Physics and Software Framework Simulation

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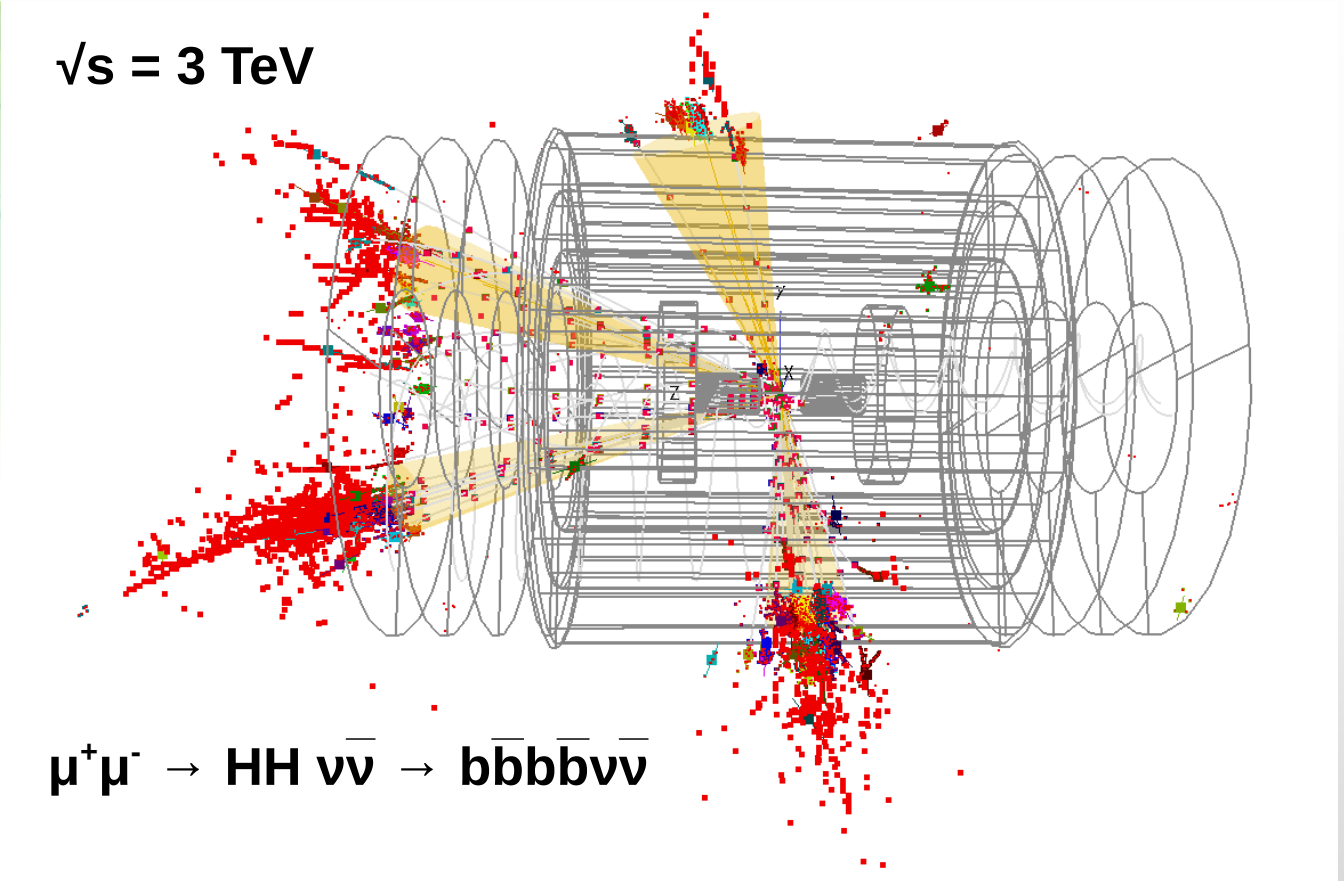
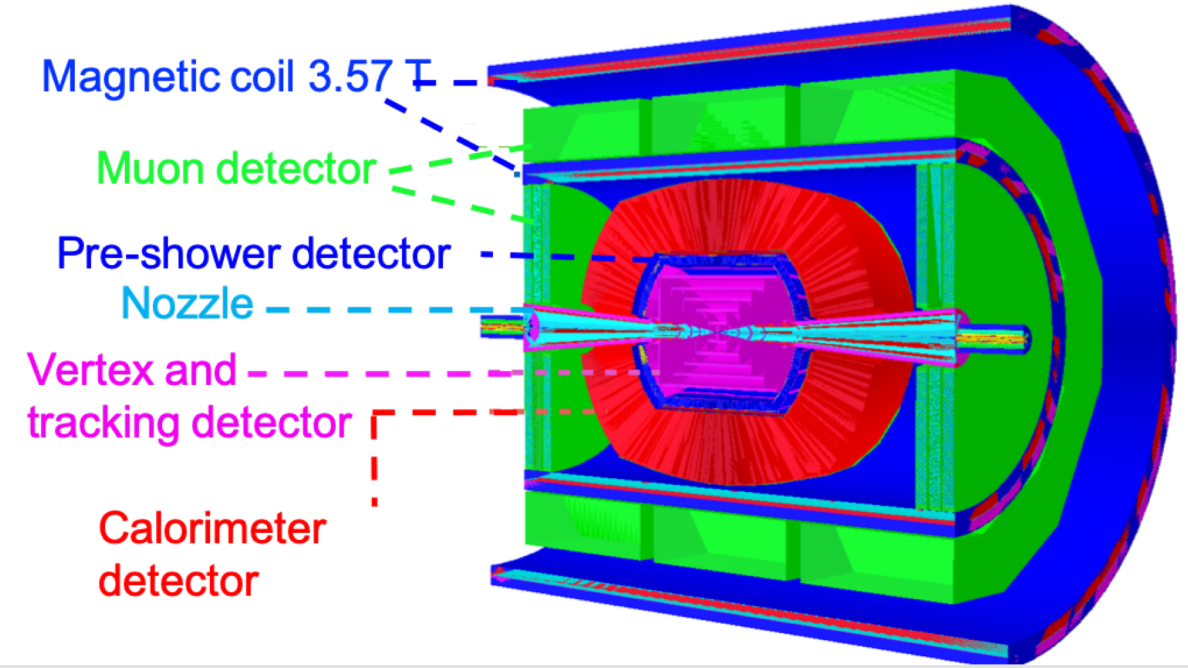
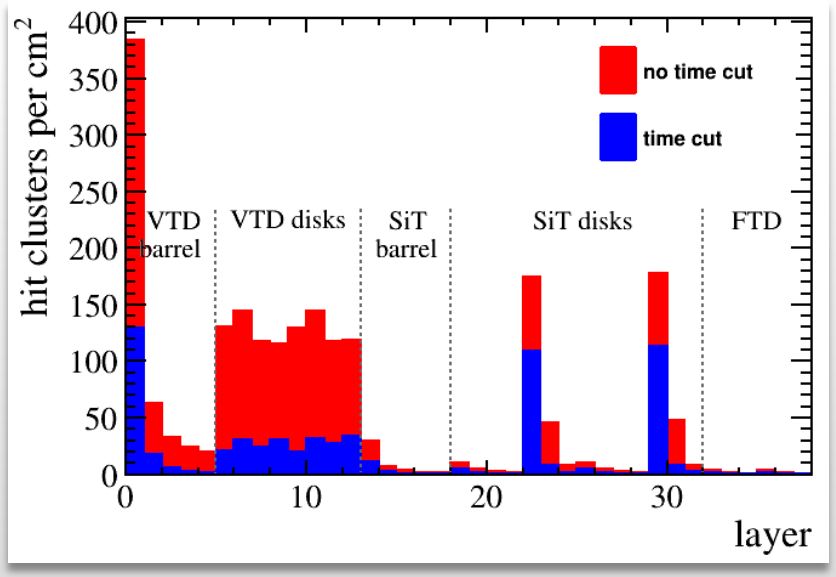


