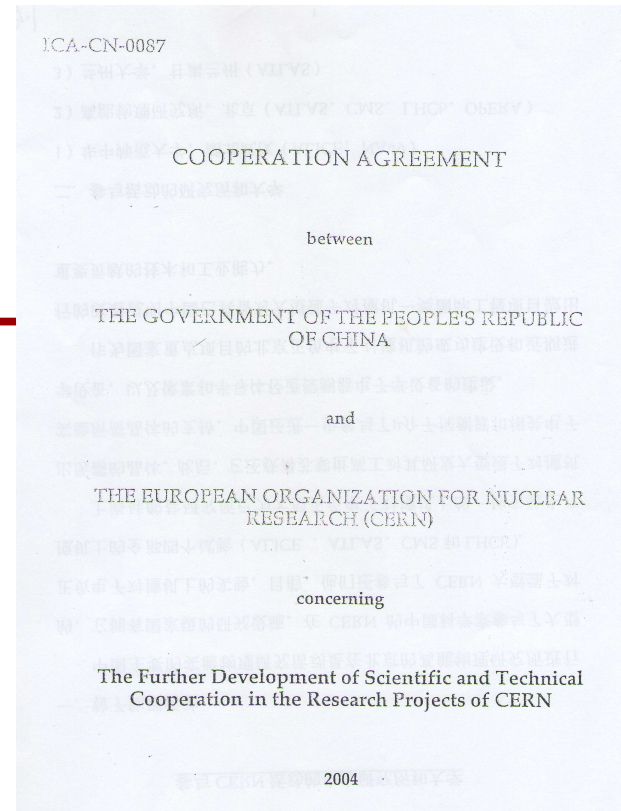
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LEP experiments (ALEPH, L3)

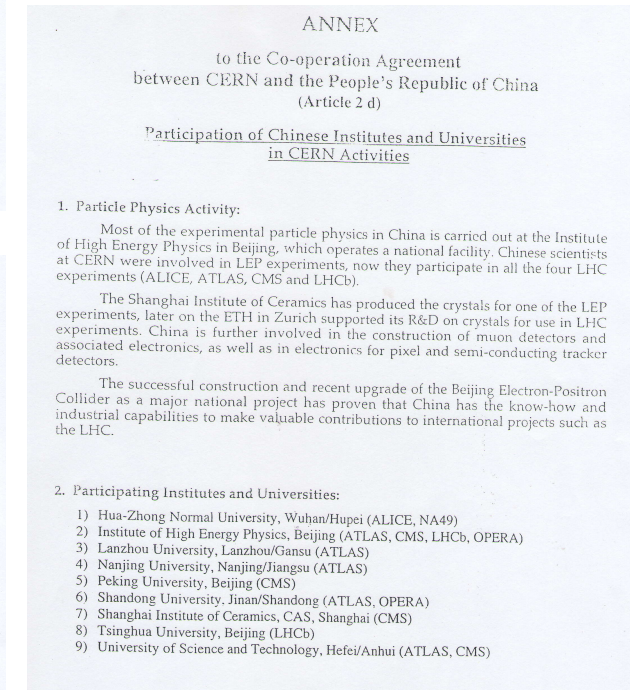
MoU's for LHC experiments

2004 Agreements signed by
MOST & CERN

This agreement shall be in force for an initial period of five years from the date of its signature by the Parties. It shall thereafter be renewed automatically, each time by a new period of five years, unless ...



2030



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2013 Two Committees organized
by MOST&MOE&NFSC

附件 1

中国-CERN 合作委员会中方成员名单
(共计 8 人)

序号	姓 名	单 位	职务/职称
1	陈霖豪	科技部国际合作司	副司长
2	彭以祺	科技部基础研究司	副司长
3	高润生	教育部科学技术司	副巡视员
4	常 青	自然科学基金会国际合作局	局长/研究员
5	刘鸣华	中科院基础科学局	局长/研究员
6	陈和生	中科院高能物理所	研究员
7	高原宁	清华大学	教授
8	赵政国	中国科技大学	教授

附件 2

国内协调工作委员会成员名单
(共计 17 人)

序号	姓名	单位	职务/职称
1	彭以祺	科技部基础研究司	副司长
2	陈霖豪	科技部国际合作司	副司长
3	高润生	教育部科学技术司	副巡视员
4	汲培文	自然科学基金会数理科学部	常务副主任/研究员
5	常 青	自然科学基金会国际合作局	局长/研究员
6	黄 敏	中科院基础科学局	副局长/研究员
7	曹京华	中科院国际合作局	副局长/研究员
8	陈和生	中科院高能物理所	研究员
9	王贻芳	中科院高能物理所	所长/研究员
10	金 山	中科院高能物理所	研究员
11	陈国明	中科院高能物理所	研究员
12	赵政国	中国科技大学	教授
13	冒亚军	北京大学	教授
14	高原宁	清华大学	教授
15	梁作堂	山东大学	院长/教授
16	祁 鸣	南京大学	教授
17	王恩科	华中师范大学	副校长/教授

科学技术部办公厅文件

国科办基〔2013〕6号

科技部办公厅关于成立中国与欧洲 核子研究中心合作委员会及国内 协调工作委员会的通知

教育部办公厅、中科院办公厅、自然科学基金会办公室：

为进一步完善我国与欧洲核子研究中心（CERN）的国际合作及国内协调工作机制，统筹整合相关资源和研究力量，推动我国与 CERN 的科技合作，经与 CERN 及国内相关部门沟通协商，决定成立中国-CERN 合作委员会和国内协调工作委员会。现将有关事项通知如下。

一、中国-CERN 合作委员会由我国有关部门代表、专家及

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2015 First CLHCP

CLHCP 2015-2022

2015 USTC: 182 participants



2016 PKU: 281 participants



2017 NJU: 283 participants



2018 CCNU: 322 participants



2019 DLUT: 314 participants



2020 THU: 453 participants (online)

2022 NJNU: 520 participants (online)

2022 NJNU: 400 participants (online/on site)

第九届中国LHC物理年会 The 9th China LHC Physics Workshop (CLHCP2023)

Nov 15 – 20, 2023
Shanghai
Asia/Shanghai timezone

Overview

[Call for Abstracts](#)

[Timetable](#)

[Contribution List](#)

[Book of Abstracts](#)

[Registration](#)

[Participant List](#)

[Accommodation](#)

[Venue](#)

[Transportation](#)

[Registration Fee and
Payment Method](#)

[Previous CLHCP](#)

[Organization Committee](#)

[Wechat Group](#)

[Proceeding Plan \(会议论文
集\)](#)

[Speaker Notice
\(Important\)](#)

- **467 participants**
- **255 abstracts**
- **1 public lecture**
- **32 plenary talks**
- **184 parallel talks**
 - 37 HF/HI/QCD
 - 50 TeV
 - 46 Theory
 - 51 Instrumental
- **22 posters**

**第九届中国 LHC 物理年会 The
9th China LHC Physics
Workshop (CLHCP2023)**

Wednesday, 15 November 2023 - Monday, 20 November 2023
Shanghai

Book of Abstracts

Chinese groups @ LHC

CMS

Institute: 11
Authors: 41

ALICE

Institute: 5
Authors: 39



LHCb

Institute: 9
Authors: 132

ATLAS

Institute: 9
Authors: 127

A fruitful year of physics

- Based on data collected from RUN1+RUN2, RUN3 is coming

一些数据和说明

ATLAS / Y. Wu (吴雨生)

通过官方数据库索引: <https://atlas-giantex.cern.cn/atlas/>

CLHCP2022以来, ATLAS中国组成员以主要作者身份 (Primary Author)

