High p_T b-tagging

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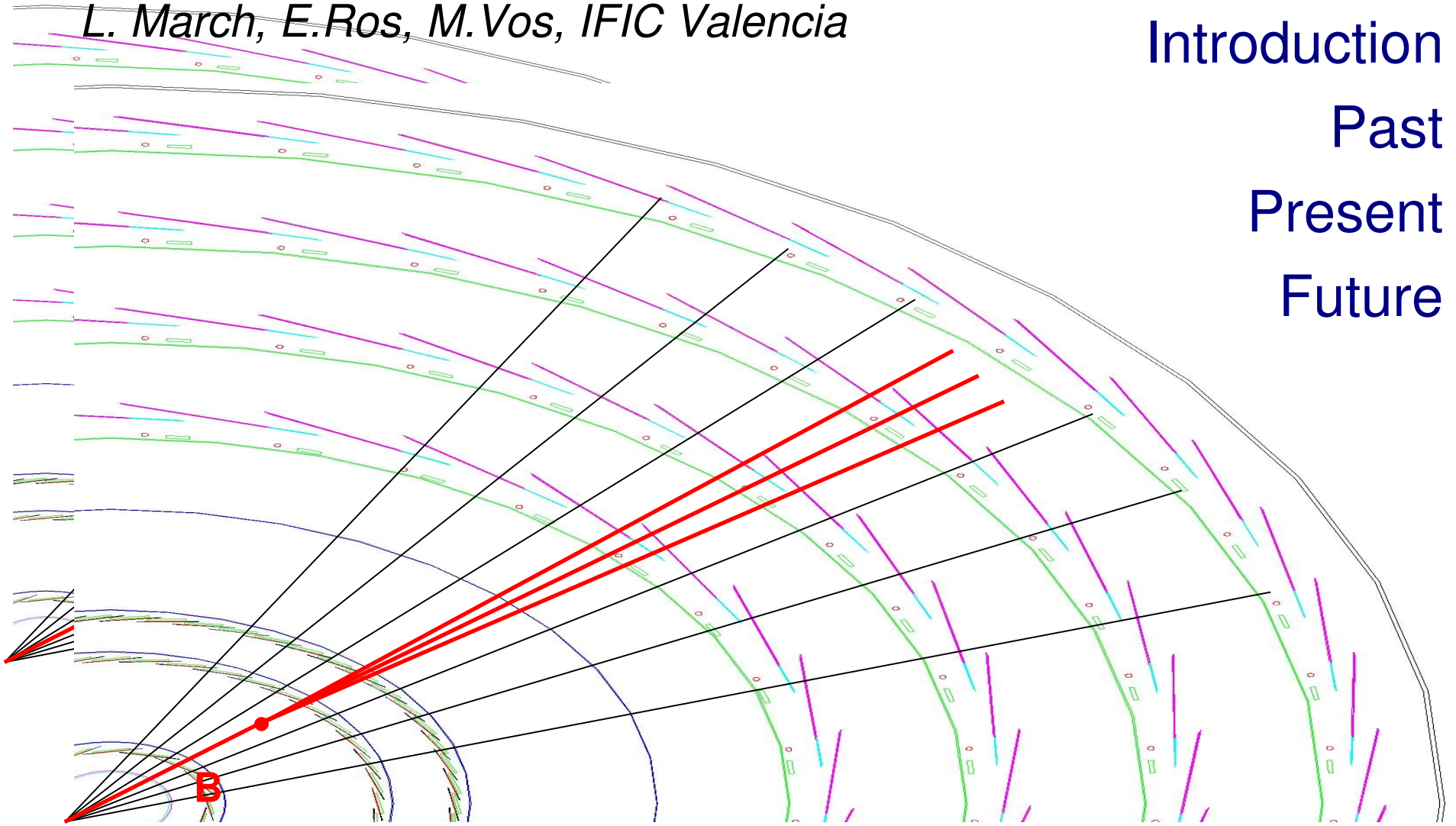
Introduction

