粒子物理卓越创新中心
工作汇报（2013.9-2014.9）

李强

北京大学高能物理实验组
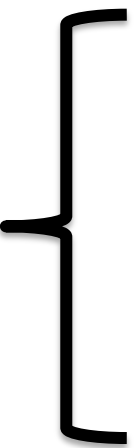
2014/11/22

个人简历

✓ 生于1980年7月

✓ 2006年北大物理学院博士毕业

✓ 在日本KEK和法国Grenoble大学访问半年

✓ 在德国(Karlsruhe)和瑞士(PSI)从事博士后研究4年半

✓ 2011年9月回国，参加北大高能物理实验组，任副教授

✓ 主要工作方向：

       (1) 大型强子对撞机LHC上CMS实验数据分析；

       (2) Monte-Carlo模拟方法及工具

- 2011.9-2013.9　简介

- 2013.9-2014.9　工作汇报

  1. CMS实验分析：　标准模型电弱物理测量
  2. CMS实验分析：　双玻色子奇异共振态寻找
  3. CEPC-100TeV模拟研究：　Z',Triple-W
  4. 其他：学生培养，会议报告，基金等

- 总结及未来工作展望

2011.9-2013.9 简介

VBF Invisible Higgs Search: **EPJC 74 (2014) 2980**

马妙钟2013.7 Pre-approval

李强负责W+Jets本底的Data-Driven估计，工作组多次报告

4个(Pre)Approval 报告
3篇期刊文章
1篇PAS

Heavy Higgs $H \rightarrow WW \rightarrow lvjj$ **CMS-PAS-13-008**

北大组从底层做起，**徐子骏**2013.3 Approval

李强负责Interference, 信号样本模拟等，工作组多次报告

EXO-WW   CMS Jet-Substructure最早分析之一 **JHEP 08 (2014) 174**

刘帅2013.7 Pre-Approval

李强参与2012.7 Kick-off会议，检验程序框架，W-tagging 效率

WWA   LHC上第一个三规范玻色子测量   **PRD 90, 032008 (2014)**
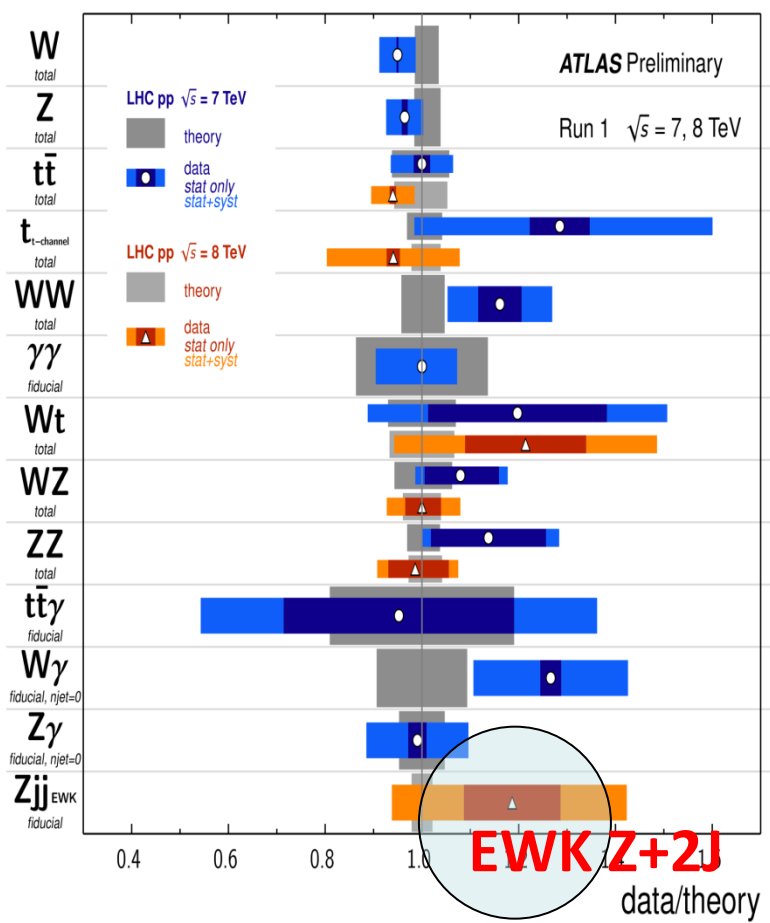
杨大能 2013.7 Approval
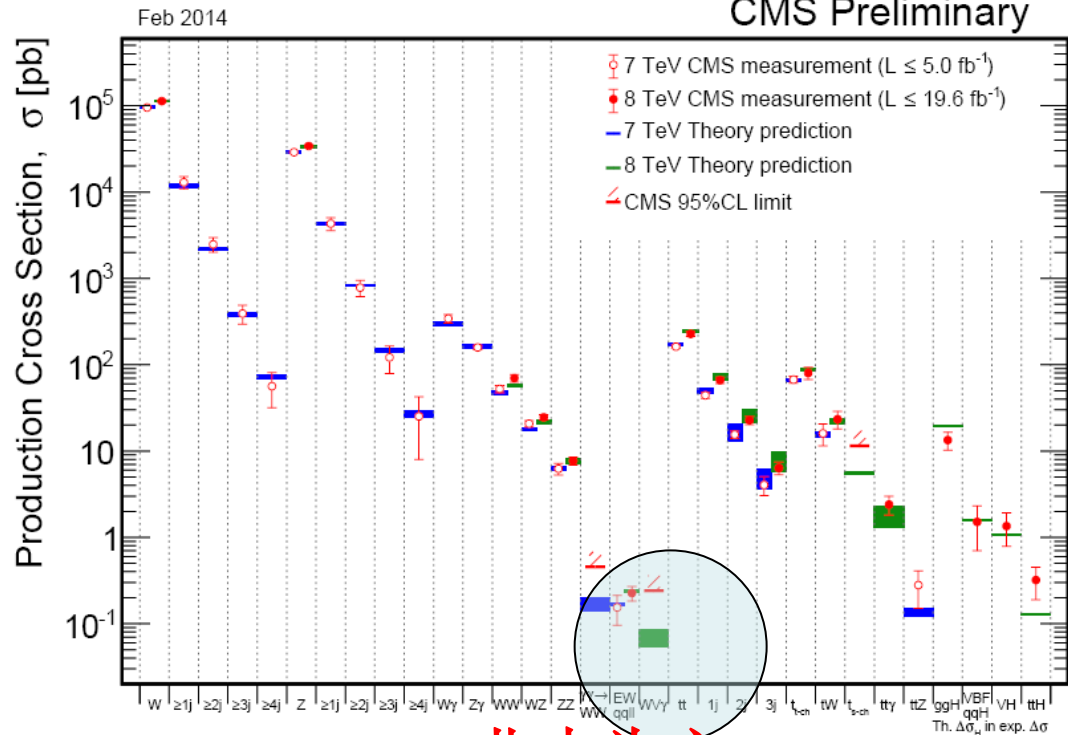
李强负责NLO MC产生子，反常耦合参数化，信号样本模拟

