Measurement of gluon jet fraction and characteristics of quark and gluon jets produced in pp collisions at the CMS detector

D.Budkouski, S.Shulha

56th meeting of the PAC for particle physics
24 January 2022

What interested in

- g-jet fraction in jet sample (α^g) is measured according to fit equation:

$$H(D) \sim \alpha^g H^g(D) + (1-\alpha^g) H^q(D),$$

S.S., Zarubin A., Shmatov S. CMS AN-2018/131

where $H(D)$ - measured discriminator distribution, $H^{q/g}(D)$ – q/g-jet discriminator distribution

- $H^{q/g}(D)$ – depends on model
- It is **the first measurement** of g-jet fraction

- Obtaining characteristics of jet:
  - Let jet sample characteristics O is linear combination of q/g-jet characteristics $O^{q/g}$:

$$O = \alpha^g O^g + (1-\alpha^g) O^q$$

  - Take two jet sample with different g-jet fraction and solve system of equations:

$$\begin{cases} O_1 = \alpha_1^g O^g + (1-\alpha_1^g) O^q \\ O_2 = \alpha_2^g O^g + (1-\alpha_2^g) O^q \end{cases}$$

- This method was improved taking into account differences in q/g-jet characteristics from different channel:

S.S., D.B. PEPAN Lett., 2021, Vol. 18, No. 2, pp. 239–243

From history

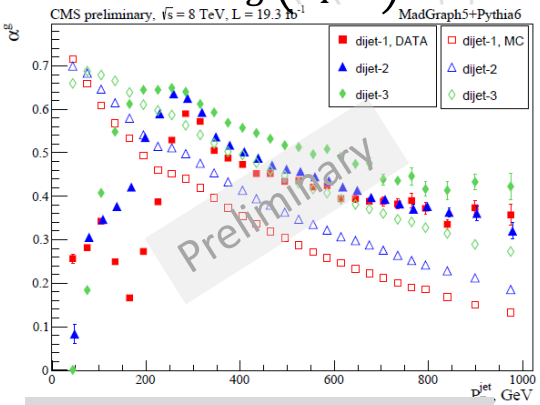
- In **2015**, a **suppression of gluon jets** was detected in semi-leptonic $t\bar{t}$-channel (CMS/Run1). This conclusion indirectly followed from the comparison of charged-particle multiplicity (CPM) in samples of "g-enriched" and "q-enriched" jets. Expected difference of CPM between samples was not observed

Zarubin A., Shmatov S., S.S.
CMS AN-2015/217

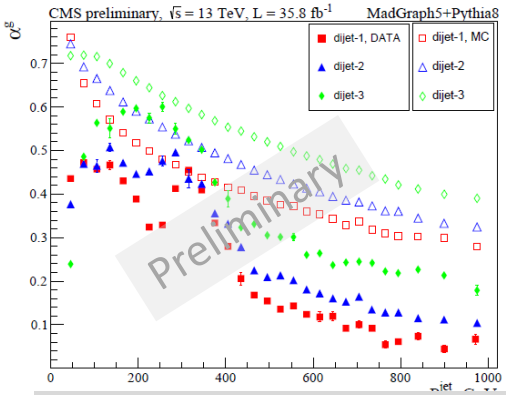
- In **2018**, in our group a method for direct measurement of g-fraction, α_g was proposed. This method was applied for semi-leptonic $t\bar{t}$ channel (CMS, Run1). The phenomenon of g-jet suppression was **qualitatively confirmed**. For quantitative conclusions, it is necessary to increase the statistics of jets

Zarubin A., Shmatov S., S.S.
CMS AN-2018/131

- In **2020**, measurements of α_g were made in "g-enriched" channel "dijets" (Run1/Run2). Tricky dependencies of $\alpha_g\left(P_T^{jet}\right)$ have been found. The suppression of g-jets has also been confirmed