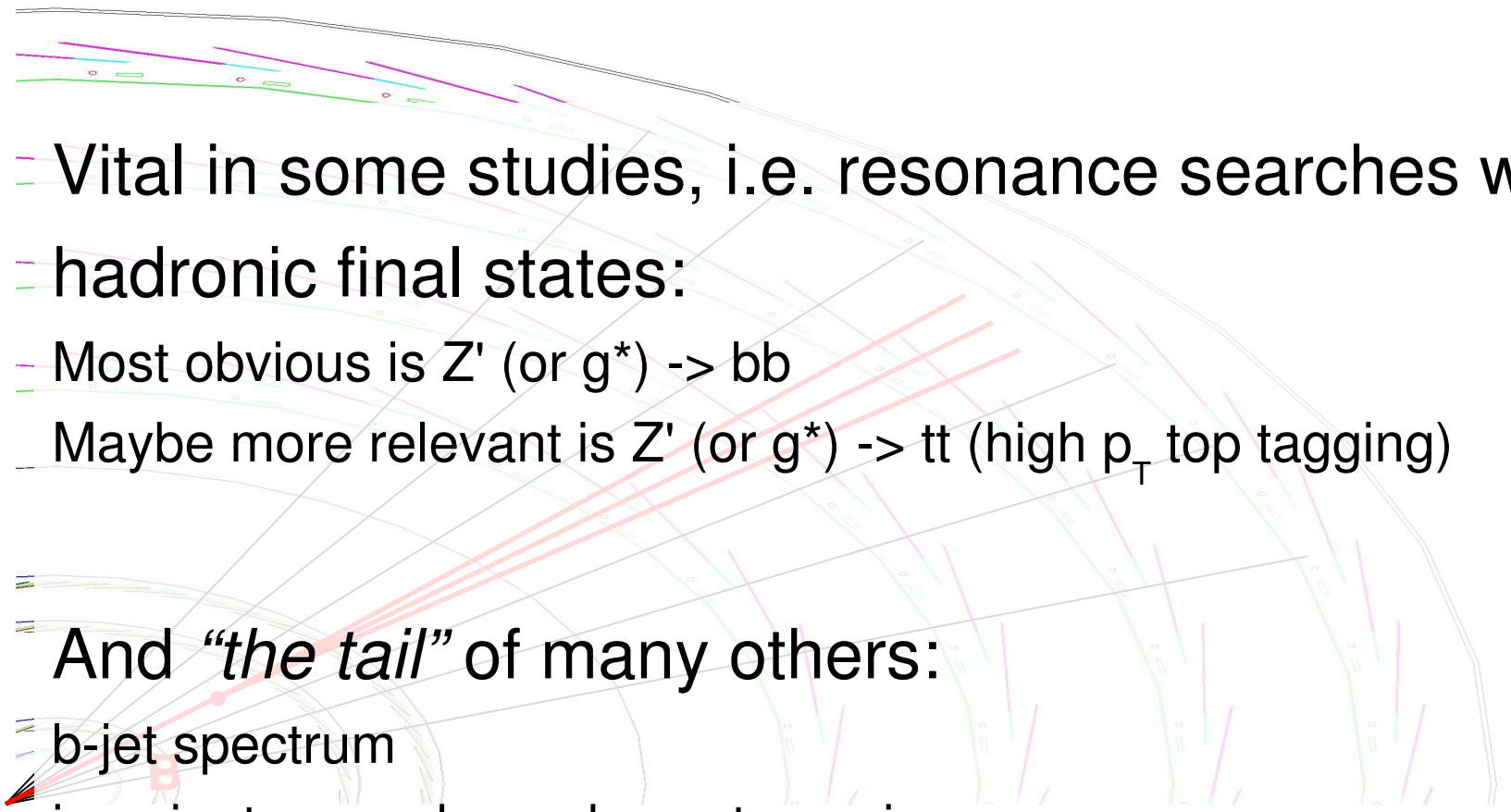
Past

Present

Future



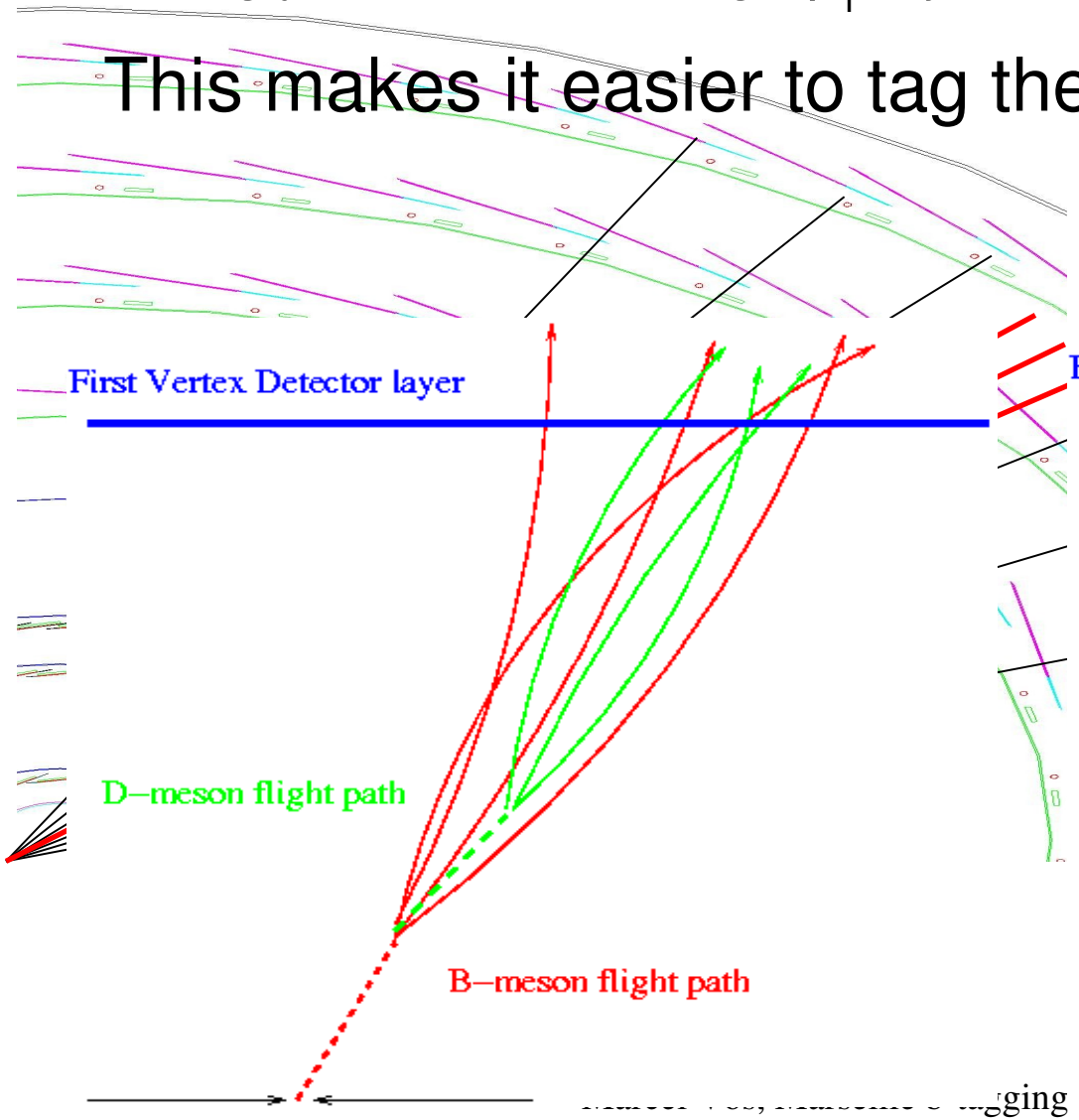
High pT b-tagging studies

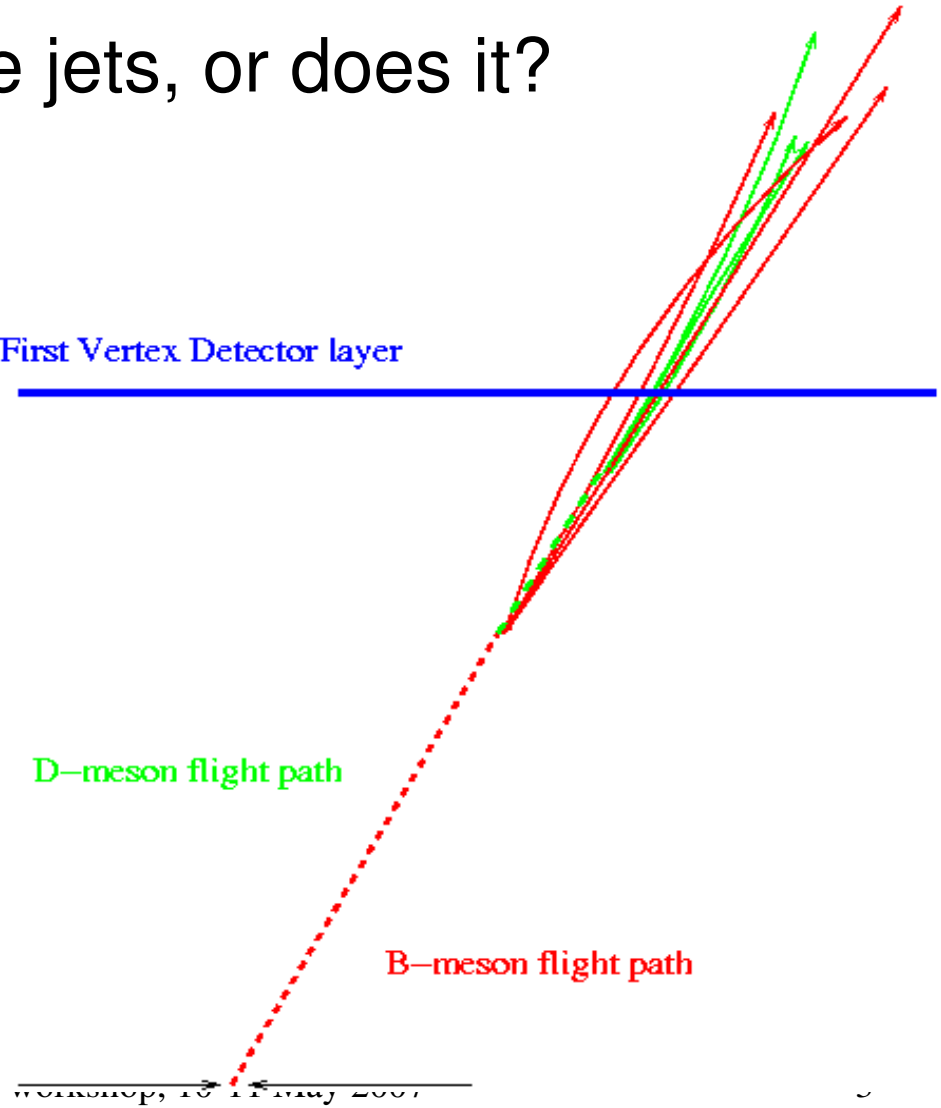


- Vital in some studies, i.e. resonance searches with hadronic final states:
  - Most obvious is Z' (or g*) -> bb
  - Maybe more relevant is Z' (or g*) -> tt (high p_T top tagging)
- And *"the tail"* of many others:
  - b-jet spectrum
  - invariant mass dependence top pairs
  - SUSY with b-jets

$L = c \tau \gamma$ –> THE experimental signature for b-tagging is strongly enhanced for high p_T b-jets

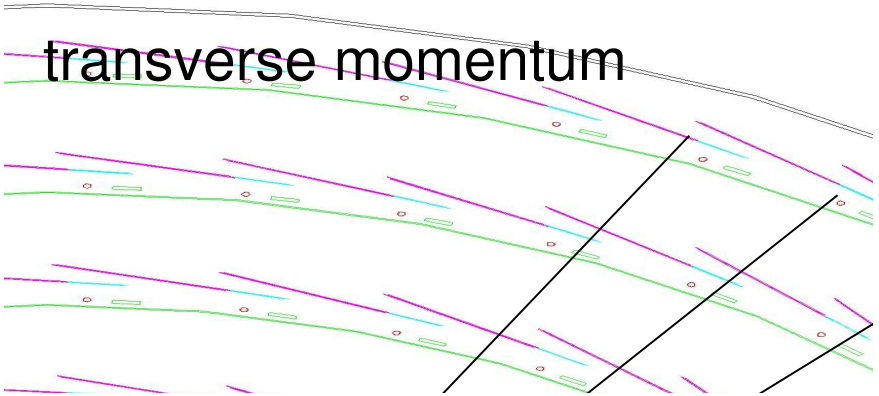
This makes it easier to tag the jets, or does it?

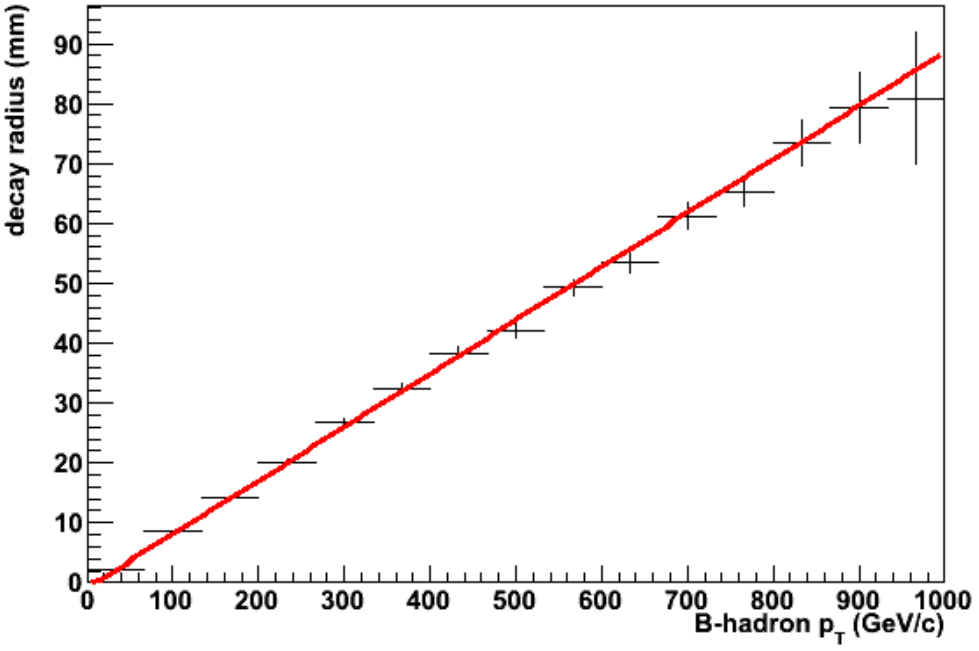


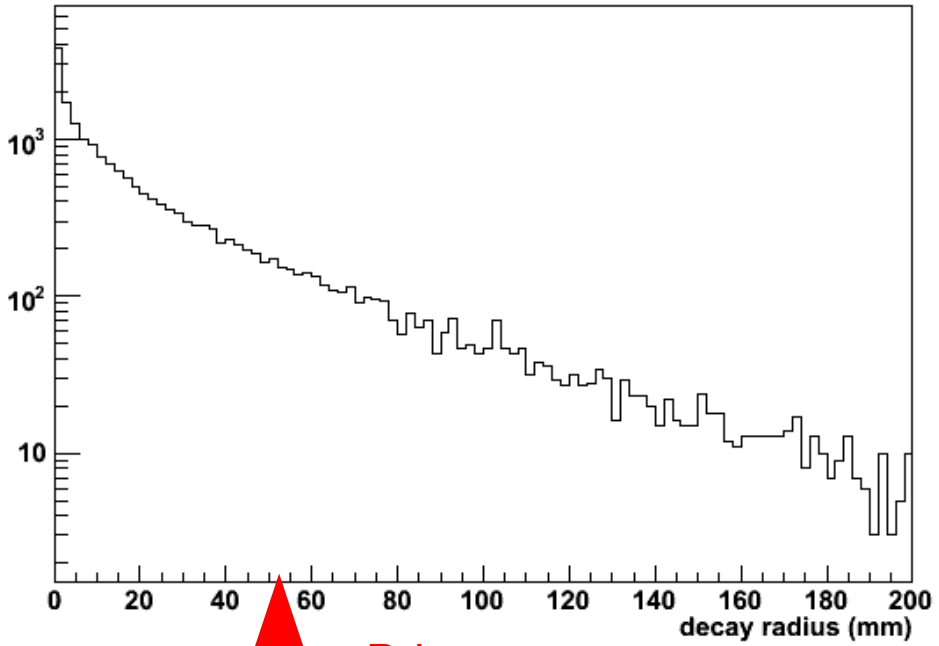


$L = c \tau \gamma$

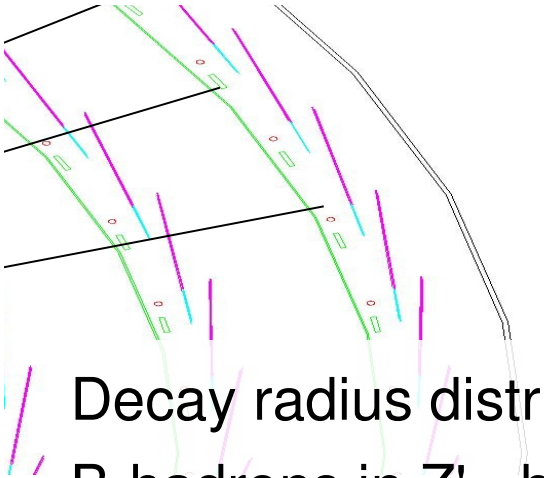
Average decay radius of B hadrons versus B-hadron transverse momentum