发表 62 篇期刊文章 (包括已投稿)

发表 29 篇会议文集 (Conference Note)

发表 8 篇公开文集 (Public Note)

后面仅高亮部分物理成果作展示

- * 选择的结果中, 中国组均起主导 (分析组负责人、文章通讯作者等) 或主要作用 (主要完成人、各类审核报告等)
- * 数家单位协作时, 按拼音顺序排列

Y. Wu @ CLHCP2023, Shanghai

2023.11.16 18

过去一年文章发表、审阅和学术报告情况

ALICE / S. Zhang (张松)

- 2022/12-2023/11, ALICE共发表文章56篇
- 中国组主导发表10篇论文, 占比17.9% (人数占比4.8%, MO&A占比2.9%)
- 中国组在投稿论文9篇
- 中国组审阅 (IR) 文章9篇
- 参加“IS2023”、“QM2023”等系列国际会议, 学术告约20个

张松(复旦大学)

CLHCP2023, 2023年11月16日

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中国组物理分析亮点

CMS / K. Yi (易凯)

挑选自22年11月至今的公开结果

- 标准模型精确测量: 2篇文章, 1篇arXiv, 1篇PAS
- 希格斯粒子性质测量: 4篇文章, 2篇arXiv, 1篇PAS
- 新物理直接寻找: 1篇arXiv, 2篇PAS
- 重离子对撞: 1篇arXiv
- B物理: 新粒子发现, 1篇arXiv

LHCb / H. Li (李衡讷)

2023年中国组主导的物理分析成果

今年投稿14篇 (其中8篇已发表), +2篇即将投稿, +12篇去年投稿今年发表。

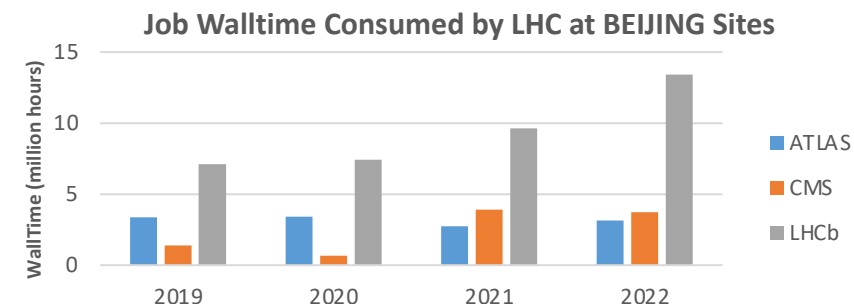
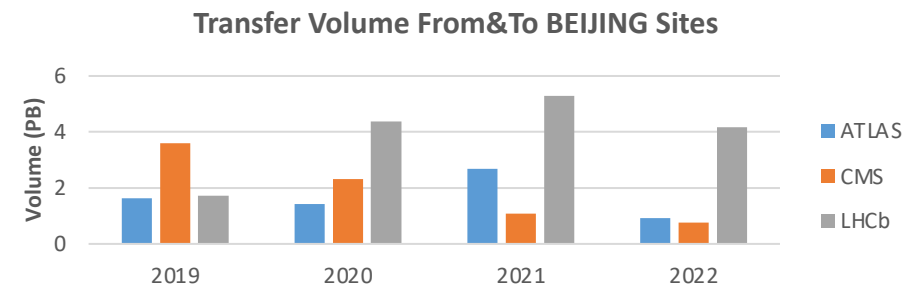
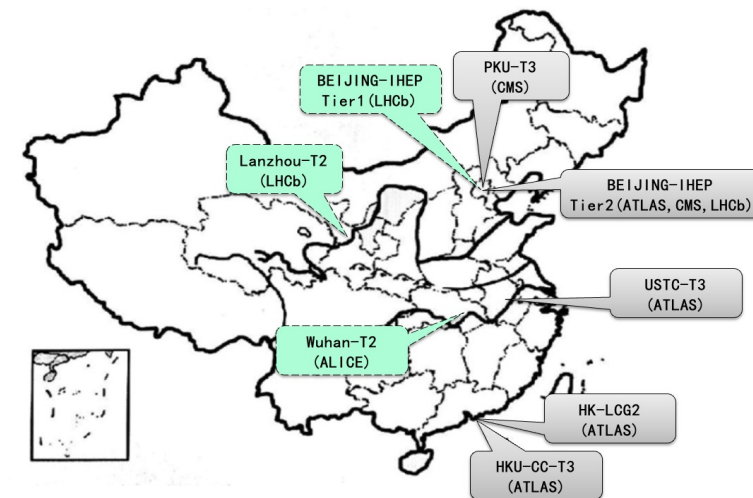
Q C D	强子谱学	观测到新的 Ω_c^0 强子态衰变到 $\Xi_c^+ K^-$ $B^0 \rightarrow J/\psi \phi K_S^0$ 衰变道中发现 $T_{\text{FSI}}^{\phi}(4000)^0$ 的迹象 J/ψ 和 Υ 介子的关联产生 J/ψ 对产生截面并研究胶子 TMDs $J/\psi - \psi(2S)$ 关联产生截面	PRL 131 (2023) 131902 (Editors' Suggestion) PRL 131 (2023) 131901 JHEP 08 (2023) 093 LHCb-PAPER-2023-022, to be submitted to JHEP LHCb-PAPER-2023-023, to be submitted to JHEP
	双部分子散射	在 $\sqrt{s_{NN}} = 5.02$ TeV 的 pPb 碰撞中测量即时 D^+ 和 D_s^+ 产生 大多重数pPb 碰撞中观察到黎介子中的奇异性增强 企鹅过程 $B_s^0 \rightarrow \phi \phi$ 衰变中的 CP 破坏 使用 $B^\pm \rightarrow D^* h^\pm$ 过程测量 CKM γ 角	arXiv:2309.14206, submitted to JHEP arXiv:xxxxxx, submitted to PRL PRL 131 (2023) 171802 arXiv:2310.04277, Submitted to JHEP
	重离子对撞	观测到 $B_s^0 \rightarrow D_{s1}(2536)^+ K^-$ $B^0 \rightarrow D^{(*)0} \phi$ 证据和 $B_s^0 \rightarrow D^{(*)0} \phi$ 衰变分支比更新 观测到 Cabibbo 抑制的双体强子衰变和 Ω_c^0 重子的精确质量测量 观测到 $\Xi_b^0 \rightarrow \Xi_c^+ D_s^-$ 和 $\Xi_b^- \rightarrow \Xi_c^0 D_s^-$ 衰变	JHEP 10 (2023) 106 JHEP 10 (2023) 123 arXiv:2308.08512, Submitted to PRL arXiv:2310.13546, Submitted to EPJC
	CP破缺	$\Lambda_b^0 \rightarrow \Lambda(1520) \mu^+ \mu^-$ 微分分支比 在 LHCb 搜索罕见衰变 $W^+ \rightarrow D_s^+ + \gamma$ 和 $Z \rightarrow D^0 \gamma$ 在 pp 碰撞中以 5.02 TeV 测量 Z 玻色子产生截面	PRL 131 (2023) 151801 CPC 47 (2023) 093002 arXiv:2308.12940, submitted to JHEP