Detector Response Simulation at $\sqrt{s}$ =1.5 TeV

Use the simulation/reconstruction tools previously developed within the MAP collaboration based on the ILCroot package: it supports signal + MARS15 background merging



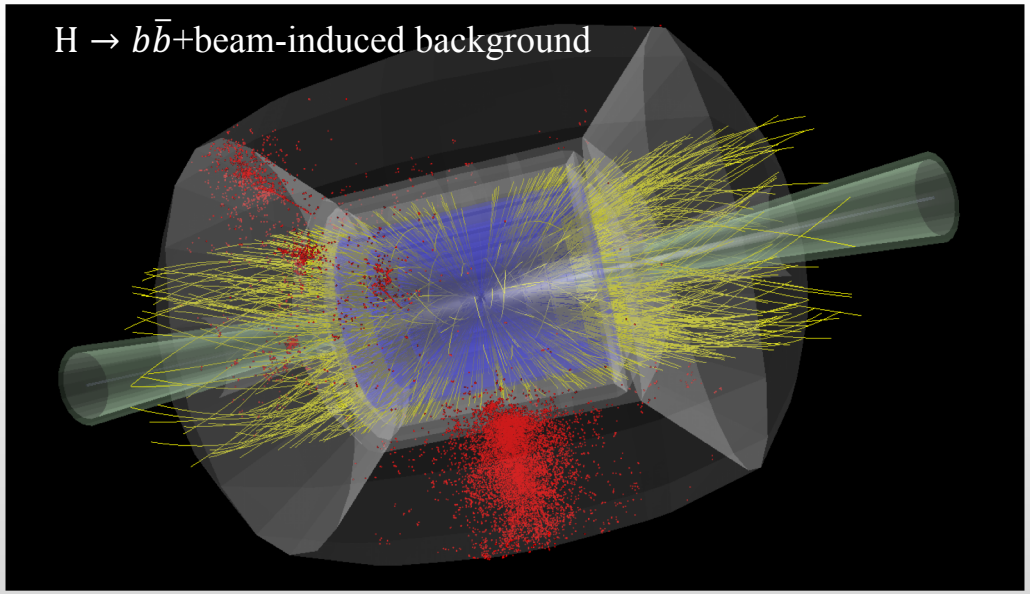
Effects of beam-induce background can be mitigated by exploiting "5D" detectors, i.e. including timing



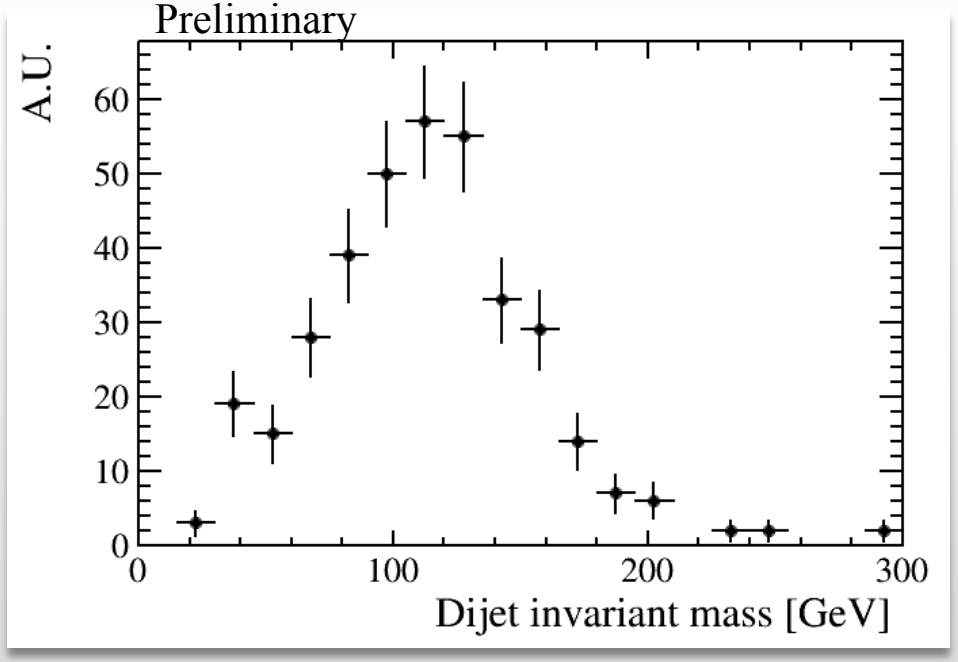
$b\bar{b}$ Studies at $\sqrt{s}$ =1.5 TeV

