b-Tagging for High-P_T and for ITk Layout

Exotic Searches using Di-bjets

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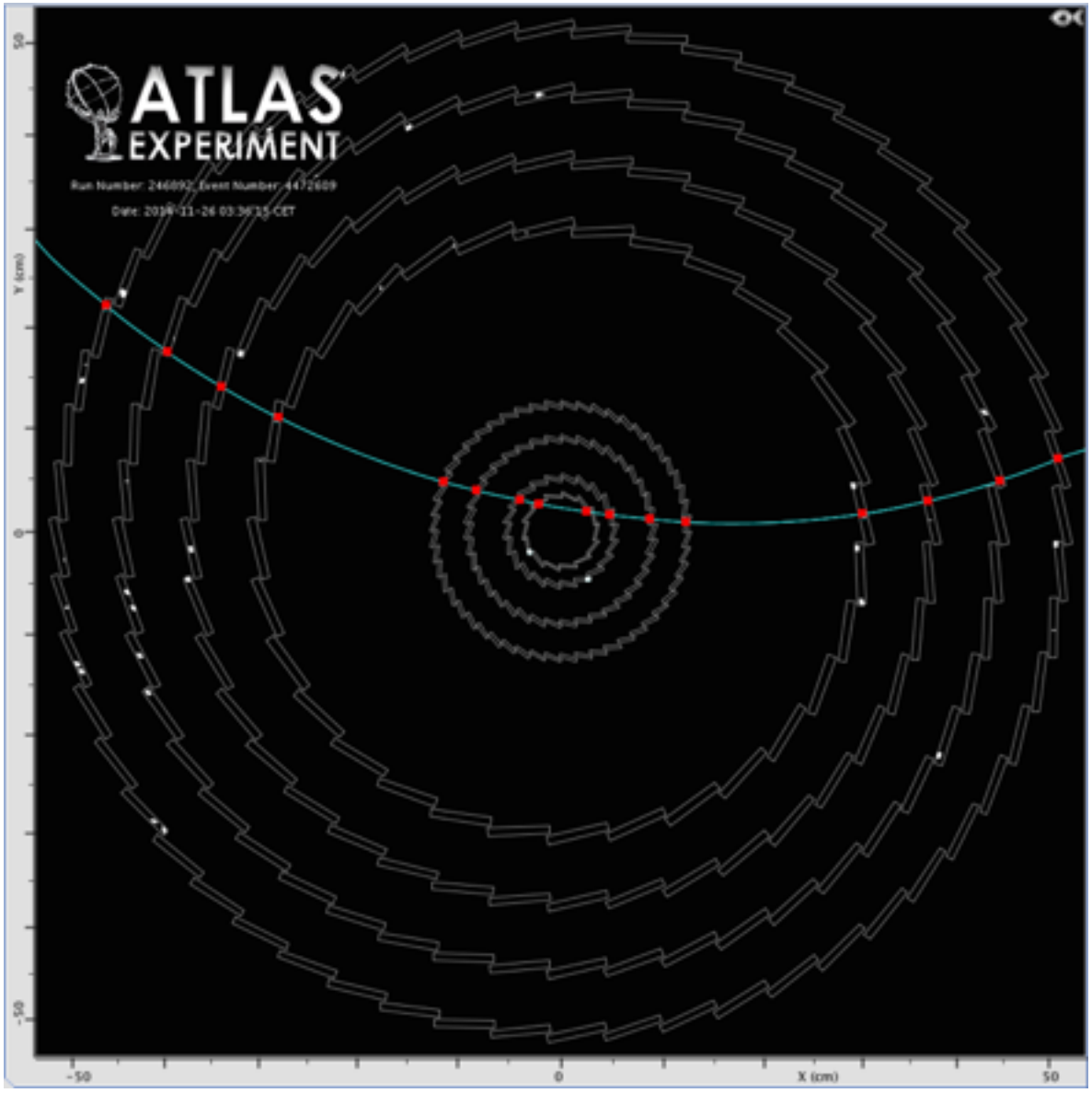
Also: Andreas, Tim, Andy, Katharine, Ines.

