La Fisica di CMS Bari
(update)

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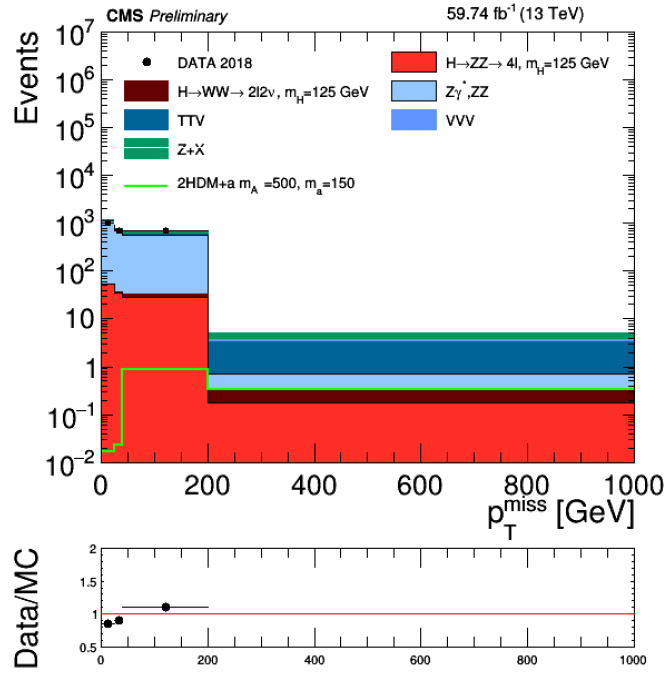
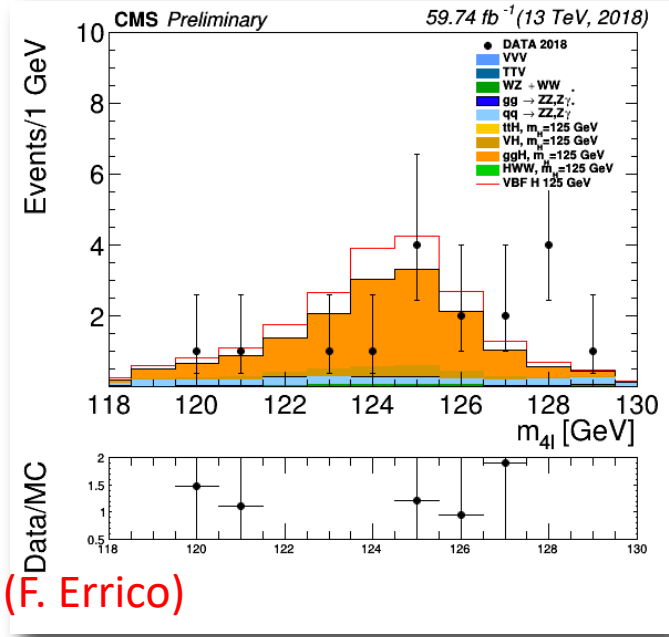
Attività di analisi per Run 2 (1)

- Ricerca di materia oscura con la segnatura di "MonoHiggs" (*full* Run 2) H+MET, con H→ZZ→4l
  - Persone: R. Aly, N. De Filippis, F. Procacci + UCDavis + LIP + FNAL)
  - Pubblicata analisi dati 2016 (G. Miniello): **JHEP 03 (2020) 025**
  - analisi dati Run2 completa
  - Modelli studiati: **2HDM+a**
  - segnatura: H → ZZ → 4e – 4μ – 2e2μ) + E_T^{miss}
  - AN completa ed inviata ai MET+X ed Exotica conveners → richieste di chiarimenti ricevute e nuova iterazione in breve tempo.
  - R. Aly con assegno di ricerca POLIBA + RPASINAIR project per un anno



- Misura della sezione d'urto di produzione del bosone di Higgs in topologia di fusione di bosoni vettori: VBF H→ZZ→4l (W. Elmetenawee, N. De Filippis + UERJ + FNAL) + G. Miniello (assegno di ricerca CLOSE)
  - analisi dati Run2 completa
  - uso di reti neurali (DNN) per discriminazione segnale da fondo
  - segnatura: H→ZZ→4l + due jet energetici in avanti
  - AN in preparazione. Iterazione con HZZ conveners e presentazione con risposte alle domande domani al HZZ meeting