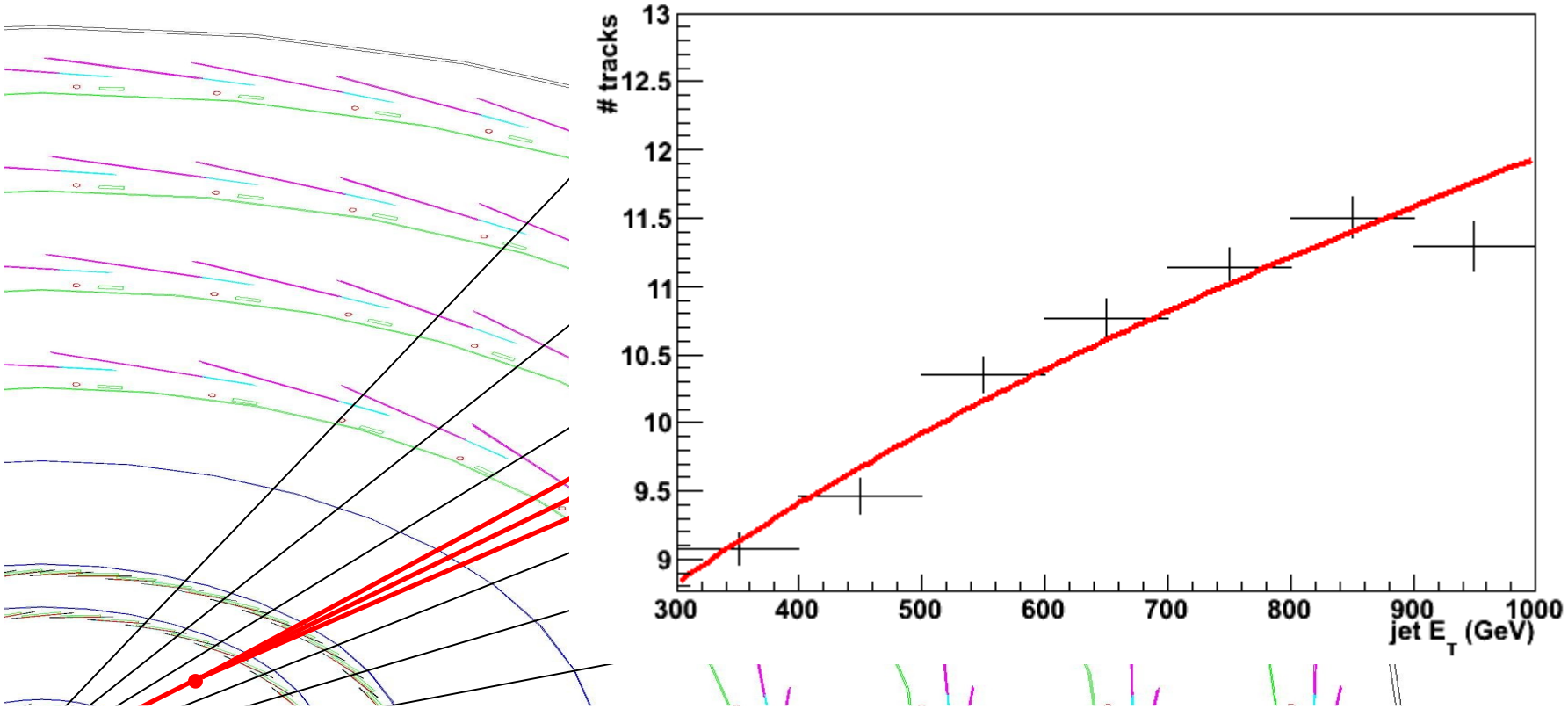




B-layer



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



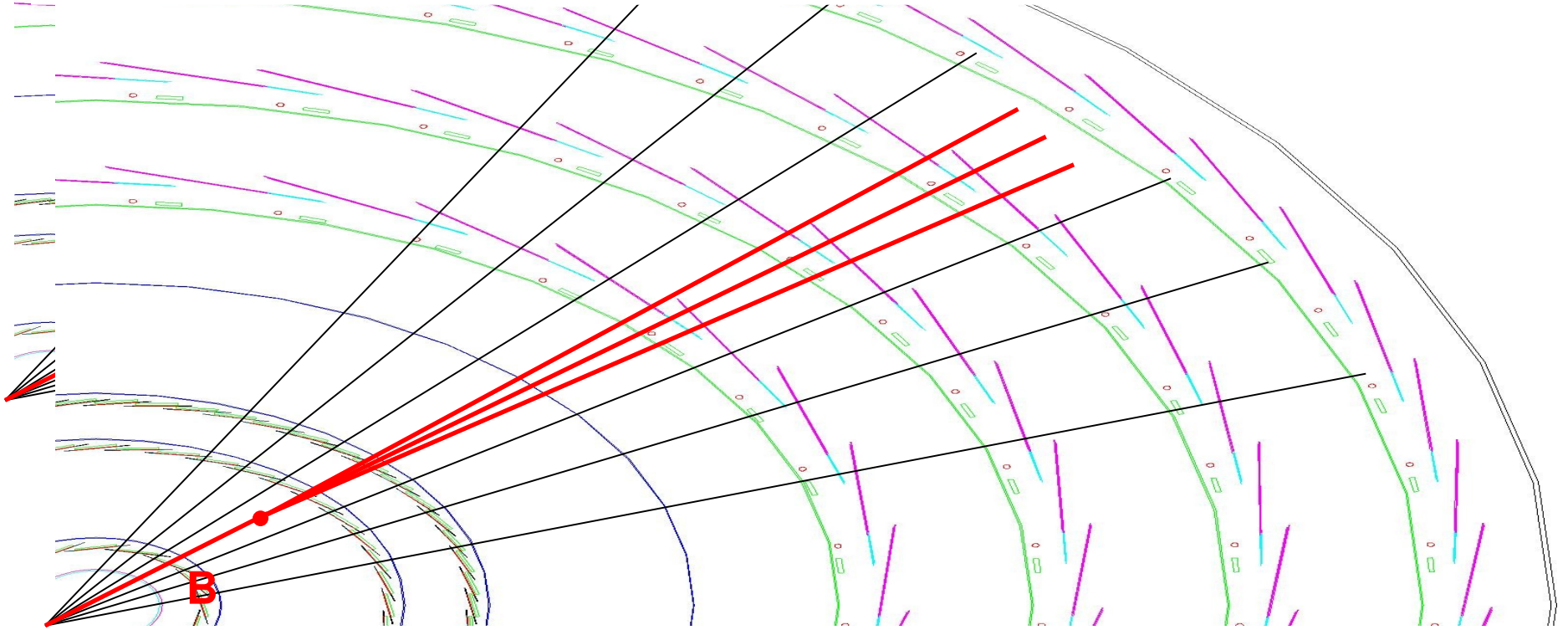
Number of tracks in jet (core) increases with jet E_T

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

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

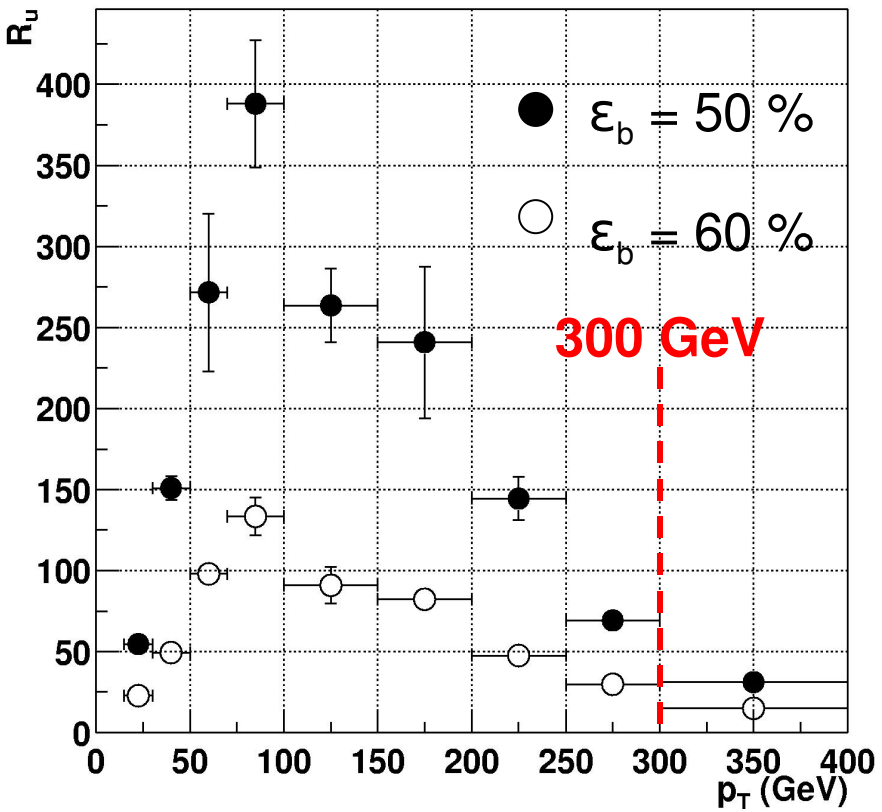
High p_T b-tagging does not fit the usual assumptions: requires a solution of its own.