20 February 2015

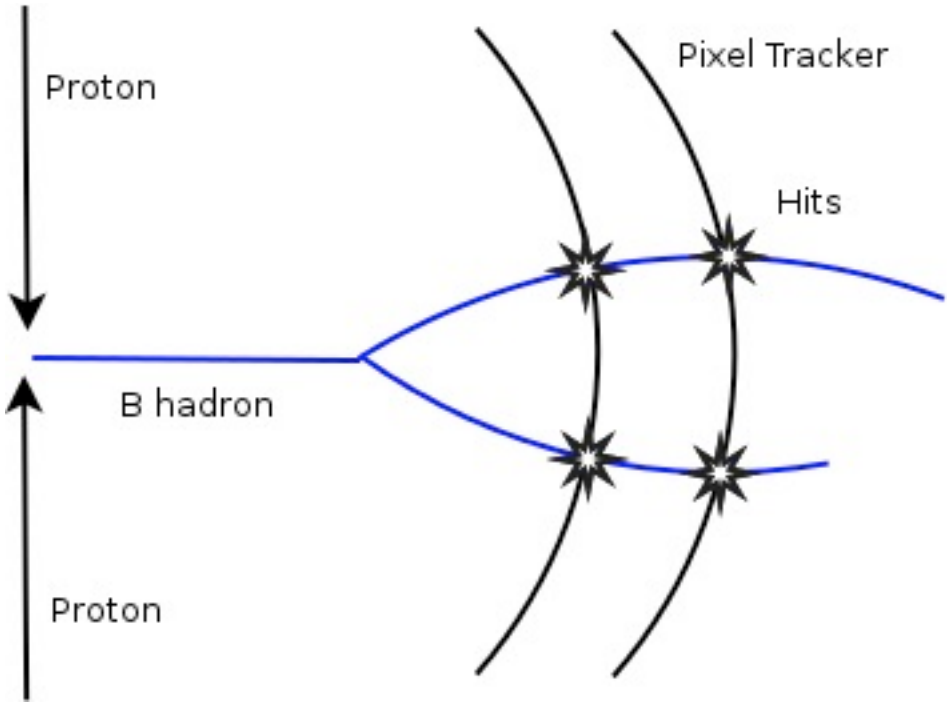
Silicon Tracker at ATLAS

- Four Cylindrical Pixel Layers close to Beam Pipe

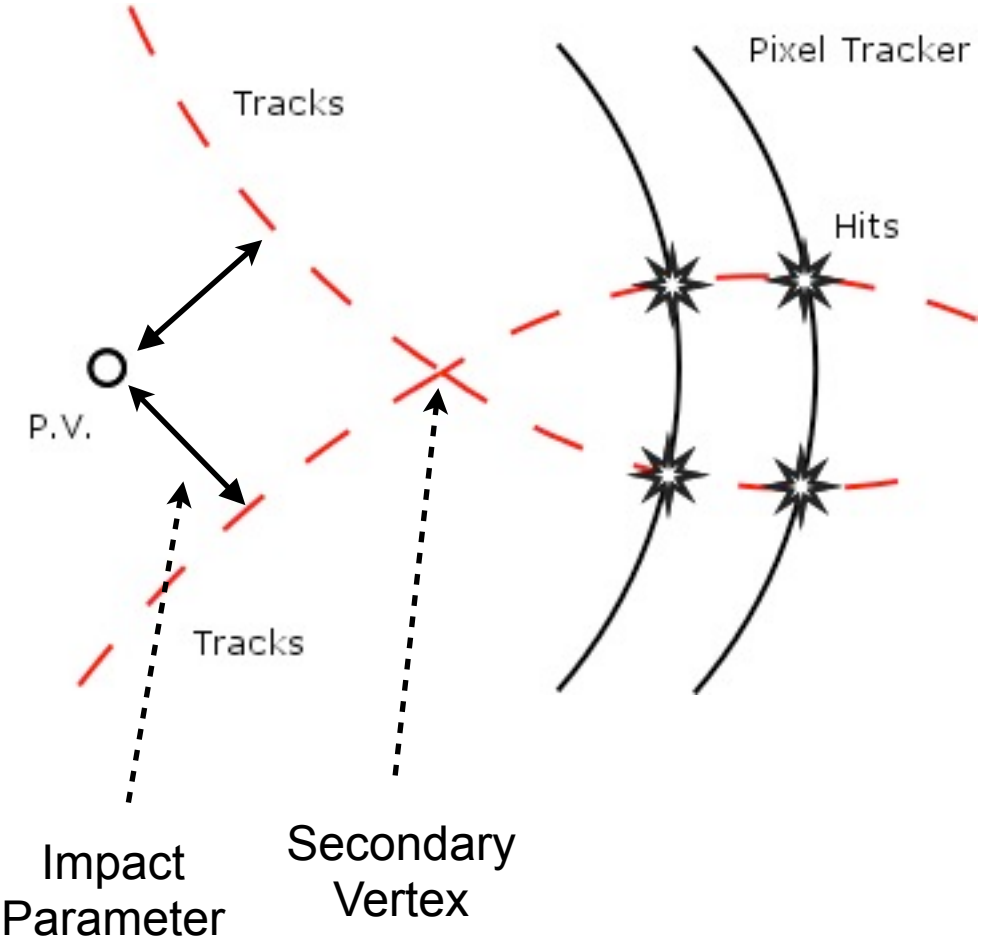
- Insertable B-Layer (IBL) added at 33mm in 2014 to improve b-tagging performance.



B-tagging



B-tagging - IP and SV



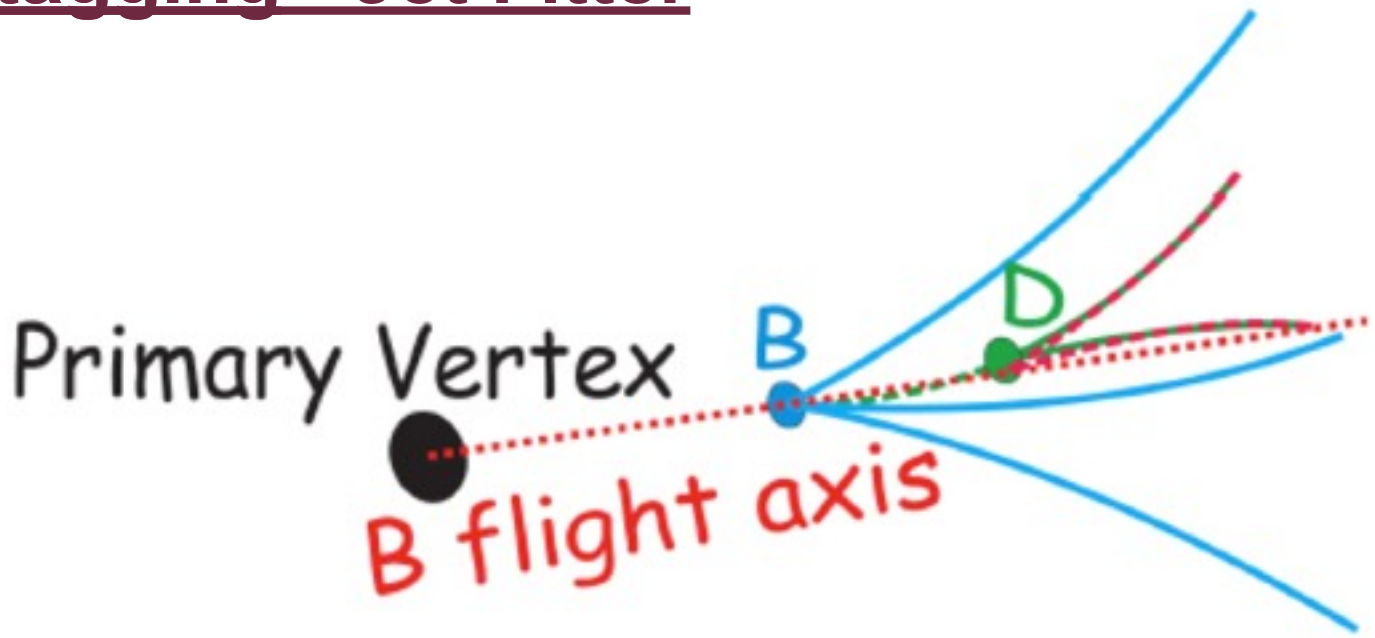
IP3D

- Look for tracks with a large impact parameter significance = (I.P. / σ)

