High p_T b-tagging

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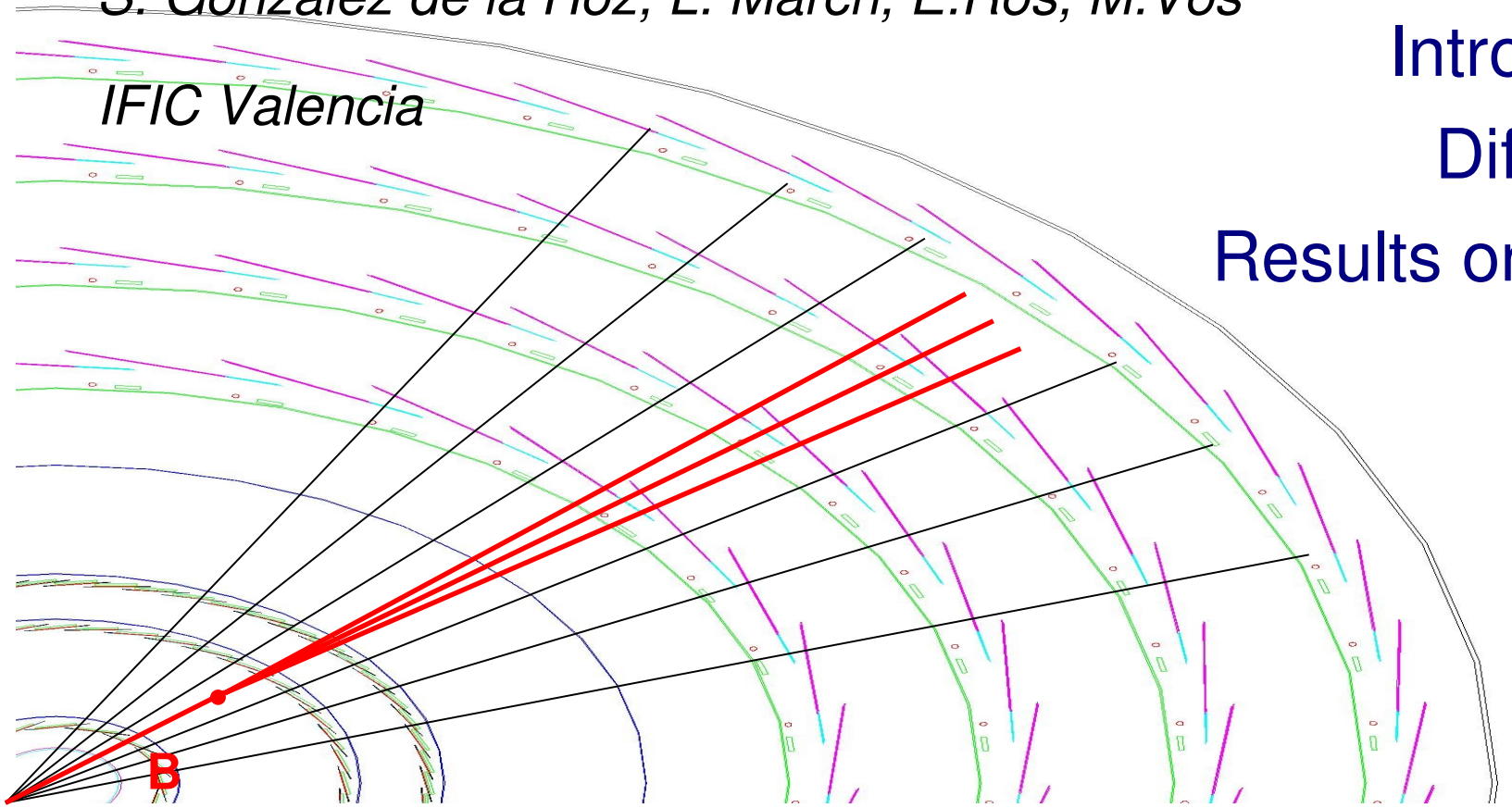


Introduction

Difficulties

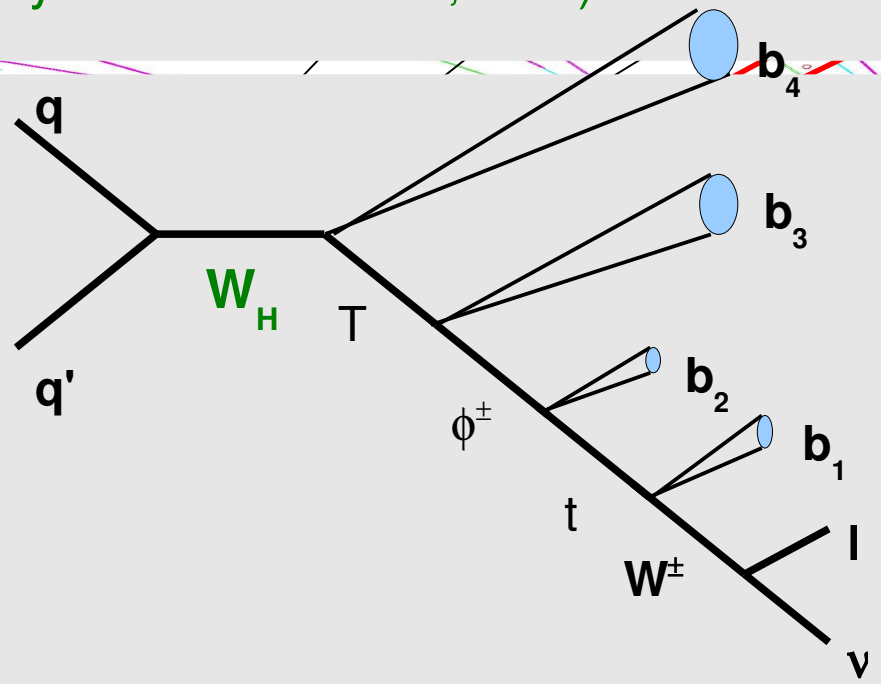
Results on 12.0.6

http://ific.uv.es/~vos/Atlas/BTagging/

Physics case for high p_T b-tagging

Typically cater for exotic physics searches (hadronic decay of heavy resonances), but also the tail of Standard Model physics.