➡ **SMP EWK/VBF & EXO-VV**

2013-14： CMS电弱物理测量

Standard Model Production Cross Section Measurements

EWK Z+2J

WVA： 北大为主
世界首次三规范玻色子测量

Only at Powerful LHC, it is possible to test 'Rare' SM Processes:
EWK V/VV+2Jets and Triple-V； Benefit VBF measurement ;
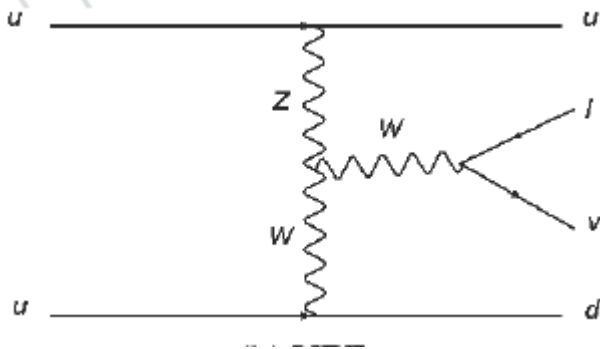Sensitive to anomalous Quartic Gauge Coupling (aQGC)
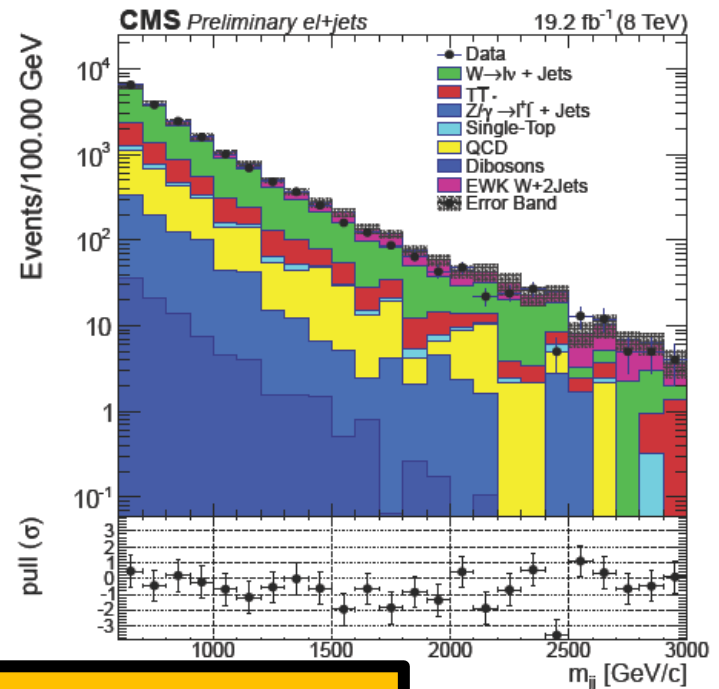
首次观测到VBF W +2Jet这个新过程

CMS-PAS-SMP-13-012, AN-2013/123　　**主要成果之一**

Simplest SM VBF Process　　>5σ

❖ 北大为主负责的工作
❖ **Two well separated high-Pt forward/backword jets with large Mjj**
❖ **Low central hadronic activity**

1. BDT to estimate main BKG: QCD Wjets
2. Fit Mjj to extract Signal Strength

Preapproved by Shuai Liu in 2014.8;
Shuai Liu is the Analysis Contact; Qiang Li as Note Submitter

首次测量VBF Wγ +2Jet

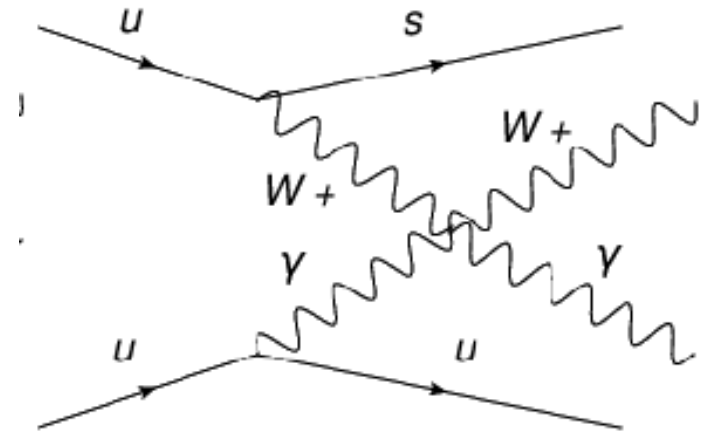主要成果之二

2nd SM VBF di-V Process

ATLAS/CMS VBF same sign WW   arXiv:1405.6241, 1410.6315   3.6/2.0σ

♣ **PKU controls this project**
♣ **Sensitive to aQGC   PKU help build the aQGC parametrization**

$$\mathcal{L}_{aQGC} = \frac{a_0^W}{4g^2}\mathcal{W}_0^\gamma + \frac{a_C^W}{4g^2}\mathcal{W}_c^\gamma + \sum_i \kappa_i^W \mathcal{W}_i^Z + \mathcal{L}_{T,0} + \mathcal{L}_{T,1} + \mathcal{L}_{T,2}.$$