SV1

- Identify a secondary vertex
- Look for large flight path significance = (F.P. / σ)

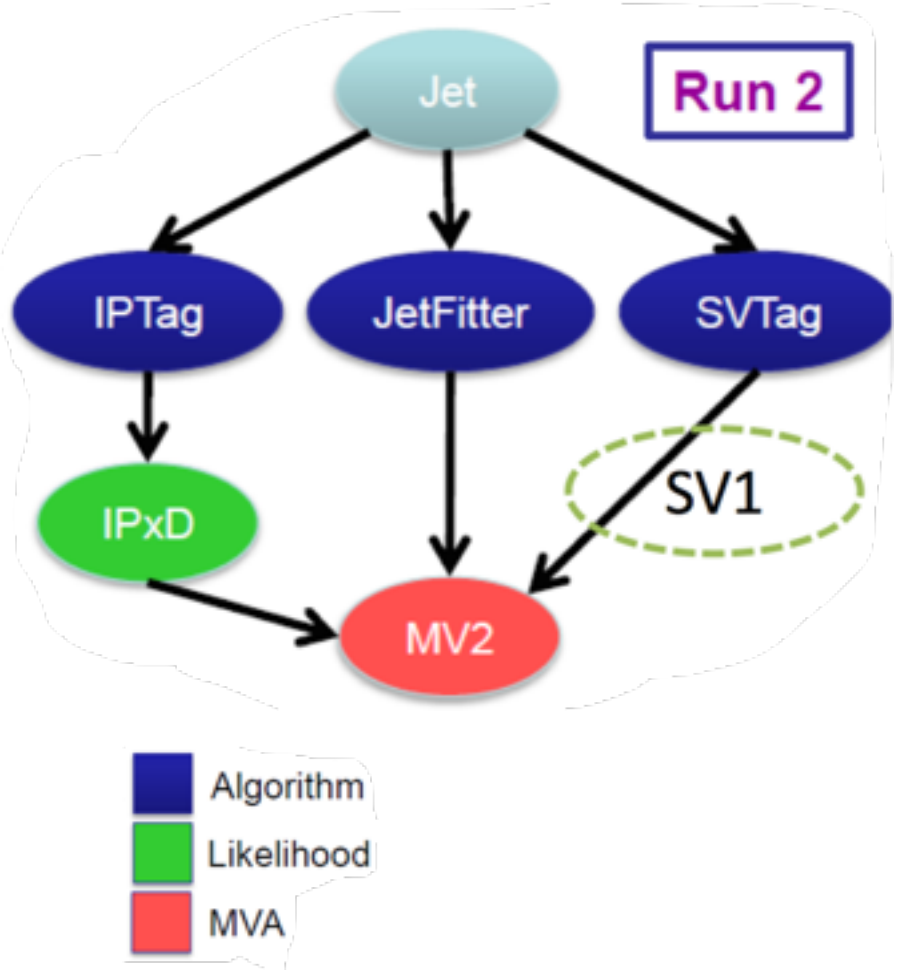
B-tagging - Jet Fitter

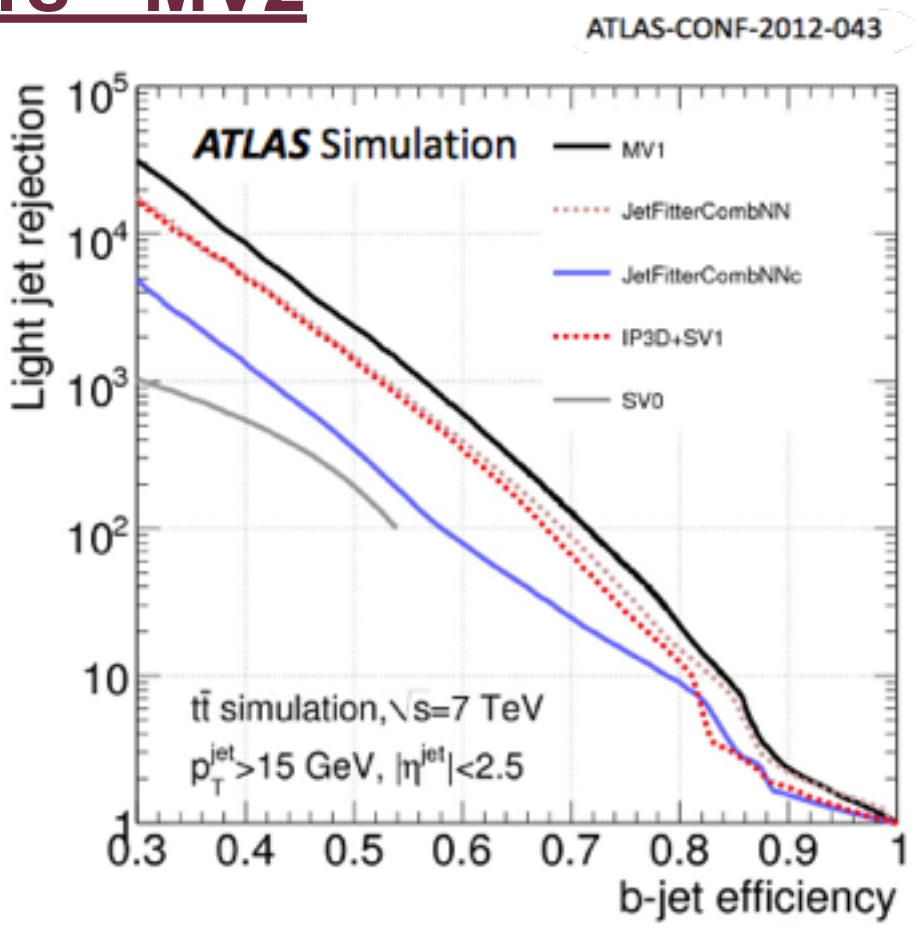


• Reconstruct the decay chain of the B hadron by reconstructing the secondary and tertiary vertices, which correspond to B and D meson decays.

• Assume that these vertices lie on the same line, the B flight axis.

