A Few Selected Activities in 2016

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- Overview
- Selected activities in 2016
- Plan for next years

Overview

- Main focus: searching for heavy (scalar) resonance
  - Coordinating analysis activities in WW
  - Strong involvement of Chinese teams
    - Shandong University: ZHAO Yongke (joint PhD), SONG Weimin (visitor at LAL), MA Lianliang et al.
    - USTC: Zuzana Blenessy (Postdoc), HAN Kunlin (future joint PhD) et al.

- Managed to have two sets of preliminary results
  - Moriond 2016: ATLAS-CONF-2016-021
  - ICHEP 2016: ATLAS-CONF-2016-074
  - Now working for final publication

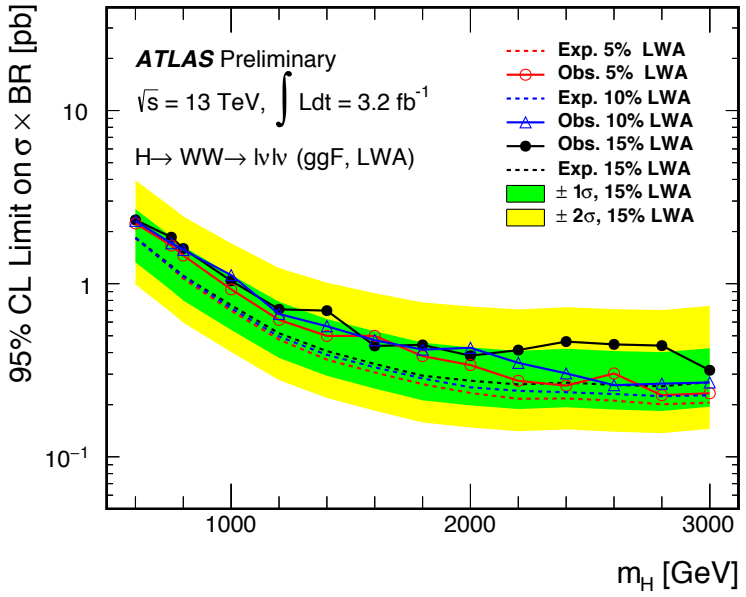
- Made an update on muon g-2 LO hadronic prediction
  - Reported by M. Davier at Tau workshop 2016

Moriond 2016 (ATLAS-CONF-2016-021)

- Based on 3.2fb^{-1} Run-2 data taken in 2015 @ 13TeV
  - Fairly model independent search with:
    - Narrow width approximation (NWA):

      4MeV for ggF & VBF
    - Large width assumption (LWA):

      width/mass: 5-15% for ggF
  - Mass range: lvlv: [600, 3000]GeV
  - Combined lvlv and lvqq channels



- Developed a simple & general procedure for optimising event selection
  - Wanted to check if the selection cuts used in Run-1 publication are still optimal

The Simple & General Procedure

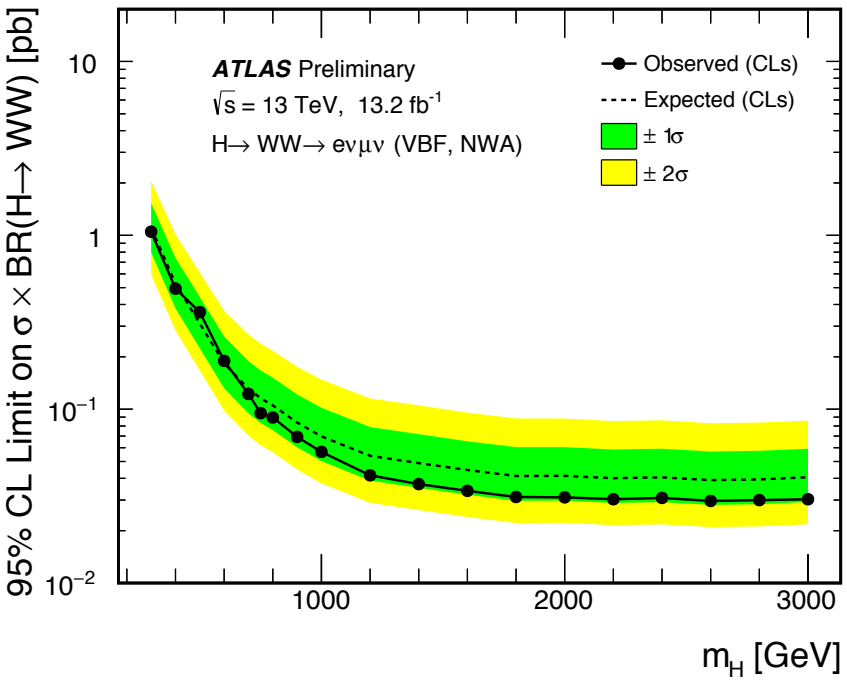
- A two-step procedure (https://users.lal.in2p3.fr/zhangzq/atlas/selection.pdf)
  - Select the most discriminating variables using BDT
    - Variables having ranking value > 40% wrt to the best ranking variable
    - If two variables are strong correlated (> 80% for both signal and background), remove lower ranked variable
  - Do a signal significance scan (iterative) to find the best threshold (cut) value
    - The signal significance could be a global one or preferably
    - Based on a discriminating variable (m_T in the case of WW→lvlv) exploiting shape difference between signal and background:

