

# Cinvestav participation at CMS

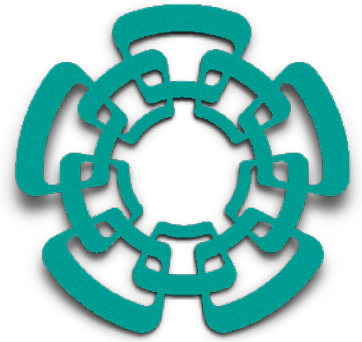
Ivan Heredia

On behalf of the Cinvestav group in CMS

CMS Workshop at Universidad Iberoamericana

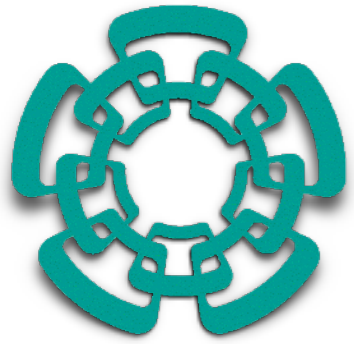
January 12, 2018

# Cinvestav



- The **Center for Research and Advanced Studies of the National Polytechnic Institute (Cinvestav)**: Mexican non-governmental scientific research institution.
- Founded in 1961; divided in 10 research centers across the country.
- Cinvestav ranks 2nd within research centers in Latin America and holds the position 109 in the world [<http://research.webometrics.info/>]
- Physics Department in Mexico City: 5 faculty members (PhDs), 1 posdoc, and 8 graduate students participating in CMS.





# Members in CMS



Heriberto Castilla Valdez  
(team leader, member since 2004)



Alberto Sánchez-Hernández



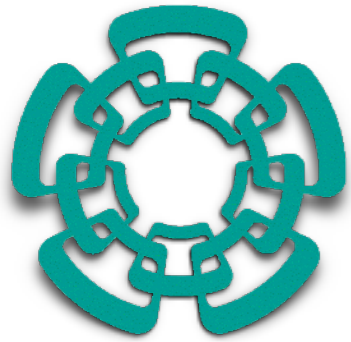
Ricardo López Fernández



Eduard de la Cruz Burelo



Iván Heredia de la Cruz



# Activities

- In the past (after joining CMS in 2004), Cinvestav members were participating on the Silicon Tracker of CMS and CMS software.
- Currently are focused mainly in the Muon RPC system and producing high quality Physics results.
- Students play a key role on these activities.

Students:

\*\* Jhovanny Mejia Guisao

\* Heber Zepeda Fernandez

Iraq Rabadan Trejo

Rogelio Reyes Almanza

Cecilia Duran Osuna

Gabriel Ramirez Sanchez

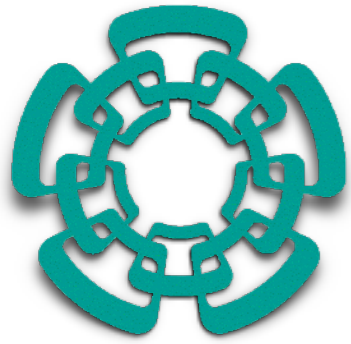
Mateo Ramirez Garcia

+ César Atzin Mondragon

+ Daniel A. Pérez Navarro

+ Gabriel A. Ayala Sánchez





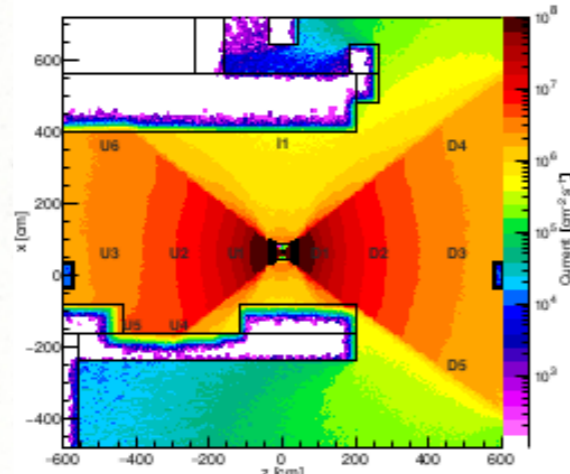
# Work on RPC System

- Detector operations as RPC-DOC.
- Prompt Feedback shifts.
- Background studies by comparing the HV currents before and after the installation of the shielding.
- Study of HV in chambers to calibrate and find the performance optimal value: efficiencies vs operation HV; stability vs time; cluster size vs operation HV.
- Study of the Occupancy in the RPC detectors.
- Study of adding the RPCs chambers in the reconstruction of muons.
- Aging studies (CMS CR-2016-064 ), luminosity dependence, etc.