Multi-Variate B Taggers - MV2

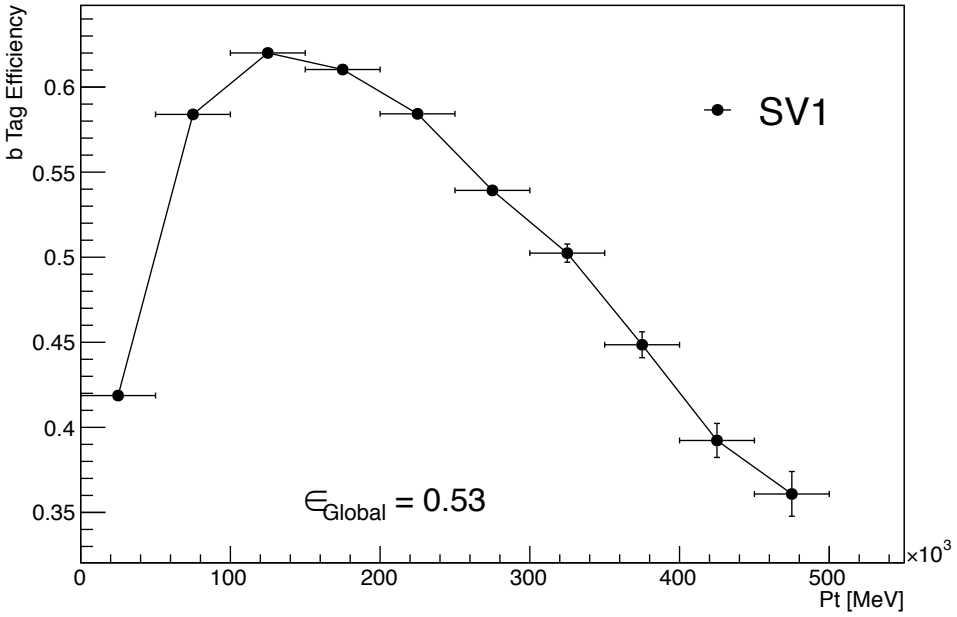




- Can combine the basic algorithms in a neural network.
- This leads to improved performance