Littlest Higgs model: $Z_H \rightarrow Zh \rightarrow l^+l^-$ bb (E. Ros, J.E. Garcia, Eur.Phys.J.C39S2:13-24,2005)



Cascade decays of heavy gauge bosons in LR twin Higgs model

$W_H \rightarrow Tb$

↳ $\phi^\pm b$

↳ tb

↳ Wb

↳ lν

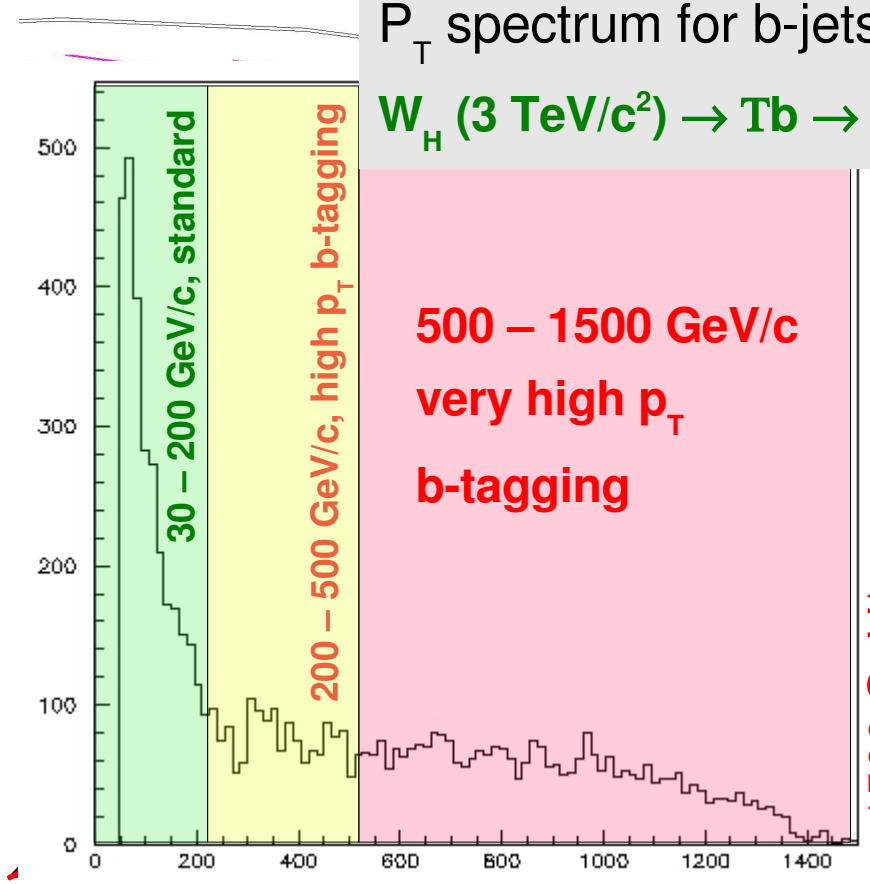
for m (W_H) = 1 TeV **b3: <p_T> = 201 GeV** **b4: <p_T> = 277 GeV**

(see Les Houches workshop for physics at TeV colliders: http://www.lpthe.jussieu.fr/LesHouches07Wiki/index.php/Preliminary_Programme)

Physics case for high p_T b-tagging

P_T spectrum for b-jets in

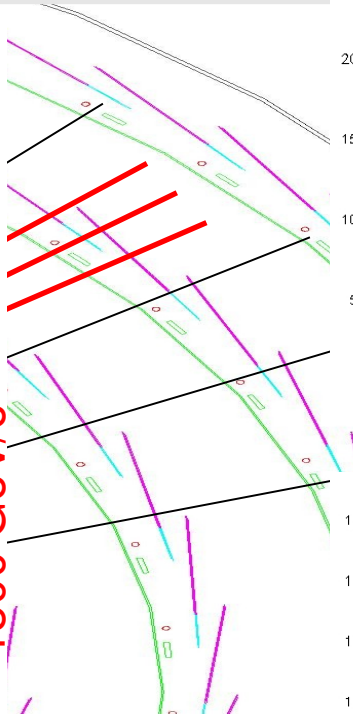
W_H (3 TeV/c^2) → Tb → 4 b + l + E_t^{miss}