新物理

强子衰变
WZ物理

WLCG in China

- Tier2 sites
 - BEIJING-IHEP site for ATLAS, CMS and LHCb; CCNU site for ALICE
 - Running as a leadership site for quality of service
 - Computing Resources at IHEP sites: ~110k HS06, Storage: ~4.7PB
- Tier3 sites: PKU-T3, USTC-T3, etc.
- New sites for LHCb will be ready
 - T1@IHEP: 3k CPU cores, 3PB disk and 10PB tape
 - T2@LZU: 3k CPU cores and 3PB Disk storage
 - Approved as proto-T1 by WLCG MB in Dec. 2022
 - The data challenge test is ongoing with WLCG and LHCb
 - LHCOPN & LHCONE member for LHC and other experiments

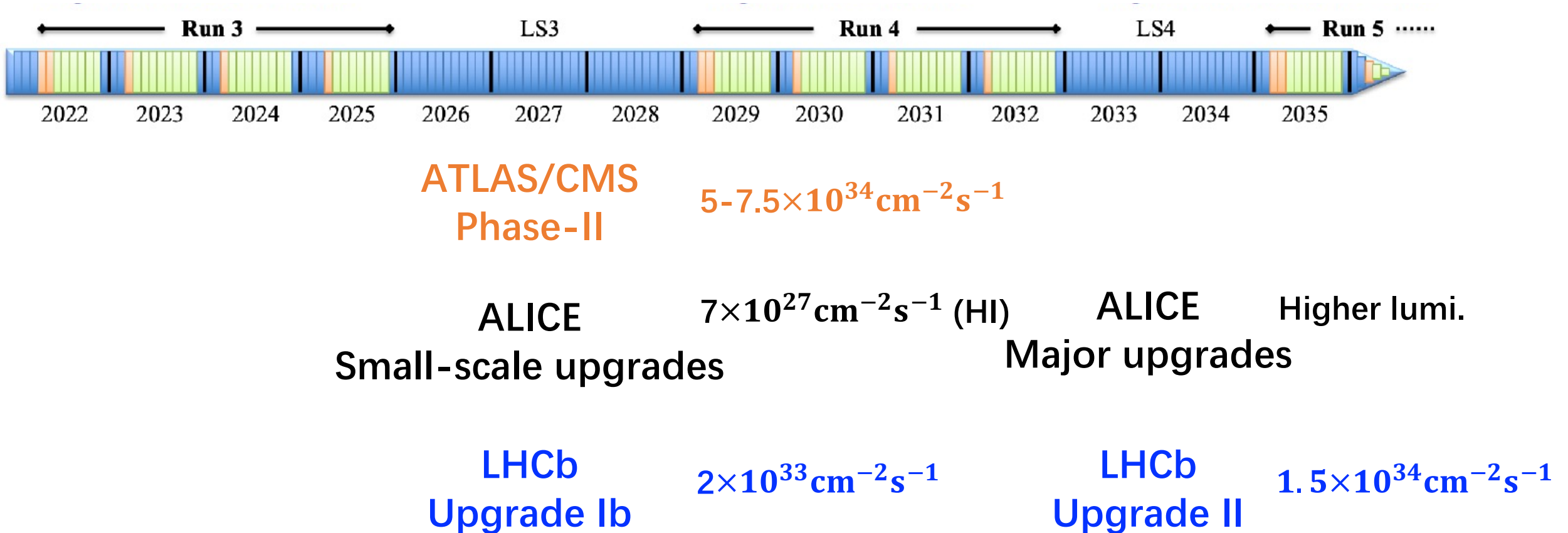


Detector upgrade

Plenary talks

L. Xu (ATLAS), F. Wang (CMS), Z. Yang (LHCb), X. Li (ALICE)
R. Zhang (Machine Learning)
+ talks in Instrumental Session

- Challenging conditions, state of the art technologies/Machine Learning
- Significant contributions, along with the increase of institutions/members



Physics at LHC

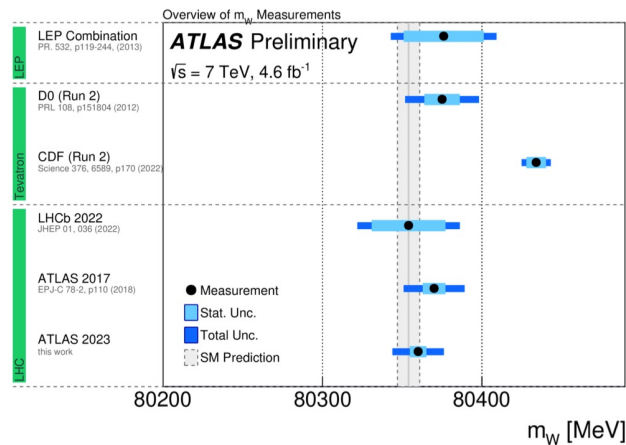
- Search for physics beyond the Standard Model
 - Use the Higgs Boson as a Tool for Discovery
 - Pursue the Physics Associated with Neutrino Mass
 - Identify the New Physics of Dark Matter
 - ~~Understand Cosmic Acceleration: Dark Energy and Inflation~~
 - Explore the Unknown: New Particles, Interactions, and Physical Principles
 - Flavor as a Tool for Discovery
- Understand the nature of the strong force

arXiv:2301.06581

Report of the 2021 U.S. Community Study
on the Future of Particle Physics
(Snowmass 2021)

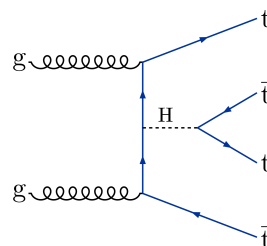
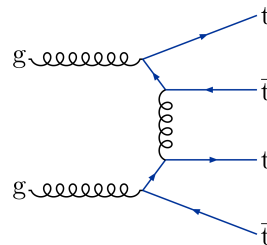
The Standard Model is re-confirmed

ATLAS-CONF-2023-004



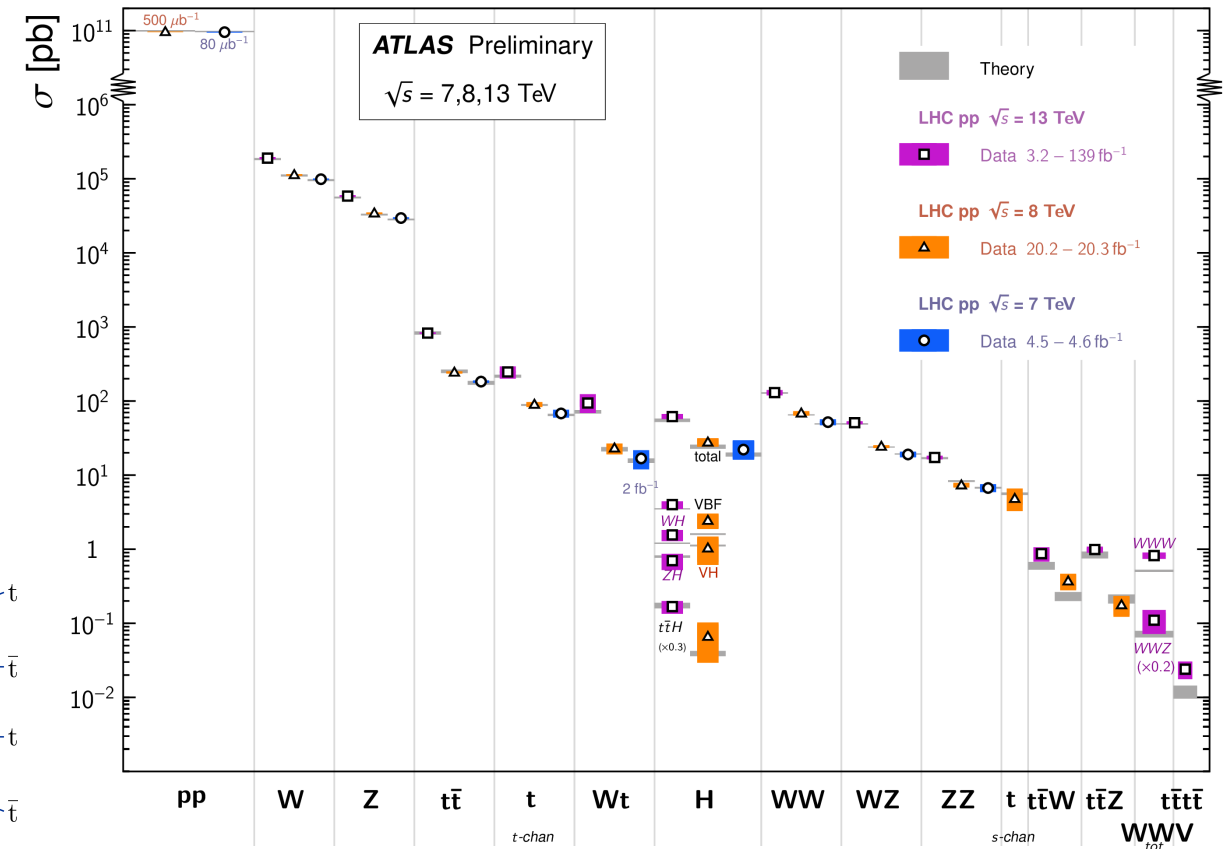
- Observations of $WW\gamma, WZ\gamma, 4\text{-top}$
- Top mass precision 0.2%
- $\alpha_s(m_Z)$ precision 1%,