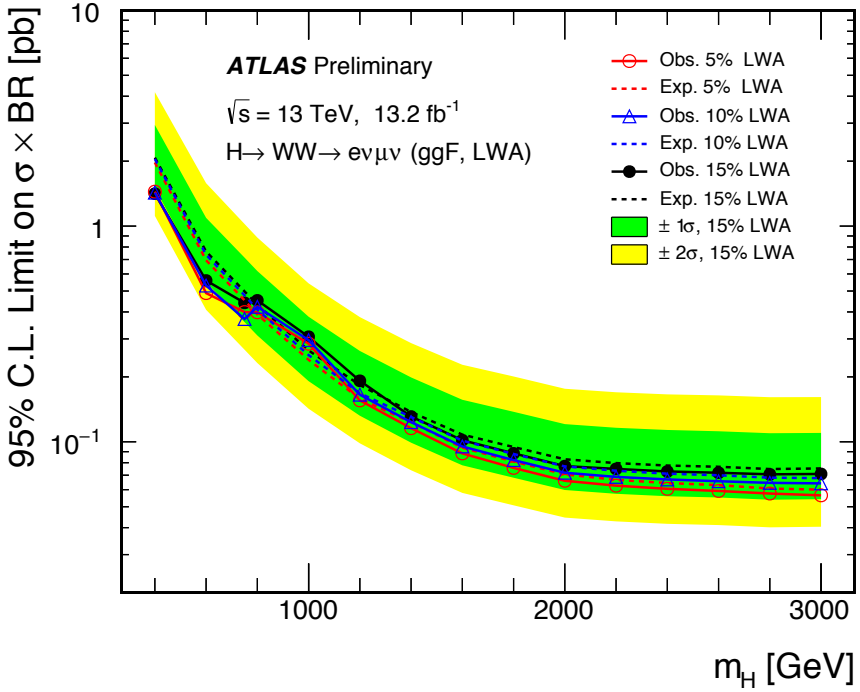
$$s_{m_{\mathrm{T}}} = \sqrt{\sum_i s_i^2}$$

$$s_i = \sqrt{2\left[(n_S^i + n_B^i)\ln\left(1+\frac{n_S^i}{n_B^i}\right) - n_S^i\right]}$$

ICHEP 2016 (ATLAS-CONF-2016-074)

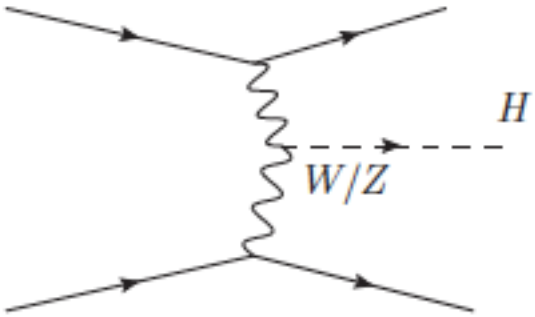
- Based on 13.2fb^{-1} Run-2 data taken in 2015 and 2016 @ 13TeV
- A number of improvements achieved
  - Extension to lower mass from 600GeV to 300GeV
  - Add VBF 1-jet category in additional to VBF 2-jet one
  - Introduce for the first time a (quasi-) inclusive ggF category