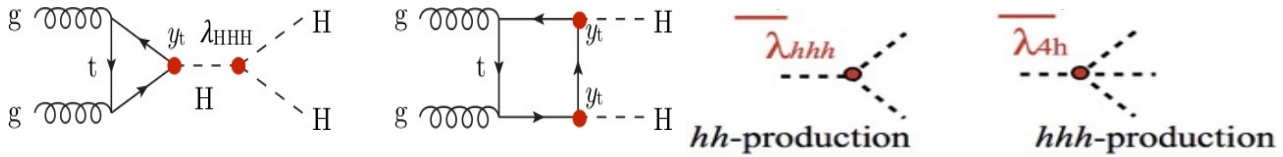
Mass and width measurement: (F. Errico)

Attività di analisi per Run 2 (2)

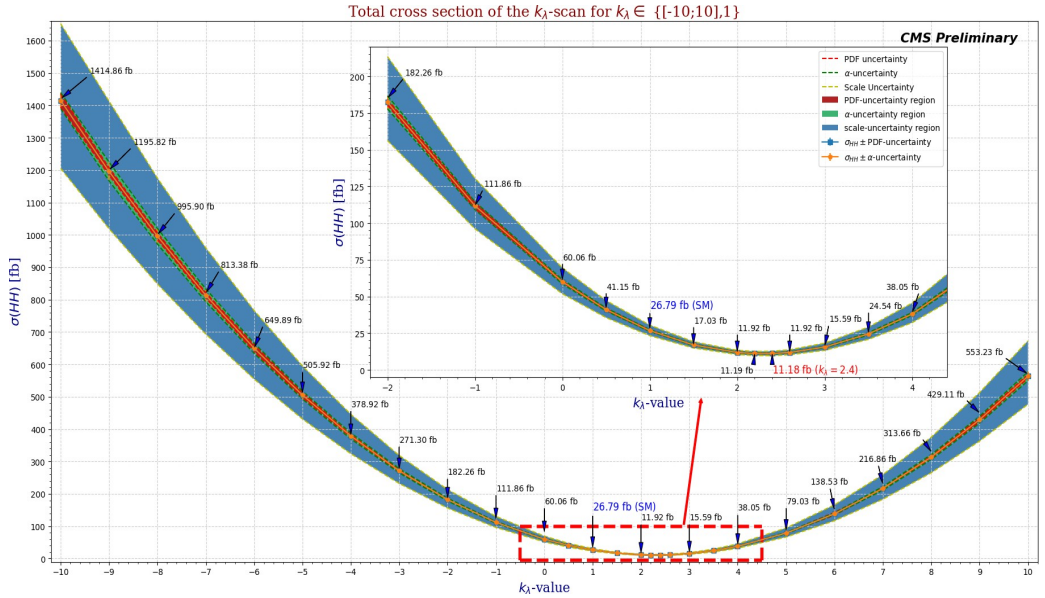
Ricerca non risonante e risonante di eventi di doppio Higgs nel canale HH→bbZZ→bb4l (I. margjeka, N. De Filippis, A. Taliercio s + Torino + FNAL et al.)

In the SM, the Higgs self-couplings are determined by the structure of the scalar potential:

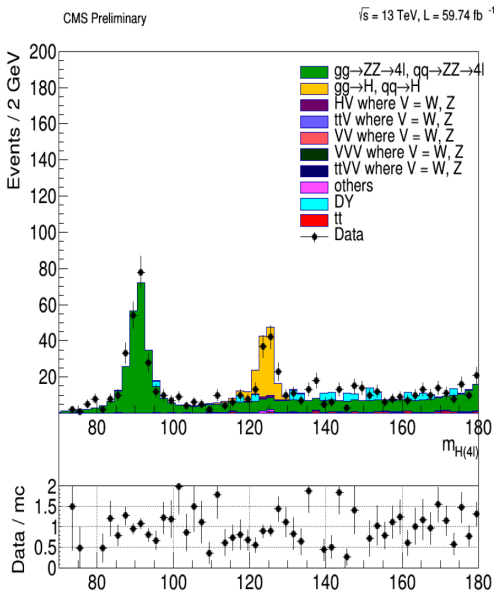
$$V = \frac{1}{2} m_H^2 H^2 + \lambda_{HHH}\, vH^3 + \frac{1}{4}\lambda_{HHHH} H^4, \qquad \lambda_{HHH} = \lambda_{HHHH} = \frac{m_H^2}{2v^2} \approx 0.13$$