Plenary talks
 C. Zhou
 + talks in Theory/TeV Session



Standard Model Total Production Cross Section Measurements

Status: February 2022



Use the Higgs Boson as a Tool for Discovery

- Precision: mass, width, couplings ...
- Rare processes: $HH, H \rightarrow Z\gamma, H \rightarrow \mu\mu, c\bar{c} \dots$

$$\sigma_{\text{on-shell}}^{\text{gg} \rightarrow H \rightarrow ZZ^*} \sim \frac{g_{\text{gg}H}^2 g_{HZZ}^2}{m_H \Gamma_H}$$

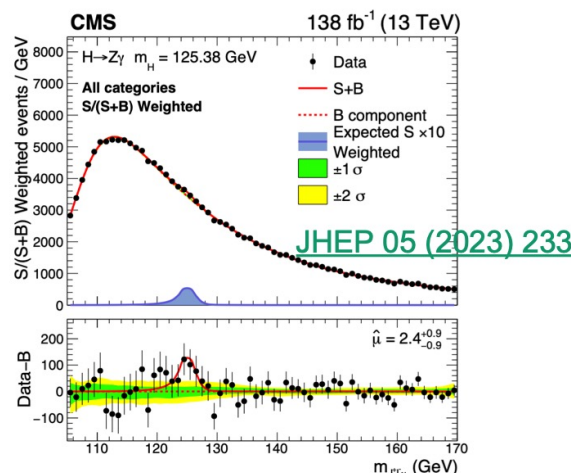
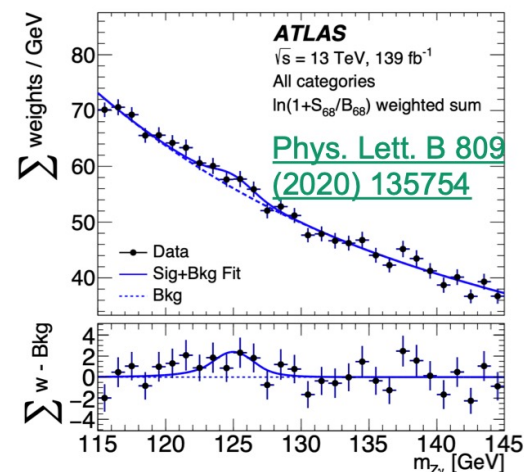
$$\sigma_{\text{off-shell}}^{\text{gg} \rightarrow H^* \rightarrow ZZ} \sim \frac{g_{\text{gg}H}^2 g_{HZZ}^2}{(2m_Z)^2}$$

CMS $\Gamma = 3.2^{+2.4}_{-1.7}$ MeV
Nat. Phys. 18 (2022) 1329

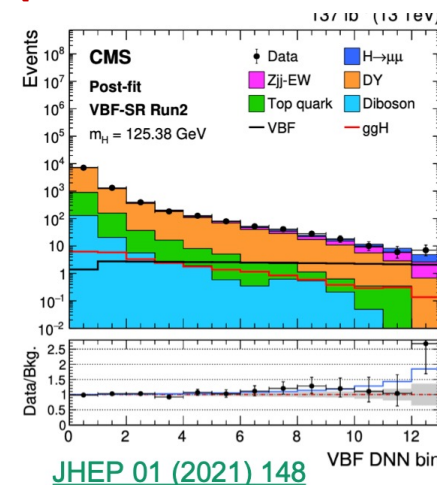
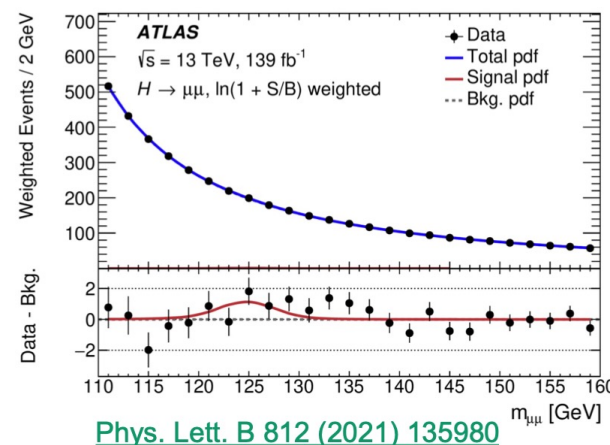
ATLAS $\Gamma = 4.5^{+3.3}_{-2.5}$ MeV
Phys. Lett. B 846 (2023) 138223

$\sim < 75\%$ precision

$H \rightarrow Z\gamma$



$H \rightarrow \mu\mu$



Plenary talks

X. Sun, N. Lu, Y. Liu
+ talks in TeV Session

Direct searches

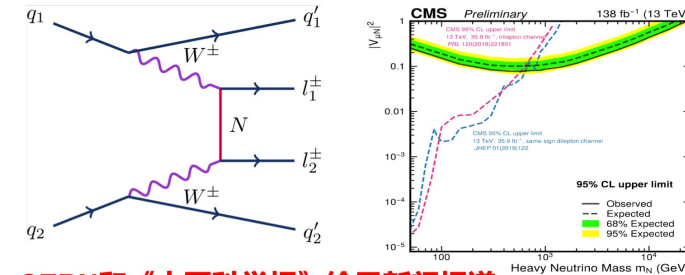
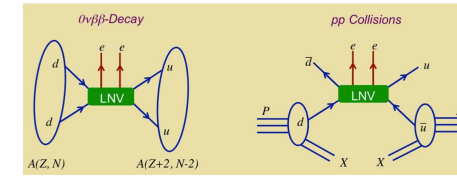
- Majorana neutrinos, heavy neutrinos
- SUSY particles, extra Higgs particles
- Dark Matter particles
- Exotics....

Not yet ...