Run I, jets anti-k_T, R=0.5



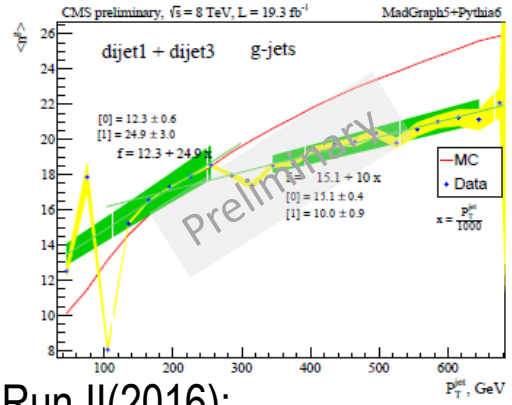
Run II, jets anti-k_T, R=0.4

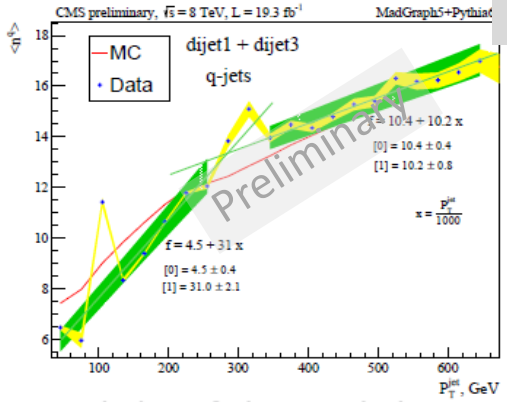
S. S., D. B. CMS AN-2020/143

Measurements of mean q/g-jet CPM's

- To measure the characteristics of q/g jets based on the measured α_g, a technique based on the two-sample method has been developed. **S. S., D.B. PEPAN Lett., 2021,V.18, p.239-243**

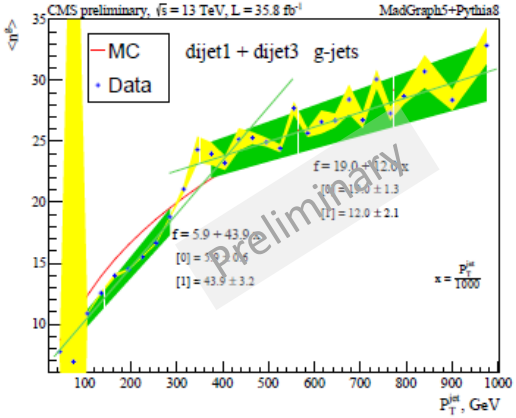
- In **2021**, measurements of **mean CPM's in q/g-jets** were completed and the results were shown at the "SMP-Jet WorkShop" (February 2021)
- Results for Run I(2012):