# Example: Mateo's work

## *RPCs performance studies*

The GIF++ provides a realistic simulation of the LHC and HL-LHC conditions in a controlled environment.



On the second half of the last year, I take care about operation of detectors and the GIF++ facilities for data taking in order to investigate the performance and aging of current detectors and prototypes at several conditions.

This studies validate the operation of current RPC's in the LHC conditions, and contribute to the study of its operation for the HL-LHC conditions.

**In collaboration with Ibero**

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# Example: Mateo's work

## *Eco-gas studies*

In order to minimize the ecologic impact of gas-detectors, new gas-mixtures are explored.

Mix	Isopropane %	SF6 %	HFO %	CO2 %
1	4.5	0.3	50.0	45.2
2	4.5	0.6	55.0	39.9
3	4.5	0.6	50.0	44.9
4	5.0	0.6	50.0	44.4
5	4.5	0.6	45.0	49.9



The operational detector parameters was investigated in order to get a lower HV working point with a lower streamer fraction probability.



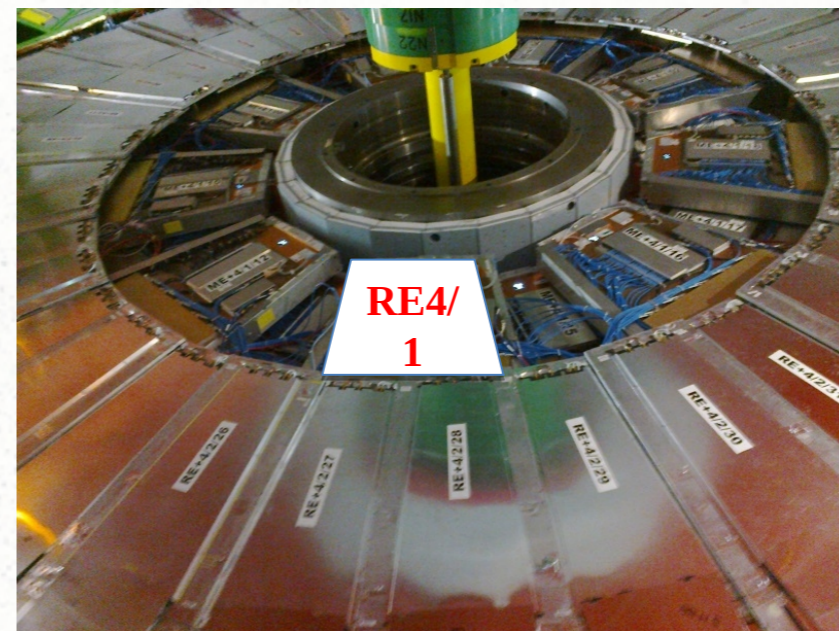
# Example: Mateo's work

## *Build iRPC prototype v-002*

HL-LHC needs to improve the RPC system.