Sensitive to new particles up to $\sim \text{TeV}$

Plenary talks

G. Li, D. Xu, N. Zhou, Y. Liu, C. Shen
+ talks in Theory Session



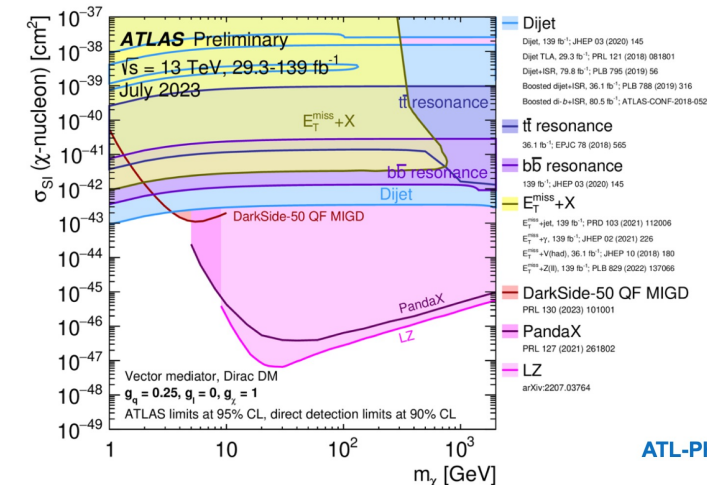
CERN和《中国科学报》给予新闻报道

Phys. Rev. Lett. 131 (2023) 011803, Editors' suggestion & Featured in Physics 17

CMS北大组主导

Combination with direct detection

- vector mediator – spin independent interaction in direct detection



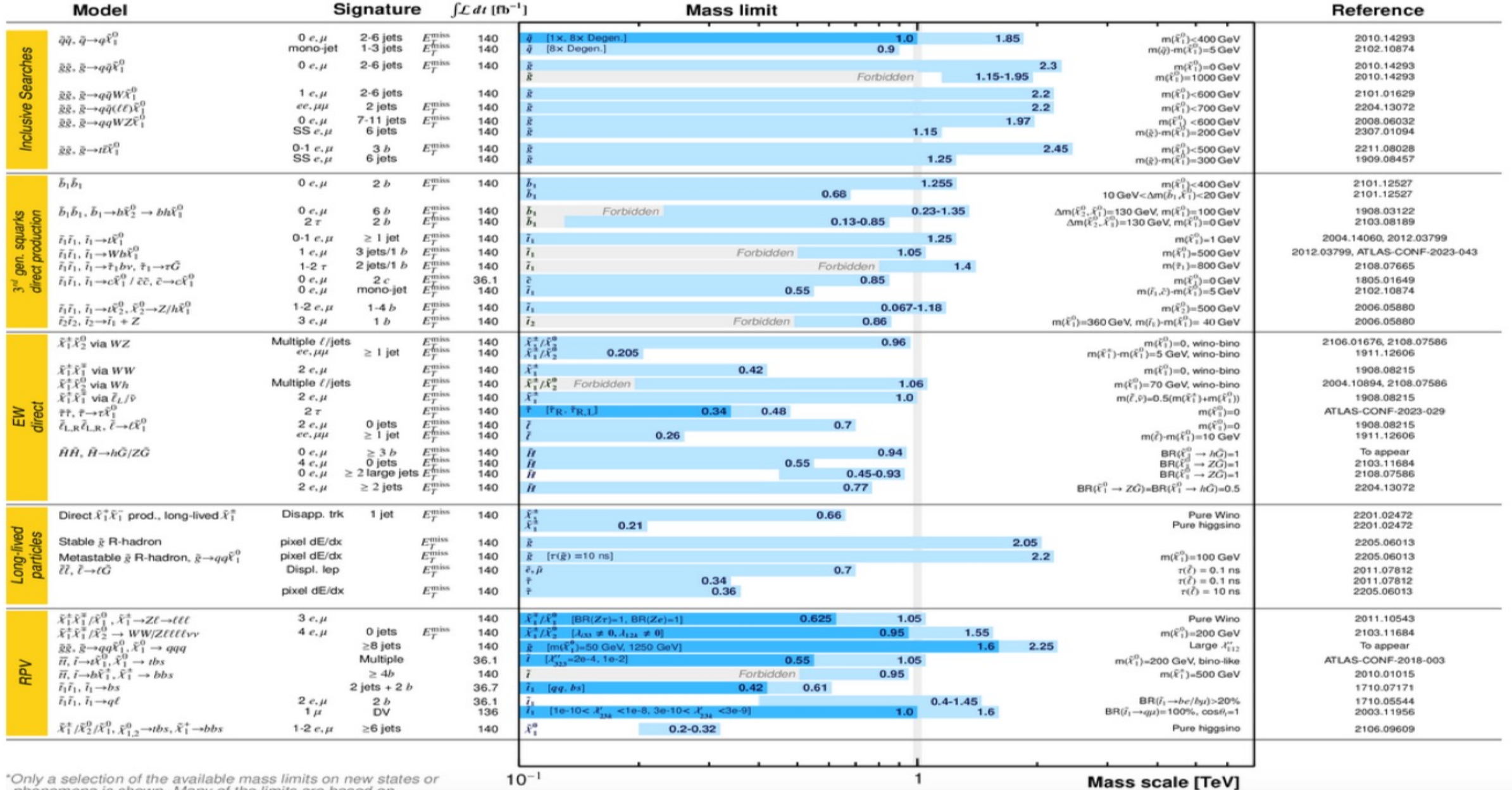
ATL-PHYS-PUB-2023-018

ATLAS SUSY Searches* - 95% CL Lower Limits

August 2023

ATLAS Preliminary

$\sqrt{s} = 13$ TeV



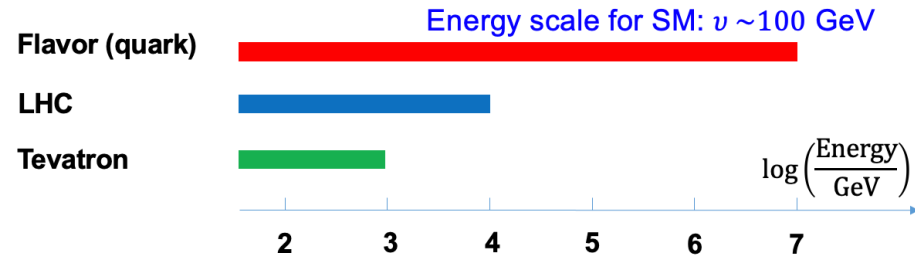
*Only a selection of the available mass limits on new states or phenomena is shown. Many of the limits are based on simplified models, c.f. refs. for the assumptions made.

Indirect searches (CPV measurements)

Energy scale of NP via indirect search

- Sensitive to New Physics scale much **higher** than direct search: $1 - 10^4$ TeV

$$\mathcal{A}(\psi_i \rightarrow \psi_j + X) = \mathcal{A}_0 \left(\frac{c_{\text{SM}}}{v^2} + \frac{c_{\text{NP}}}{\Lambda^2} \right) \quad \text{NP scale: } \Lambda$$



- **Statistics or precision** essential for flavor program

- NP scale, i.e. Dim = 6, proportional to $\sqrt[4]{\text{statistics}}$ or $1/\sqrt{\text{Uncertainty}}$