- Secondary vertexing algorithms seems more promising than impact parameter-based taggers (vertex gives very clear indication, while d_0 resolution degrades for decay outside B-layer)



Some remote history: p_T dependence of b-tagging

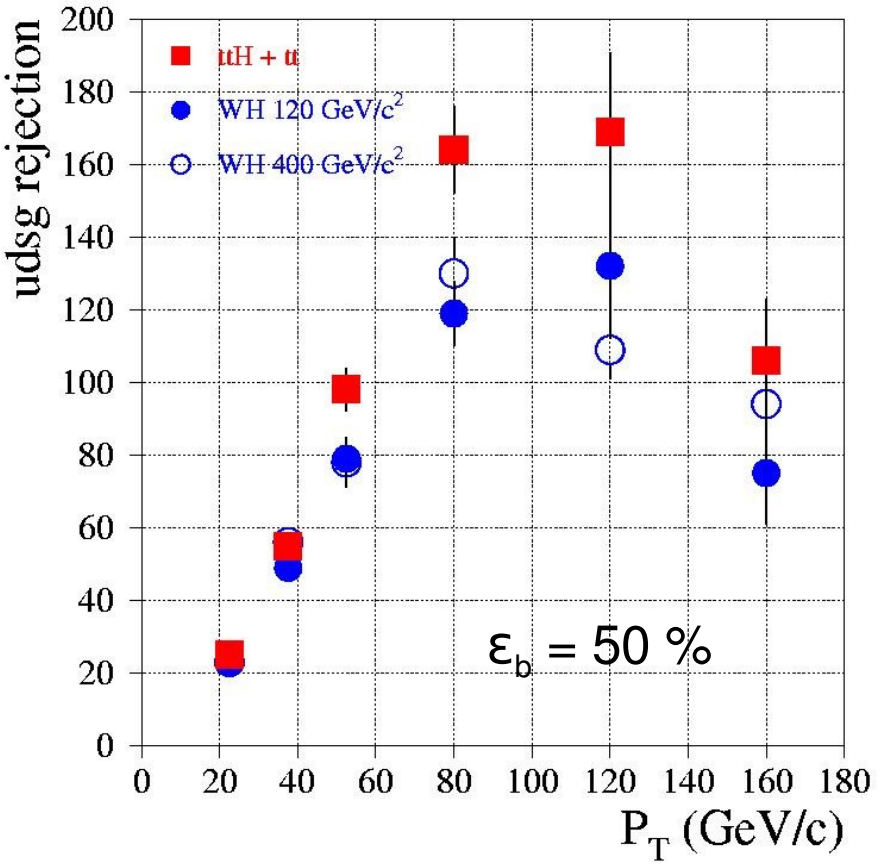
ATL-COM-INDET-2003-017



2D algorithm – DC1 data

pp → W H (120 + 400 GeV) → b b̄

ATL-PHYS-2004-006



2D algorithm – DC1 data

W H + t t̄ samples

Some history: Rome samples for high p_T b-jet studies

$Z_H \rightarrow$ (2 Tev)

- b b — 20000 events
- u u — 20000 events
- c c — 20000 events

Private production using the GRID (LCG)

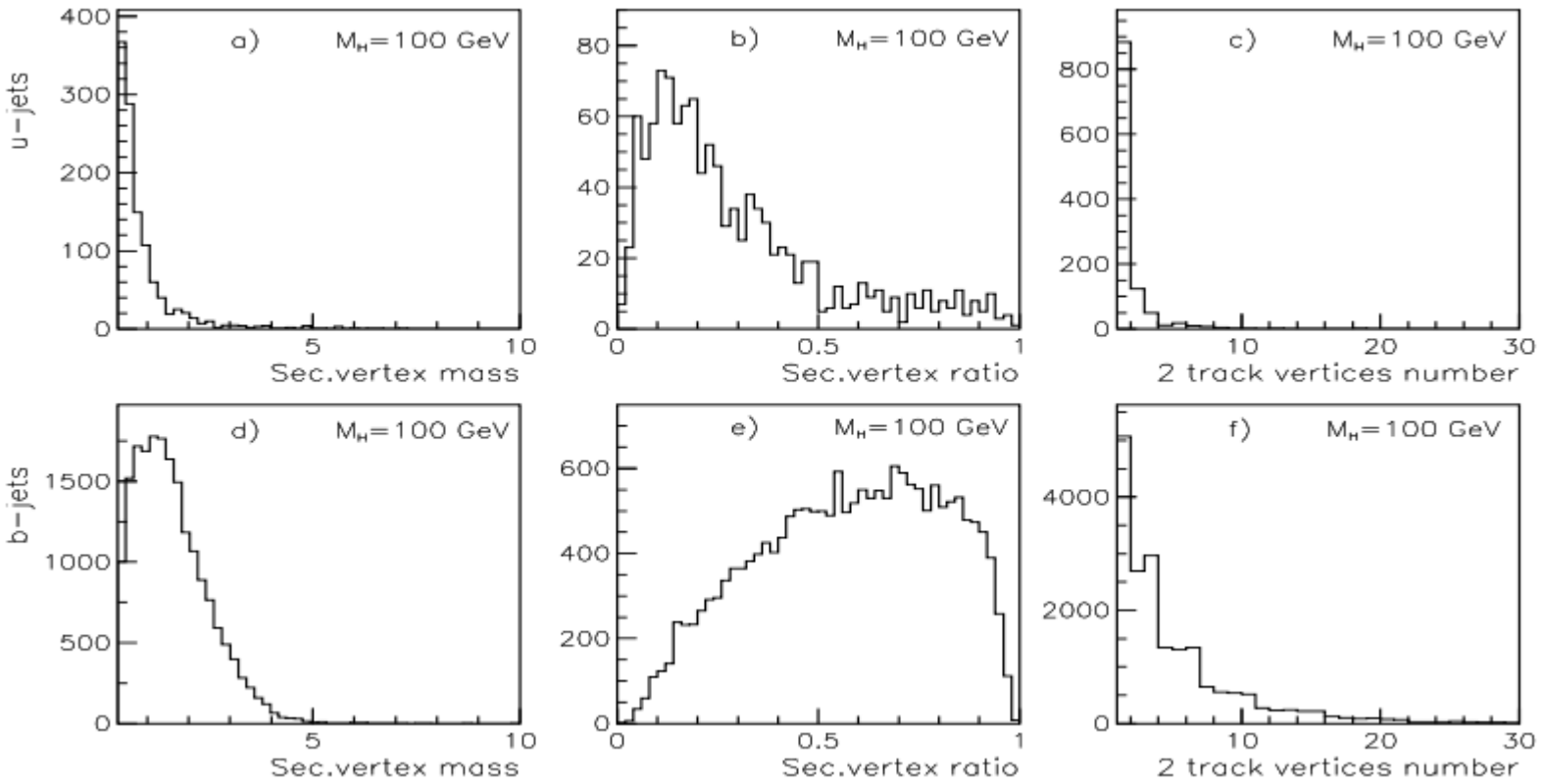
ATHENA release 10.0.1 - Full Simulation

Rome Final Layout geometry

CBNT, ESD, AOD — SV1 algorithm available

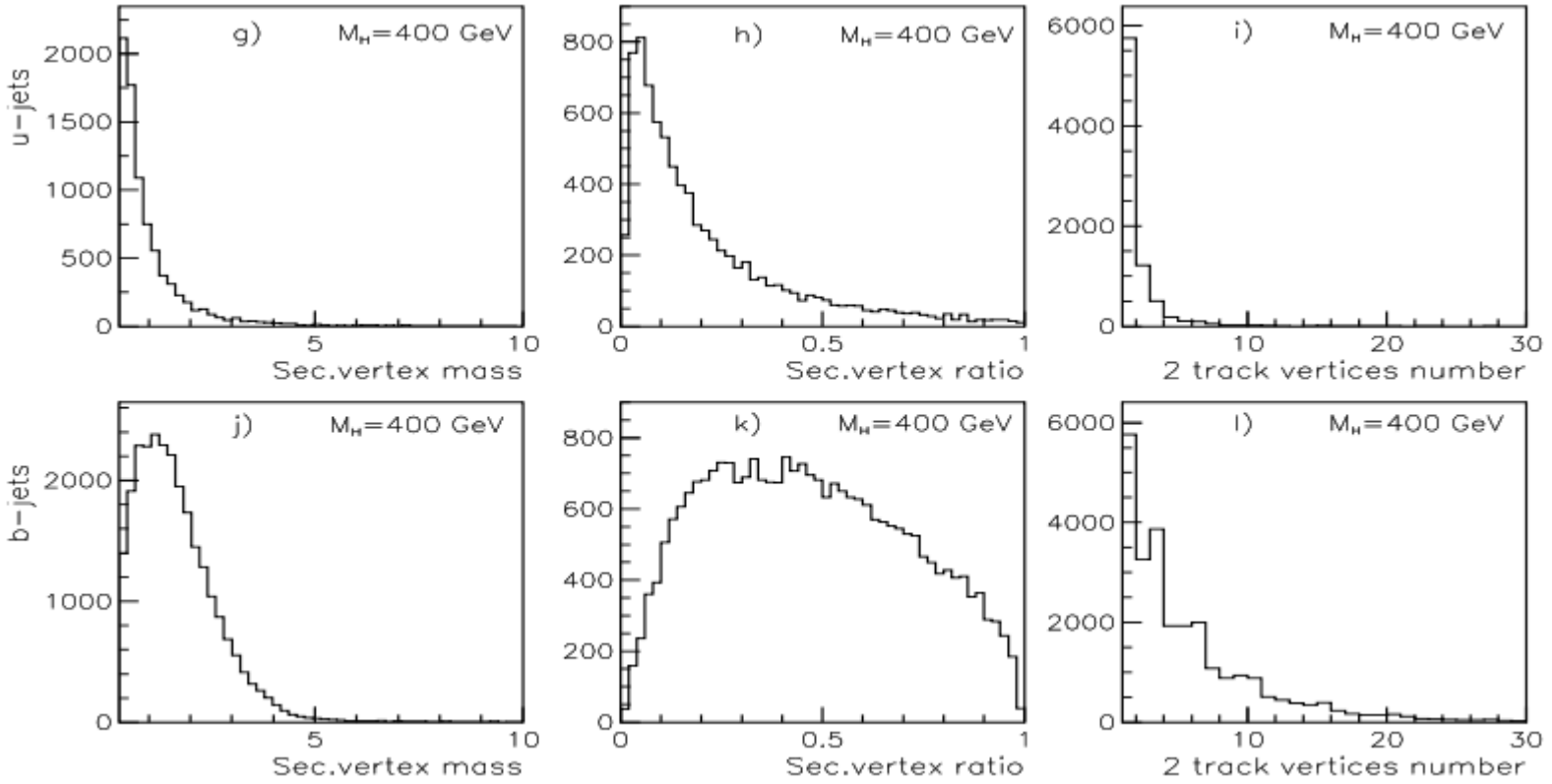
From: A. Kostyukhin, Secondary vertex based b-tagging, ATL-PHYS-2003-033

Secondary vertex properties for b- and u-jets in a WH120 sample.