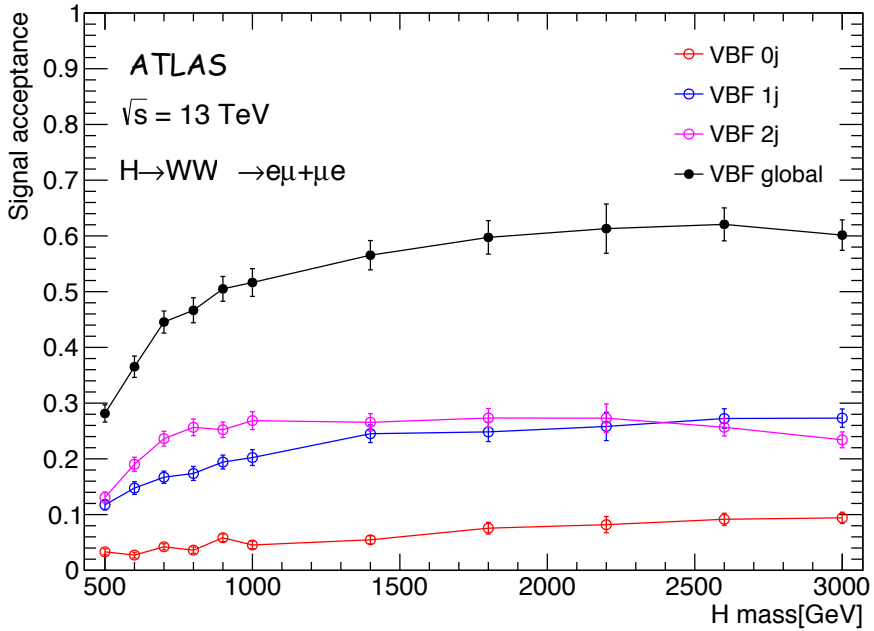


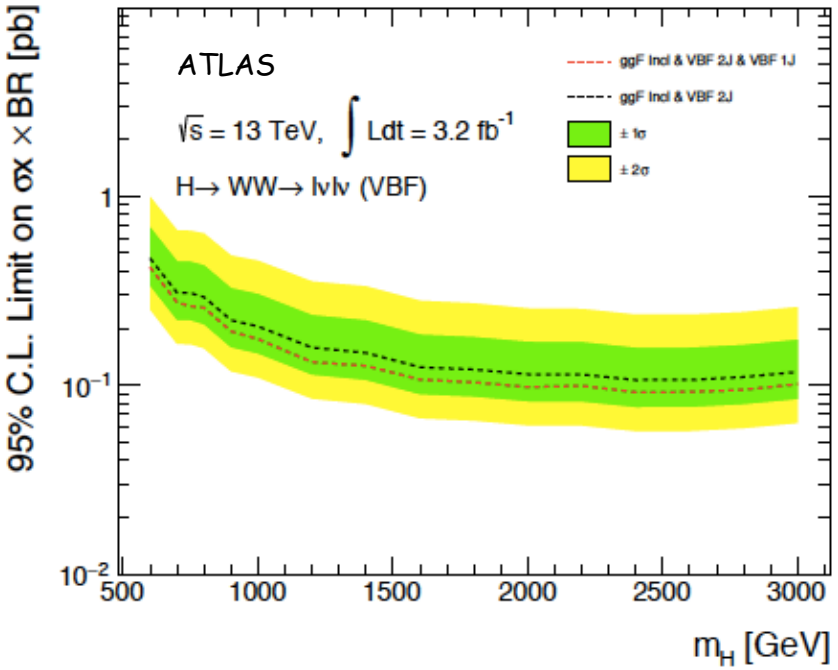


Gain Sensitivity by adding VBF 1-Jet Category

- VBF events usually selected by requiring at lest 2 jets with large Δy_{jj} and m_{jj}
  - But there is a large fraction of VBF in (ggF) 1-jet category
  - A new VBF 1-jet category introduced to maximise VBF/ggF signals