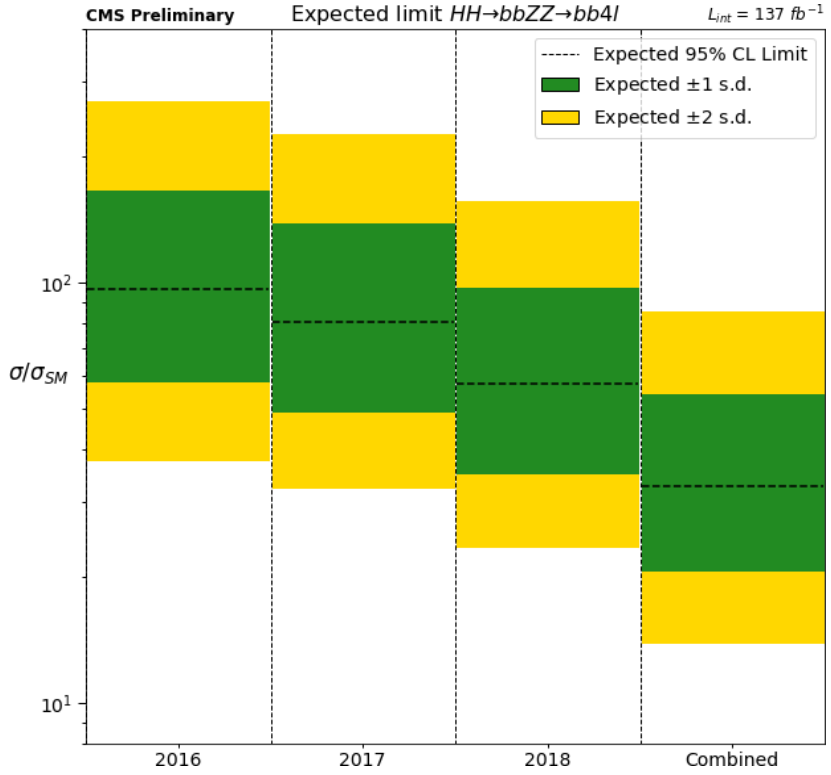


$$\sigma(14\,TeV)^{NNLO}_{FTapprox}\,[fb] = 36.69^{+2.1\%}_{-4.9\%}\,(scale) \pm 2.1\%(PDF) \pm 2.1\%(\alpha_s) \pm 2.7\%(top)$$



2018





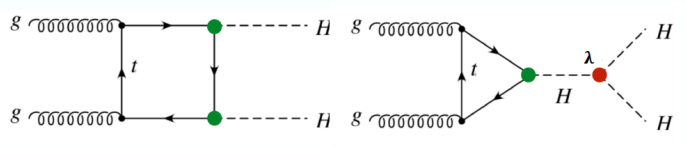
- Analisi non risonante pubblicata: AN-2019/117, PAS HIG-20-004
- Work on-going per l'analisi risonante.

Coordinamento articolo di combinazione delle analisi HH (1)

N. De Filippis

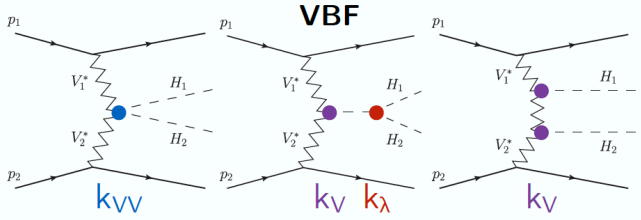
- Study two production modes

ggF



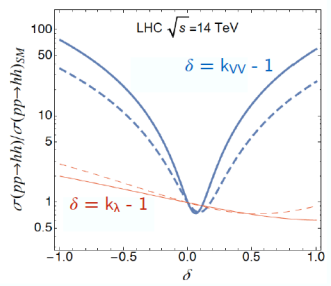
$\sigma = 31.05$ fb (13 TeV)
$= \sigma(k_\lambda, k_t)$