- **Jet Fake Photon Data-Driven Estimation**
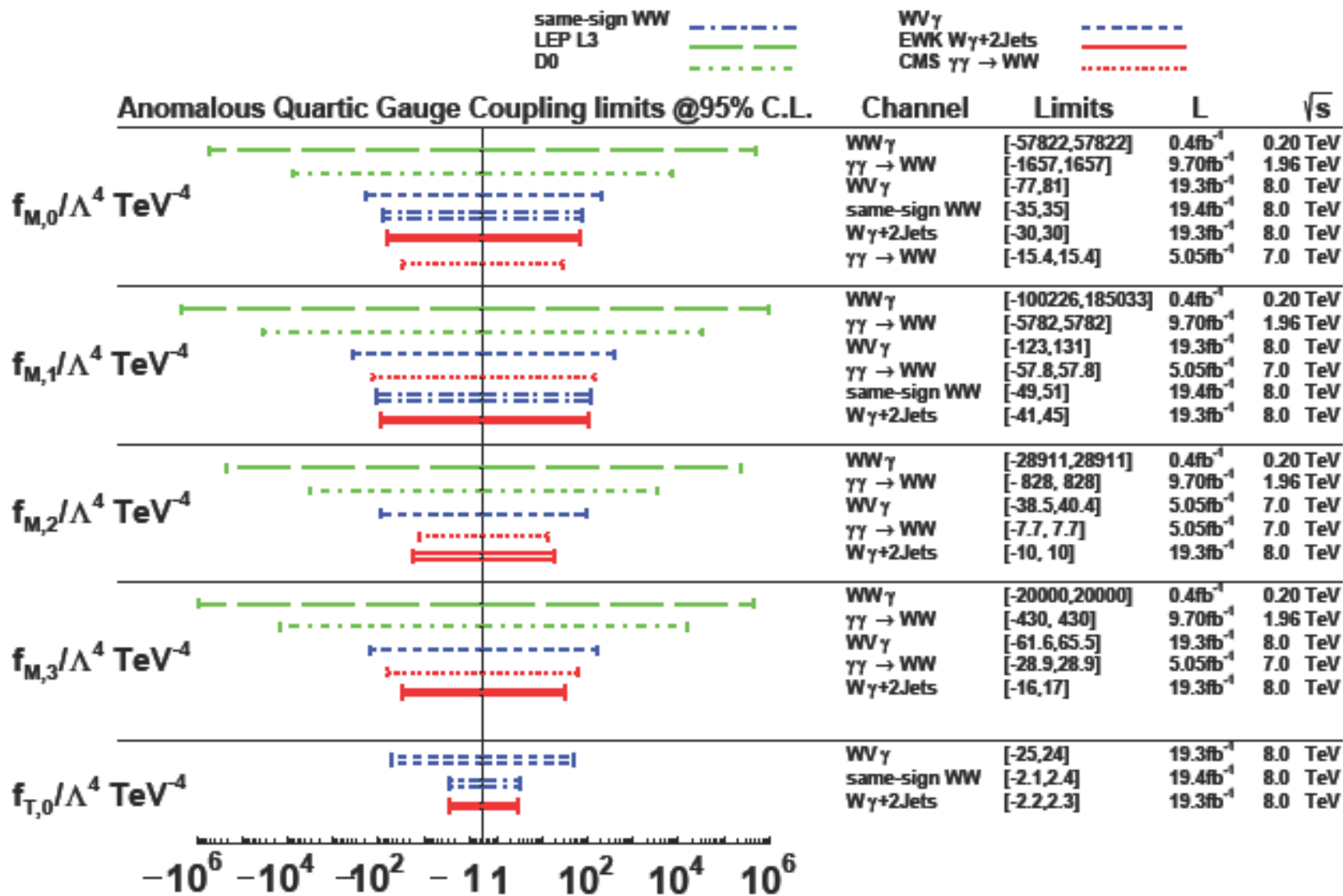- **QCD WAJets Data-Driven Estimation**

Preapproved by Daneng Yang in 2014.9;
Daneng Yang is the Analysis Contact and Note Submitter

aQGC World limit
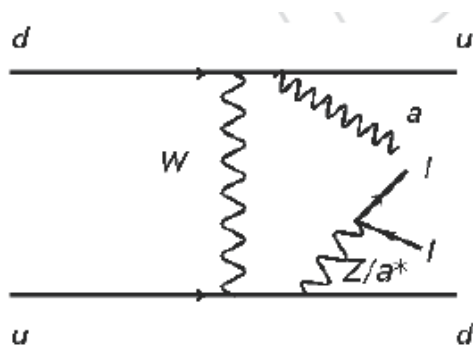## 北大给出世界最佳结果

CMS-PAS-SMP-13-009; arXiv:1404.4619
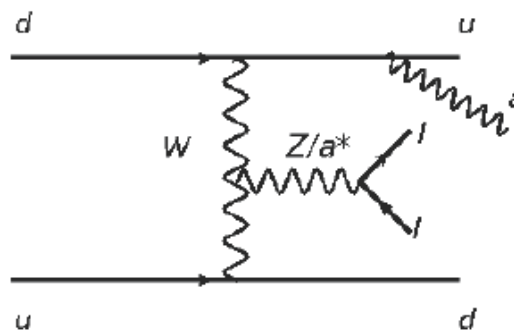
3rd SM VBF di-V Process