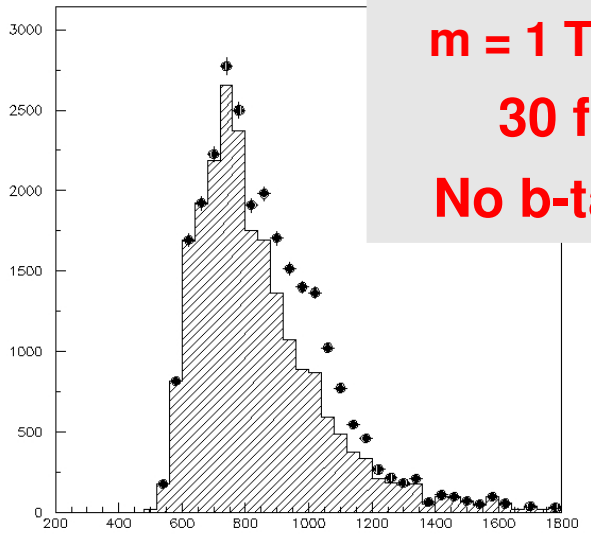


500 – 1500 GeV/c

very high p_T

b-tagging

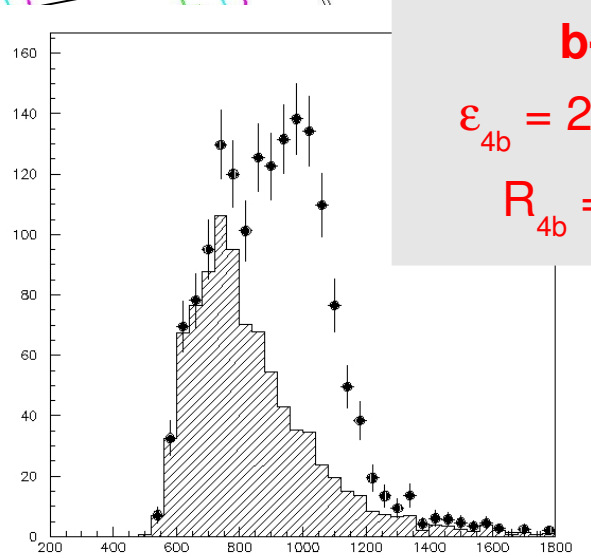




m = 1 TeV

30 fb^{-1}

No b-tag



b-tag

ε_{4b} = 20 %

R_{4b} = 25

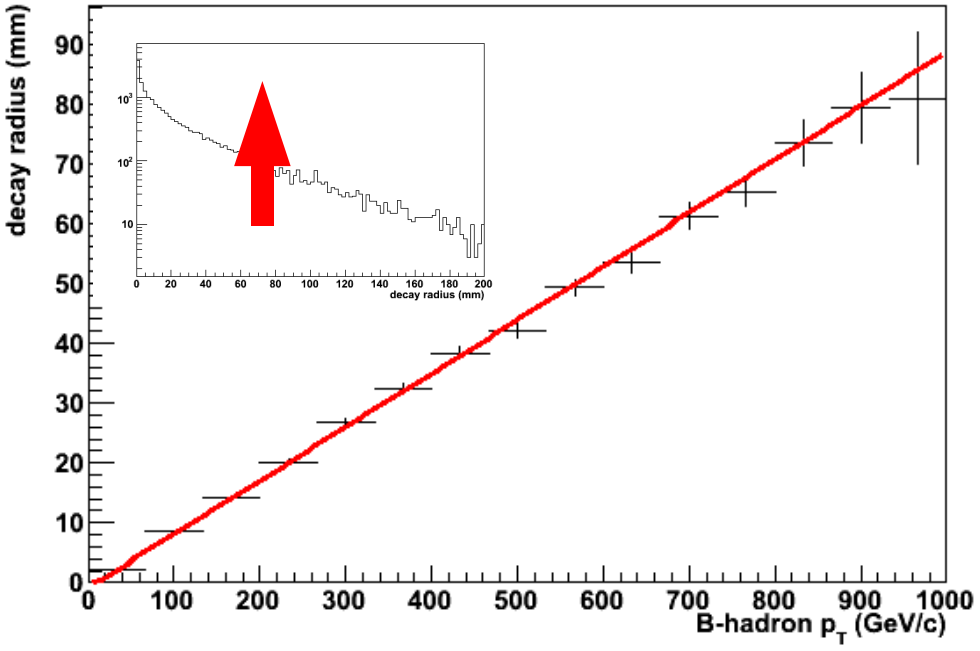
existing studies

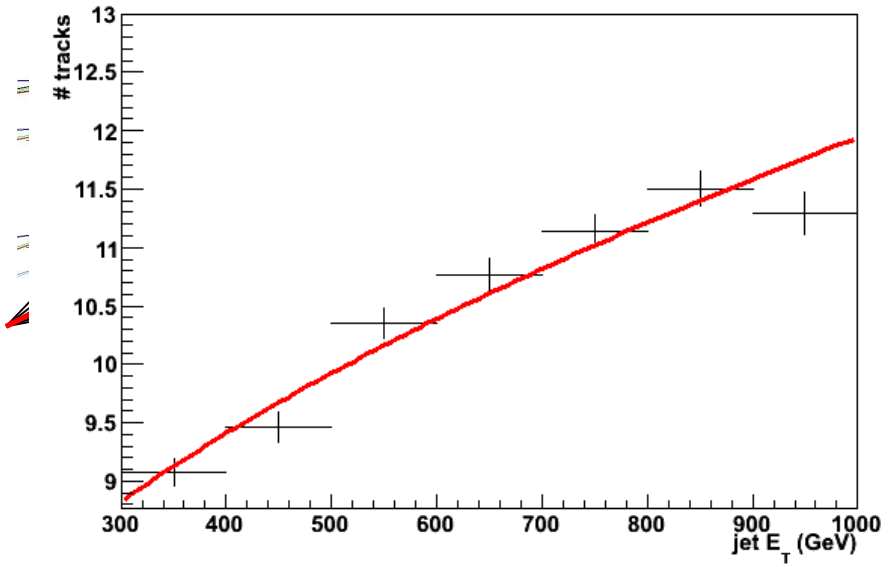
uncharted territory

$L = c \tau \gamma$

Average decay radius of B hadrons versus B-hadron transverse momentum

Inset: Decay radius distribution for B-hadrons in Z'->bb events ($m_{Z'}$ = 2 TeV)





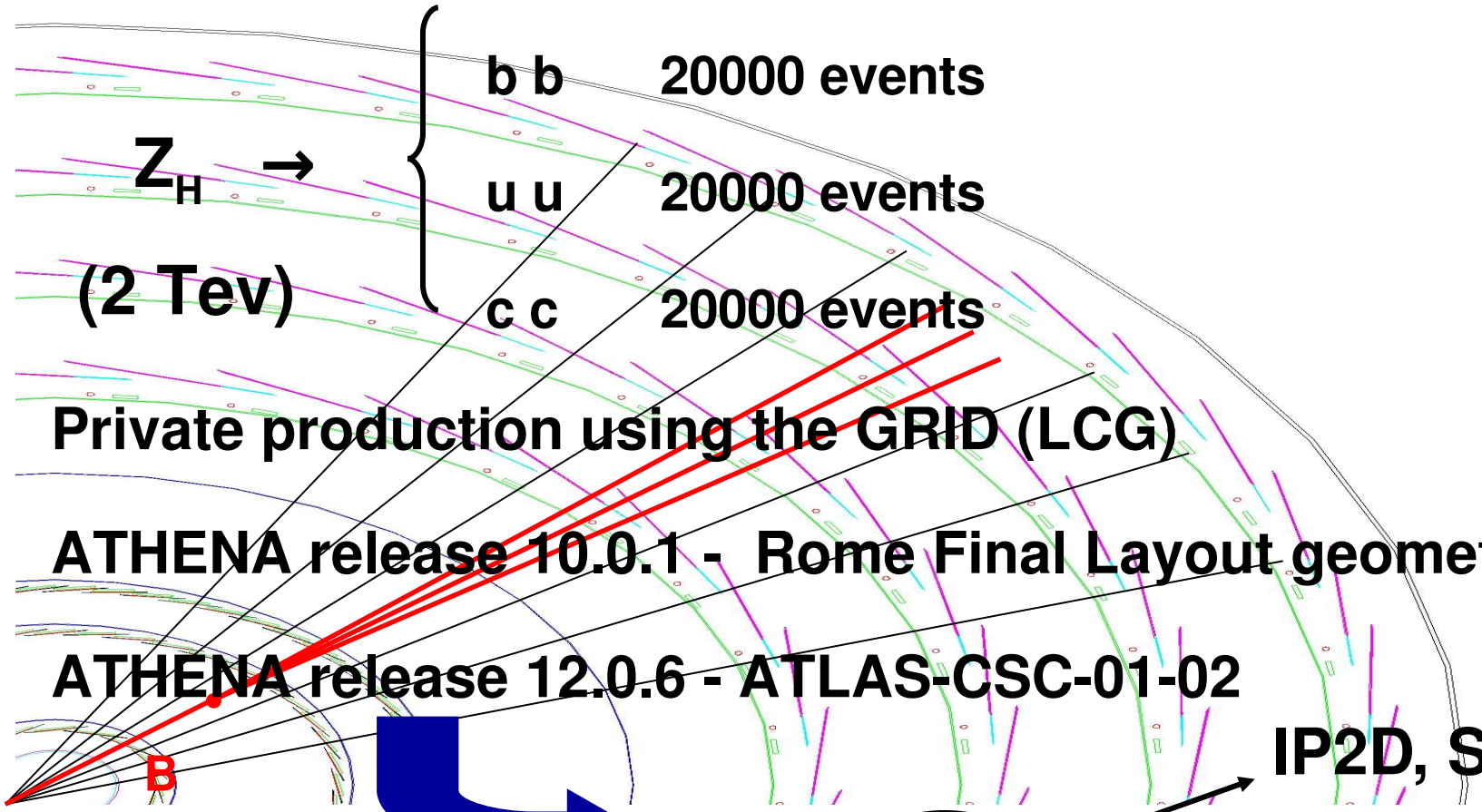
Number of tracks in jet (core) increases with jet E_T