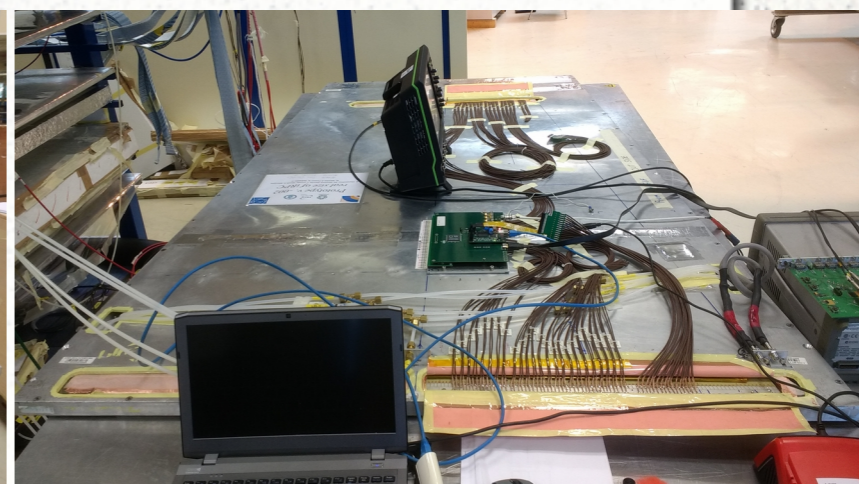
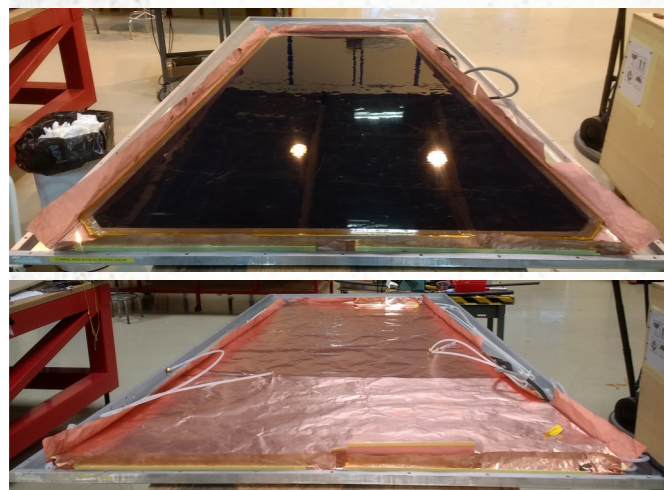
New improved RPC (iRPC) detectors will cover empty rings, in end-caps, in order to improve geometrical acceptance and, time and spatial, resolution.

Some iRPC prototypes are designed in order to pass the HL-LHC conditions. So, the iRPC prototype v-002 was built in the second half of the last year in the RPC-Lab (CERN, Bdg. 904).

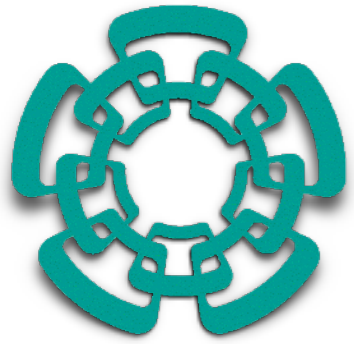


Main characteristics:

- 1.4 mm gaps.
- Double-side signal strip.
- New electronics.

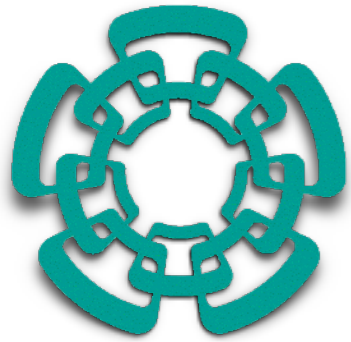






# Work on Computing and Software

- Implementation of the FTS3 in PhEDEx, enhancements of the FTS3 client.
- Monte Carlo development: interface for EvtGen-Pythia 8; developed filtering strategy for BPH samples (save CPU at the order of 2-10).



# Physics analysis

- **Study of B hadron lifetimes** (J. Mejia / **E. De La Cruz**), CMS-PAS-BPH-13-008, **submitted to EPJC** in 10/2017 (arXiv:1710.08949).
- **Study of the cross-section measurements of J/psi, psi(2s) and upsilon(nS) (n=1,2,3) at 13 TeV** (H. Zepeda / **A. Sánchez**), CMS-PAS-BPH-15-005, **submitted to PLB** (arXiv: 1710.11002) in 10/2017.
- **Study of the system Bs-pi to search the state X(5668)**, CMS-PAS-BPH-16-002 (M. Ramírez / **I. Heredia**), **submitted to PRL** in 11/2017 (arXiv:1712.06144).
- **Study of the Lambda\_b polarization and angular parameters of the decay Lambda\_b -> J/psi Lambda** (**R. Reyes** / H. Castilla), CMS-PAS-BPH-15-002, **to be submitted to PRD**, now in post-FR.
- Working on quarkonium:
  - **chi\_b** and feed-down studies at 8 and 13 TeV.
  - **chi\_c polarization** at 8 TeV
  - **phi polarization**.
- Working on **exotics hadrons**: Pc -> J/psi p in decays of Lambda\_b (also Pc -> J/psi Lambda in collaboration with Ibero).
- Working on **photo-production in UPC p-Pb collisions** (with Kansas), e.g. J/psi.