♣ **PKU controls this project**

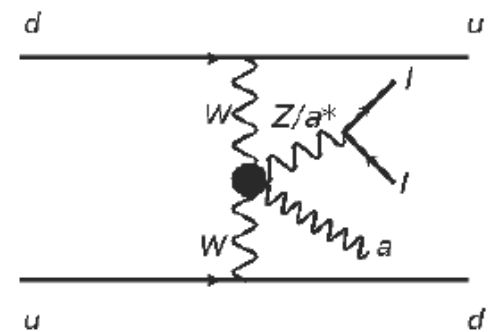♣ **Sensitive to aQGC　PKU help build the aQGC parametrization**

Jet Fake Photon Data-Driven Estimation
QCD ZAJets Data-Driven Estimation

(a) Bremsstrahlung　　　(b) VBF with TGC　　　(c) VBF with QGC

To be Preapproved by end Nov, 2014;
FengWangdong Zhang is the Analysis Contact
Qiang Li as Note Submitter

2013-14：CMS双玻色子奇异共振态寻找

- We joined CMS EXO-VV group since 2012.7
- We contributed a lot on W-tagging and EXO-WW
- We are also authors in EXO-ZZ and other notes
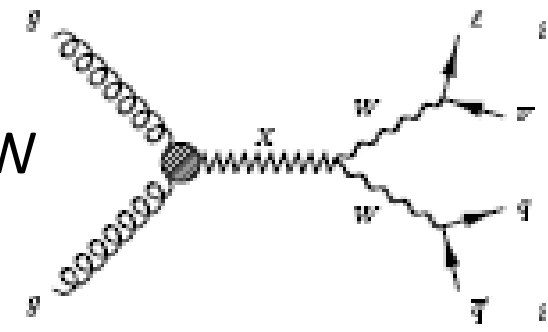
$$X \rightarrow WW / WZ \rightarrow l + v + J$$
$$X \rightarrow ZW / ZZ \rightarrow l + l + J$$

$$X \rightarrow WW / WZ / ZZ \rightarrow J + J$$

JHEP 08 (2014) 173

新物理？？

JHEP 08 (2014) 174

北大负责
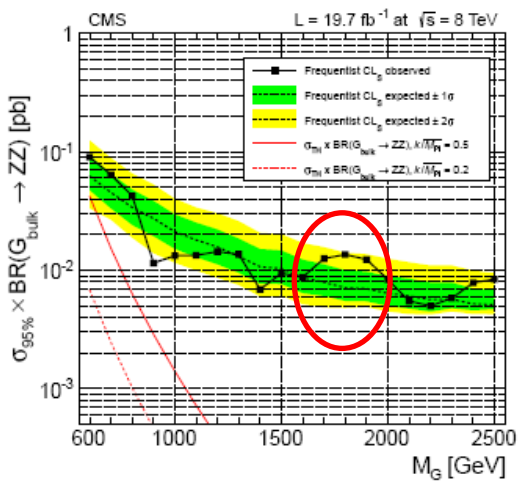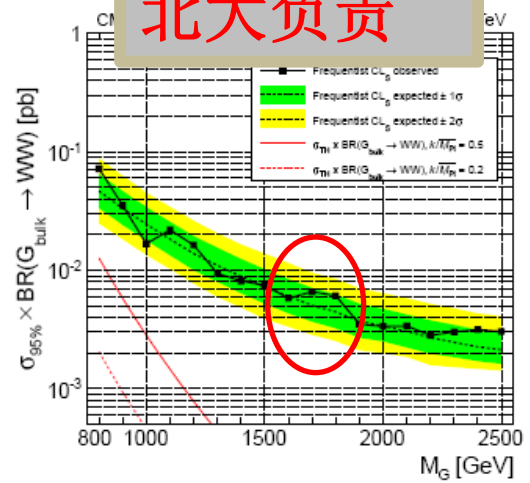
CMS 8TeV: 3 different analysis, 1-2 sigma excesses ~ 1.8TeV
Shuai Liu Presented at PASCOS13; Zijun Xu at 2nd Boston Jet Workshop

首次寻找WH共振态.   Surprise?

CMS-PAS-EXO-14-010, AN-2014/121   主要成果之四
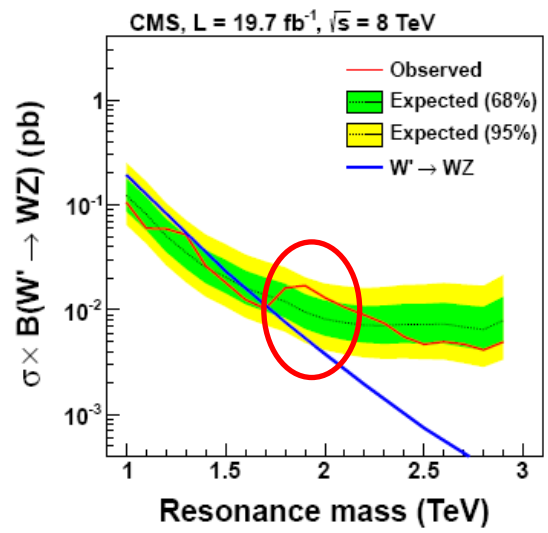
❖ **W-tagging and H-tagging (Jet and Subjet b-tagging)**
❖ **PKU in collaboration with Zurich Univ. CMS group**
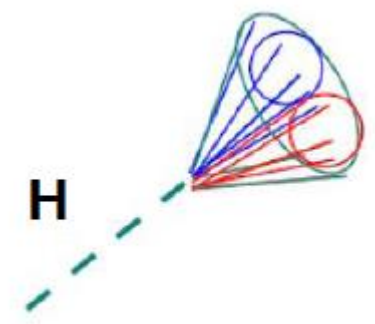
Composite Higgs as Benchmark model

To be combined with EXO-WW/ZZ

Excess@1.8TeV or not??