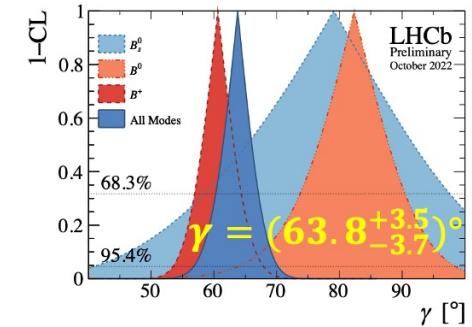
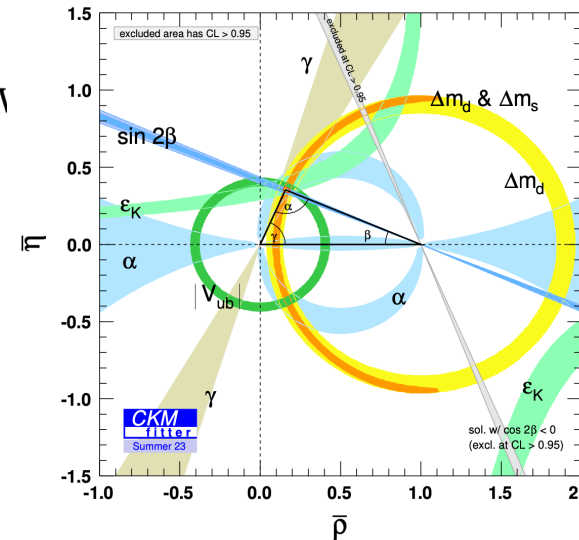
- Also “tasteful”, not only can tell if there is NP, but also tell properties of NP based on flavour it couples to

2023/11/20

W. Qian, UCAS

7

Plenary talk
W. Qian
+ talks in Theory & HI/QCD/HF Session

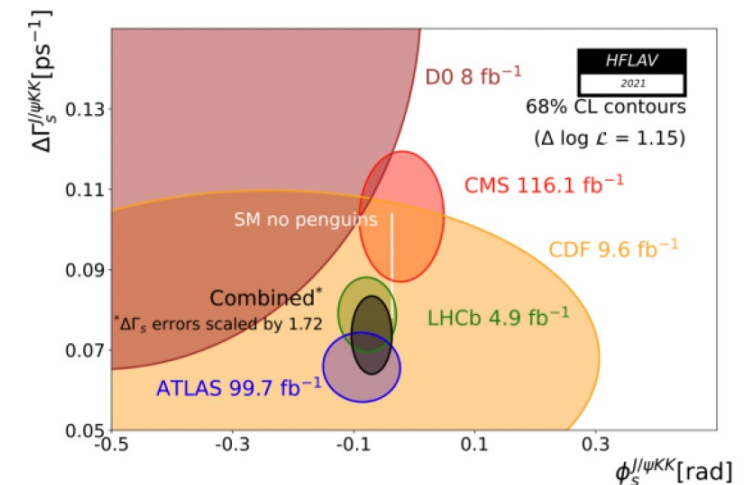


Compatible with indirect determination

$$\gamma = (65.5^{+1.1}_{-2.7})^\circ \quad \text{CKMfitter}$$

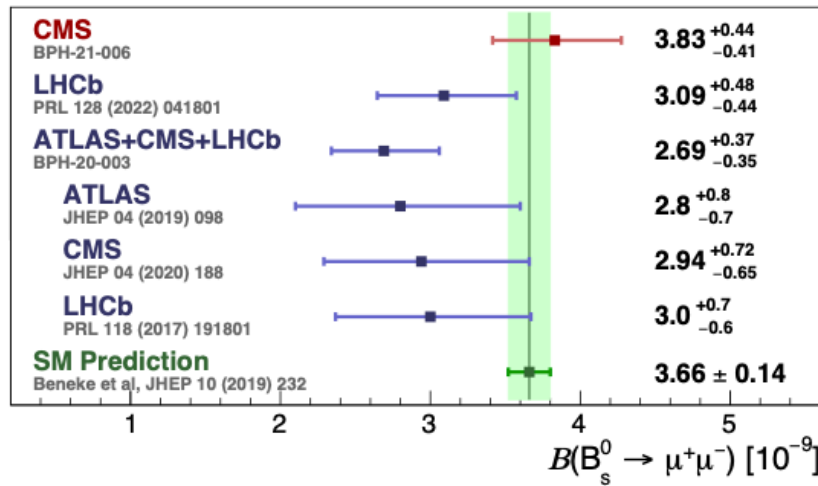
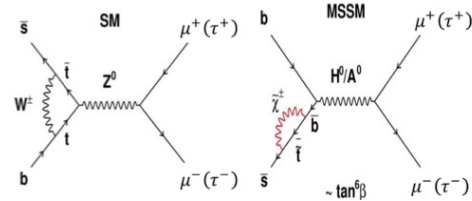
$$\phi_s^{c\bar{c}s} = (-50 \pm 19) \text{ mrad}$$

$$\Delta\Gamma_s = (0.082 \pm 0.005) \text{ ps}^{-1}$$



Indirect searches (rare decays)

$$B_{(s)}^0 \rightarrow \mu^+ \mu^-$$



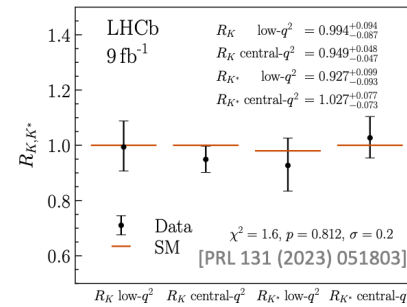
Plenary talk

J. He

+ talks in Theory & HI/QCD/HF Session

LFU in $b \rightarrow s \ell^+ \ell^-$ decays

- Deviations mostly gone

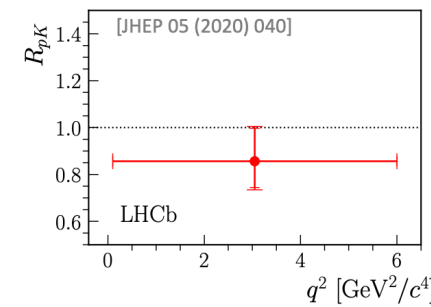
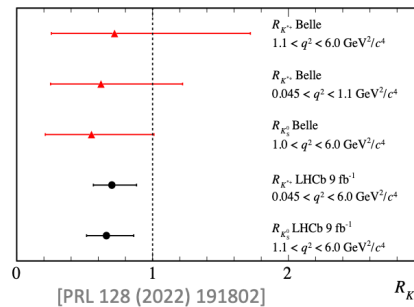


Precision at 5-10%

$\mathcal{O}(1\%)$ LFUV still possible

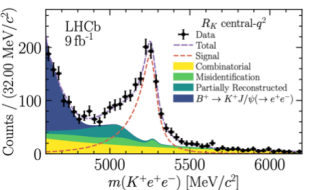
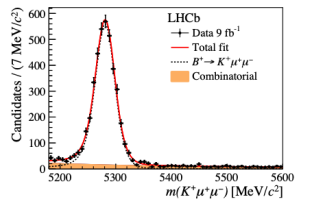
路漫漫其修远兮，吾将上下而求索
The road ahead will be long and our climb will be steep

$$R_K = 0.78^{+0.46}_{-0.23} {}^{+0.09}_{-0.05} \quad [\text{CMS, BPH-22-005-PAS}]$$