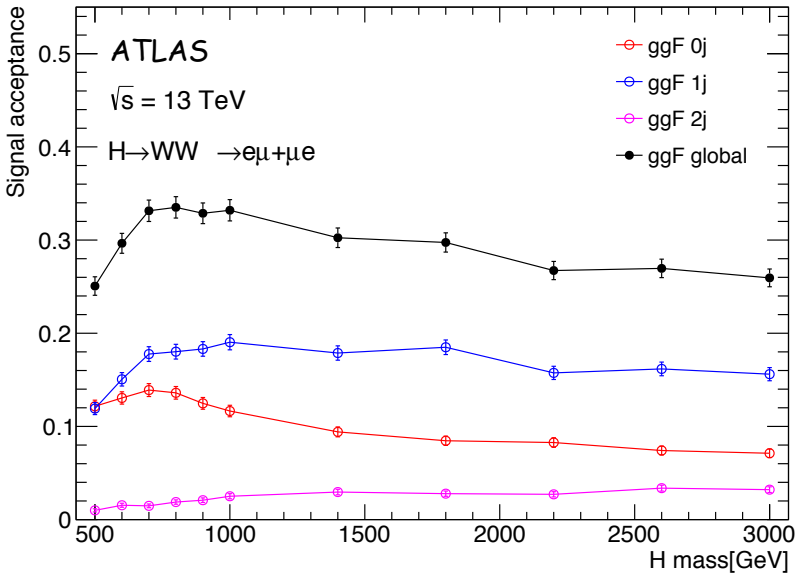


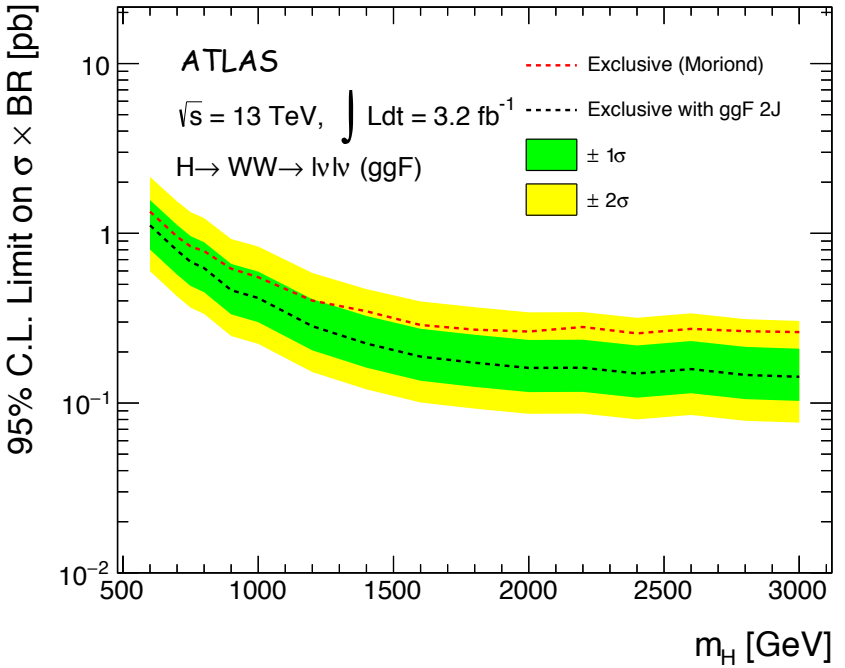


Introduce New (Quasi-)Inclusive ggF Category

- The usual jet categories for 125GeV analysis not ideal for heavy resonance search
  - Jet p_T threshold 25GeV too low
  - Heavy boson has the tendency to "radiate" more jets
  - 2-jet not optimised for ggF
  - Large jet bin migration errors

