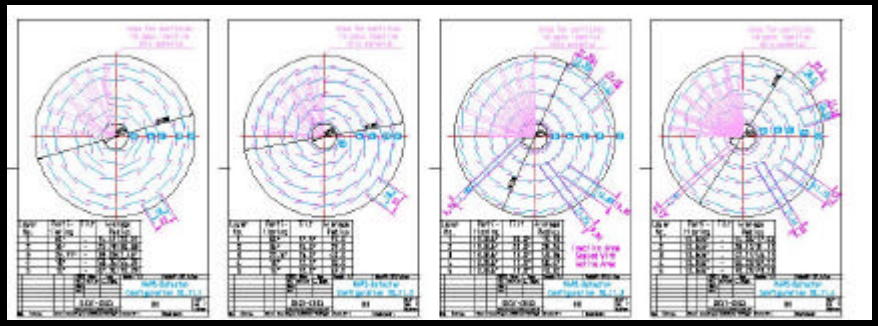
SGV and ZVTOP

Simulation Session, 15 Nov. 03

Tobias Haas (with V. Adler and P. Luzniak)
DESY/F1

Introduction

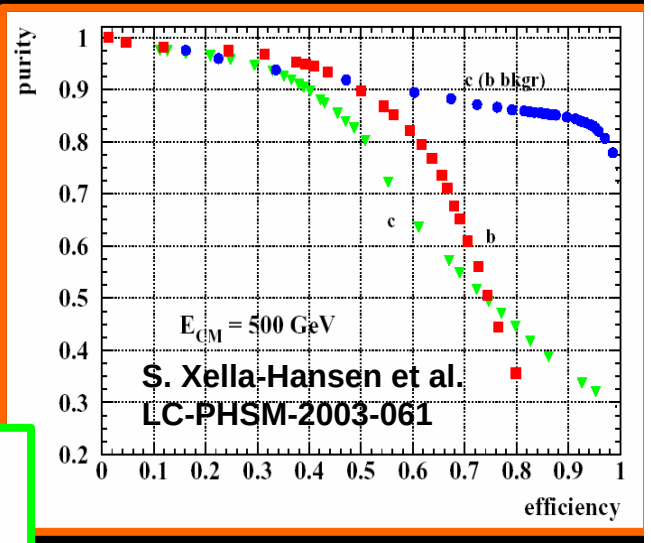


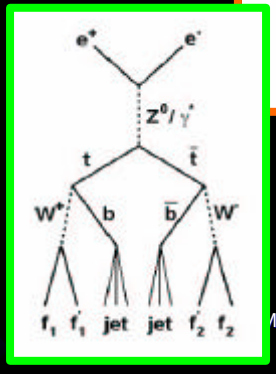
- Goal:
  - Optimization of design parameters for VXD:
    - Support, sensor thickness, overlaps, layer spacing…
  - Special considerations for specific technologies: MAPS, CCD, DEPFET
    - Placement of readout
    - Power, etc.
- Steps
  - First
    - Explore many configurations quickly
    - Moderate Accuracy
    - Full physics capabilities
  - Second
    - Verify results with a high precision tool

Þ SGV

Optimization Parameters

- What should be the optimization parameters?
- e.g. Tagging Efficiency…
- … or effective error on some physics process?





- *?M ?*

Detector Optimization using a Complete “Toy” Analysis

- Requirements:
  - Physics Generators
  - Fast Simulation (SGV)
  - Reconstruction/Analysis Suite
    - Tracking
    - EFOs
    - Jet Finders
    - Vertexing
    - Flavor Tagging
    - …