Main Bkgs are QCD Wjets and Ttbar:
 Data-Driven from H-pruned Jet mass side-band
 Data-Driven from Ttbar Control Region
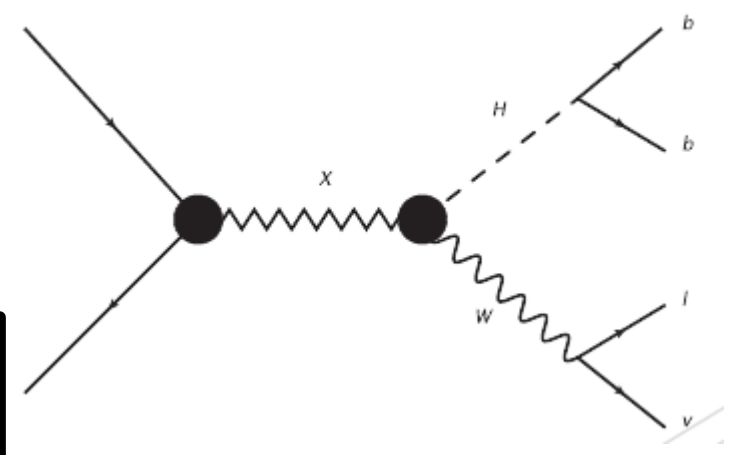
**Conditionally Preapproved on Nov/20, 2014;
Qiang Li is the Analysis Contact
Mengmeng Wang as Note Submitter**

RunI 4个分析中本人所起作用

提出物理动机，构建基本框架（利用前**2**年在**HWW**组的工作经验）

指导**5**名博士生（**2010**级**1**人，**2012**级**2**人，**2013**级**2**人）参与；组织团队协作完善、自动化北大本土程序

协调中韩合作会议 **EWK ZA+2Jets**

EXO-WH工作分析负责人 （北大**+**苏黎世大学）

担任**CMS JETMET MC Contact**； 在**CMS JEC**， **JETMET Trigger**软件服务方面做出了重要贡献

2013-14： CEPC-100TeV模拟研究

Z prime search at SPPC

95% CL exclusion limit on Z'_{SSM}

6.3/34.3TeV
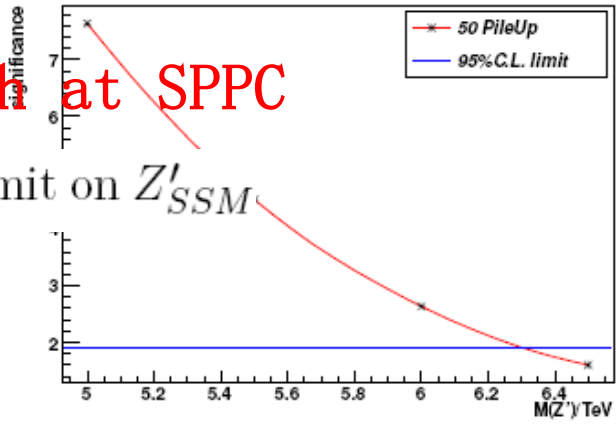
(a) $\sqrt{s} = 14TeV, \mathcal{L} = 300fb^{-1}$
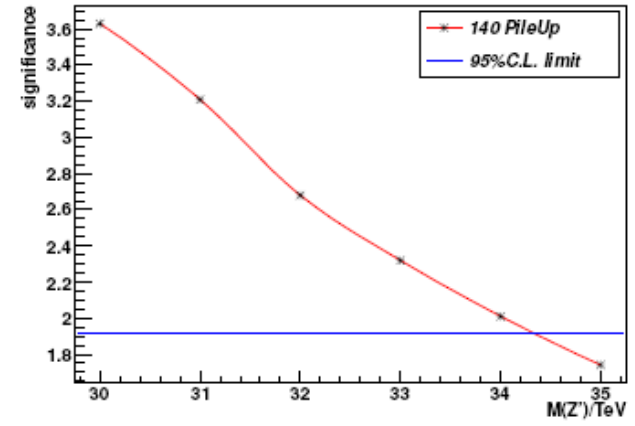
(b) $\sqrt{s} = 100TeV, \mathcal{L} = 1000fb^{-1}$

WWW:
MadGraph+Pythia+Delphes
8/14/100TeV pp collider
  CMS Sim Card
   Snowmass 100TeV Card

主要成果之五

 arXiv:1407.4922 **Submitted to JHEP**

Pre-CDR 相关部分协调组织
egroup: CEPC-100pp@cern.ch
Many Video Meetings
上海交大**CEPC2014**代表**MC**组给予报告
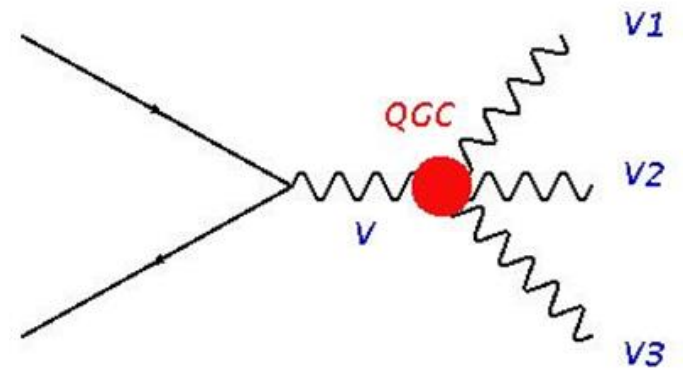
CMS报告73次
（由于大部分题目是北大控制，北大组内报告更多但此处没有计入）

本人**+**学生 国际报告**5**次 ， 国内报告**7**次

    PASCOS13 2 Parallel，
    MBI Workshop 1 Plenary
    WIN2013 1 Parallel
    Korea LHC Workshop 2014 1 Invited

- 国际合作与本地优势项目结合
- 在北大建立起一支较强的分析队伍，特别是**VBF**、**EWK**方面有主导权
- 本土化**code**框架
- 强调软件服务工作，注重基础及框架建设