Problems at High P_T

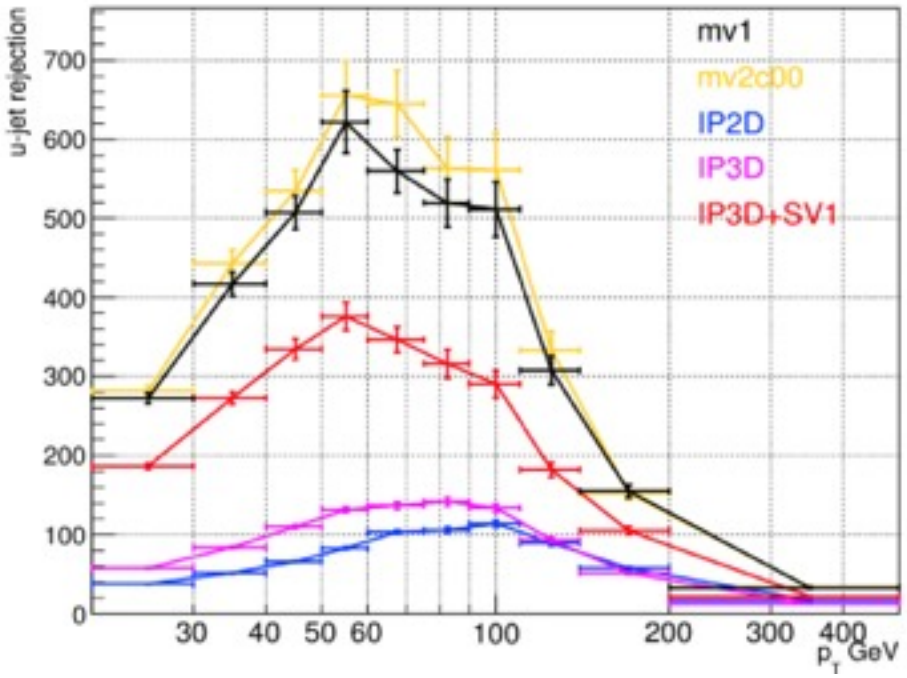
First Look at R20 - Yulia Rodina



Global Cut Efficiency = 0.53

For a fixed discriminant cut
SV1_llr > 4.5

13TeV ttbar

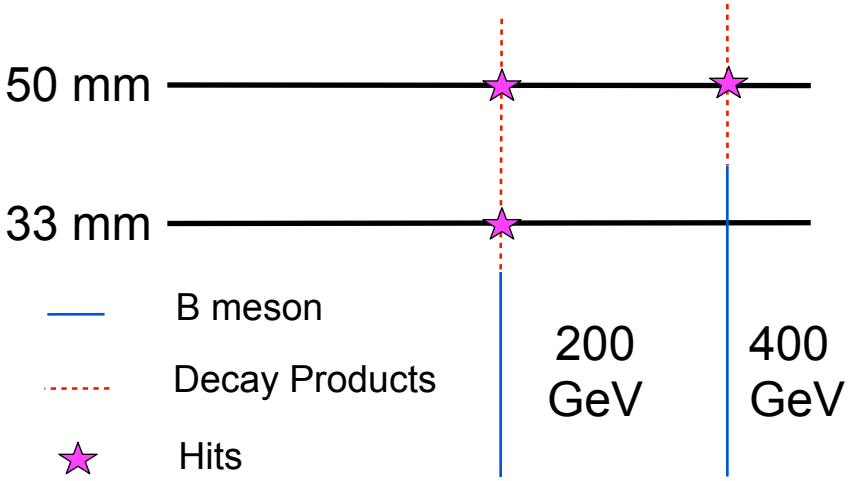


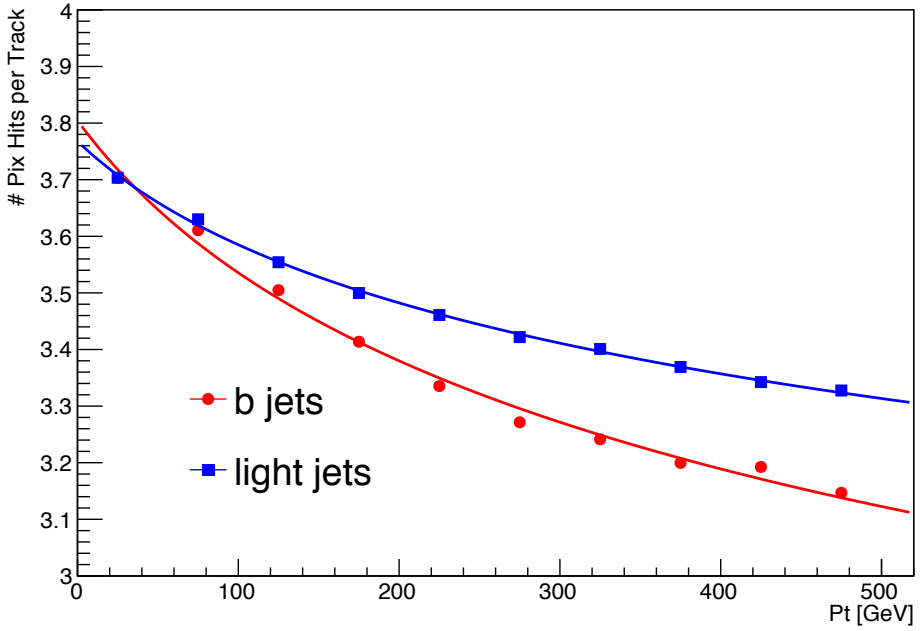
Flat Cut Efficiency = 0.7

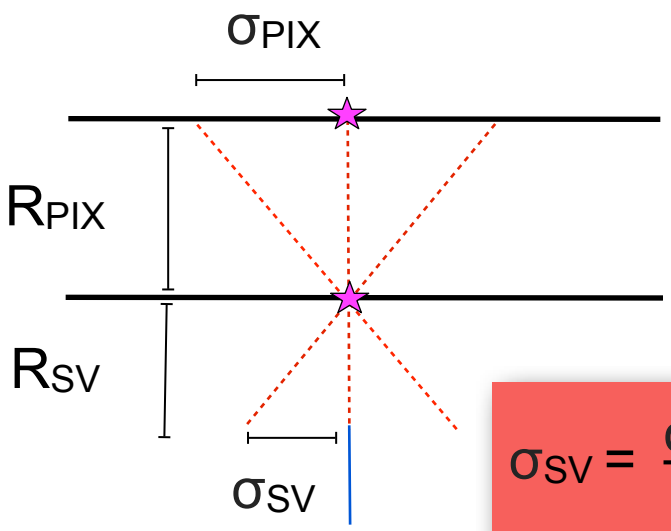
13TeV ttbar

Problems at High P_T - Lifetime

B_0 Meson	$c\tau \sim 450\mu m$
P_T ~ 200 GeV	$vt \sim 20mm$
P_T ~ 400 GeV	$vt \sim 40mm$







$$\sigma_{SV} = \frac{\sigma_{PIX} R_{SV}}{R_{PIX}}$$

Problems at High P_T - Boost

- Each track has a trajectory error associated with it from reconstruction.

➡ These errors can be visualised as a “tube” around the track.

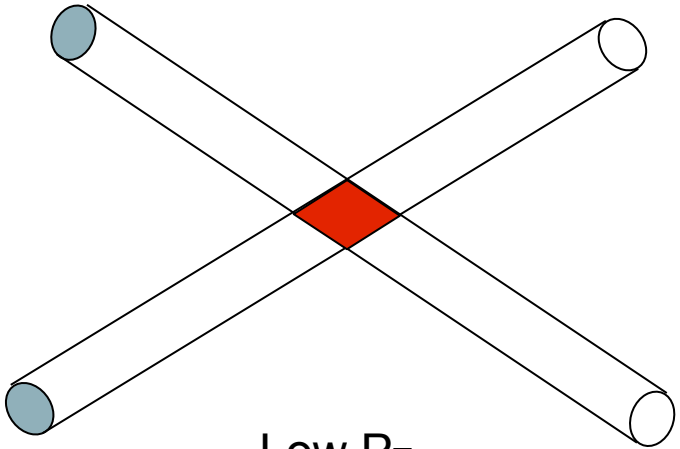
- Verities are constructed from two tracks crossing

➡ The error on the position of the vertex is the overlap of the two “tubes”.

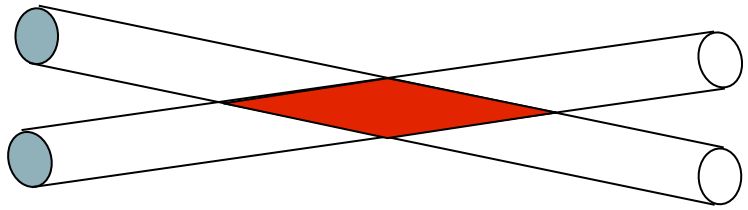
- At high P_T the jet becomes boosted, and tracks lie closer together

➡ This leads to larger errors on the vertices.

➡ Also we will get more fake vertices.