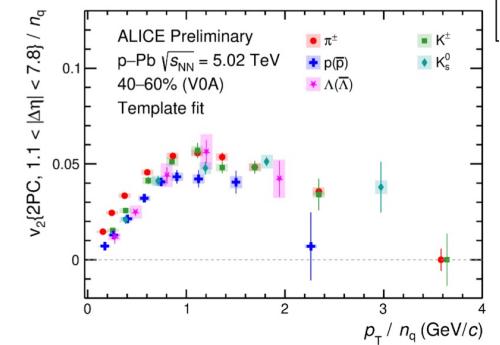
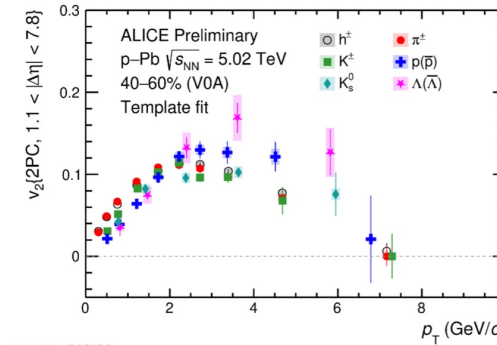
after Dec 2022

$$R_X = \frac{\mathcal{B}(H_b \rightarrow X \mu^+ \mu^-)}{\mathcal{B}(H_b \rightarrow X e^+ e^-)}$$



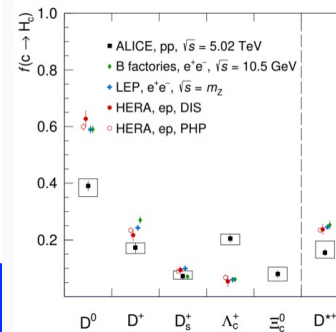
Heavy ion collisions

- *QGP effects* also in small system?
- Fragmentation processes universal?

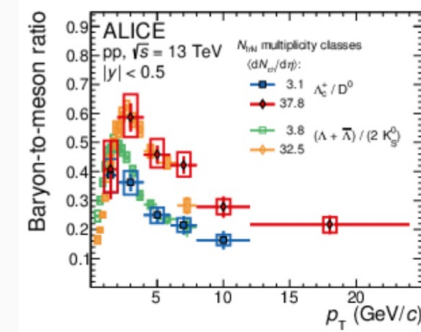


The definition of “new physics”
is too conservative in our field?

- In e^+e^- , the heavy quark turns into a heavy hadron primarily through the universal fragmentation mechanism.
 - Chance that heavy quark recombines with another parton is power suppressed.
- In pp , AA , low p_T heavy baryon/meson ratio is found to significantly deviate from e^+e^- .
 - Explained by recombination (easier to form baryon) in a parton-rich environment.



Strong enhancement of Λ_c fraction.



Clear multiplicity dependence at low and intermediate p_T

★ Power-suppressed contribution is enhanced by environments.

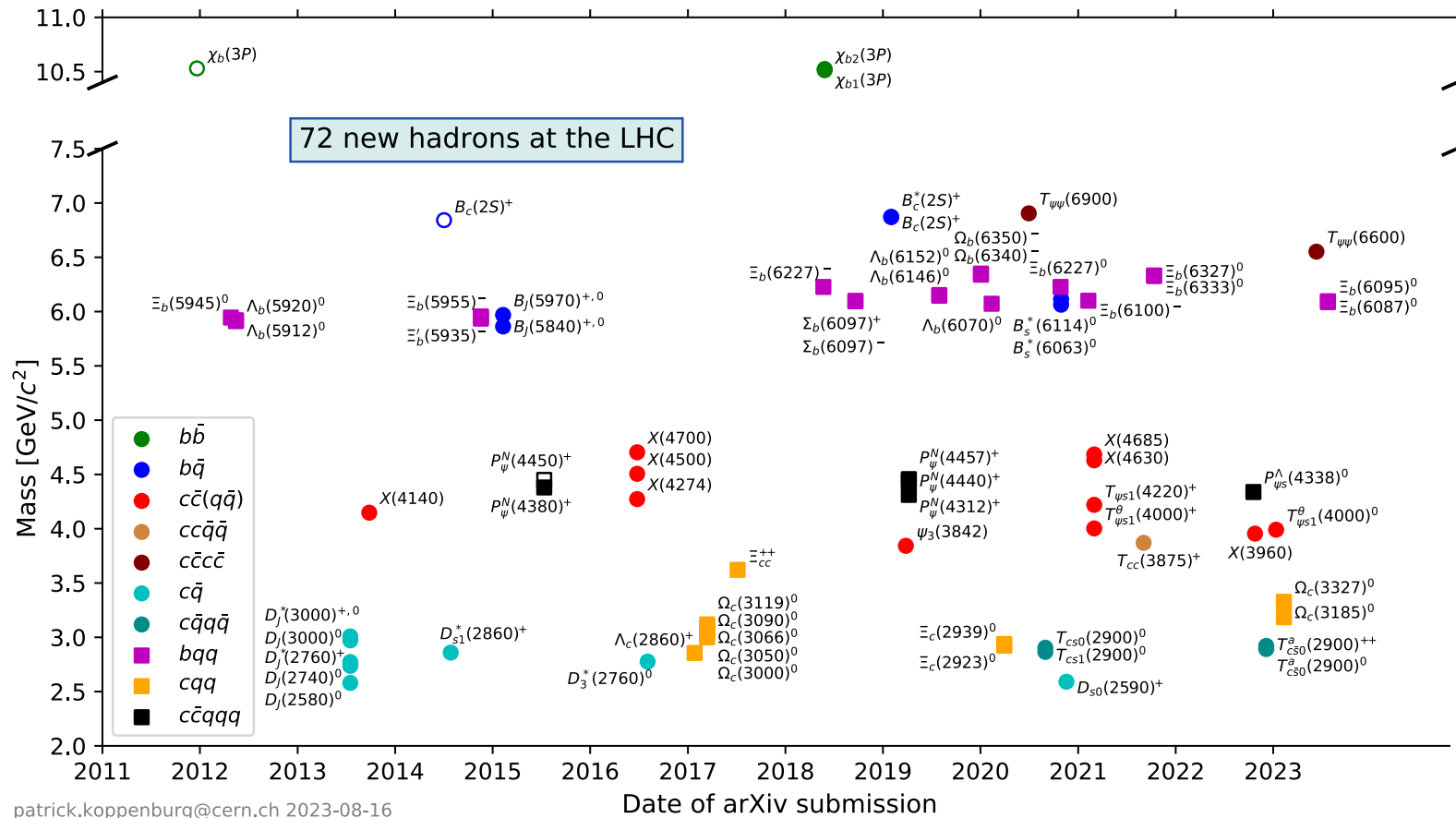
★ Fragmentation mechanism is still universal $\Rightarrow$ a two-component model.

★ How to match the two? May require EFT analysis.

Plenary talks

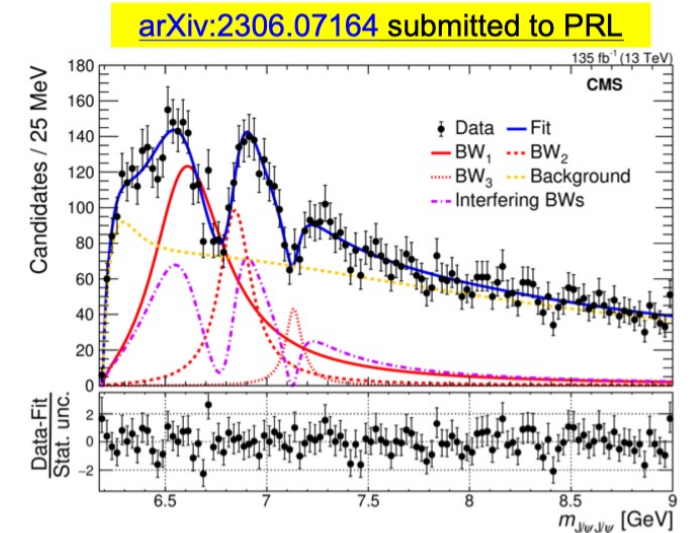
Q. Shou, Z. Yin, X. Peng, Q. Hu
+ talks in Theory & HI/QCD/HF Session