jet core is getting very dense (shared hits in pixel detector)

tracks from B-decay = constant: relative weight tracks from B-decay decreases

B-layer

Samples



$Z_H \rightarrow$ (2 Tev)

b b 20000 events

u u 20000 events

c c 20000 events

Private production using the GRID (LCG)

ATHENA release 10.0.1 - Rome Final Layout geometry

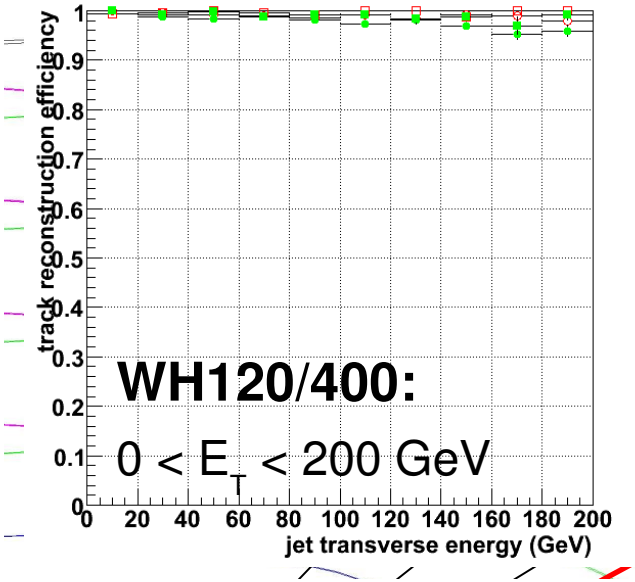
ATHENA release 12.0.6 - ATLAS-CSC-01-02

B

ESD, AOD

IP2D, SV1 algorithms available

Tracking in high p_T jets - I

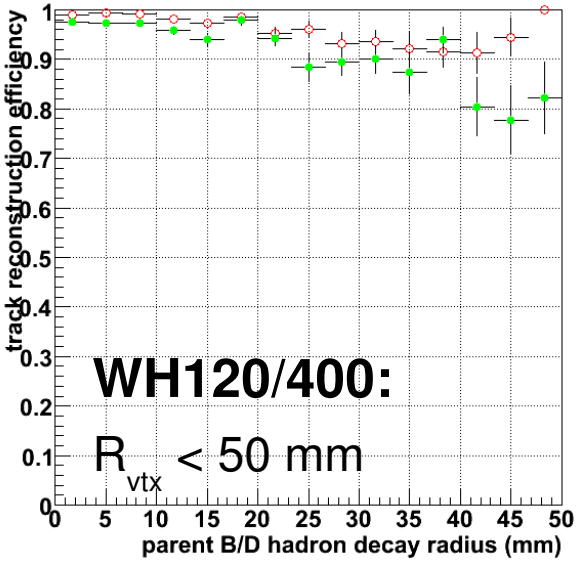


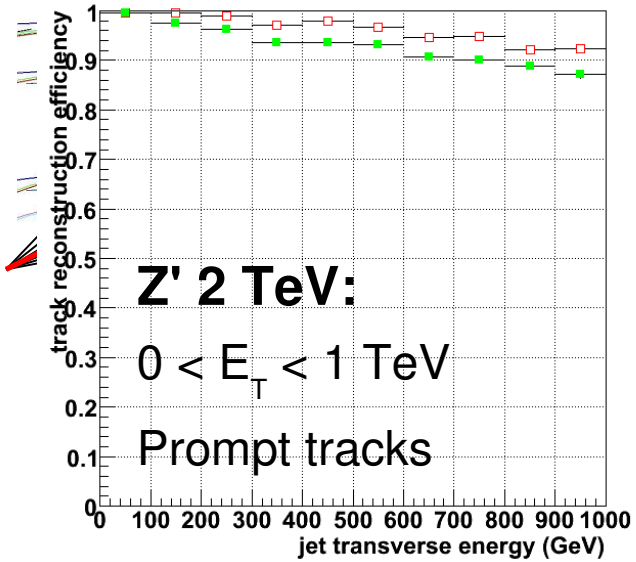
Reconstruction efficiency for "good" tracks >90% inside highest p_T jets!

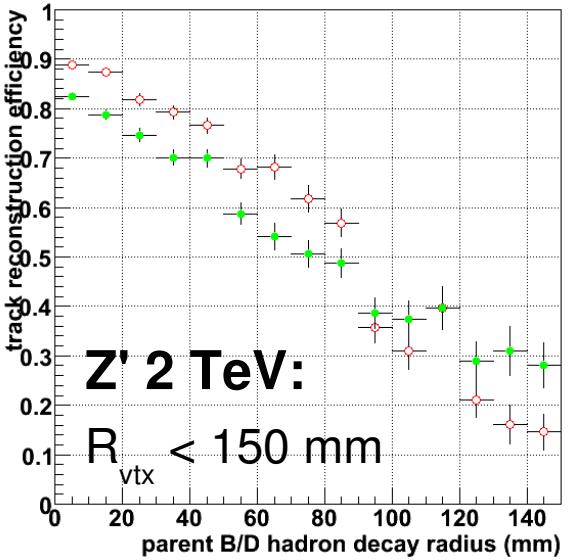
displaced vertices present a real challenge!