基金，教学等

- 主持青年科学基金一项，金额**22万，2013.1-2015.12**
  "强子对撞机上高精度全局性蒙特卡罗模拟方法的应用及发展"

- 主持基金委国际（地区）合作与交流项目一项 **4.8万**
  对方为韩国**KNU CMS**组

- 面上基金参与一项， **2015.1-2018.12，承担40%共32万**
  与中科院大学晏启树合作

- 参与科技部973计划及基金委项目"大型强子对撞机实验CMS和ATLAS物理研究"

承担北大大二工学院电磁学课程教学，**120人**

总结及未来工作展望

- ## 继续完成4项北大为主RUNI分析；

1. VBF W+2Jets, Preapproved, 刘帅为分析负责人

2. VBF Wγ+2Jet, Preapproved，杨大能为分析负责人

3. VBF Zγ+2Jet, to be preapproved, 张冯望东为分析负责人

4. Exotic WH resonance, preapproved this week, 李强为分析负责人

CMS相关报告：总73次；国际报告5次；国内报告7次；

- ## 继续丰富完善CEPC Pre-CDR ， Physics/Simulation

- ## 积极准备CMS RunII工作（分析+服务）

谢谢大家！

个人会议、报告情况

国际**2**次，国内**5**次报告； 另协同组织会议**2**次

Conference Talks, Tutorials in 2013.09.01 - 2014.09.31

[T1] Multi-boson production at the LHC, LHC Workshop, 2 May. 2014, KNU, Korea.

[T2] Multiboson production and searches for anomalous gauge couplings at CMS, WIN2013: XXIV Workshop on Weak Interactions and Neutrinos, 16-21 Sep. 2013, Natal, Brazil.

[T3] High Mass EXO-VV/HH/VH Resonance Searches with Jet-Substructure, CMS Week 2013, 9-13 Sep. 2013, Taipei, Taiwan.

[T4] MC group report, The Fourth International Workshop on Future High Energy Circular Colliders, 12-13 Sep. 2013, Shanghai.

[T5] Anomalous Quartic Gauge Coupling at the LHC, TeV Physics Workshop, 16 May. 2014, Guangzhou, China.

[T6] Jet Parton Matching, the HEP Computing Min-Workshop, 30 Nov. 2013, CHEP, PKU, Beijing.

[T7] Tutorial: MC Sample Analysis: Event generation, Background rejection and Signal selection, International Summer school on TeV Experimental Physics (iSTEP), 2014, Beijing, China.

School and Workshops in 2013.09.01 - 2014.09.31

[S1] Co-organizer of the International Summer school on TeV Experimental Physics, 2014, Beijing.

[S2] Co-organizer of the HEP Computing Mini-Workshop, Nov.27-30, 2013, CHEP, PKU, Beijing.

此外，受邀 参与**BNL** 举办的**Multi-Boson Interactions Workshop**，由于签证问题转推荐本组在美硕士生温一闻给予**Plenary** 报告介绍**CMS EWK V+2Jet**

个人会议、报告情况

CMS内部报告7次

1. Update on W+2jets EWK , SMP VJ meeting, Friday, July 25, 2014

https://indico.cern.ch/event/298916/

2. New models for WH and ZH, Diboson Resonances Meeting, Monday, June 2, 2014

https://indico.cern.ch/event/322109/

3. Status of MC Production, DPG-PH JetMET, Monday, November 11, 2013

https://indico.cern.ch/event/282869/

4. Update on CA8 JEC, Jet Energy Corrections and Resolution Meeting, Thursday, September 26, 2013, https://indico.cern.ch/event/273599/

5. JetMET status and plans for MC production, PH Generator meeting, Monday, November 18, 2013, https://indico.cern.ch/event/276315/
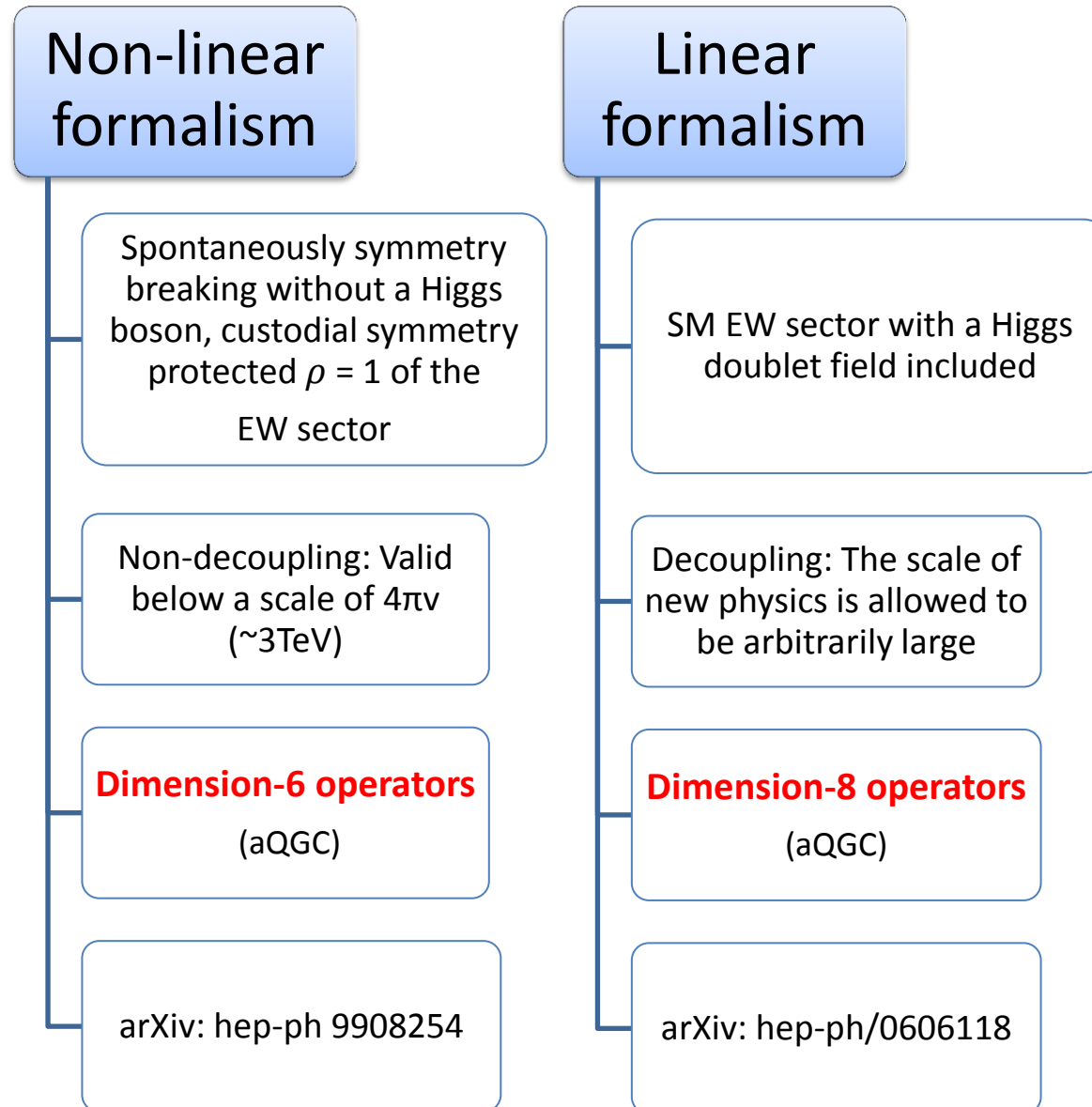
6. High Mass EXO-VV/HH/VH Resonance Searches with Jet-Substructure, CMS Week Exotica Meeting, Tuesday, September 10, 2013, https://indico.cern.ch/event/271239/