## **Also involved in (< 2015):**

- Bs -> J/psi pi+pi-
- Bs -> phi mu+mu-
- Bs -> mu+mu-

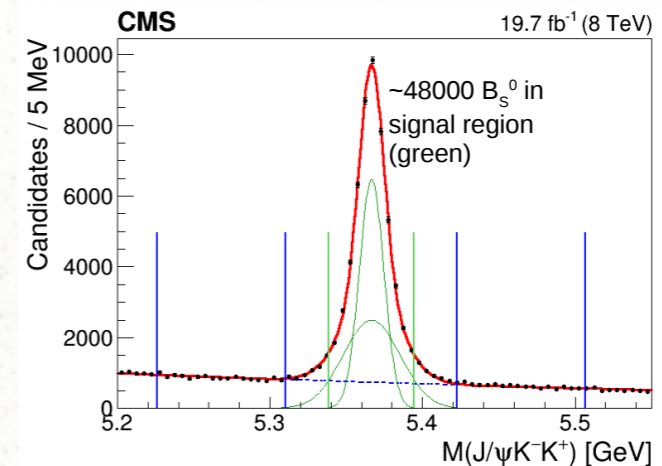
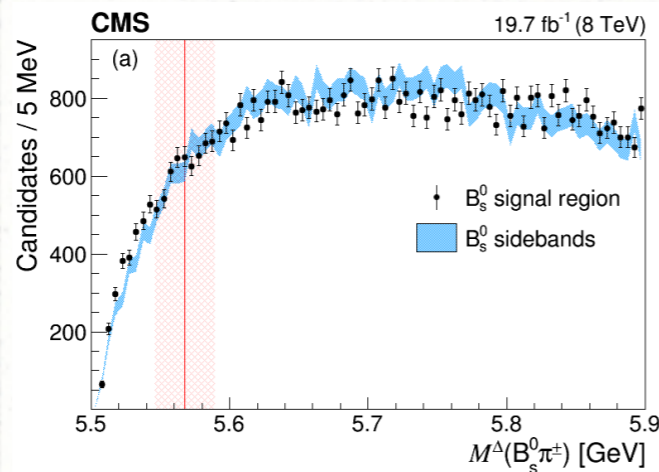


# Example: Mateo's work

## $B_S^0 \pi^\pm$ system at CMS

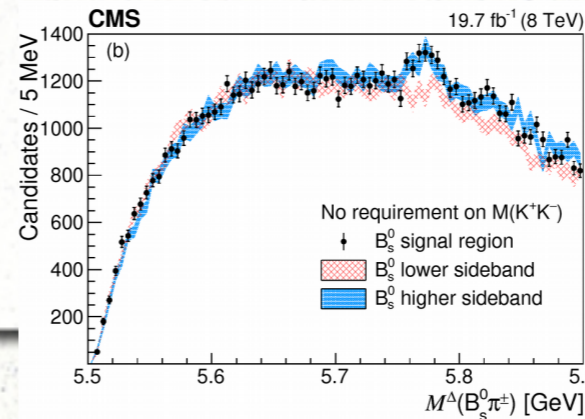
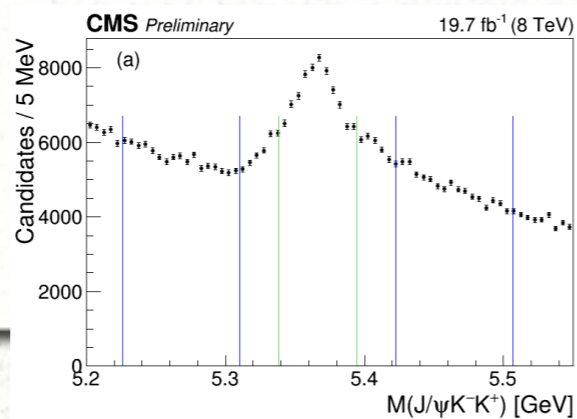
arXiv:1712.06144 [hep-ex]

A similar selection criteria than Phys. Lett. B 757 (2016) 97-120 is used to reconstruct  $B_S^0$  mesons



Pion candidates are combined with  $B_S^0$  meson candidates, from signal and sideband regions, to form the  $B_S^0 \pi$  system. **No excess is found** in the region observed by D0.