IpatRec (red) performs slightly better than New Tracking (green)

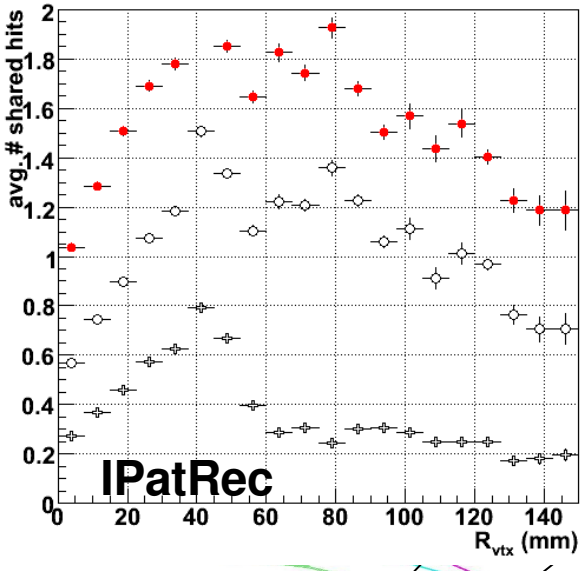
Incursions in ATHENA 13 to investigate causes/remedies (13.0.10, Z-scan) with no result so far.

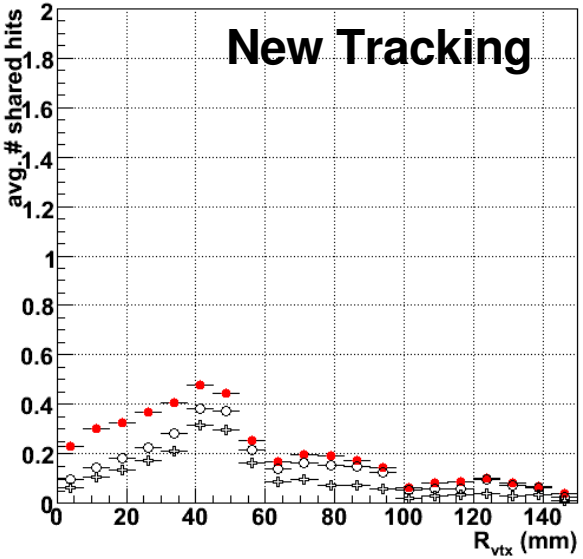


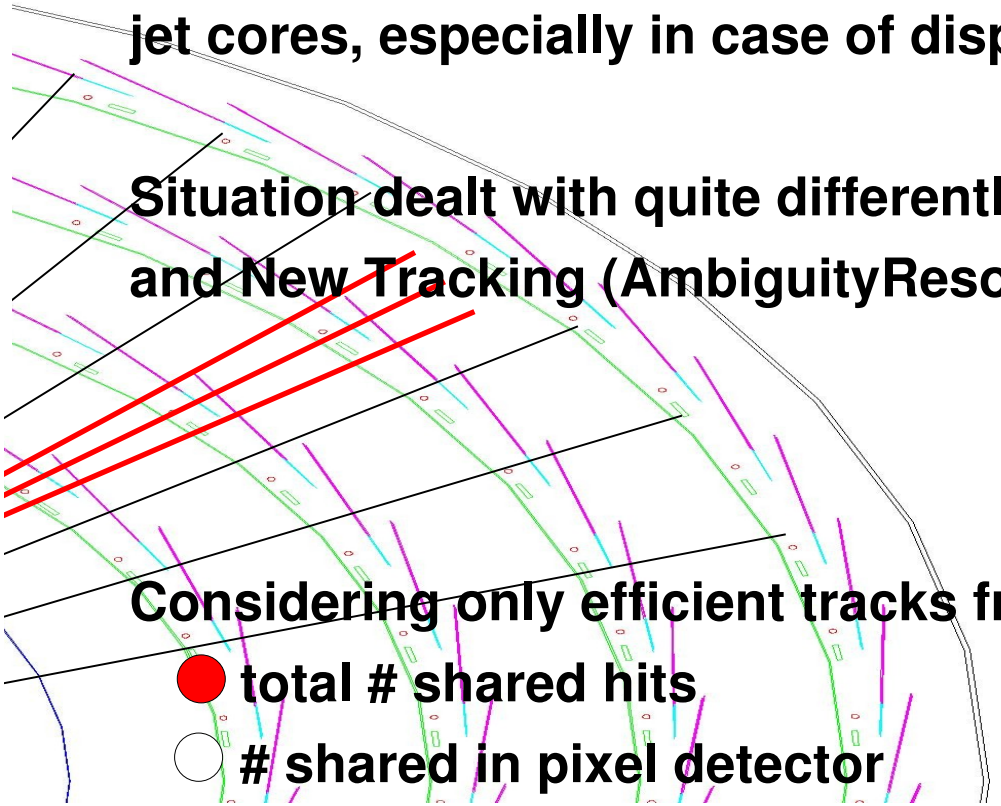




Tracking in high p_T jets - II







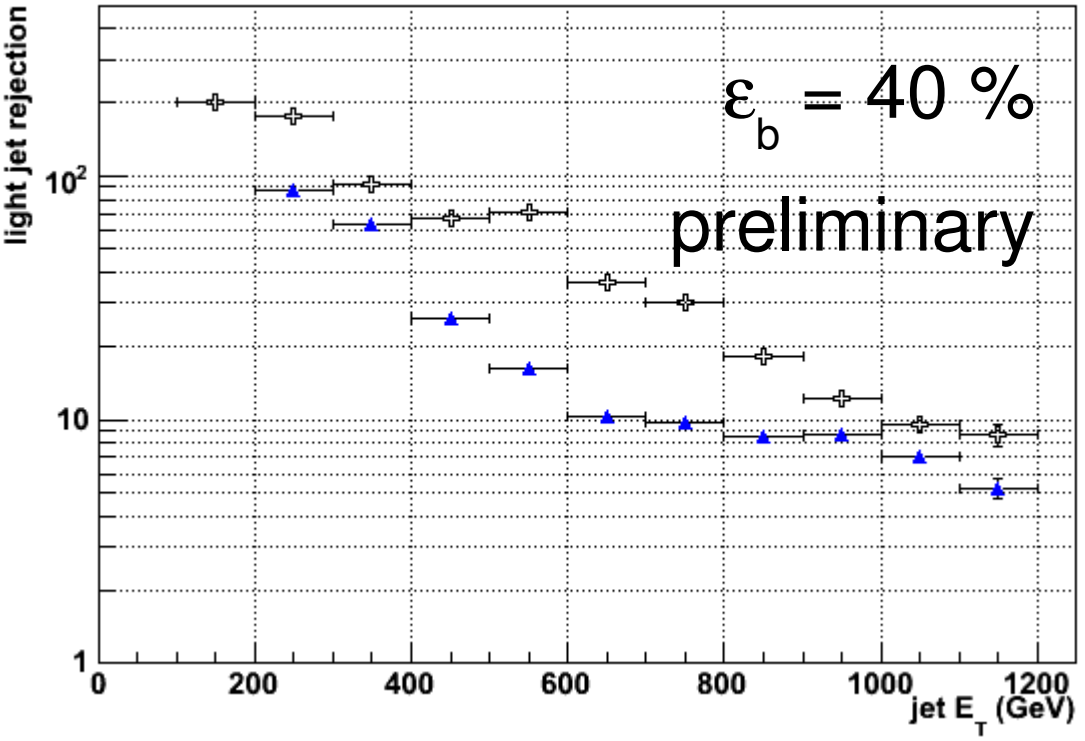
The sharing of hits becomes inevitable in dense jet cores, especially in case of displaced vertices