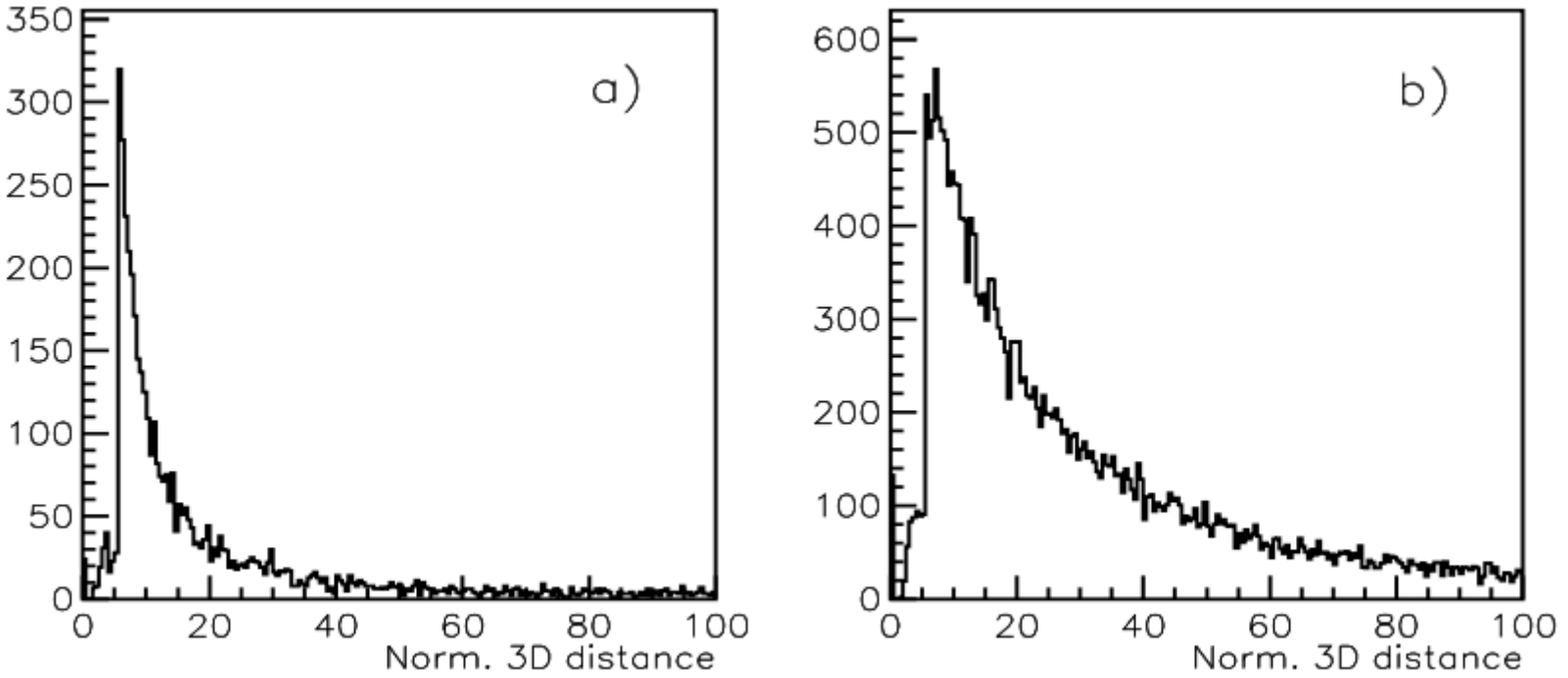
From: A. Kostyukhin, Secondary vertex based b-tagging, ATL-PHYS-2003-033

Secondary vertex properties for b- and u-jets in a WH400 sample.



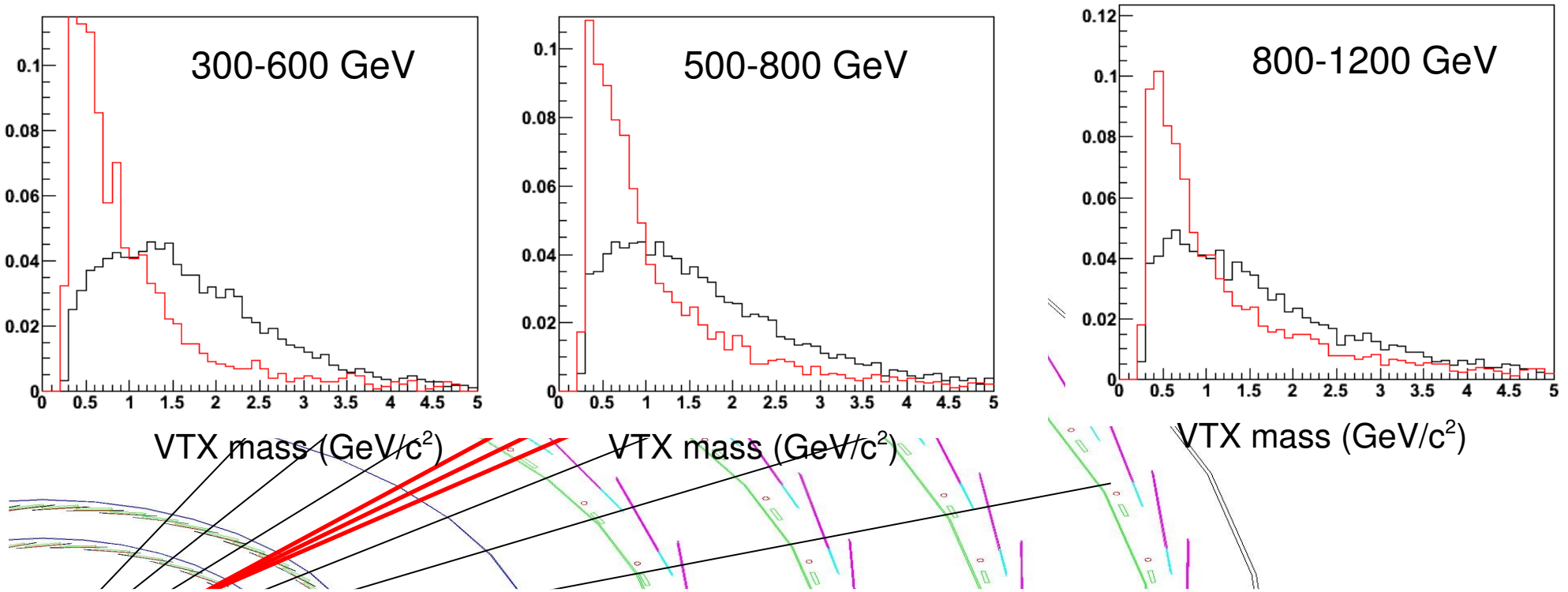
From: A. Kostyukhin, Secondary vertex based b-tagging, ATL-PHYS-2003-033

Secondary vertex properties for b- and u-jets in a WH120 sample.



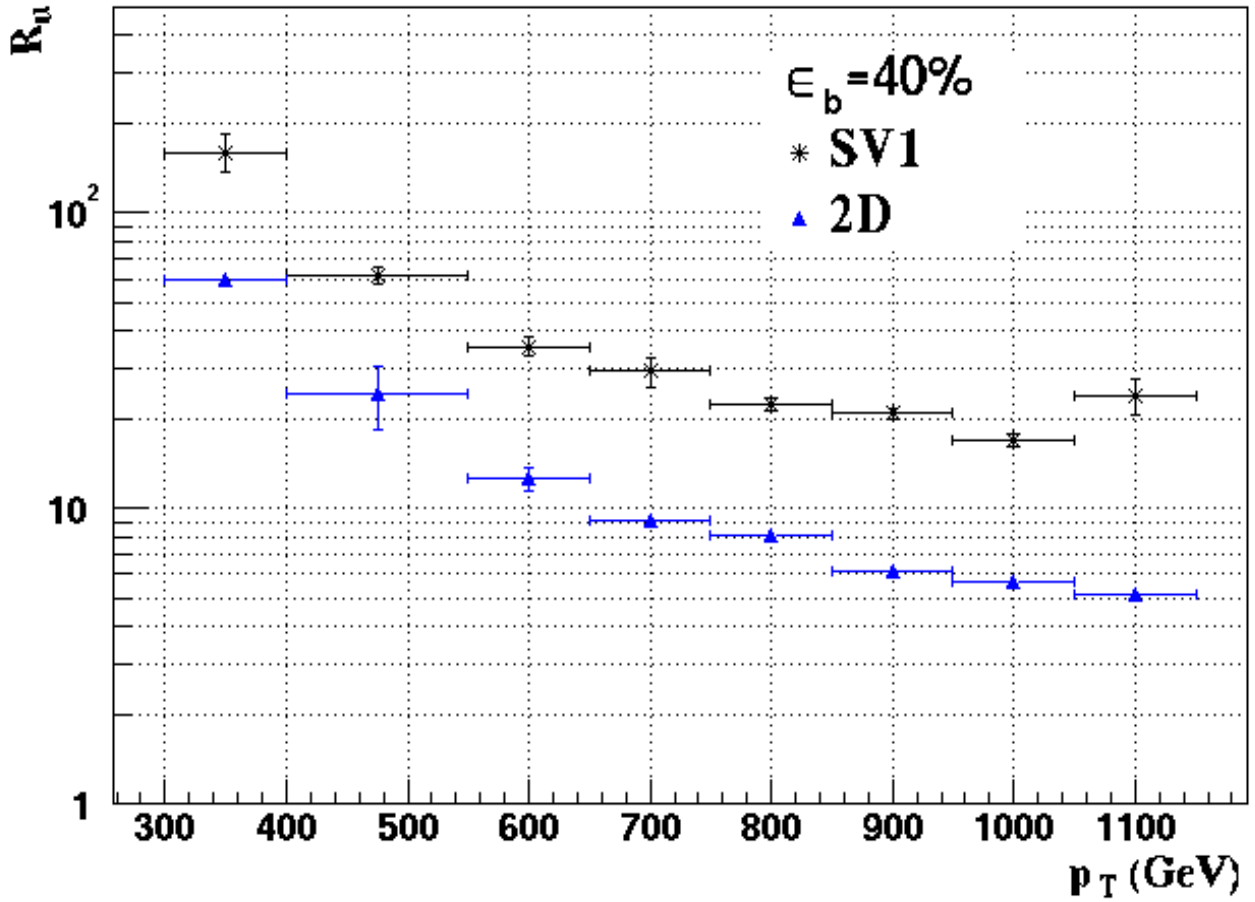
Note: 3D distance SV-PV not used in SV1 tagger (reason: correlation with IP)