$B^0 \rightarrow J/\psi K^- \pi^+$  decays, from  $B_1(5721)^+ \rightarrow B^{*0} \pi^+$ ,  $B_2^*(5747)^+ \rightarrow B^{*0} \pi^+ \gamma$   
 $B_2^*(5747)^+ \rightarrow B^0 \pi^+$ , can be seemed as a  $B_S^0 \rightarrow J/\psi K^- K^+$ . So removing a cut on the mass of  $K^- K^+$ :



This validate the reconstruction procedure.

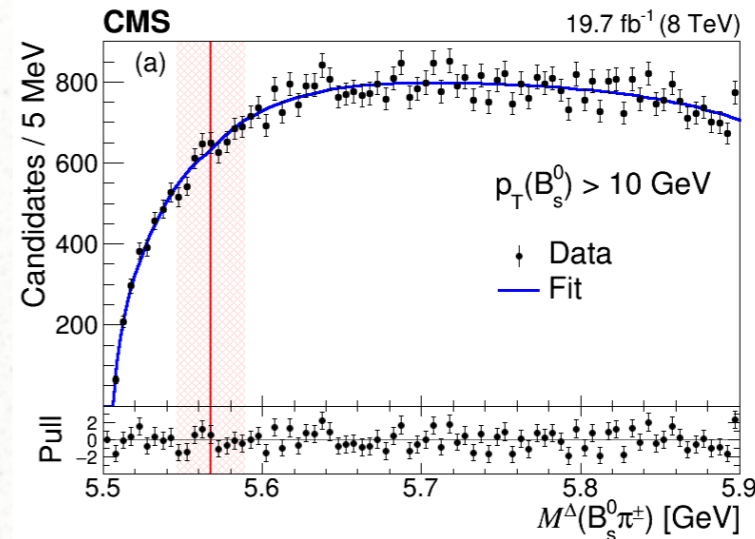
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# Example: Mateo's work

## *CMS limit to the relative production*

The  $B_s^0 \pi$  distribution is fitted without any excess:

- Signal: S-wave relativistic Breit-Wigner convoluted with a three-Gaussian resolution,
- Bkg:  $(x - x_0)^\alpha \text{Pol3}(x)$ .



Several crosschecks are done without signals of the X(5568):

- Fixing Bkg parameters from data or MC.
- Changing quality and kinematics requirements.
- Changing Bkg models and regions.

A limit estimation on  $\rho$  is performed using a tool developed by LHC Higgs Combination Group. Several variations on the procedure are tested (Bkg models, adding systematics, different fitting regions) and the most conservative result is:

$$\rho_X (B_s^0 p_T > 10 \text{ GeV}/c) < 0.011 @ 95\% \text{ CL.}$$

$$\rho_X (B_s^0 p_T > 15 \text{ GeV}/c) < 0.010 @ 95\% \text{ CL.}$$

A harder limit than LHCb result and in contradiction to D0



# Summary

- **Cinvestav** members in CMS were previously members of the UA1, Focus, H1, D0 and ATLAS collaborations.
- Extensive experience mainly on heavy flavor physics (also EW, BSM, etc.).
- Extensive participation in operations/testing/building of silicon and (currently RPC) muon detectors.
- Mainly involved in the BPH group at CMS and most recently in photo-production/UPC studies.