Situation dealt with quite differently by IpatRec and New Tracking (AmbiguityResolver)

Considering only efficient tracks from B/D decay

- **total # shared hits**
- **# shared in pixel detector**
- **# shared hits in B-layer**

b-tagging in high p_T jets



SV1

IP2D

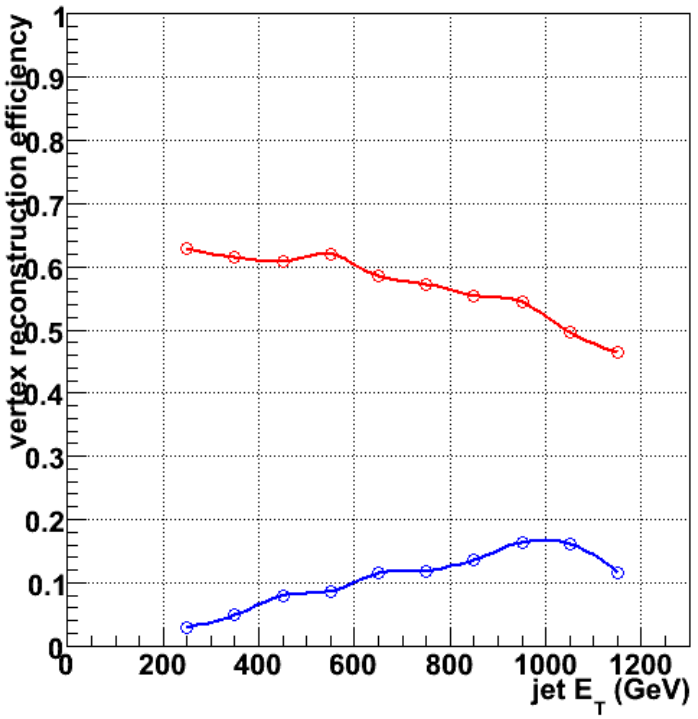
"Acceptable performance"

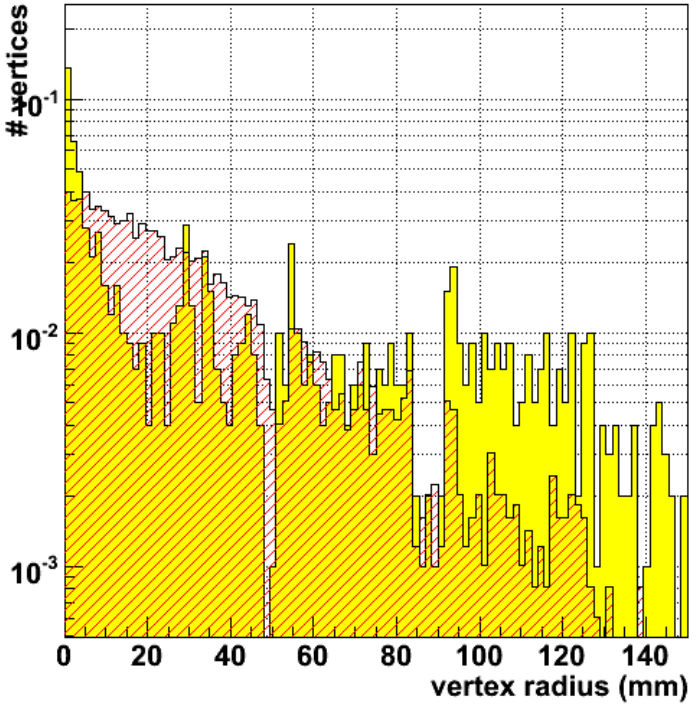
Retune SV1 and IP2D algorithms to deal with high pT jets:

- **IpatRec tracks**
- **jet-track association Δ R**
- **minimal track p_T**
- **shared hits**
- **B-layer hit**