Secondary vertex tagging (Rome)



- Normalized Secondary VTX mass distributions for **u-jets (red)** and **b-jets (black)** reconstructed with BtagVrtSec

p_T dependence on Rome samples (SV1 versus 2D)



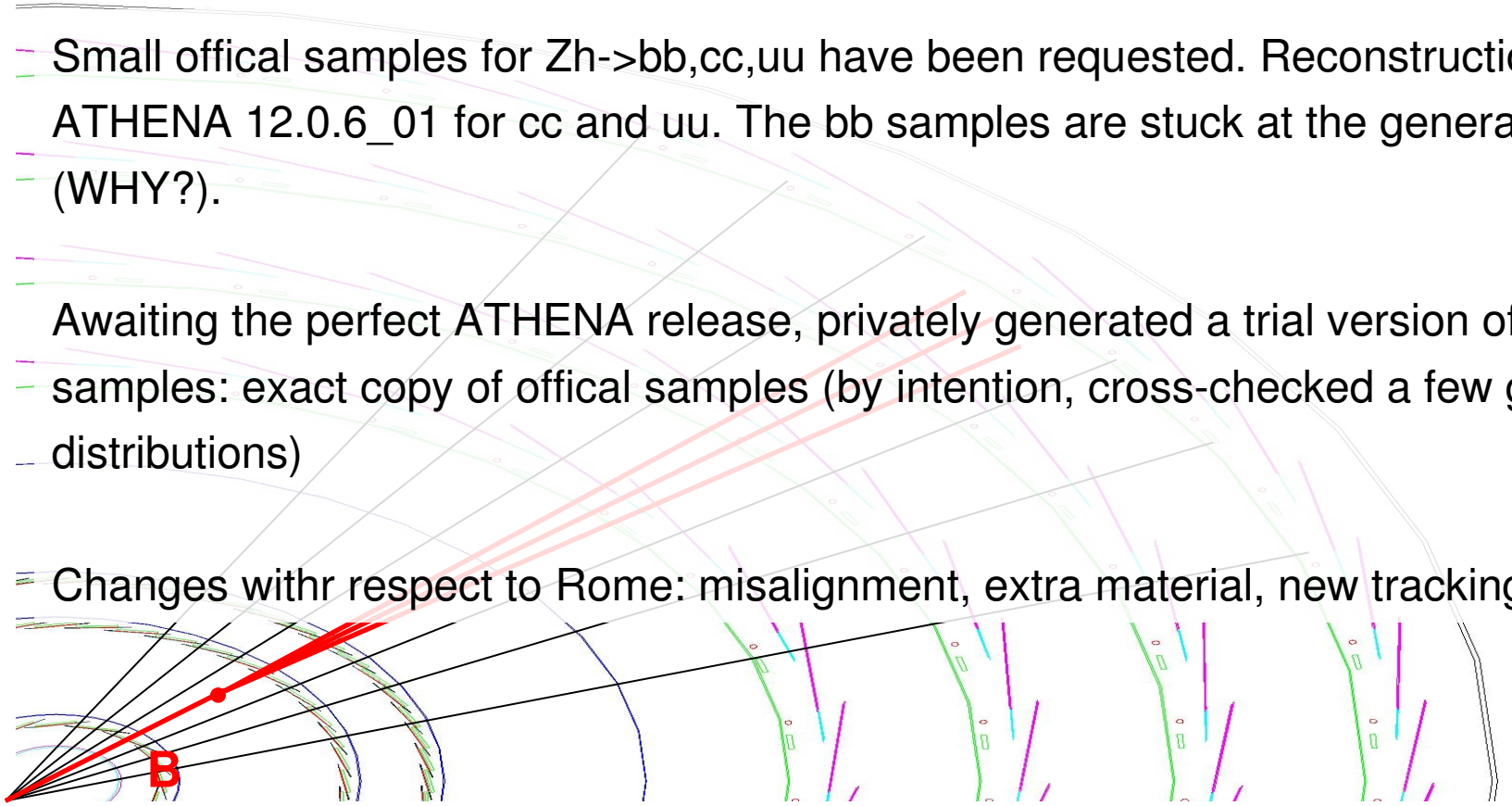
Standard ATLAS tagging algorithms, without retuning

The present

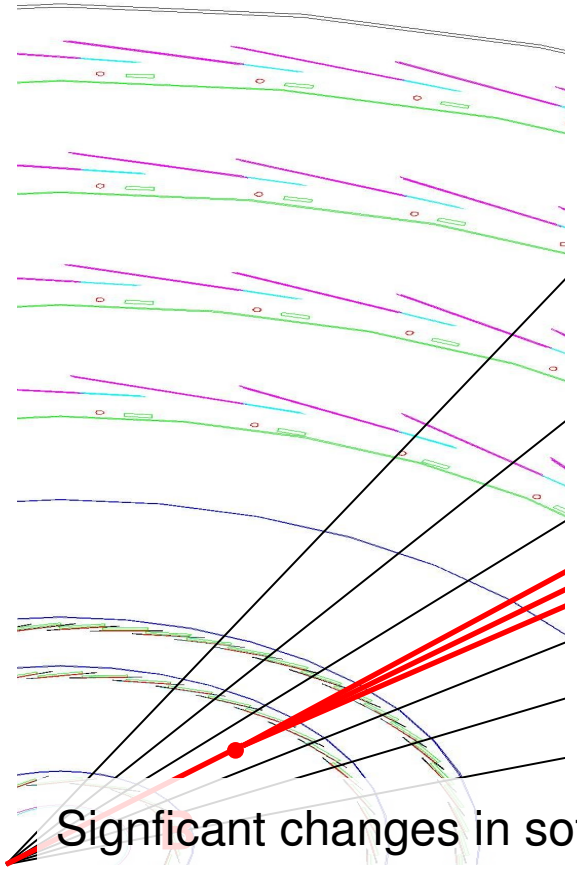
- Small offical samples for Zh->bb,cc,uu have been requested. Reconstruction done with ATHENA 12.0.6_01 for cc and uu. The bb samples are stuck at the generation stage (WHY?).

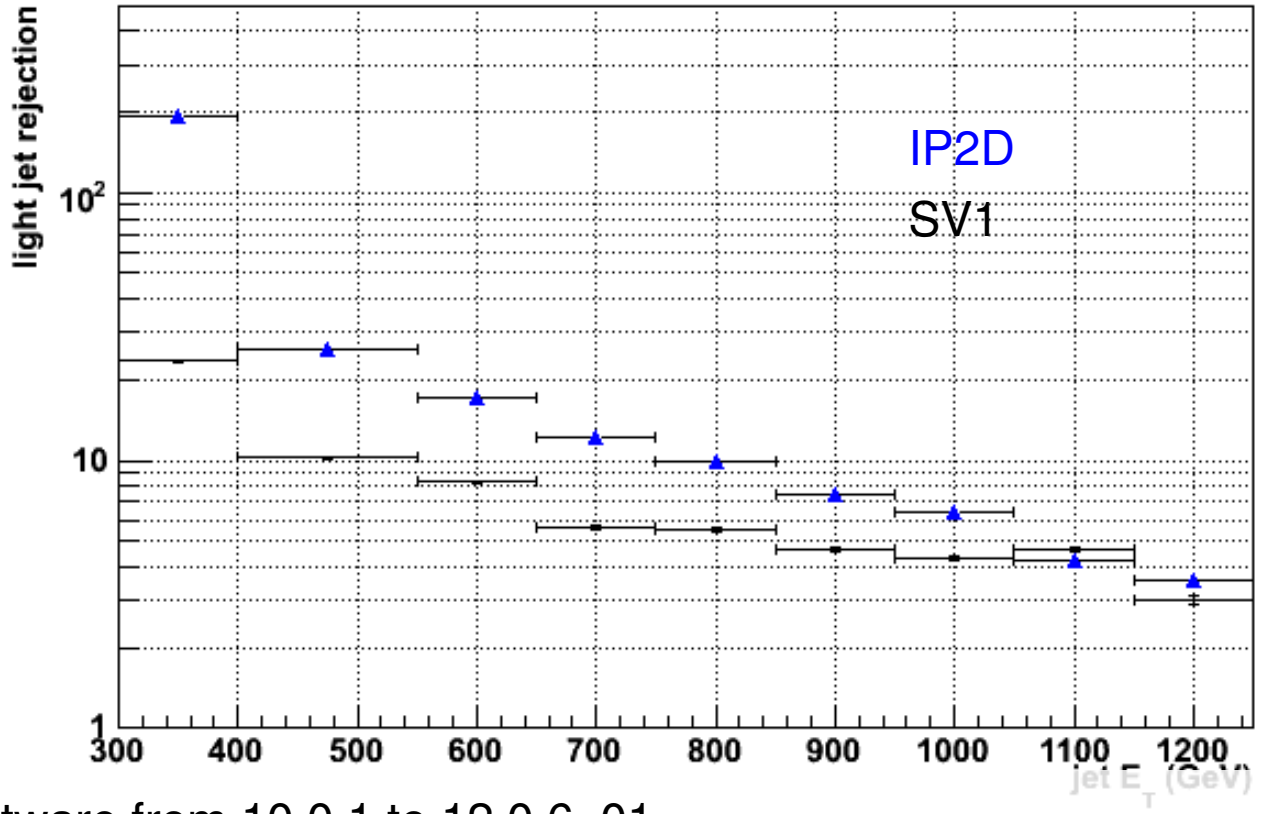
- Awaiting the perfect ATHENA release, privately generated a trial version of the ZH samples: exact copy of offical samples (by intention, cross-checked a few global distributions)