VBF

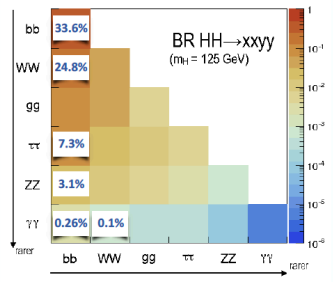


$\sigma = 1.73$ fb (13 TeV)
$= \sigma(k_\lambda, k_{VV}, k_V)$

- **ggF**: Negative interference between box and triangle diagrams
  - ▻ Largest interference at $k_\lambda \approx 2.45$
- **VBF**: Cross section greatly enhanced by non-SM k_{VV} configuration
  - ▻ Primary channel for studying quartic VVHH coupling
  - ▻ Expect sensitivity on k_{VV} although σ_{VBF} is small



- Considered decays
  - bb + (bb, $\gamma\gamma$, $\tau\tau$, WW, ZZ(4l))
  - WW$\gamma\gamma$
  - multilepton (WWWW + WW$\tau\tau$ + $\tau\tau\tau\tau$)



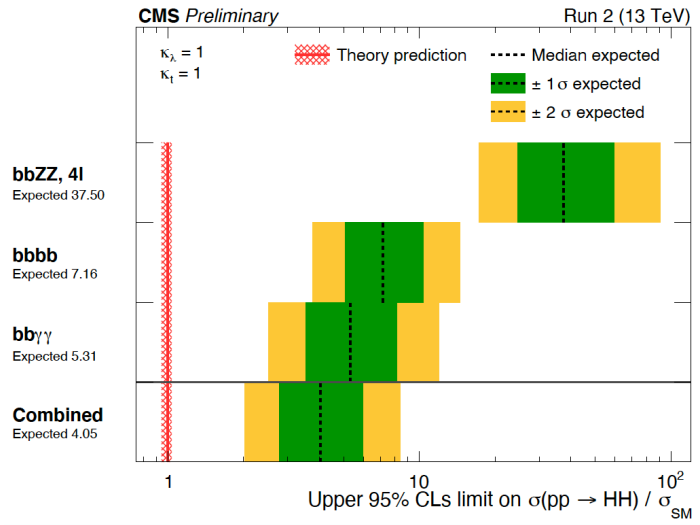
- **Channels**

		ggF	VBF
bbgg	- HIG-19-018 - ACCEPT	✓	✓
bbZZ(4l)	- HIG-20-004 - PAS-SUB	✓	
bbbb	- HIG-20-005 - PRE-APP	✓	✓
bbbb (boosted)	- B2G-21-001 - GoingToPreApp	✓	✓
bbtt	- HIG-20-010 - AWG	✓	✓
bbWW	- HIG-21-005 - AWG	✓	✓
multilepton	- HIG-21-002 - GoingToPreApp	✓	✓
WWgg	- - Finalizing	✓	

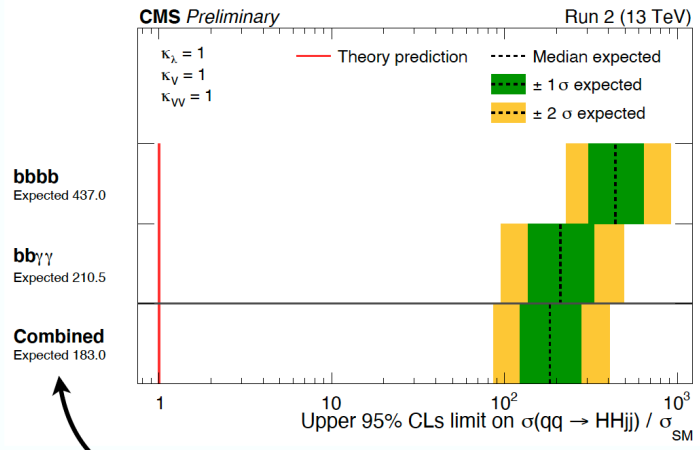
- **Combination**
  - HIG-20-011, aiming for summer conferences