vertexing in high p_T jets

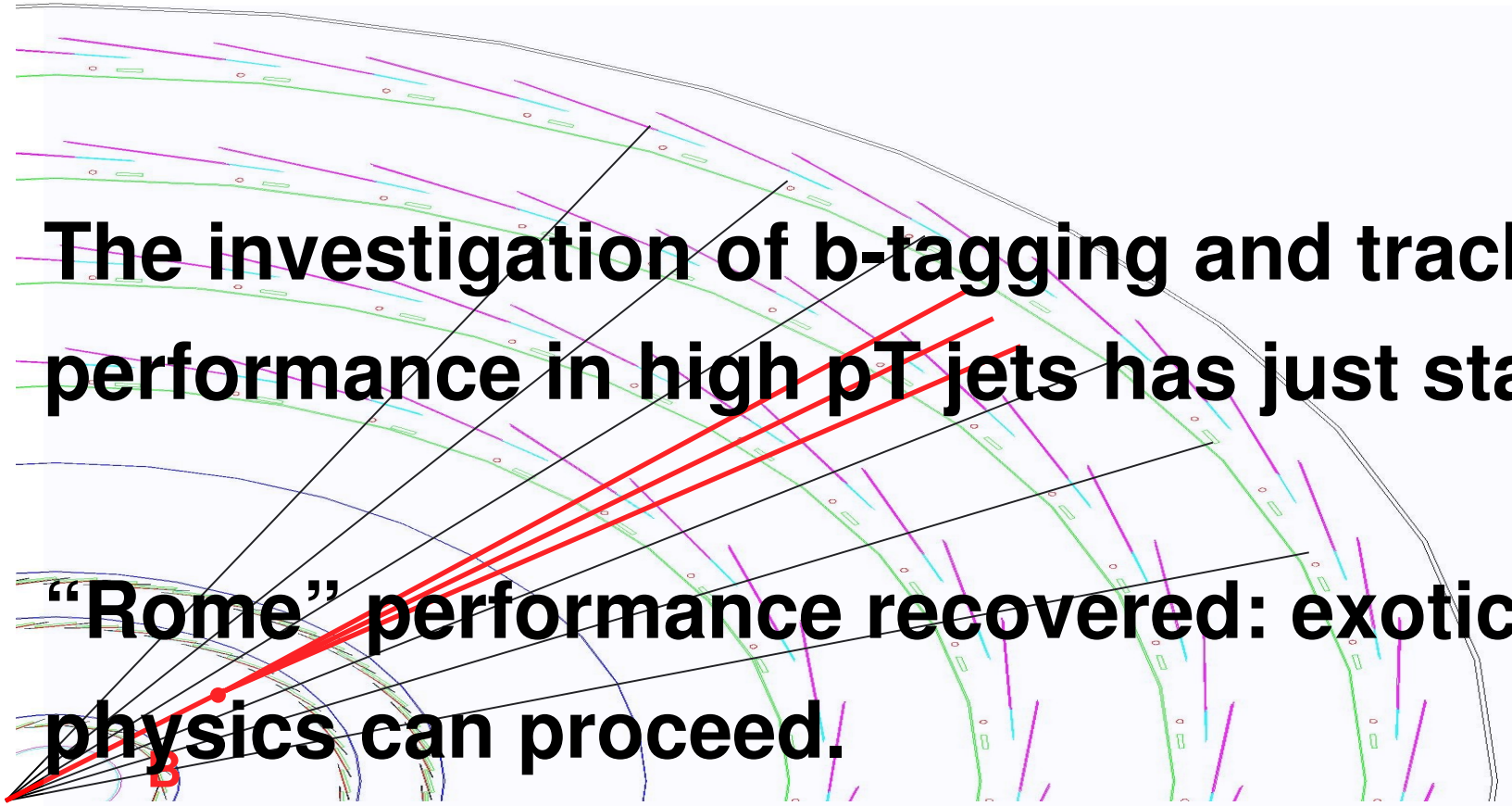
VkalVrt: Vertex reconstruction efficiency in b-jets and light jets