$\mu^+\mu^- \to HX, H \to b\bar{b}$ and $\mu^+\mu^- \to b\bar{b}X$ generated @$\sqrt{s} = 1.5\ TeV$ with PYTHIA 8

Process	cross section [pb]	
$\mu^+\mu^- \to \gamma^*/Z \to bb$	0.046	
$\mu^+\mu^- \to \gamma^*/Z\gamma^*/Z \to b\bar{b}$ +X	0.029	
$\mu^+\mu^- \to \gamma^*/Z\gamma \to bb\gamma$	0.12	
$\mu^+\mu^- \to HZ \to b\bar{b}$ +X	0.004	
$\mu^+\mu^- \to \mu^+\mu^- H\ H \to b\bar{b}$ (ZZ fusion)	0.018	
$\mu^+\mu^- \to \nu_\mu\nu_\mu H\ H \to bb$ (WW fusion)	0.18	Signal



$\mu^+\mu^- \to H\nu\bar{\nu} \to b\bar{b}\nu\bar{\nu}$ + beam-induced background fully simulated



Higgs $b\bar{b}$ Couplings Results

- The instantaneous luminosity, $\mathcal{L}$, at different √s is taken from MAP
- The acceptance, A, the number of signal events, N, and background, B, are determined with simulation

$\sqrt{s}$ [TeV]	A [%]	ϵ [%]	$\mathcal{L}$ [$\mathrm{cm^{-2}s^{-1}}$]	$\mathcal{L}_{int}$ [$\mathrm{ab^{-1}}$]	σ [fb]	N	B	$\frac{\Delta\sigma}{\sigma}$ [%]	$\frac{\Delta g_{Hbb}}{g_{Hbb}}$ [%]
1.5	35	15	$1.25 \cdot 10^{34}$	0.5	203	5500	6700	2.0	1.9
3.0	37	15	$4.4 \cdot 10^{34}$	1.3	324	33000	7700	0.60	1.0
10	39	16	$2 \cdot 10^{35}$	8.0	549	270000	4400	0.20	0.91

	$\sqrt{s}$ [TeV]	$\mathcal{L}_{int}$ [$\mathrm{ab^{-1}}$]	$\frac{\Delta g_{Hbb}}{g_{Hbb}}$ [%]
Muon Collider	1.5	0.5	1.9
	3.0	1.3	1.0
	10	8.0	0.91
CLIC	0.35	0.5	3.0
	1.4	+1.5	1.0
	3.0	+2.0	0.9