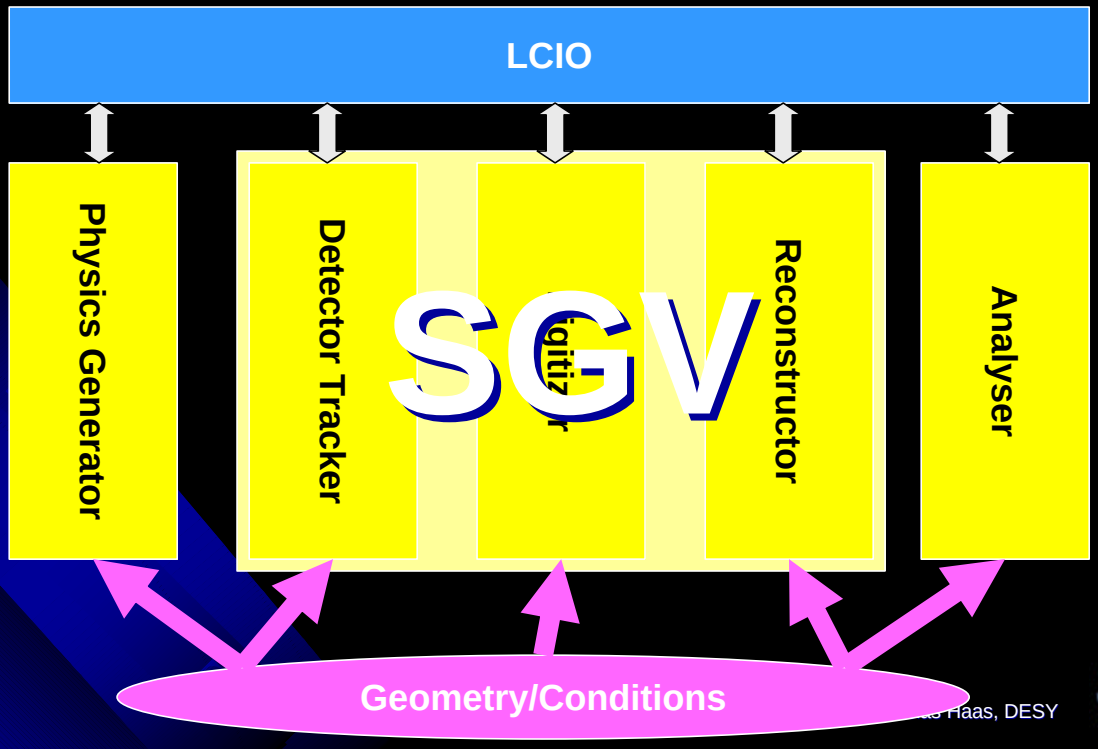
(ZVTOP)