 7. Physics Analyses in PKU CMS Group, PKU-Kyungpook Meeting, November 26, 2013, https://indico.cern.ch/event/284640/

aQGC

Request SU(2)⊗U(1) gauge symmetry and independently conserved C, P

Non-linear formalism

Spontaneously symmetry breaking without a Higgs boson, custodial symmetry protected $\rho = 1$ of the EW sector

Non-decoupling: Valid below a scale of 4πv (~3TeV)

Dimension-6 operators

(aQGC)

arXiv: hep-ph 9908254

Linear formalism

SM EW sector with a Higgs doublet field included

Decoupling: The scale of new physics is allowed to be arbitrarily large

Dimension-8 operators

(aQGC)

arXiv: hep-ph/0606118

Background estimation: alpha method

➢ **4 main background sources:**

Wjets, TTbar, SingleTop, VV

➢ For **non-Wjets background,** use the MC fitting results (both normalization and shape)

➢ For **Wjets background**, we use data driven method to estimate

---> fit m_j in SB to extract Wjets normalization in SR

---> fit SR and low SB m_{WH} of Wjets MC to extract Wjets shape

$$\alpha_{\mathrm{MC}}(m_{lvj}) = \frac{F_{\mathrm{MC,SR}}(m_{lvj})}{F_{\mathrm{MC,SB}}(m_{lvj})}$$

---> data driven background extrapolation in SR

$$F_{\mathrm{data,SR}}(m_{lvj}) = \alpha_{\mathrm{MC}}(m_{lvj}) \times F_{\mathrm{data,SB}}(m_{lvj})$$

Estimated wjets shape in SR

Fit data SB with summed components to get wjets shape in low SB region

Code	Name	Status	PAS	PAPER	ARC	IRC	Contact
EXO-14-010 » | ▲show	X to WH to lvbb	GoingToPreApp	📄		NO ARC	NO IRC	Qiang Li (PEKING-UNIV)

EXO-14-010 *(Thu, 20 Nov 2014 13:40:09)* 🖨

Name	X to WH to lvbb	Description	search for W' to WH and H to a fat Higgs jet
Status	**GoingToPreApp**	Contact Person	Qiang Li (PEKING-UNIV)
Twiki	EXO-14-010 ⤷	HN	EXO-14-010 ⤷
Data,Samples	DataSet: not set Samples: not set	Conference	
Target Date PreApp	17/11/2014	Target Date PhysApp	
Talks	No Pre-Approval Talk | No Approval Talk	Actions	Not in Edit Mode
Related Analyses	none	Related CMS Notes	AN-2014/121

Physics Analysis Summary (PAS)

ARC Chair	none	ARC	No ARC yet
PAS Actions	📄 ⚠	PAS CDS id	

PAPER

Target Journal		Target Date Pub	
AuthorList	No AL available yet	IRC	No IRC yet
PAPER Actions		PAPER CDS id	
arXiv		DOI	
HepData		Rivet Plugin tar file	

Code		Name			Status	PAS	PAPER	ARC	IRC	Contact
SMP-13-012 » | ▲show		EW production of W + 2 jets			PRE-APP	📄		Chiara Mariotti (TORINO)	NO IRC	Shuai Liu (PEKING-UNIV)

SMP-13-012 *(Thu, 20 Nov 2014 13:45:24)* 🖨

Name	EW production of W + 2 jets	Description	W production with forward jet tagging
Status	**PRE-APP**	Contact Person	Shuai Liu (PEKING-UNIV)
Twiki	SMP-13-012 ↗	HN	SMP-13-012 ↗
Data,Samples	DataSet: 2012 Samples: not set	Conference	TOP2014
Target Date PreApp	18/10/2013	Target Date PhysApp	
Talks	No Pre-Approval Talk | No Approval Talk	Actions	Not in Edit Mode
Related Analyses	none	Related CMS Notes	AN-2013/123