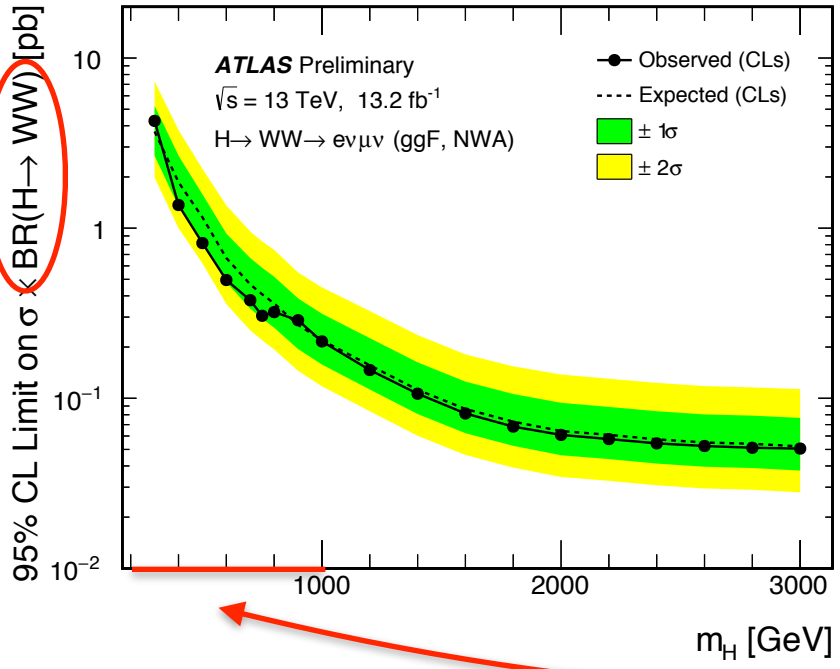
- New strategy:
  - Increased p_T threshold to 30GeV
  - Recovered sensitivity in ggF 2-jet phase space
  - Excluding VBF 1-jet & 2-jet phase spaces → Quasi-inclusive ggF category

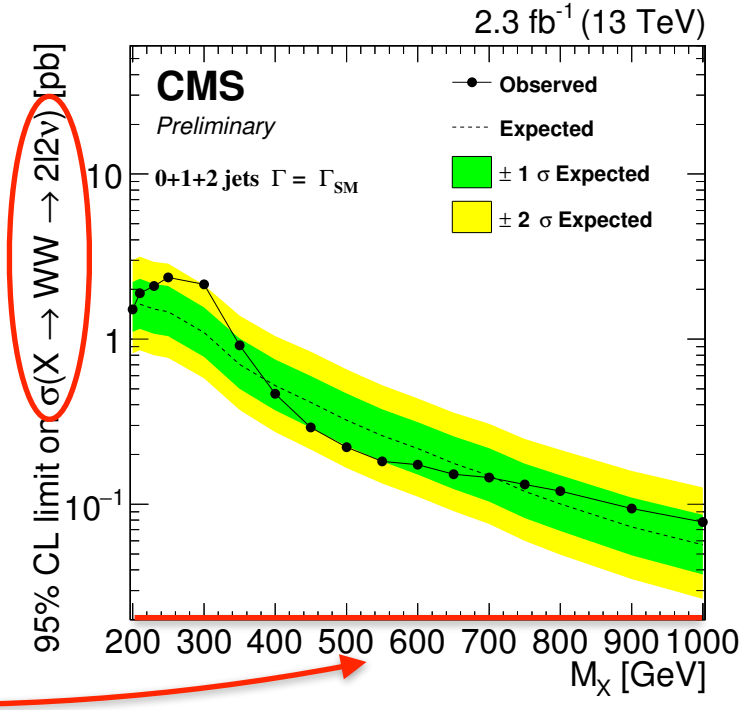




A Comparison with CMS (ICHEP Results)