Coordinamento articolo di combinazione delle analisi HH (2)

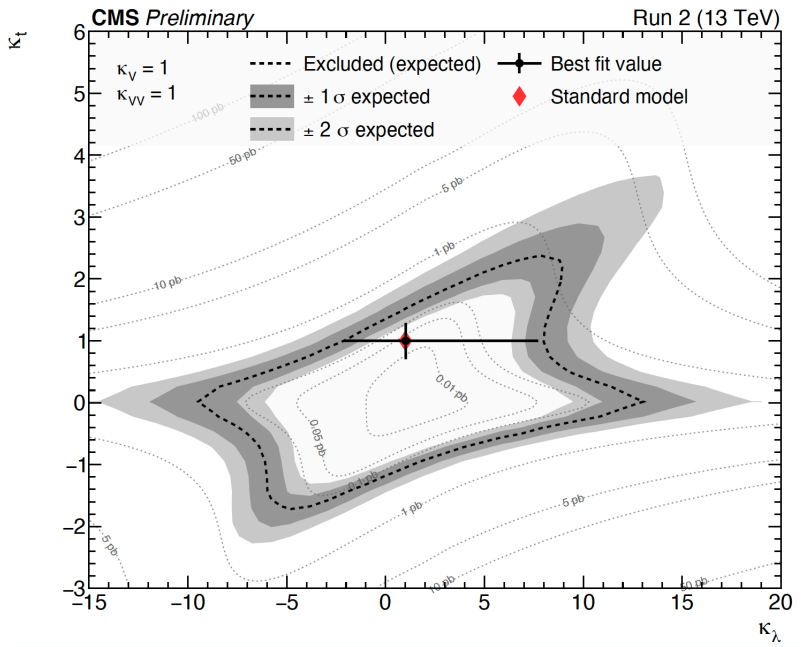
Inclusive (r)