More or less covered by SGV

Not covered by SGV

Ties Behnke

Integration of Simulation/Reconstruction/Analysis



… while waiting …

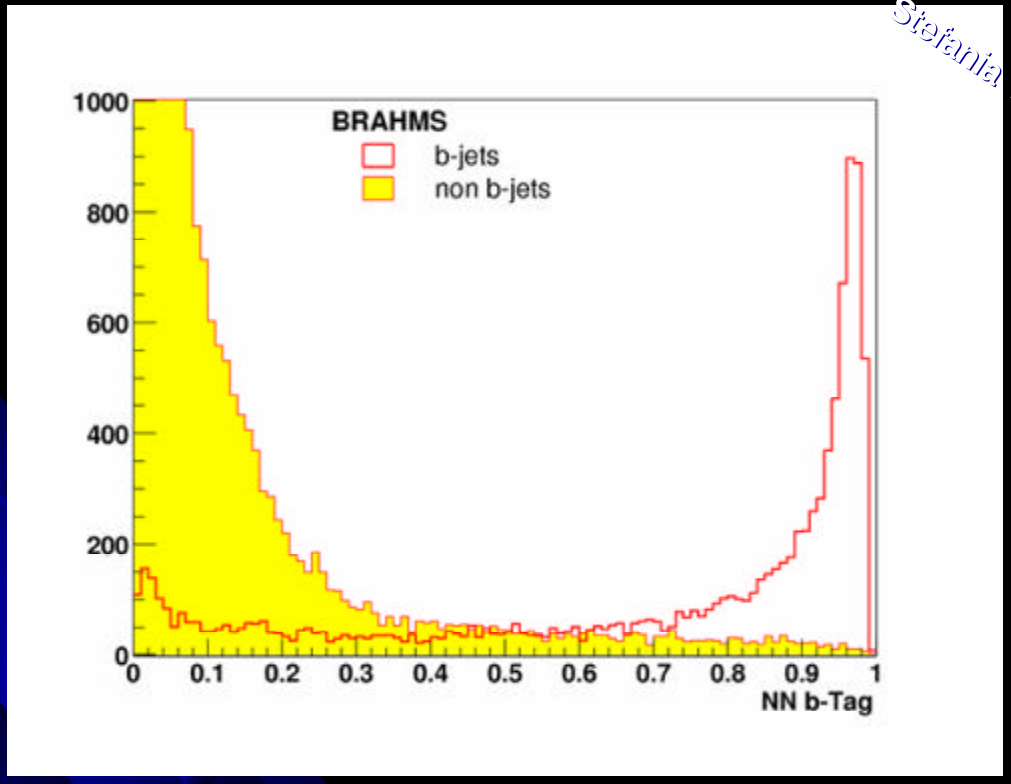
- V. Adler has latched b-tagging used in Brahms onto SGV
- Not a completely trivial procedure:
  - Refit the resolution function to match the data set
  - A number of numerical issues (mostly evaluation of integrals)
  - Extend range of “Joint-Probability” tag to cover impact parameters significances up to 200
  - Tune the definition of which tracks enter into the ZVTOP procedure
  - … get all coordinate transformations right!

B-tagging

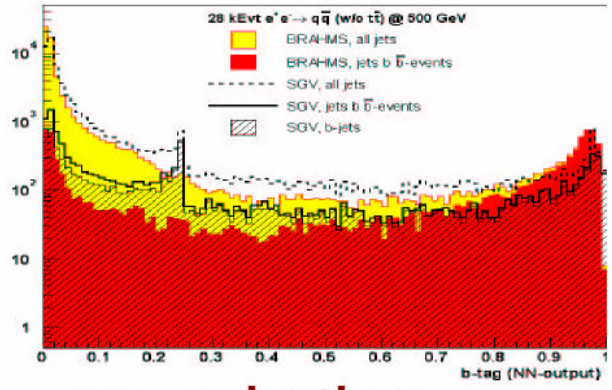
- 4 algorithms classify jets:
  - Impact parameter joint probability tag
  - “tear down” vertex finder
  - “most significant” tracks in the jet
  - ZVTOP
- NN gives three tagging outputs
  - B tag
  - C tag
  - B/C distinction tag

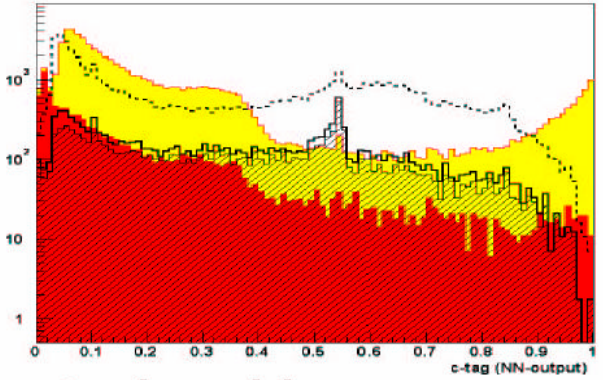
Example

ntuple thanks to Stefania Xella -Hansen



Initial Results
(shown in Amsterdam by V. Adler)





pre–selection:

a) $p_t \geq 5$ GeV

b) #tracks ≥ 6

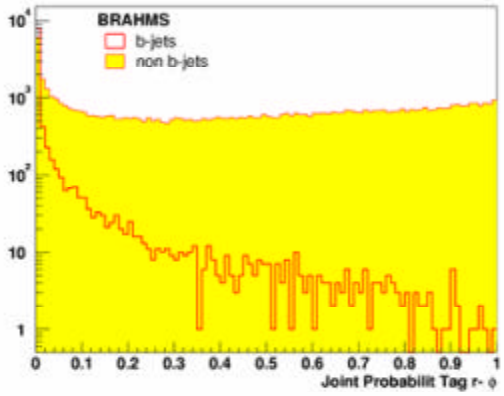
actual problem:

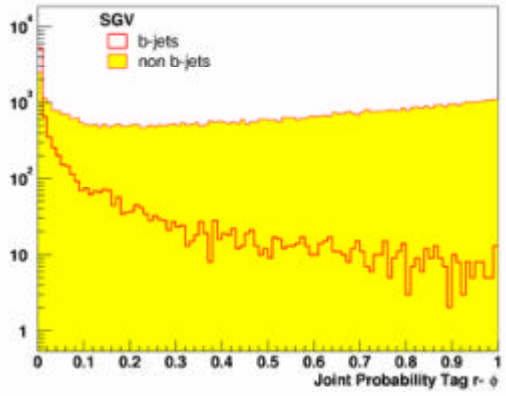
NN–output does not describe jet flavours well

⇒check SGV–input w.r.t. BRAHMS

*) Thanks to S.M. Xella Hansen for providing the ntuples.

Results 1


BRAHMS
b-jets
non b-jets
Joint Probabilit Tag r- ϕ


SGV
b-jets
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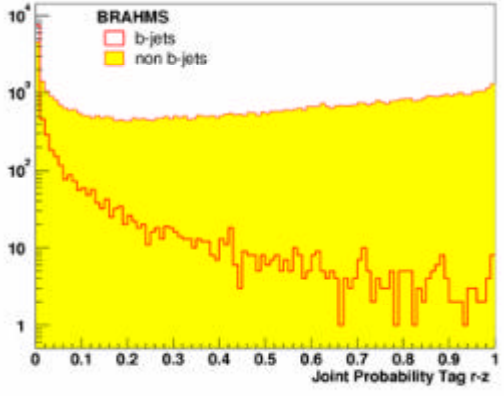
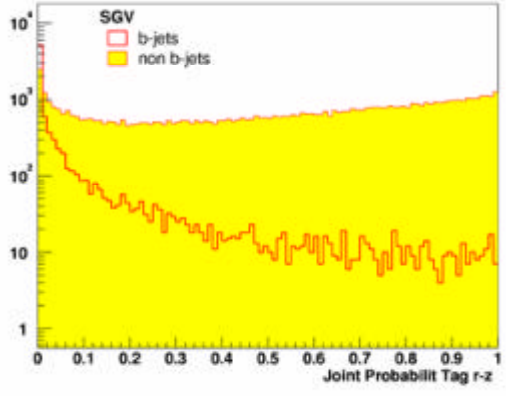
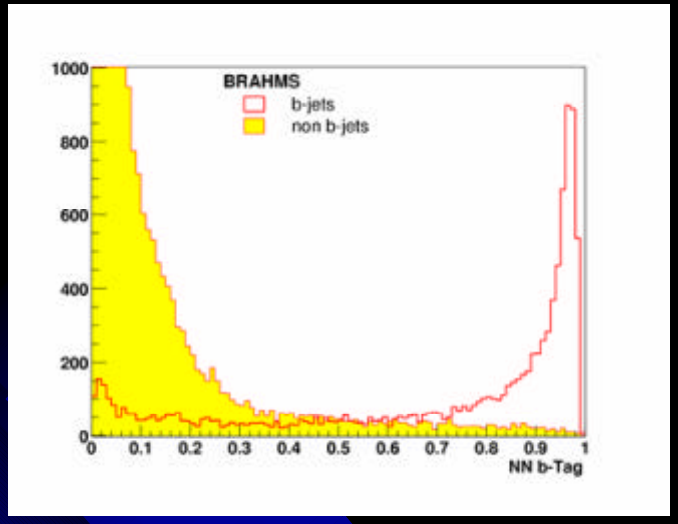
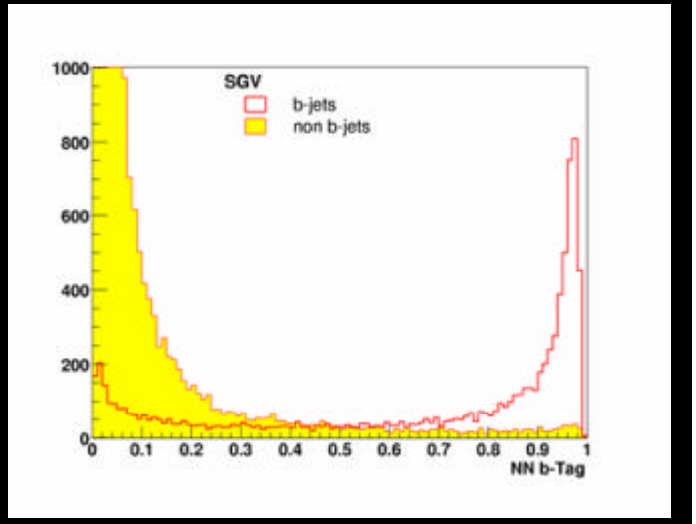
Joint Probability Tag r- ϕ