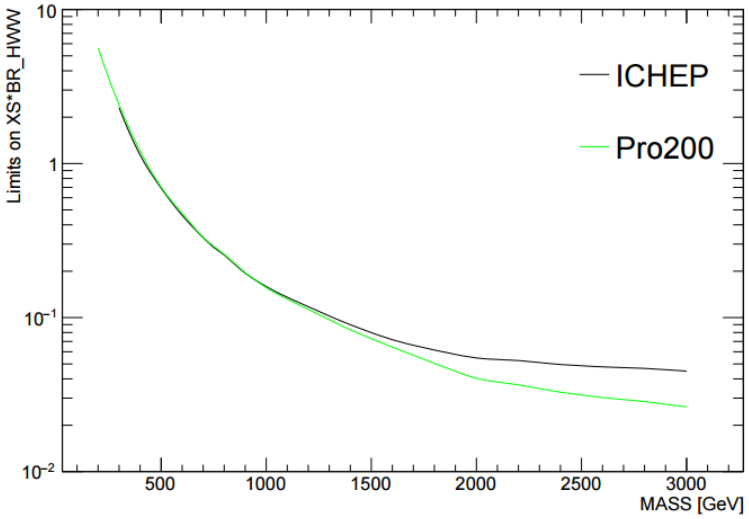
Item	ATLAS	CMS
Lumi (fb^{-1})	13.2	2.3
Mass range	[300, 3000] GeV	[200, 1000] GeV
Interpretation	NWA, LWA	EW singlet model
Event categorisation	ggF: quasi-inclusive VBF: 1-jet, ≥2-jets	0, 1, ≥2 jets
Reference	ATLAS-CONF-2016-074	CMS PAS HIG-16-023