Low P_T

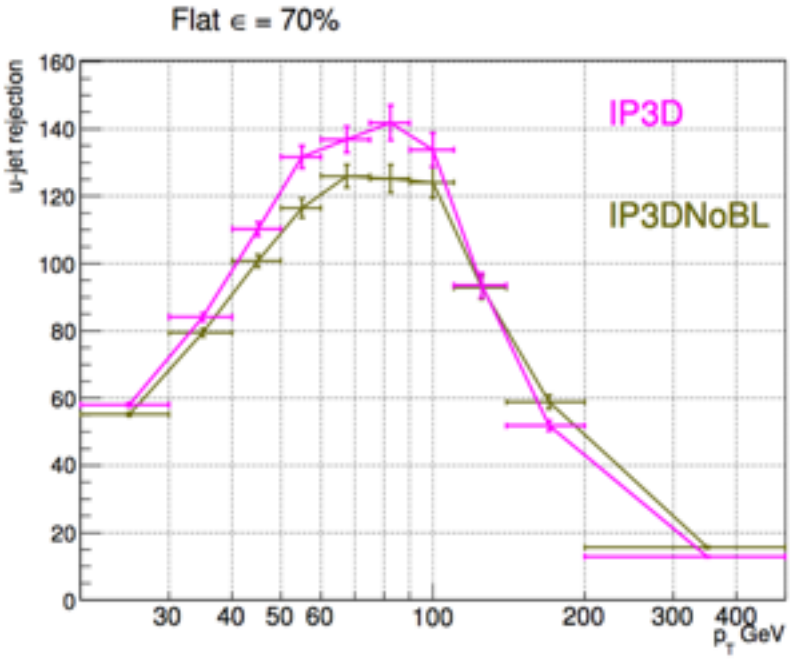


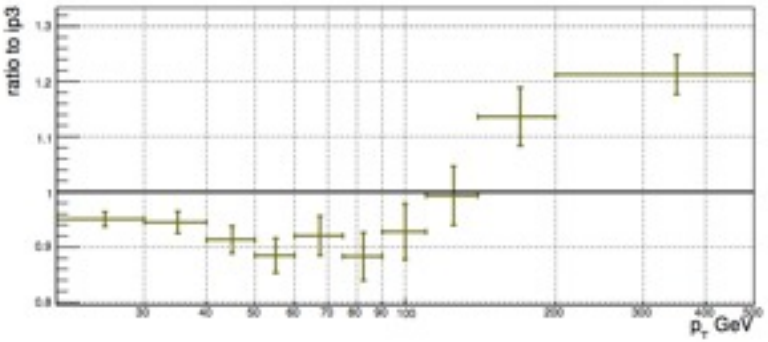
High P_T

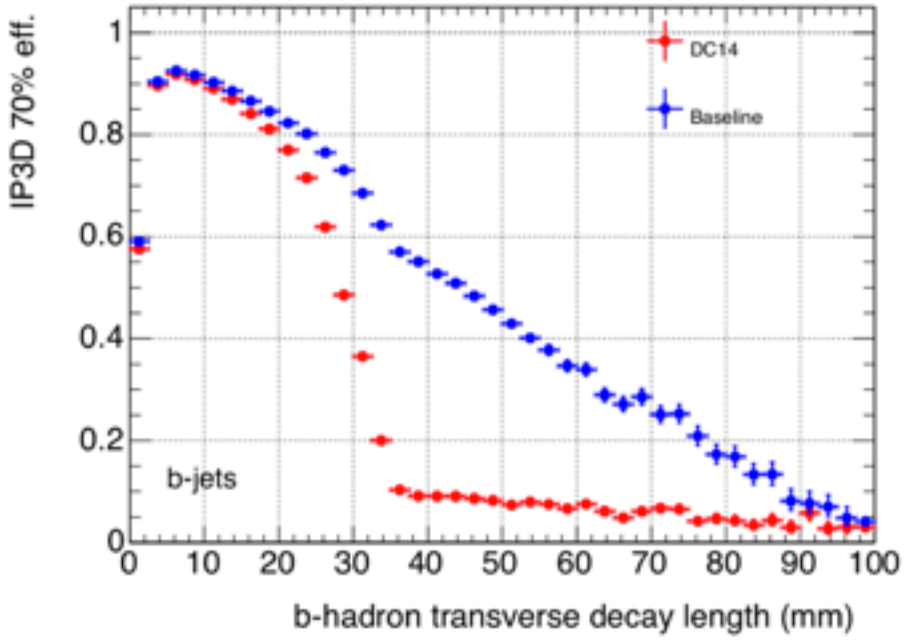
Improving BTag at High P_T

From Michaël Ughetto's Talk at Flav Tag Workshop

Dropping Requirement of IBL Hit IP3D Alg.