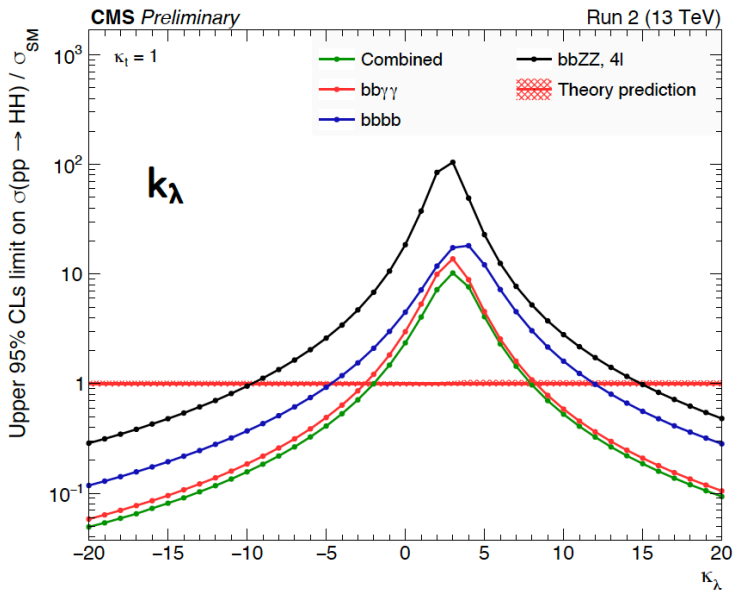


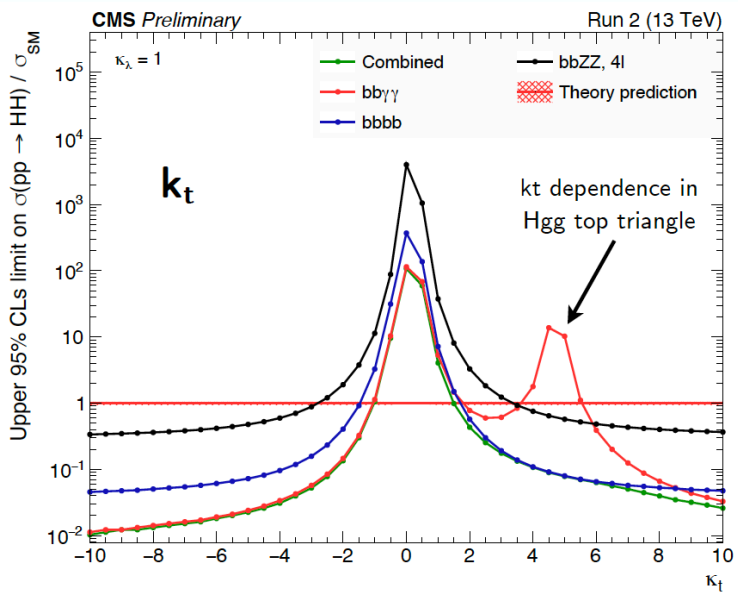
VBF (r_qqhh)

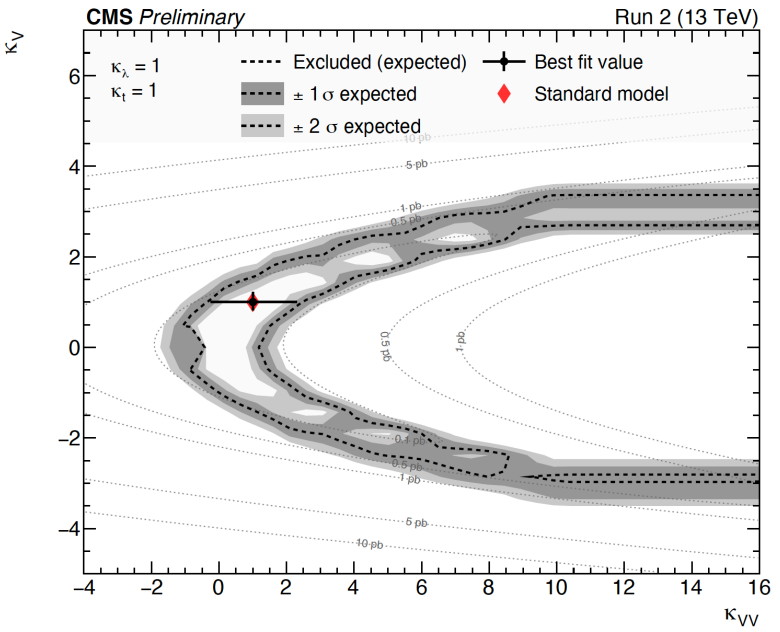


Contains bbzz4l cards







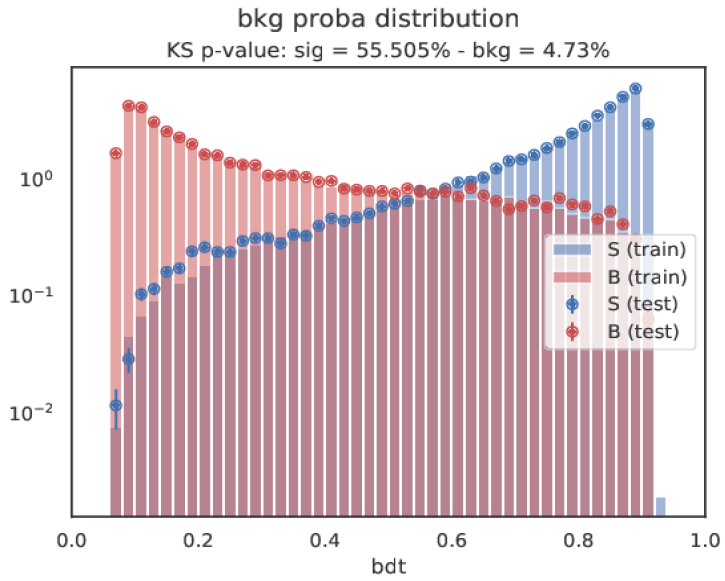


Attività di analisi per Run 2 (3)