BRAHMS
b-jets
non b-jets
Joint Probability Tag r-z


SGV
b-jets
non b-jets
Joint Probabilit Tag r-z

Results 2


BRAHMS
b-jets
non b-jets
1000
800
600
400
200
0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
NN b-Tag


SGV
b-jets
non b-jets
1000
800
600
400
200
0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
NN b-Tag

Remarks

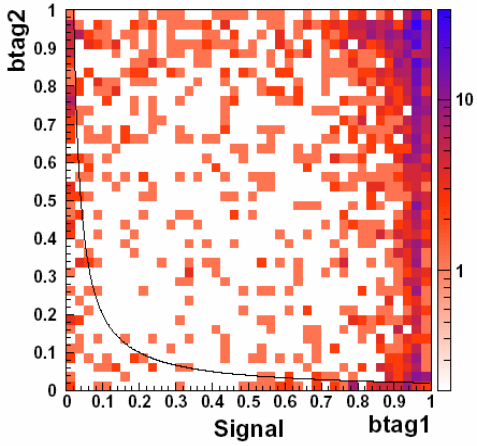
- Generally, there is good agreement between BRAHMS and SGV …
- … but still small discrepancies.
- Possible reasons:
  - SGV precision is limited:
    - Only cylindrical/planar geometries
  - B-tagging NN may have to be retrained
- However, may still go ahead and use this for analysis
  - H branching fractions in e^+e^- ? *ZH* ? *qqXY* ***(by P. Luzniak)***

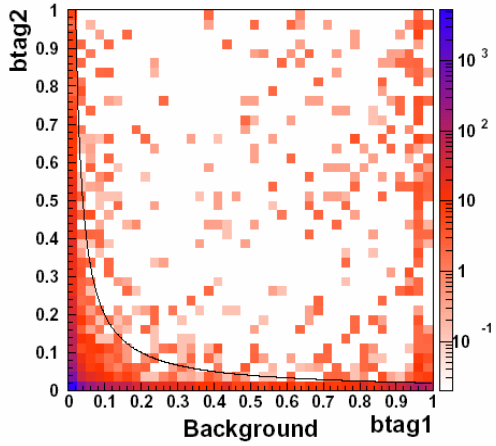
Measurement of SM Higgs branching ratios

	$\sigma(fb)$	events expected $(500 fb^{-1})$	events simulated
Signal:			
$H \rightarrow b\bar{b}$	23	11 500	10 000
$H \rightarrow WW^*$	27	13 500	10 000
$H \rightarrow ZZ^*$	3.6	1 800	5 000
$H \rightarrow c\bar{c}$	1.4	700	5 000
$H \rightarrow gg$	2.0	1 000	5 000
$H \rightarrow \tau\tau$	2.0	1 000	5 000
Background:			
$e^+e^- \rightarrow W^+W^-$	7 690	3 845 000	1 927 500
$e^+e^- \rightarrow q\bar{q}$	11 230	5 615 000	2 812 500
$e^+e^- \rightarrow t\bar{t}$	575	287 500	145 000
$e^+e^- \rightarrow Z^oZ^o$	652	326 000	162 500