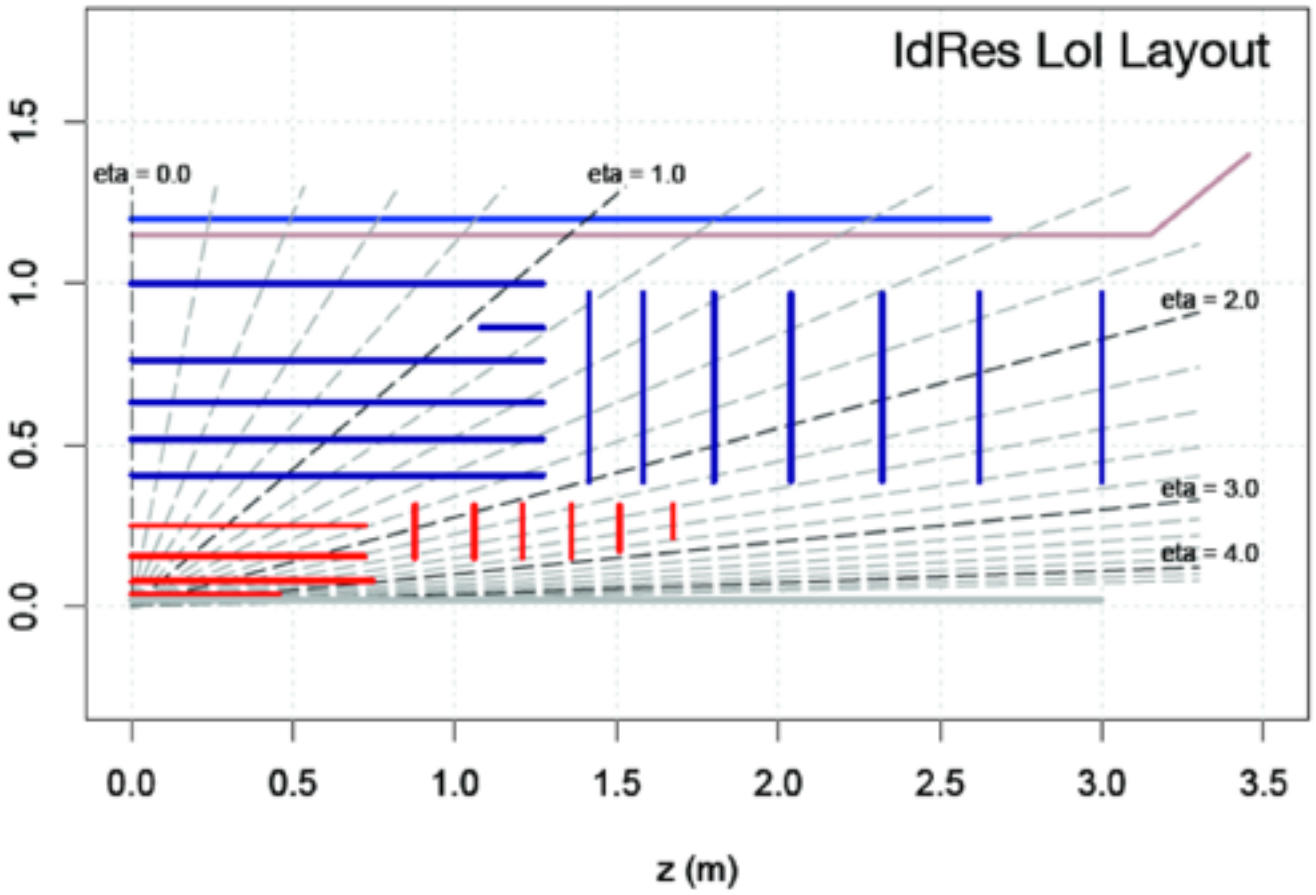




Baseline means retagged without IBL requirement

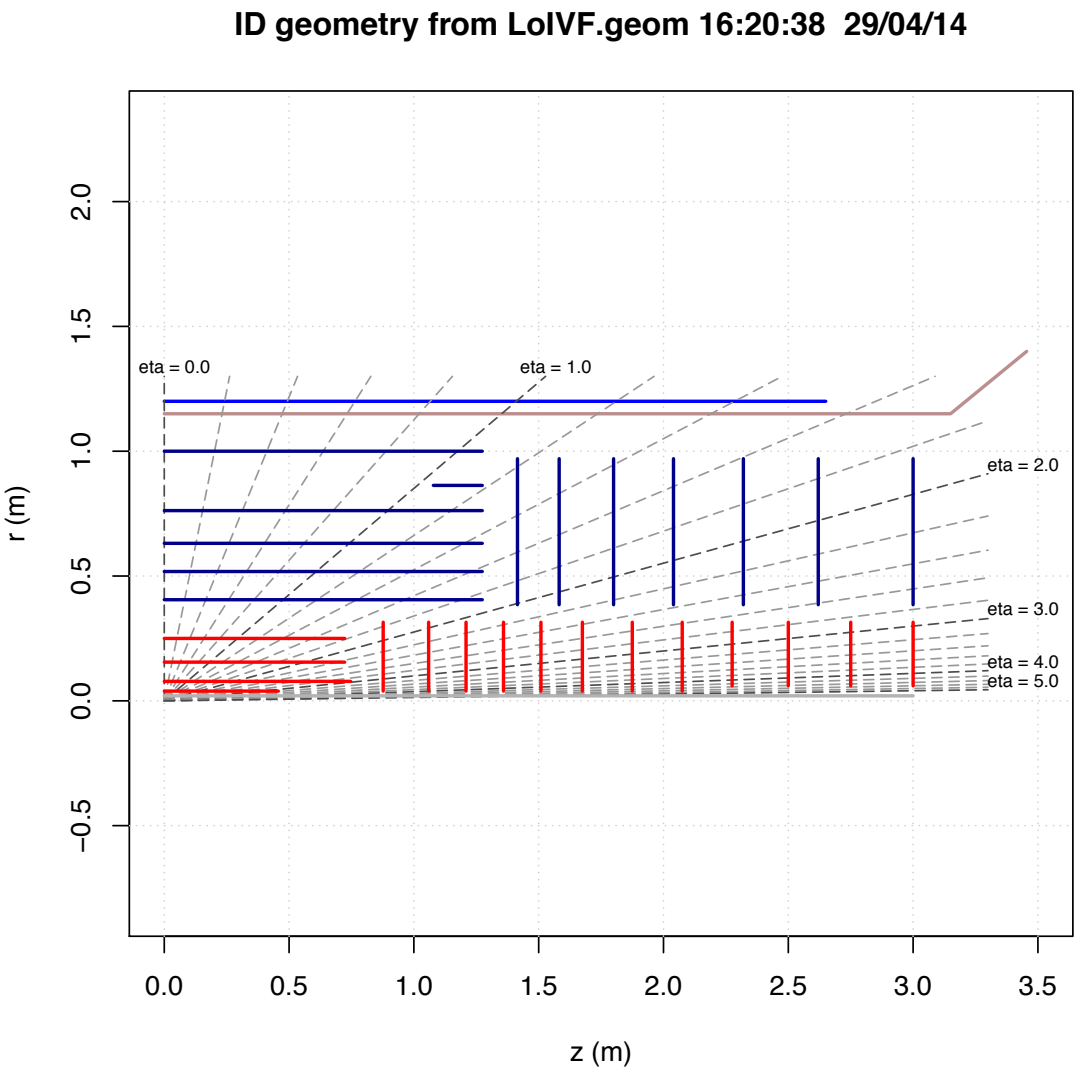
We need to create a new set of cuts for high-P_T b-tagging

B-tagging in the ITk Layout



- New geometry required to deal with higher LHC luminosity after 2022 shutdown.
- Many layouts in discussion.
- Need to determine optimal b-tagging performances of layouts.