Hadron spectroscopy



Plenary talks

K. Yi, L. An, C. Shen
+ talks in Theory & HI/QCD/HF Session

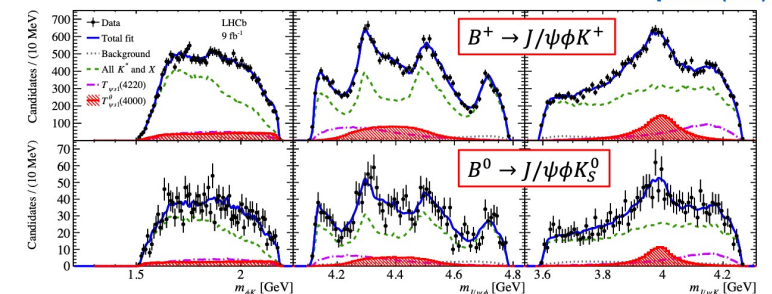


Evidence of $T_{\psi s1}^{\theta}(4000)^0$ in $B^0 \rightarrow J/\psi \phi K_S^0$

- $B^0 \rightarrow J/\psi \phi K_S^0$ and $B^+ \rightarrow J/\psi \phi K^+$ are related by isospin symmetry
- Joint amplitude fit performed assuming isospin symmetry except for $T_{\psi s1}^{\theta}(4000)^0$, with significance of 4σ (5.4σ under isospin assumption)

Zhihong Shen
Liming Zhang

[PRL 131 (2023) 131901]



$$M(T_{\psi s1}^{\theta}(4000)^0) = 3991_{-10}^{+12} {}_{-17}^{+9} \text{ MeV}$$

$$\Gamma(T_{\psi s1}^{\theta}(4000)^0) = 105_{-25}^{+29} {}_{-23}^{+17} \text{ MeV}$$

$$\Delta M(T_{\psi s1}^{\theta 0} - T_{\psi s1}^{\theta +}) = -12_{-10}^{+11} {}_{-4}^{+6} \text{ MeV}$$

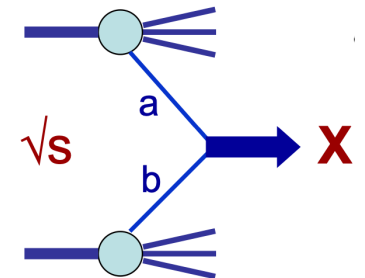
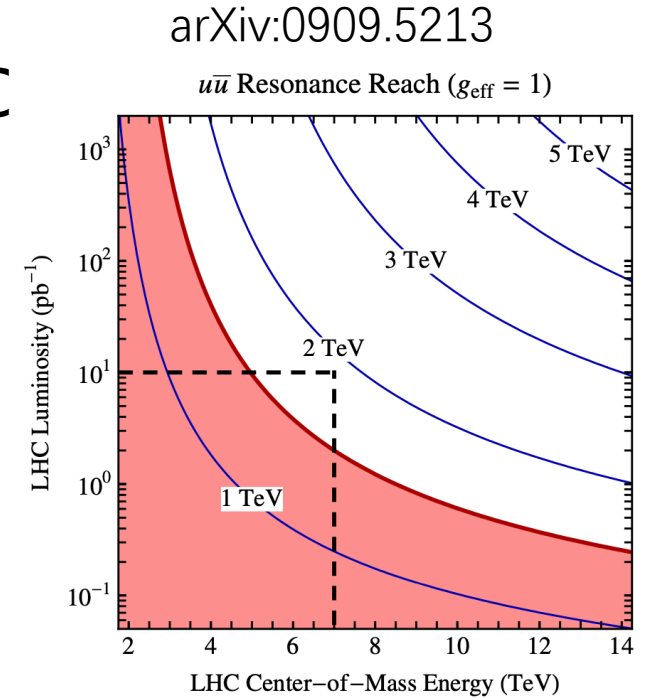
$T_{\psi s1}^{\theta}(4000)^0$ and $T_{\psi s1}^{\theta}(4000)^+$ are likely to be isospin partners

Prospects

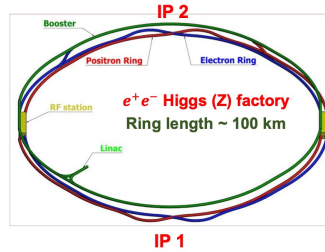
- With higher and higher luminosities from LHC/HL-LHC
 - precisions
 - rare processes
 - accessible of higher CMS energies
- Experiment/Theory interplay is of special importance

Plenary talks

B. Yan, H. Li, W. Ke, G. Li, H.-J. He
+ talks in Parallel Sessions



Working hard for our future



Operation mode			ZH	Z	W+W-	$t\bar{t}$
$\sqrt{s}$ [GeV]			~240	~91.2	~160	~360
Run time [years]			7	2	1	-
CDR (30 MW)	$L / IP [\times 10^{34} \text{ cm}^{-2}\text{s}^{-1}]$	3	32	10	-	
	$\int L dt [\text{ab}^{-1}, 2 \text{ IPs}]$	5.6	16	2.6	-	
	Event yields [2 IPs]	1×10^6	7×10^{11}	2×10^7	-	
Run Time [years]			10	2	1	~5
Latest	30 MW	$L / IP [\times 10^{34} \text{ cm}^{-2}\text{s}^{-1}]$	5.0	115	16	0.5
	50 MW	$L / IP [\times 10^{34} \text{ cm}^{-2}\text{s}^{-1}]$	8.3	191.7	26.6	0.8
		$\int L dt [\text{ab}^{-1}, 2 \text{ IPs}]$	20	96	7	1
		Event yields [2 IPs]	4×10^6	4×10^{12}	5×10^7	5×10^5

Both 50 MW and $t\bar{t}$ modes are currently considered as upgrades.

Plenary talk
J. Wang
+ talks in Parallel Sessions



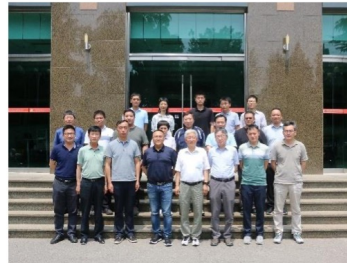
CEPC Accelerator TDR



International Technical Review
@ HK, Jun 12-16, 2023



International Cost Review @ HK,
Sept 11-15, 2023



Domestic Civil Engineering
Cost Review, June 26, 2023

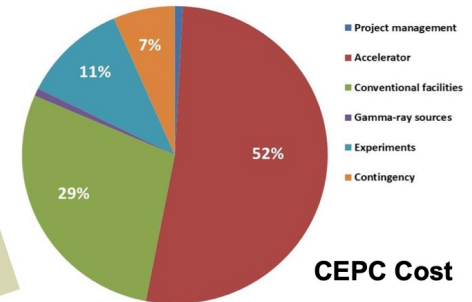
11/17/2023



Endorsed by CEPC IAC
Oct 29-31, 2023

The CEPC Accelerator TDR covers

- Design, knowledge and progress of the CEPC
- Advancement of technologies that CEPC depends upon, delivered through a comprehensive R&D program, HEPS experience, international contributions and cooperation
- Innovative ideas and future upgrades to make the CEPC state-of-the-art as time moves forward
- Cost of the CEPC



CEPC Cost

The CEPC accelerator TDR will be released on **Dec 15, 2023**, when the author list is finalized

Sign TDR to support CEPC!

Thanks to



CLHCP2023 program committee

CLHCP2023 local committee

Supporting staffs/volunteers