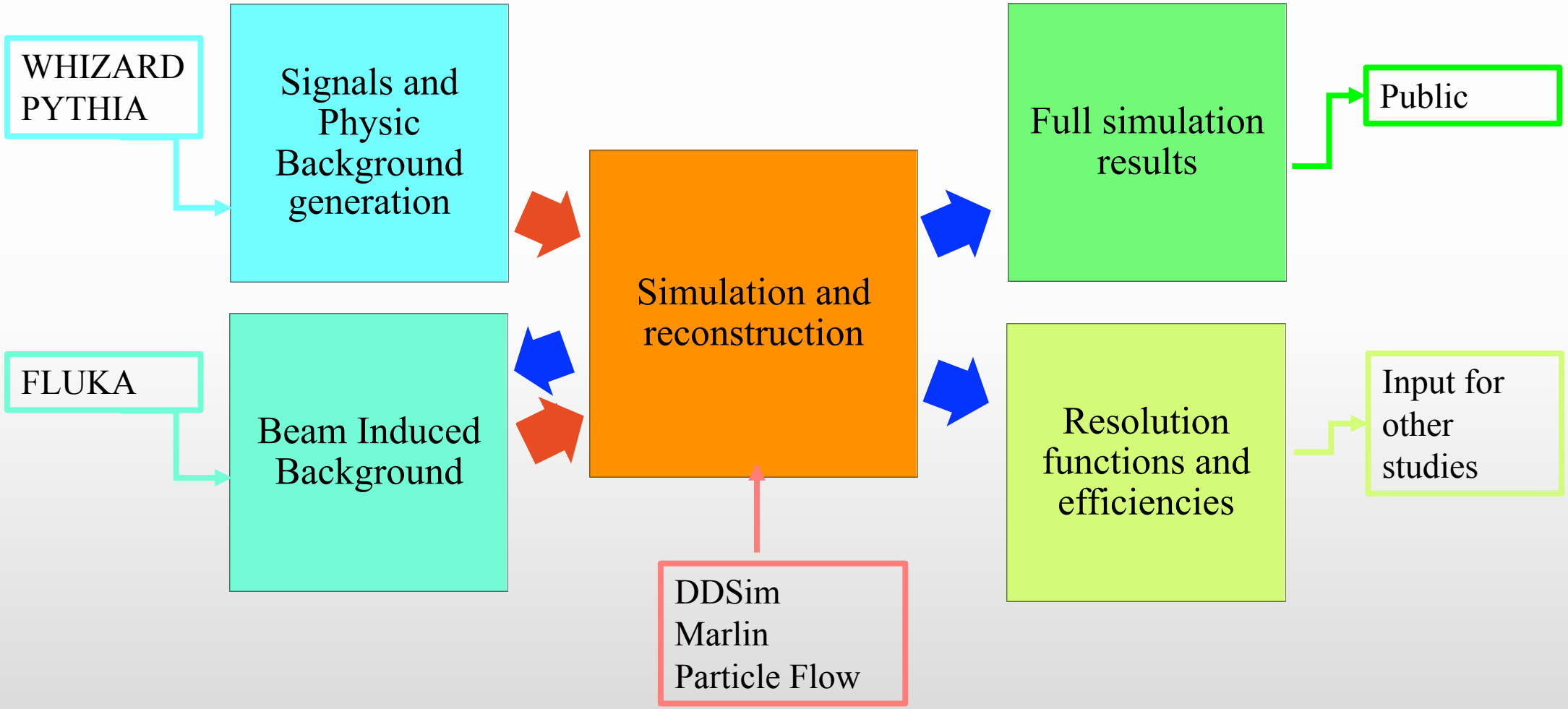
CLIC numbers are obtained with a model-independent multi-parameter fit performed in three stages, taking into account data obtained at the three different energies

Results published in open access as Detector and Physics Performance at a Muon Collider Accepted for publication JINST

Software Info

- The work done so far used the MAP framework
- We decided to move to a Future Collider Framework, ILCSoftware.
- We are setting up a GRID VO, muoncoll.infn.it everybody can register
- We are preparing the environment to be able to submit to the GRID/cloud
- Right now we have a cloud VM that can be installed anywhere
- Some resources, machines and disk space is available on CloudVeneto
- Code on github