$E_{CMS} = 500\ GeV$, $M_{Higgs} = 140\ GeV$. Following method published by:
M. D. Hildreth, T. L. Barklow, D. L. Burke Phys. Rev. D 49 3441(1994)

$H \rightarrow b\bar{b}$





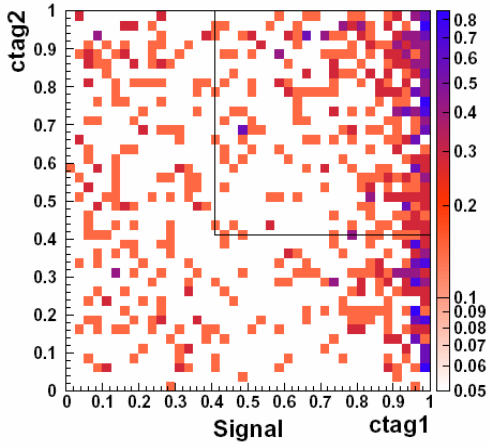
Choice: $btag1 * btag2 > 0.02$ (after some optimization)

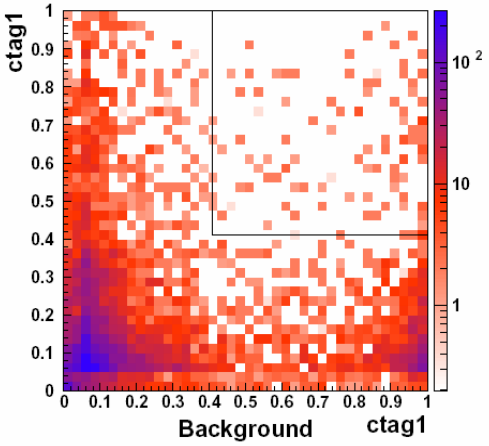
Signal - 1620 events

Background - 431 events

$$\frac{\sigma(\sigma_{tot} \times \Gamma(H \rightarrow b\bar{b}))}{\sigma_{tot} \times \Gamma(H \rightarrow b\bar{b}))} = 2.8\%$$

$H \to c\bar{c}$





Choice: $ctag1 > 0.41$, $ctag2 > 0.41$, $ycut < 0.075$ (after some optimization)

Signal - 50.8 events

Background - 171.2 events

$$\frac{\sigma(\sigma_{tot}\times\Gamma(H\to c\bar{c}))}{\sigma_{tot}\times\Gamma(H\to c\bar{c}))} = 29\%$$

Finally: Use for Detector Optimization Studies:

Results

	MAPS $50\mu m$	MAPS $300\mu m$ without layer 1
$\frac{\sigma(\sigma_{tot}\times\Gamma(H\rightarrow b\bar{b}))}{\sigma_{tot}\times\Gamma(H\rightarrow b\bar{b})}$	2.8 %	2.8 %
$\frac{\sigma(\sigma_{tot}\times\Gamma(H\rightarrow c\bar{c}))}{\sigma_{tot}\times\Gamma(H\rightarrow c\bar{c})}$	29 %	36 %

- Note: Result is compatible with results by T. Kuhl using SIMDET

Summary

- A first important analysis tool (B-tagging à la ZVTOP) is now available with SGV.
- Results have been carefully cross checked with full simulation/standard analysis in BRAHMS.
- Has been submitted to M. Berggren (author of SGV) to be available as a general facility.
- First results on Higgs branching fractions show the usefulness of the tool.
  - e.g. Full power of vertex detector (5 very thin layers) does not matter for B tagging but important for charm.