The team: C. Aruta, A. Colaleo, M. Maggi, F. Simone, R. Venditti, P. Verwilligen

Search for $\tau \rightarrow 3\mu$ decays in Heavy Flavor channel

- Current upper limit on BR($\tau \rightarrow 3\mu$)= $2*10^{-8}$ by Belle 1
- CMS: HF channel: $\mathcal{O}(10^{13})$ τ produced~$\mathbf{10^5}$ $\boldsymbol{\tau \longrightarrow 3\mu}$ events
  - Challenge: low p_T muons mainly in forward region, background from combinatorial+fakes
  - Analysis approved on 2016 dataset : observed UL=$8.8*10^{-8}$
  - Goal is to beat Belle I with full Run 2 dataset:
    - Present UL ~ $4*10^{-8}$ on full 2018 dataset
    - **AN-20-102**
- Analysis optimization for Run3 data-taking. **Goal is to be competitive with Belle II.**



Status:

- analysis workflow fully implemented, together with main systematic uncertainties
- 2017 and 2018 datasets and MC samples UltraLegacy are being used (following CMS Physics-coord. recommendation)
- last update on analysis status at BPH Exotica-and-Rare Decays subgroup in feb 2021
- full synchronisation with group working on W channel
- documentation completion in progress (AN-20-102)

Next:

- custom tools (MVA-based) for muon ID and reconstruction implemented, muon reco. scale factors computed for custom ID: will be presented in a dedicated talk at muon POG soon (within few weeks)
- will plan soon next update at BPH group meeting to start review phase

Attività di analisi per Run 2 (4): B-physics & quarkonia

- **A. Pompili "B-Physics" (BPAG) convener (L2)**, Sept.2019-21

  + CMS representative in HFLAV cross-experiment group since 2018 [https://hflav.web.cern.ch/ **]**

  "*Averages of b-hadron, c-hadron, and τ-lepton properties as of 2018*» accepted by publication by EPJC

- **S. Lezki + A.P. + A. Di Florio + CMS CINVESTAV (**Mexico City**) [Progetto MAECI** Italia-Messico 2018-2020**]**

  - Inclusive search for exotic X_b state [b-partner of X(3872)**] in the final states** $\chi_{b1}(1P)\pi\pi$ & $\Upsilon(1S)\pi\pi$ (pre-approval in the fall)

  - Production studies of the excited B_c states in pp collisions at 13 **TeV** [relative Xsections of $B_c^{(*)+}(2S)$] (BPH-19-001) (going to FR)

- **V. Mastrapasqua + A.P. + N. Sur (TIFR)**

  - Charged exotic *Z* spectroscopy with the 3-body decay $B_d^0 \to J/\psi K\pi$
  (full amplitude fit on GPUs) [BPH-14-003**]**

  (thesis endorsement; to be continued)

  - B_c spectroscopy (Run-2/B-parking**)**
  - HLT for Run-3 & HLT Validation

- **A. Di Florio (L3 Tracking @ HLT,** BPAG *Combine* contact**) + A.P.**

  - Inclusive search for exotic *X(4140)* state & partners in $J/\psi\,\phi$ **final state**
  (pre-approval in the fall)

$$R^+ \equiv \frac{\sigma(B_c^+(2S))}{\sigma(B_c^+)} \cdot \mathcal{B}(B_c^+(2S) \to B_c^+ \pi^+\pi^-) = \frac{N(B_c^+(2S))}{N(B_c^+)} \frac{\epsilon(B_c^+)}{\epsilon(B_c^+(2S))},$$

$$R^{*+} \equiv \frac{\sigma(B_c^{*+}(2S))}{\sigma(B_c^+)} \cdot \mathcal{B}(B_c^{*+}(2S) \to B_c^+ \pi^+\pi^-) = \frac{N(B_c^{*+}(2S))}{N(B_c^+)} \frac{\epsilon(B_c^+)}{\epsilon(B_c^{*+}(2S))},$$

$$R^{*+}/R^+ = \frac{\sigma(B_c^{*+}(2S))}{\sigma(B_c^+(2S))} \cdot \frac{\mathcal{B}(B_c^{*+}(2S) \to B_c^+ \pi^+\pi^-)}{\mathcal{B}(B_c^+(2S) \to B_c^+ \pi^+\pi^-)} = \frac{N(B_c^{*+}(2S))}{N(B_c^+(2S))} \frac{\epsilon(B_c^+(2S))}{\epsilon(B_c^{*+}(2S))}.$$

@LHCP