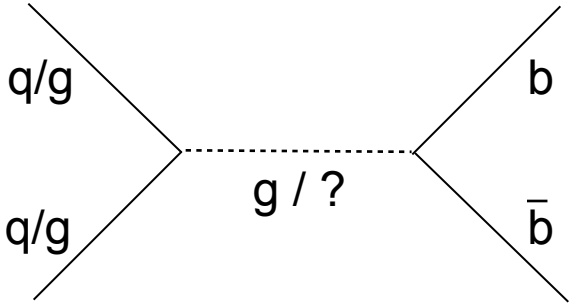
Very Forward ITk Layout

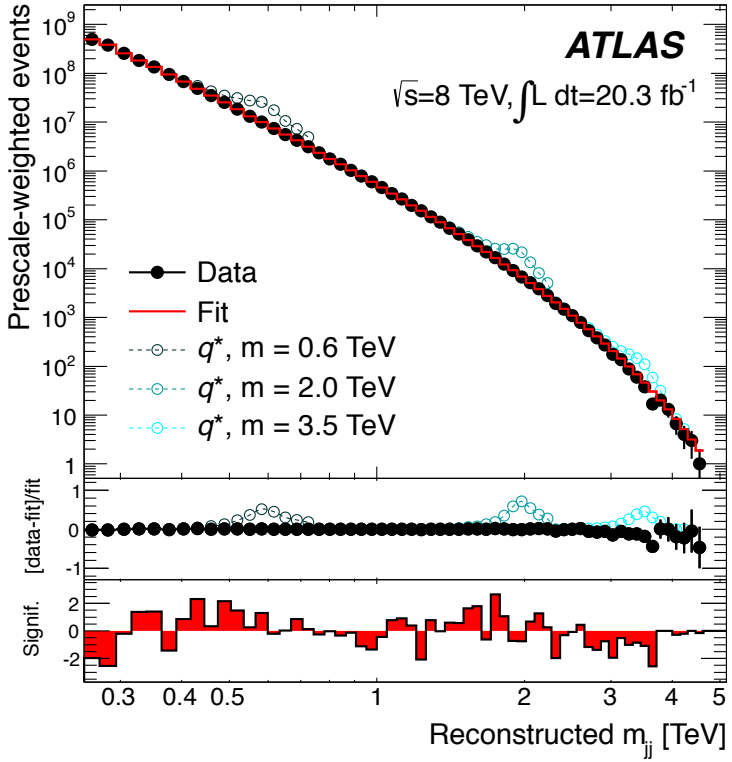


- VF layout has coverage out to eta = 4

➡ New regime for b-tagging

Exotic Searches in Di-bjets





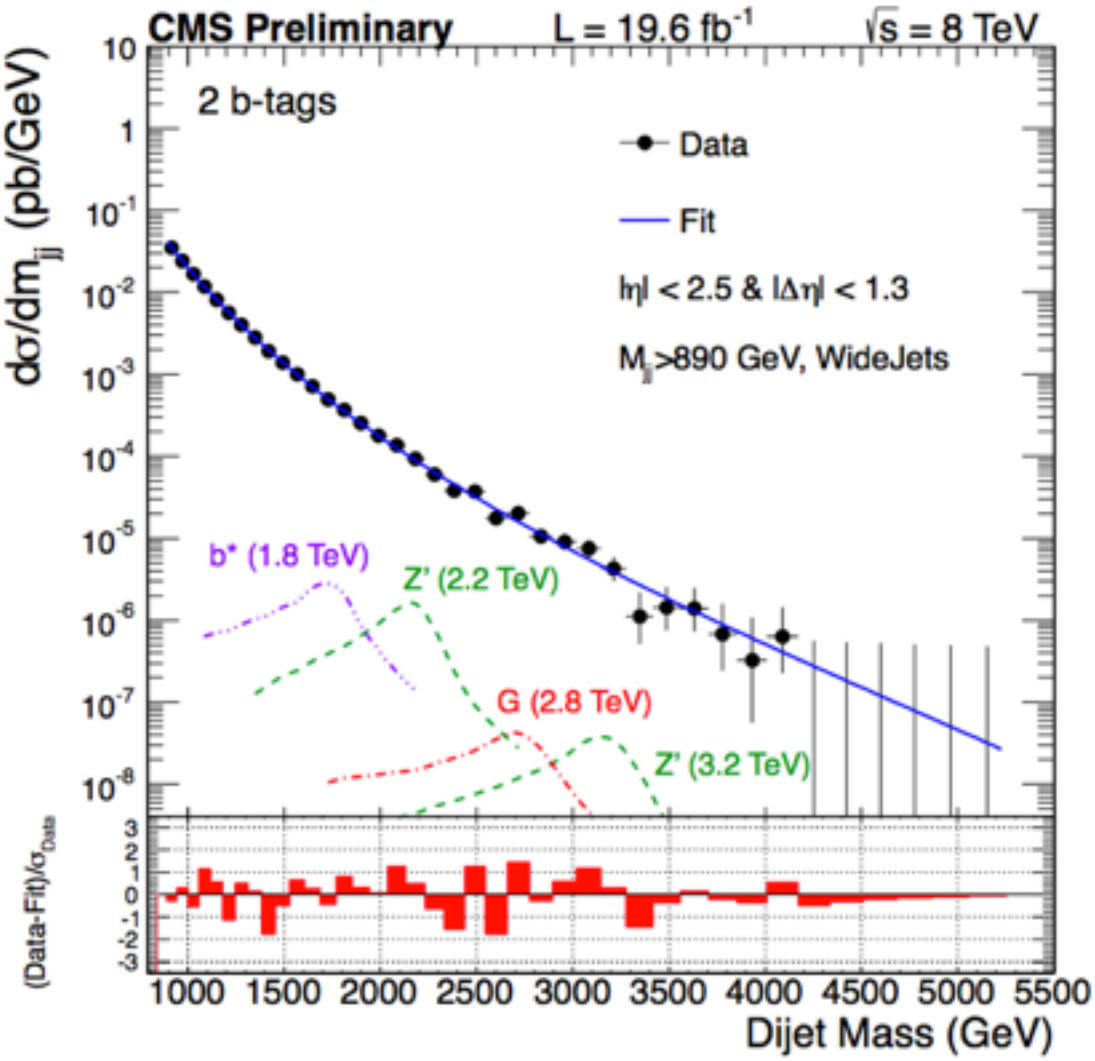
- Search for pairs of b-tagged jets.
- Di-jets is one of the most sensitive probes of new physics at high masses.
- Many BSM models predict resonances that have decays to $b\bar{b}$ as it is a member of the third generation of quarks.

Challenges

- We require effective b-tagging at extremely high-p_T (~1TeV)
- Uncertainties from the b-jet energy scale

Backup

CMS Di-b-jets


CMS Preliminary
L = 19.6 fb-1
√s = 8 TeV
2 b-tags
Data
Fit
|η| < 2.5 & |Δη| < 1.3
Mjj >890 GeV, WideJets
b* (1.8 TeV)
Z' (2.2 TeV)
G (2.8 TeV)
Z' (3.2 TeV)
dσ/dmjj (pb/GeV)
(Data-Fit)/σData
Dijet Mass (GeV)

B-Efficiency - P_T : All Taggers