Simulation Framework



Physics Program

The idea is to study the following items in the next months at the center of mass energies: 1.5, 3 10 TeV

Higgs fermions couplings

$\mu^+\mu^- \to HX, H \to b\bar{b}$

$\mu^+\mu^- \to HX, H \to \tau^+\tau^-$

Higgs bosons couplings

$\mu^+\mu^- \to HX, H \to W^+ W^-$

$\mu^+\mu^- \to HX, H \to ZZ$

$\mu^+\mu^- \to HX, H \to \gamma\,\gamma$

Higgs self-couplings

$\mu^+\mu^- \to HHX, H \to b\bar{b}, H \to b\bar{b}$

$\mu^+\mu^- \to HHHX, H \to b\bar{b}, H \to b\bar{b}, H \to b\bar{b}$

First look at HH

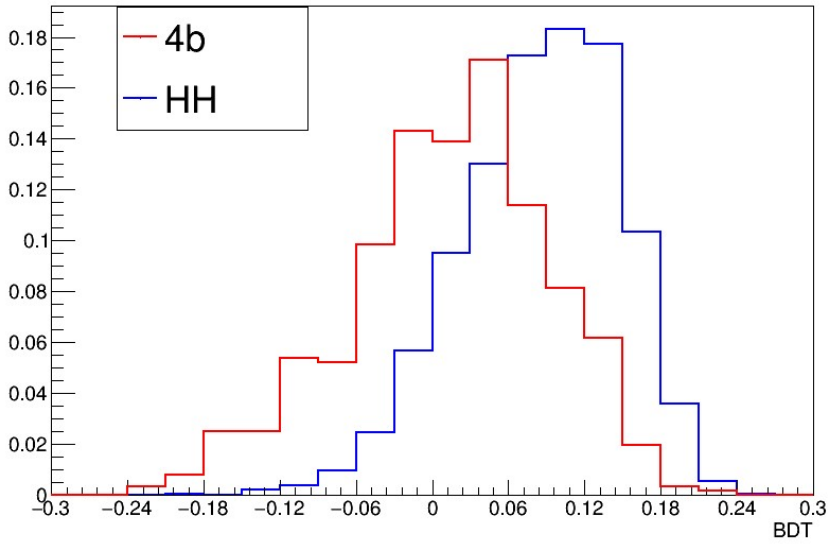
- $\mu^+\mu^- \to HH\nu\bar{\nu} \to b\bar{b}b\bar{b}\nu\bar{\nu}$ simulated
- $\mu^+\mu^- \to b\bar{b}b\bar{b}\nu\bar{\nu}$ inclusive simulated

with WHIZARD 2.8.2 at $\sqrt{s} = 3$ TeV

BDT cut	S	B	Significance	Δσ/σ
-0.06	50	469	2.21	0.45
-0.03	49	417	2.28	0.44
0	47	340	2.39	0.42
0.03	43	266	2.44	0.41
0.06	37	172	2.55	0.39
0.09	28	102	2.47	0.40
0.12	19	51	2.22	0.45
0.15	8	16	1.73	0.58
0.18	2	3	1.06	0.94

$S = \sigma_{HH}\, Br(H \to b\bar{b})^2\, L_{int}\, W_{sign}/N_{sign}$

$B = \sigma_{bbbb}\, L_{int}\, W_{bkg}/N_{bkg}$



Use the $\sqrt{s} = 1.5$ TeV detector and beam-induced background.

$\mathcal{L}_{int} = 1.3\ ab^{-1} \to t = 4 \cdot 10^7$ s

Laura Buonincontri

General Info

- We meet every two weeks on Tuesday afternoon, next meeting will be next Tuesday June 9;
- We have a e-mailing list muon_collider_studies@lists.infn.it, please contact us if you want to subscribe;
- At the moment we have a google site where we keep the relevant information MuonCollider;