Physics Analysis Summary (PAS)

ARC Chair	Chiara Mariotti (TORINO)	ARC	Accepted | show 4 members
PAS Actions	📄	PAS CDS id	

PAPER

Target Journal		Target Date Pub	
AuthorList	No AL available yet	IRC	No IRC yet
PAPER Actions		PAPER CDS id	
arXiv		DOI	
HepData		Rivet Plugin tar file	

Code	Name	Status	PAS	PAPER	ARC	IRC	Contact
📊 SMP-14-011 » | ▲show	Wgamma EWK production	PRE-APP 📄			Matthew Fairbanks Herndon (WISCONSIN)	NO IRC	Daneng Yang (PEKING-UNIV)

SMP-14-011 (*Thu, 20 Nov 2014 13:45:10*) 🖨

Name	Wgamma EWK production	Description	Wgamma + 2 jets production in EWK processes
Status	**PRE-APP**	Contact Person	Daneng Yang (PEKING-UNIV)
Twiki	SMP-14-011 ➡	HN	SMP-14-011 ➡
Data,Samples	DataSet: 2012 Samples: not set	Conference	Future2020
Target Date PreApp	19/09/2014	Target Date PhysApp	
Talks	Pre-Approval Talk » | No Approval Talk	Actions	Not in Edit Mode
Related Analyses	none	Related CMS Notes	AN-2013/314

Physics Analysis Summary (PAS)

ARC Chair	Matthew Fairbanks Herndon (WISCONSIN)	ARC	Accepted | show 3 members
PAS Actions	📄	PAS CDS id	

PAPER

Target Journal		Target Date Pub	
AuthorList	No AL available yet	IRC	No IRC yet
PAPER Actions		PAPER CDS id	
arXiv		DOI	
HepData		Rivet Plugin tar file	

Code		Name	Status	PAS	PAPER	ARC	IRC	Contact
SMP-14-018 » | ▲show		Zgamma EWK production	AWG	🔴		NO ARC	NO IRC	Fengwangdong Zhang (PEKING-UNIV)

SMP-14-018 *(Thu, 20 Nov 2014 13:45:16)* 🖨

Name	Zgamma EWK production	Description	Zgamma + 2 jets production in EWK processes and aQGC
Status	**AWG**	Contact Person	Fengwangdong Zhang (PEKING-UNIV)
Twiki		HN	SMP-14-018 ⇥
Data,Samples	DataSet: 2012 Samples: not set	Conference	Future2020
Target Date PreApp		Target Date PhysApp	
Talks	No Pre-Approval Talk | No Approval Talk	Actions	Not in Edit Mode
Related Analyses	SMP-14-011	Related CMS Notes	AN-2013/316

Physics Analysis Summary (PAS)

ARC Chair	none	ARC	No ARC yet
PAS Actions	🔴	PAS CDS id	

PAPER

Target Journal		Target Date Pub	
AuthorList	No AL available yet	IRC	No IRC yet
PAPER Actions		PAPER CDS id	
arXiv		DOI	
HepData		Rivet Plugin tar file	

Pre-CDR: Monte Carlo Tools for future collider projects

Tongguang Cheng, Sergei Chekanov, Bo Feng, Bin Gong, Tao Han, Gang Li, Liang Li, Qiang Li, Zhao Li, Meenakshi Narain, Sanjay Padhi, Meade Patrick, Jimmy Proudfoot, Huilin Qu, Manqi Ruan, Dayong Wang, Jian-Xiong Wang, Kechen Wang, Liantao Wang, Yiwen Wen, Yongcheng Wu, Keping Xie, Qi-Shu Yan, Daneng Yang, Gao Yu, Bin Zhang, Jian-Hui Zhang, Xiao-Ran Zhao, Zhijie Zhao

- International Collaborations;

- Theorists and Experimentalists

Contents

- e+e- and pp
- Parton level and fast simulation
- Tool: User friendly and high precision

有主要贡献的Publication

[P1] A Search for WWgamma and WZgamma production in pp Collisions at sqrt(s) = 8 TeV, CMS Collaboration, Phys. Rev. D 90, 032008 (2014).

[P2] Search for massive resonances decaying into pairs of boosted bosons in semi-leptonic final states at sqrt(s) = 8 TeV, CMS Collaboration, JHEP 08 (2014) 174.

[P3] Qiang Li, Qi-Shu Yan, Xiaoran Zhao, Higgs Pair Production: Improved Description by Matrix Element Matching, Phys. Rev.D89, 033015 (2014).

[P4] Yiwen Wen, Huilin Qu, Daneng Yang, Qi-shu Yan, Qiang Li, Yajun Mao, Probing Triple-W Production and Anomalous WWWW Coupling at the CERN LHC and future 100TeV proton-proton collider, [arXiv:1407.4922], submitted to JHEP.

2011年前主要工作

[1] Jet angular correlation in vector-boson fusion processes at hadron colliders,
Kaoru Hagiwara, Qiang Li, Kentarou Mawatari, **JHEP 0907 (2009) 101**
引用**67**次，他引**61**次
给出了**Higgs**产生衰变的极化振幅，对测量**Higgs**性质有重要意义

[2] Spin-2粒子模拟的一系列**(4篇)**文章：**MadGraph**中的实现，**Jet/Parton Matching**，**Spin-2 + 2Jets**，**NLO QCD Spin-2**产生
例如 HELAS and MadGraph/MadEvent with spin-2 particles*, K. Hagiwara, J. Kanzaki, Q.Li, K. Mawatari*, Eur.Phys.J. C56 (2008) 435-447
引用**41**次，他引**31**次

[3] H+Jets 微分截面模拟
Matched predictions for Higgs production via heavy-quark loops in the SM and beyond, Johan Alwall, Qiang Li, Fabio Maltoni. Phys.Rev. D85 (2012) 014031
引用**15**次，他引**10**次