- Changes withr respect to Rome: misalignment, extra material, new tracking vs. iPatRec,



The present (SV1 versus 2D)





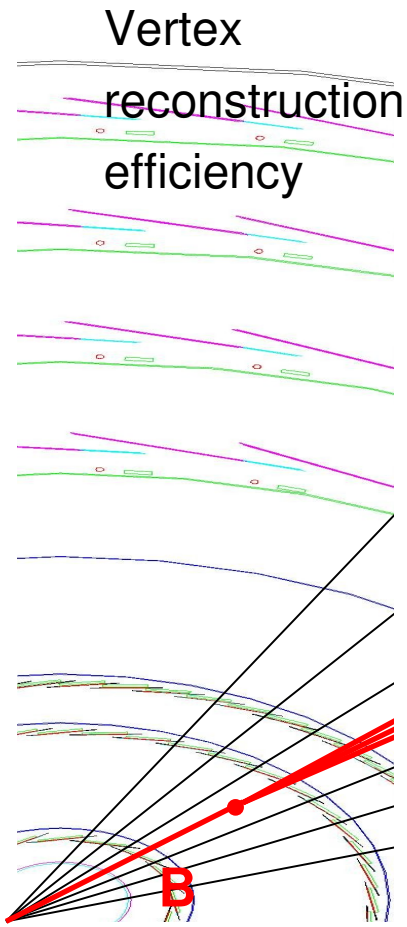
Signficant changes in software from 10.0.1 to 12.0.6_01

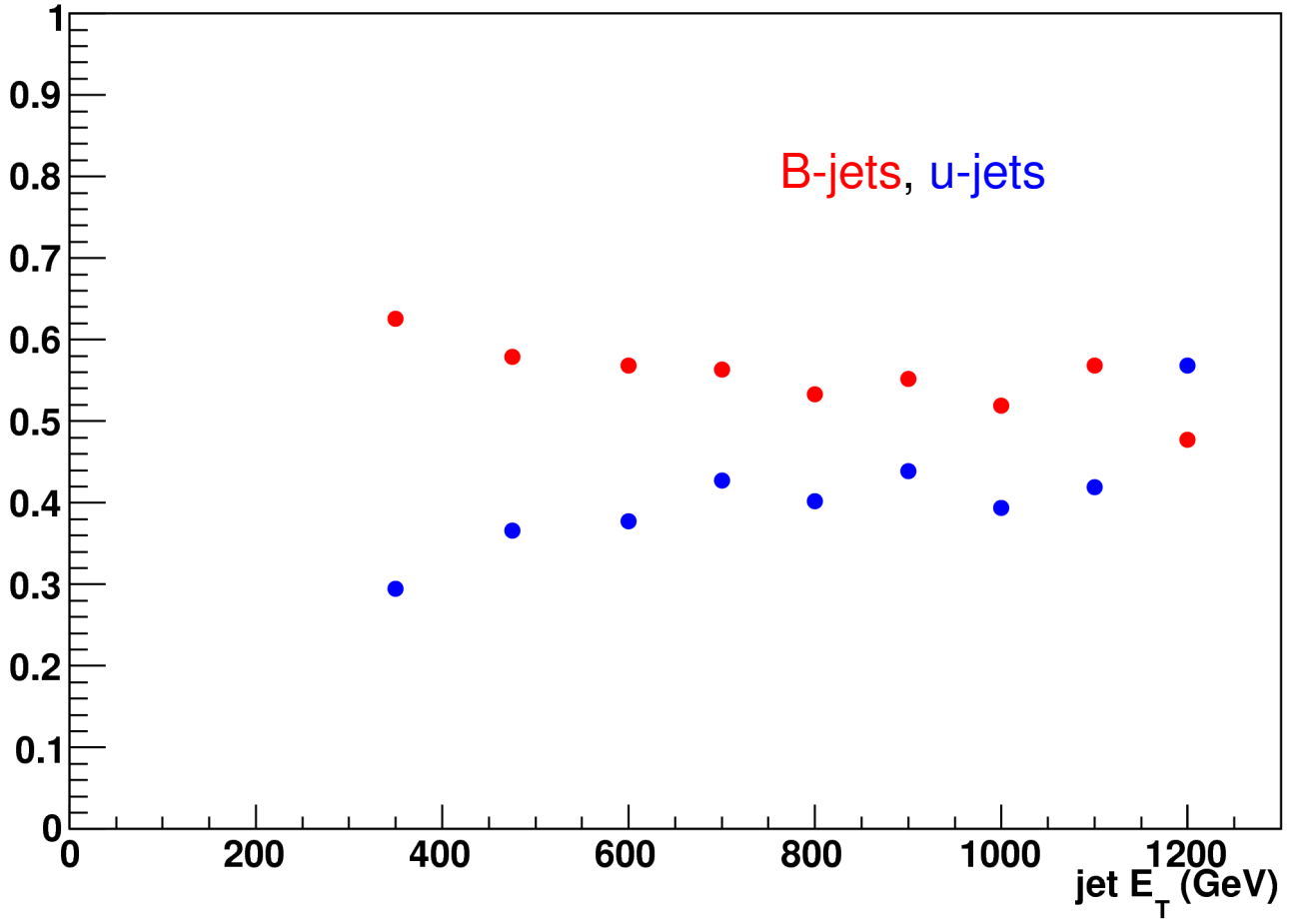
Nevertheless IP2D performance essentially the same as in “Rome” analysis

SV1 performance dramatically degraded with respect to “Rome”

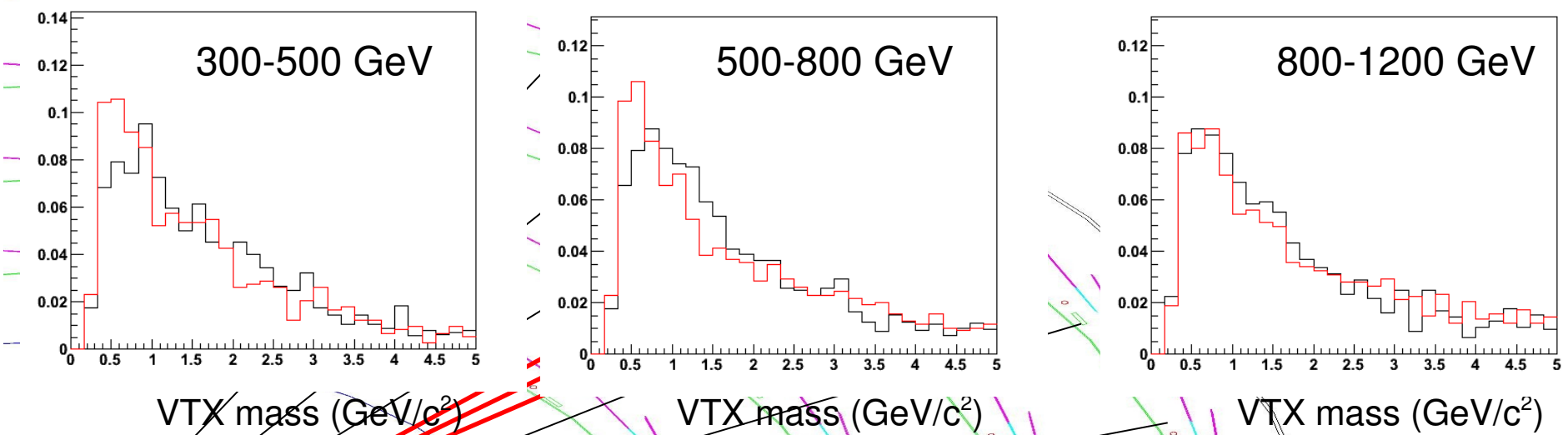
NOTE: SV1 not intended for stand-alone use

The present


Vertex
reconstruction
efficiency
B


B-jets, u-jets
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
200
400
600
800
1000
1200
jet E_T (GeV)

The present (CSC samples)