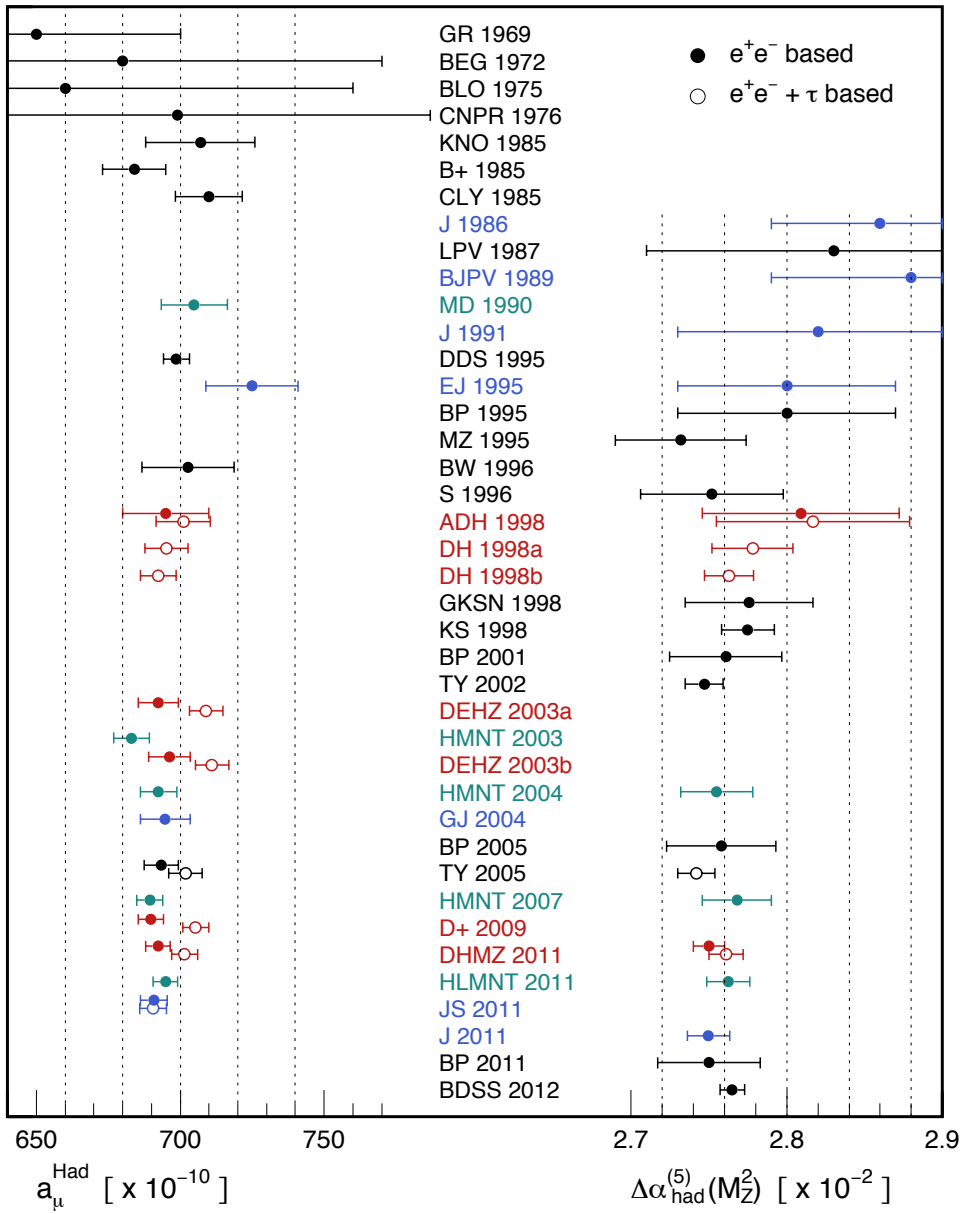
Towards Publication by Moriond 2017

- Use full 2015+2015 data @ 13TeV: 36.5 fb^{-1}
- A number of improvements planned
  - Extension to lower mass down to 200GeV & high-mass up to 4TeV
  - Reoptimise m_T binning
  - Improved background and signal systematic uncertainties
  - Include additional model interpretations
    - Spin-1 signal in heavy vector triplet (HVT) model
    - Spin-2 signal in Randall-Sundrum bulk graviton model
    - Dimension-6 operator in effective field theory
  - Study the impact of interference effects between H-h-SM e.g. in electroweak singlet model



- Once published, combination with other VV channels foreseen

Activities on Muon g-2 Prediction



- LO Hadronic Vacuum Polarization being the most uncertain part for a_μ & $\Delta\alpha$ has been the focus over last 5 decades.
- Our prediction has been a reference for comparison with measurements (e.g. DHMZ 2011 has over 500 citations)

Davier, Hoecker, Malaescu, Zhang, for "**Standard Theory Essays in the 60th Anniversary of CERN" published recently by World Scientific**

Recent Update

- The update take advantage of more complete data from BABAR, KLOE, BESIII, CMD3 and SND at VEPP-2000, KEDR

Channel	DHMZ 2011	DHMZ 2016
$\pi^+\pi^-$	507.8 ± 1.2 ± 2.5 ± 0.6 (2.9)	506.9 ± 1.1 ± 2.2 ± 0.7 (2.5)
$\pi^+\pi^-2\pi^0$	18.01 ± 0.14 ± 1.17 ± 0.40 (1.24)	18.16 ± 0.06 ± 0.49 ± 0.27 (0.56)
$2\pi^+2\pi^-$	13.35 ± 0.10 ± 0.43 ± 0.29 (0.53)	13.70 ± 0.03 ± 0.28 ± 0.13 (0.31)
K_LK_S	12.96 ± 0.18 ± 0.25 ± 0.24 (0.39)	12.81 ± 0.06 ± 0.18 ± 0.15 (0.24)
a_μ(Had, LO)	692.2 ± 1.4 ± 3.1 ± 2.4 (4.2)	692.8 ± 1.2 ± 2.6 ± 1.6 (3.3)

- The predictions vs measurement:

QED 11658471.885 ± 0.004
EW 15.4 ± 0.1
had LBL 10.5 ± 2.6
had LO 692.8 ± 3.3
had NLO -9.87 ± 0.09
had NNLO 1.24 ± 0.01

Prediction: 11659181.9 ± 4.2
Exp BNL: 11659208.9 ± 6.3
→ Deviation: 27.0 ± 7.6 (3.6σ)

Plan for Next Years

- Complete heavy resonant search in WW channel
  - Would still take a few months with all foreseen improvements
  - Aim for an ATLAS publication ready by Moriond 2017
  - Thesis defence of ZHAO Yongke in 2017 after the publication

- Preparing two new projects in ATLAS
  - A generic search in inclusive Z events at high p_T (thesis of HAN Kunlin)
  - Precision measurement of the W boson mass
    - 19 MeV achieved by ATLAS with 7 TeV data, best single measurement
    - To be compared with 8 MeV from SM prediction (global EW fit)
    - Aim for 10 MeV precision with 8 TeV and 13 TeV data
    - Without new direct discovery at the LHC in next years, precision measurements will be the focus of the LHC physics

- Available to help the CEPC (R&D) project