# Spares



# Search of the $X(5568)$ in CMS

**D0 Collaboration; PRL 117, 022003 (2016)**

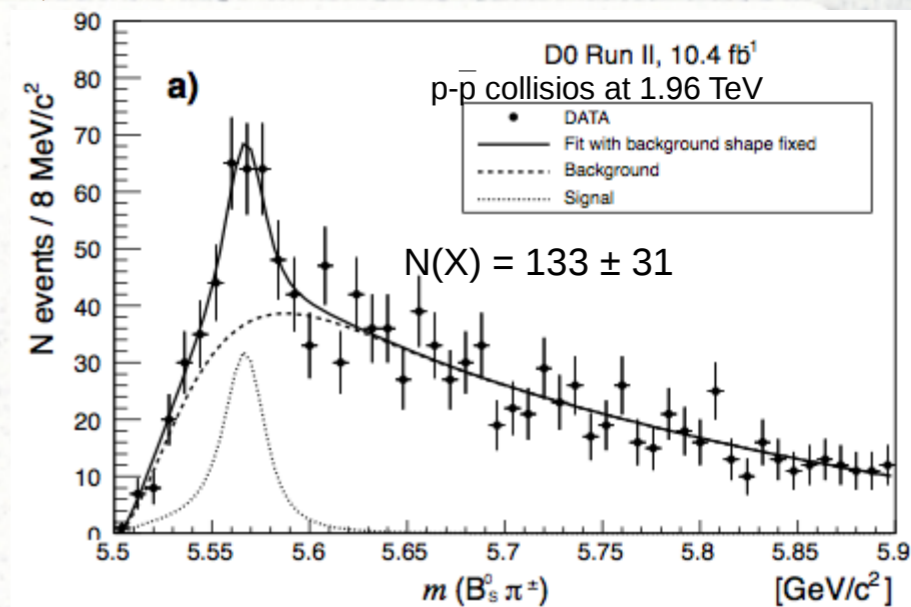
With  $\sim 5600 B_S^0$  mesons, D0 present evidence of a tetraquark state in the  $B_S^0$ - $\pi$  system.

-  $M = 5567.8 \pm 2.9$  (stat) MeV

-  $\Gamma = 21.9 \pm 6.4$  (stat) MeV.

-  $\rho = \frac{\sigma(X) Br(X \rightarrow B_S^0 \pi^\pm)}{\sigma(B_S)} = \frac{N_X}{N_{B_S}} \epsilon_{\pi^\pm} = 8.6 \pm 2.4\%$ .

- Significance =  $5.1 \sigma$ .



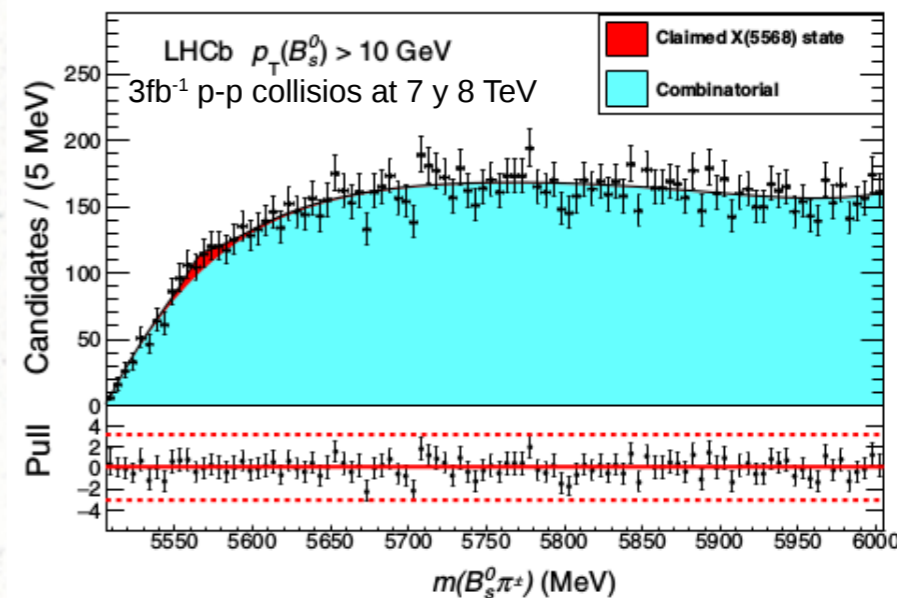
**LHCb; PRL 117, 152003 (2016)**

With  $\sim 44000 B_S^0$  mesons, in two decay channels, LHCb doesn't found significant signal of the  $X(5568)$

$\rho_X^{LCHb}(B_S^0 p_T > 5 \text{ GeV}/c) < 0.011$  (0.012) @ 90% (95%) CL.

$\rho_X^{LCHb}(B_S^0 p_T > 10 \text{ GeV}/c) < 0.021$  (0.024) @ 90% (95%) CL.

$\rho_X^{LCHb}(B_S^0 p_T > 15 \text{ GeV}/c) < 0.018$  (0.020) @ 90% (95%) CL.



**Phys. Lett. B 757 (2016) 97-120**

CMS has  $\sim 44000 B_S^0$  mesons in  $19.7 \text{ fb}^{-1}$  of pp collisions at 8 TeV