VkalVrt: reconstructed vertex radius distribution for b-jets and light jets

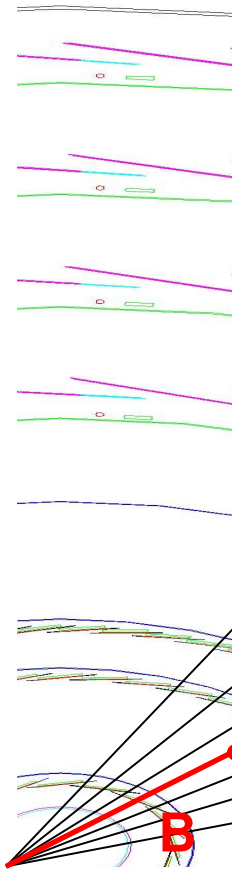
Conclusions

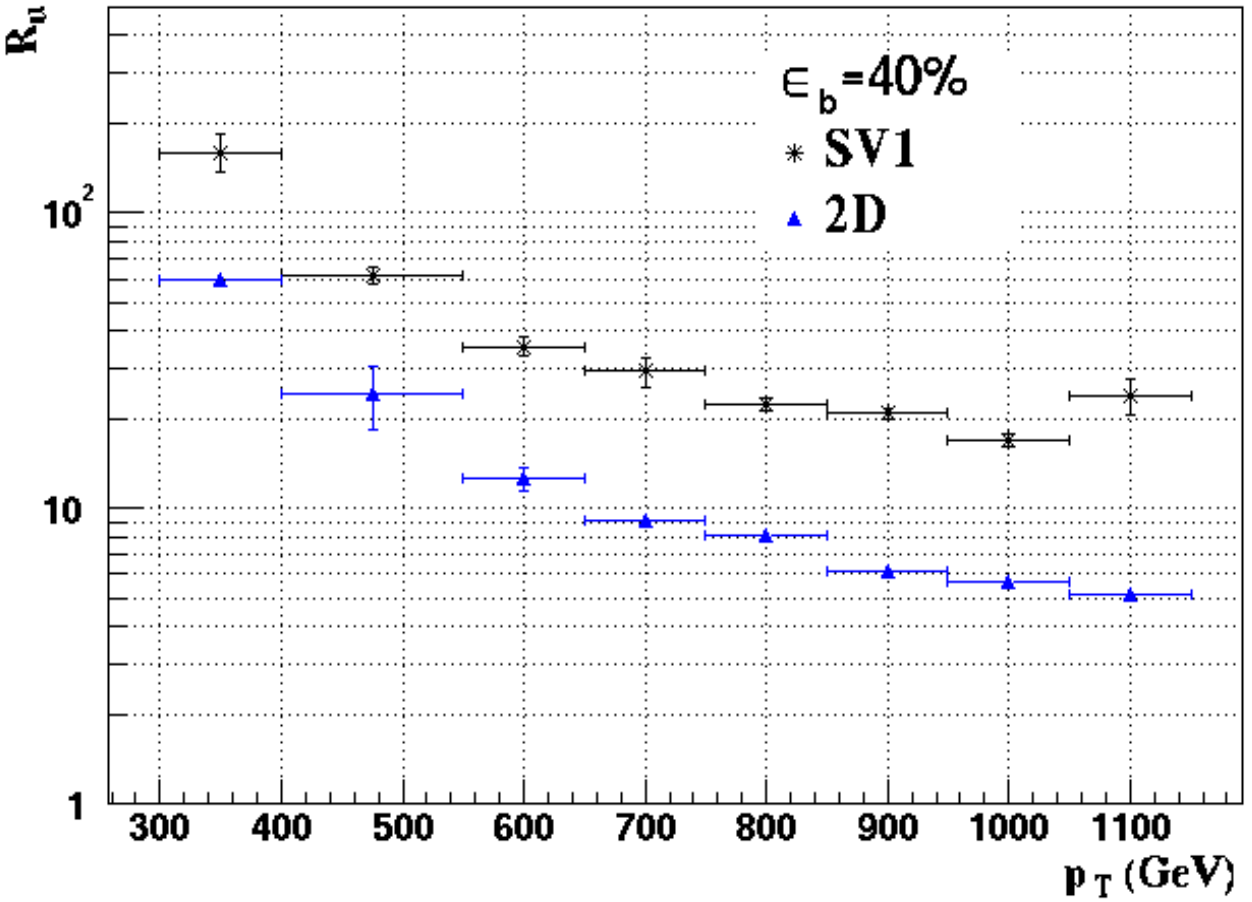


The investigation of b-tagging and tracking performance in high pT jets has just started

“Rome” performance recovered: exotic physics can proceed.

p_T dependence on Rome samples (SV1 versus 2D)

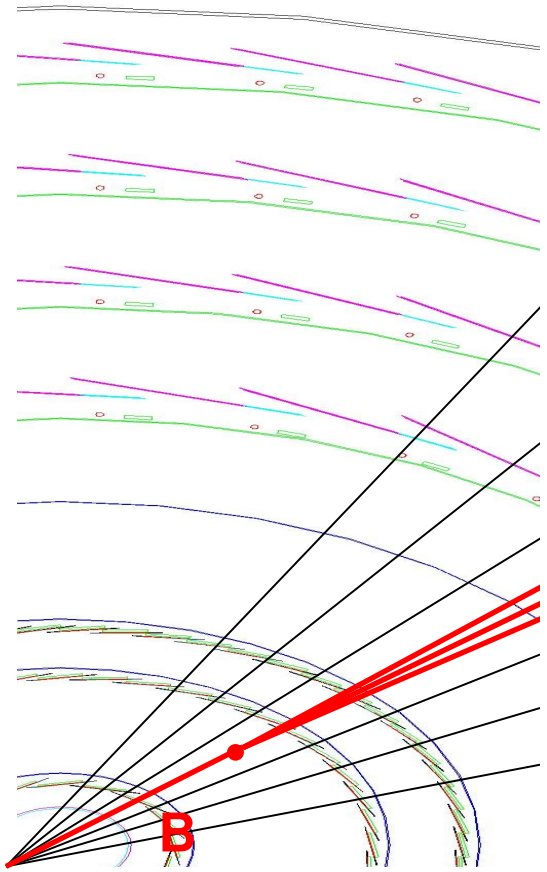


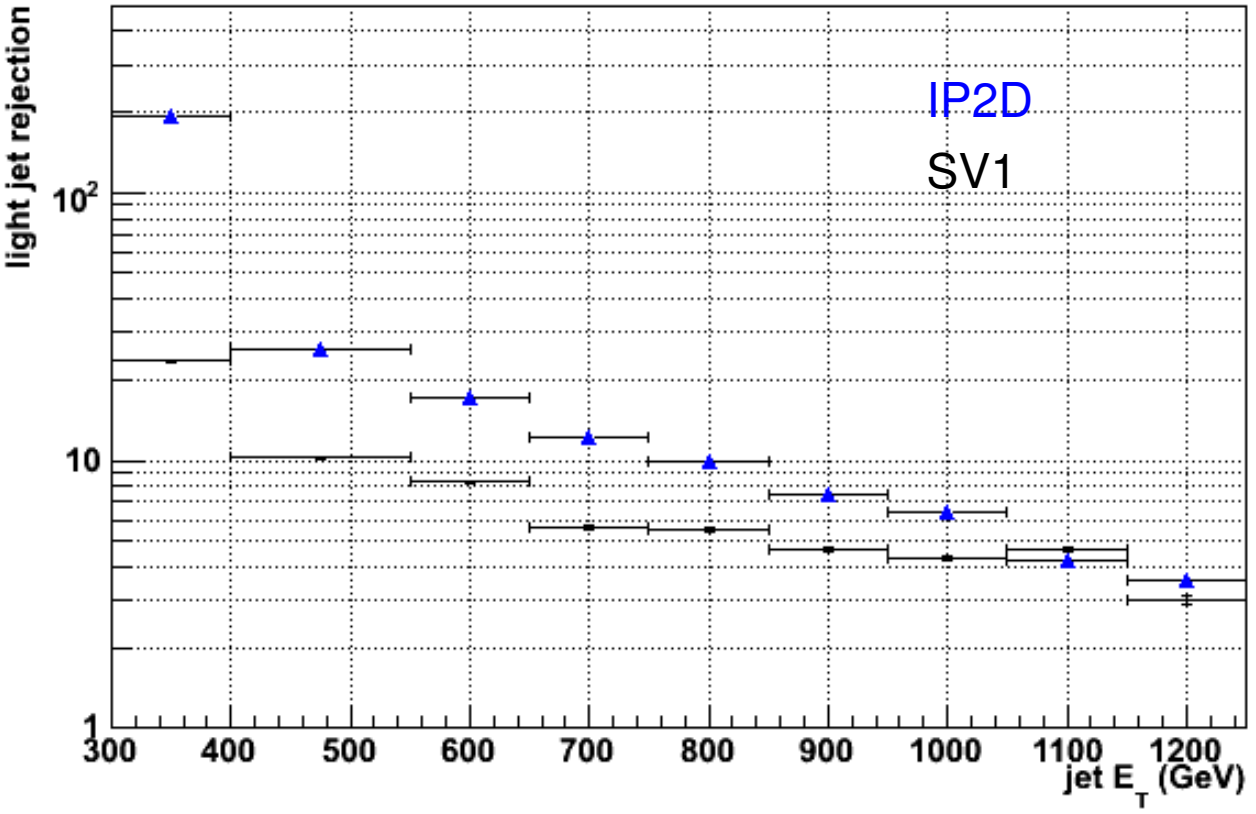


Standard ATLAS tagging algorithms, without retuning

Standard 12.0.6 performance

(SV1 versus 2D)





Signficant changes in software from 10.0.1 to 12.0.6_01

Nevertheless IP2D performance essentially the same as in “Rome” analysis

SV1 performance dramatically degraded with respect to “Rome” NOTE: SV1 not intended for stand-alone use