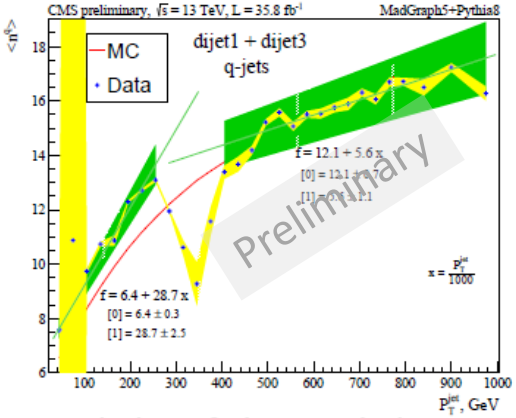




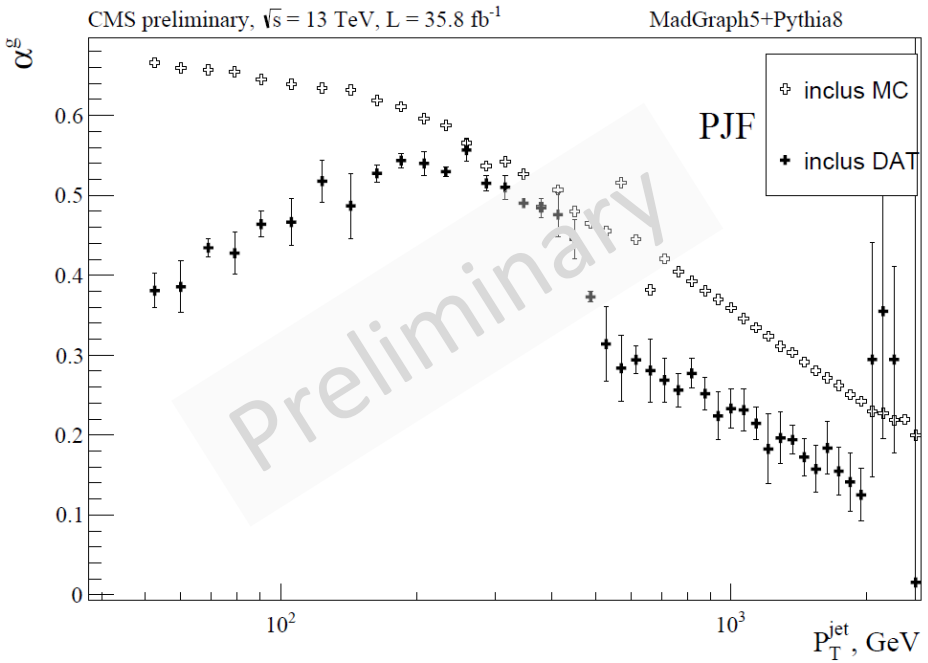
S. S., D. B. CMS AN-2021/024

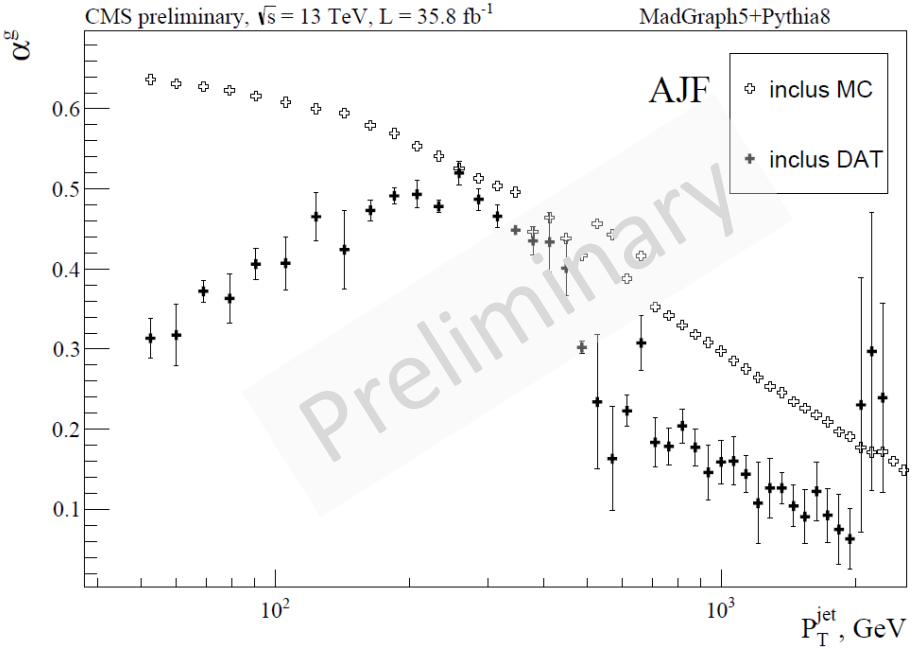
- Results for Run II(2016):

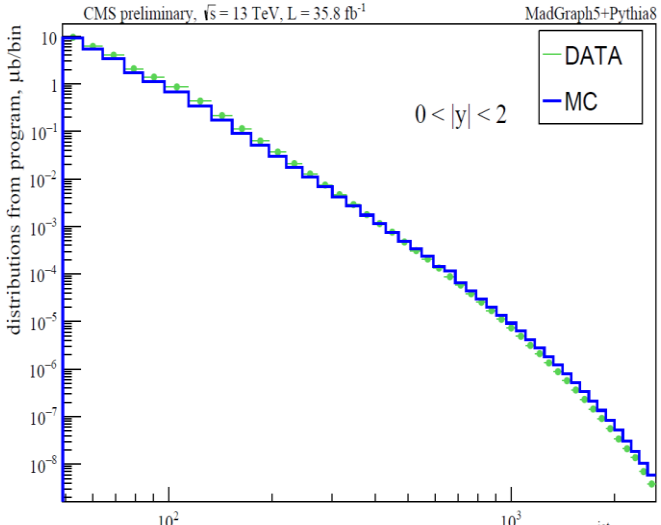




G-jet fractions in inclusive jet samples (Run-II, 2016)







- We confirm the suppression of g-jets at low P_T^{jet} in inclusive jet samples (Run-II, 2016)
- Gluon jet suppression phenomenon, observed in 2015 in a semi-leptonic $t\bar{t}$-channel (Run1), is universal
- Possible explanation – gluon splitting

Status and outlook

- In **2020**, a group from University of Ioannina (Greece) presented preliminary measurement results for the **inclusive jet channel** based on 2016 data (CMS/Run2), taking into account **trigger prescaling**. This will make it possible to compare measurement results with generator (theoretical) values.
- This group showed approximate coincidence of α_g in the data and in MC. In this work, the officially recommended "**scale factor**" method was used.
- In our group a n**ew** data-driven "**scale factor**" was proposed
- Since April 2021, we have been working **together** with University of Ioannina group. The first joint results will be presented for the CMS collaboration in January-February 2022