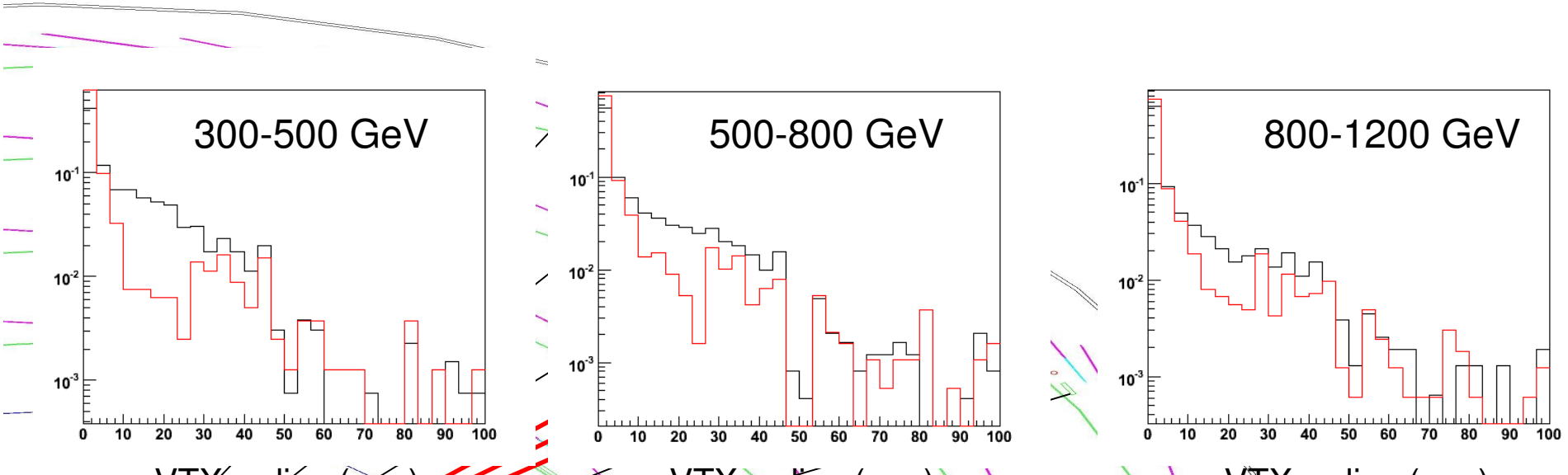


Normalized Secondary VTX mass distributions for **u-jets (red)** and **b-jets (black)** reconstructed with BtagVrtSec

Distributions of all observables used by SV1 to distinguish b- and u-jets seem quite seriously degraded

The present (CSC samples)

The present



Normalized Secondary VTX radius distributions for **u-jets (red)** and **b-jets (black)** reconstructed with BtagVertSec (V. Kostyukhin)

SV-PV distance (significance) to be added to likelihood for stand-alone SV tagger

get_tag Reconstruction/VKalVrt/BTagVrtSec -r 12.0.6

>> *2.0.6;AtlasReconstruction;/Reconstruction/VKalVrt/BTagVrtSec;BTagVrtSec-00-02-04* (Mon Oct 16, 2006)

get_tag Reconstruction/VKalVrt/BTagVrtSec -r 12.0.3

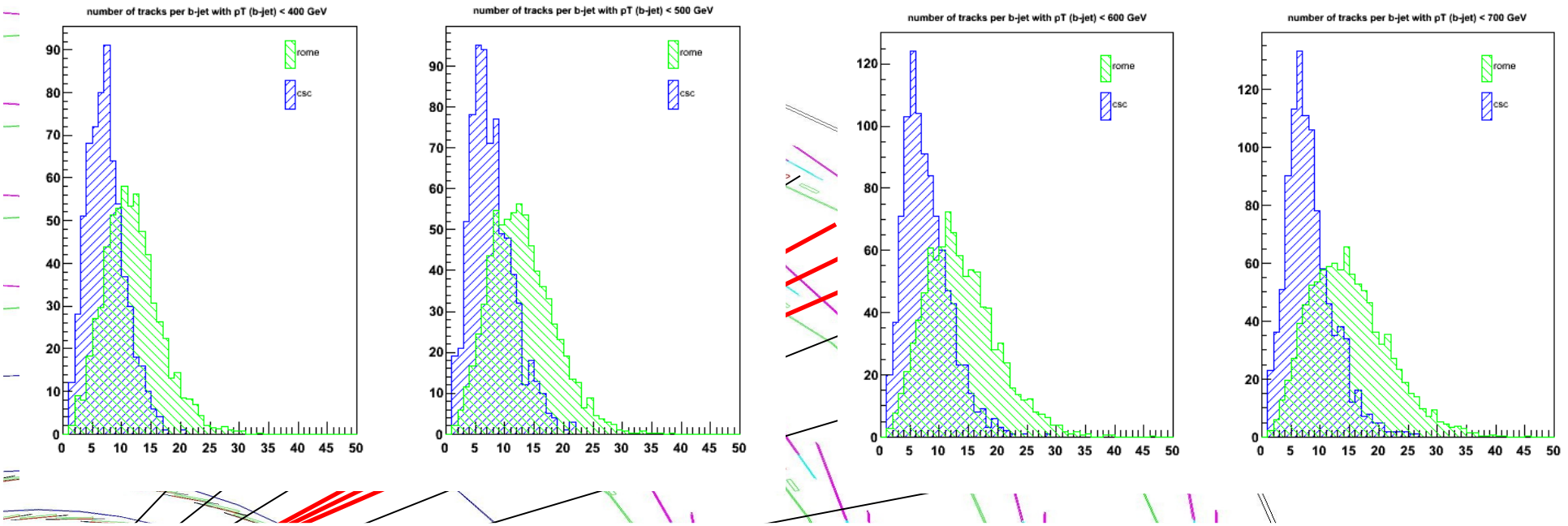
>> *2.0.3;AtlasReconstruction;/Reconstruction/VKalVrt/BTagVrtSec;BTagVrtSec-00-01-11* (Mon Jul 24, 2006)

No major change in Seconday vertex code (BTagVrtSec)

Diff for /offline/Reconstruction/VKalVrt/BTagVrtSec/src/BTagVrtSec.cxx between version 1.25 and 1.34

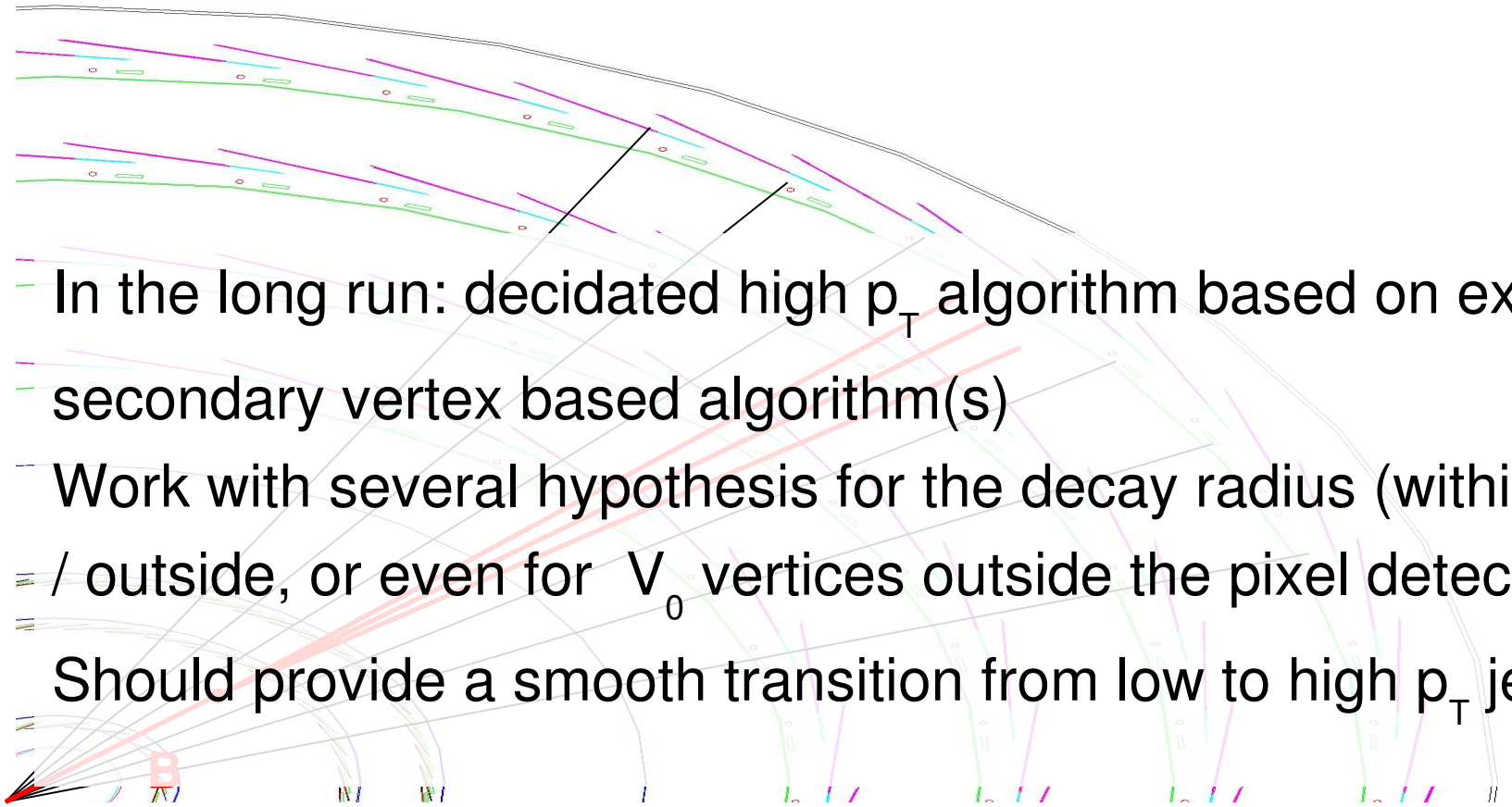
version 1.25, 2006/07/24 16:35:34	version 1.34, 2006/10/22 10:54:37
Line 15	**Line 15**
const std::string& name,	const std::string& name,
const IInterface* parent):	const IInterface* parent):
AlgTool(type,name,parent),	AlgTool(type,name,parent),
m_CutSctHits(6),	m_CutSctHits(4),
m_CutPixelHits(1),	m_CutPixelHits(1),
m_CutSiHits(9),	m_CutSiHits(7),
m_CutBLayHits(0),	m_CutBLayHits(0),
m_CutSharedHits(0),	m_CutSharedHits(0),
m_CutPt(769.2),	m_CutPt(769.2),
Line 84	**Line 84**
m_massK0 = 497.648 ;	m_massK0 = 497.648 ;
m_massLam =1115.683 ;	m_massLam =1115.683 ;
	m_MultiVertex = 0 ;

The present: CSC Tracking



- Reconstructed track multiplicity (after quality cuts) for high p_T jets much reduced with respect to Rome
- Track parameter distributions (chi-squared, N hits in pixel, silicon, B-layer) do not seem to provide hints

The future



- In the long run: decidated high p_T algorithm based on existing secondary vertex based algorithm(s)
- Work with several hypothesis for the decay radius (within B-layer / outside, or even for V_0 vertices outside the pixel detector).
- Should provide a smooth transition from low to high p_T jets.