UCLouvain
Institut de recherche en mathématique et physique
Centre de Cosmologie, Physique des Particules et Phénoménologie

MG5aMC@NLO: status and plan

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MG5 today

- 2.9.X is a long term stable release
  - Bug fixing only
    - Pledged support up to December
    - Useless?
- 3.1.x : official release of EW
- 3.2.0 : ee collision (ISR + beam effect)
- 3.3.0 : EWA + tagged photon + FXFX handling of weak jet

Python 2 versus 3

Current status

- Support of python 2.7
  - ➡ Not all feature supported
- Support of python 3.7/3.8/3.9/3.10
  - ➡ Minimal test on 3.10
- Run “python3” as default

Future

- 3.4.0 will drop python2.7
- MadDM not yet python3 ready
- Test suite has “ordering” issue
  - Couple of bugs passed undetected
- MadSTR

Bazaar/launchpad

Current status

MadGraph5_aMC@NLO has 108 active branches owned by 4 people and 8 teams. There were 94 commits by 7 people in the last month.

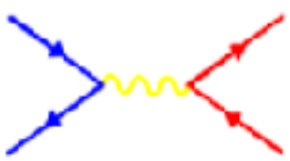
- I like bzr/launchpad but
  - ➡ Launchpad has issue (spam, tarball, ...)
  - ➡ Bzr is ... dead

Plan

- Have launchpad and GitHub
- Move to git when we drop 2.9.x
  - Use 3.4.0 as a syncing branch
  - Sync first all branches that we want to keep to 3.4.0
  - Do the migration

Web-interface

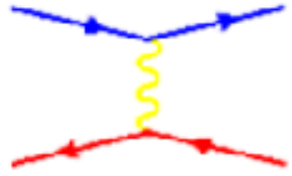
High Energy Physics Illinois



The MadGraph5_aMC@NLO homepage

UCL UIUC Launchpad

by the MG/ME Development team



Generate Process | Register | Tools | My Database | Cluster Status | Downloads (needs account) | Wiki | Answers | Bug reports

Ressource for MadGraph5_aMC@NLO

Generate events | **Bug Report/question with attachment** | **Wiki/Documentation** | **contact us/question (no attachment)**

NLOAccess

STRONG 2020

Please note the correct reference for MadGraph5_aMC@NLO, arXiv:1405.0301 [hep-ph].

MadTeam

Web-interface ii

Web service

- Model database
  - ➡ Store path to model (and check them every 24h)
- Installation database
  - ➡ Path to tarball
- Auto-update service

Server

- Two server in high availability
  - UCLouvain
  - UIUC
    - Need to prepare a replacement

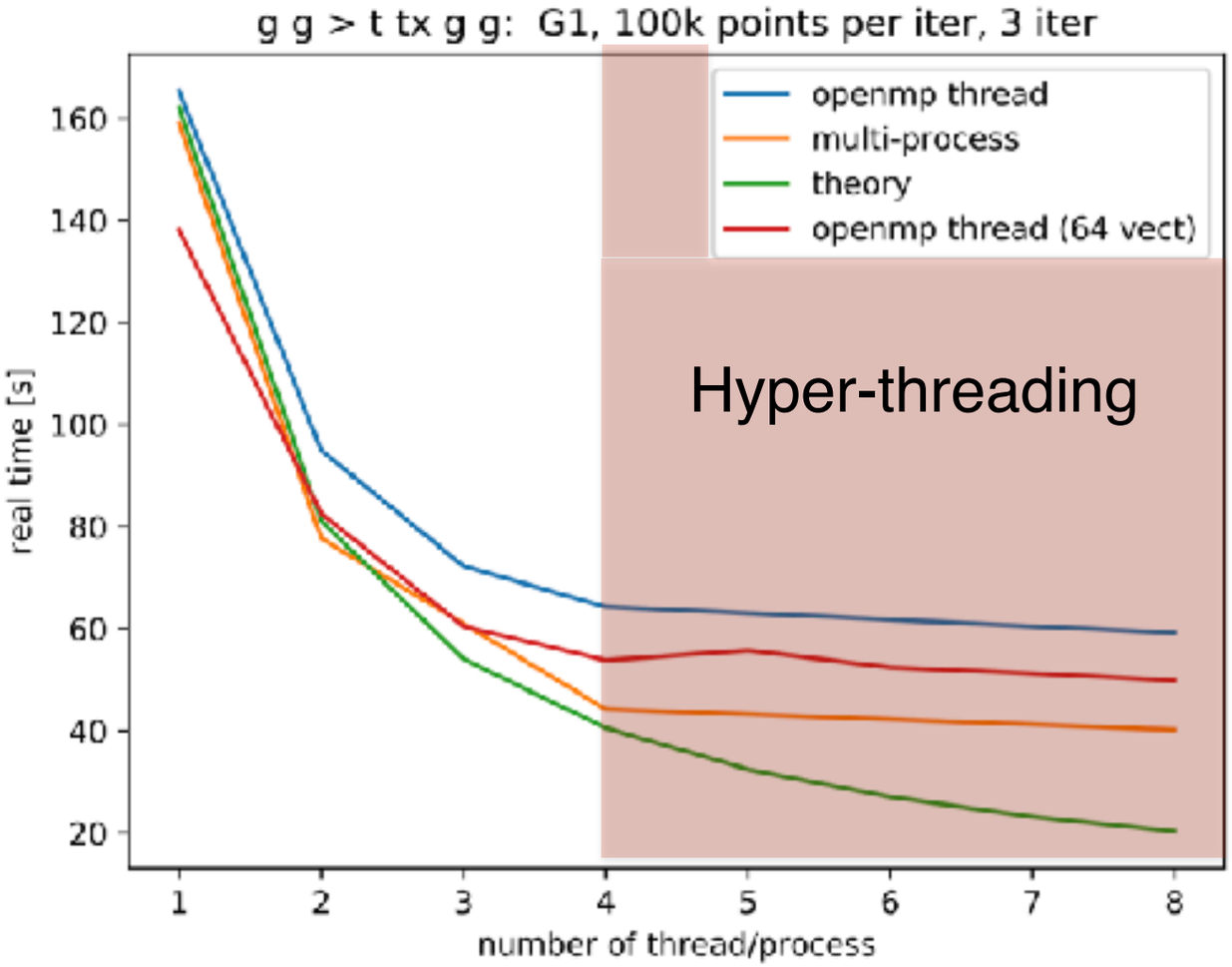
CMS/ATLAS REQUEST

- More Documentation (ATLAS)
  - ➡ CMS is fine with the status
  - ➡ New Paper?
- Multi-thread implementation (CMS)
- Faster code (HSF -> HL-LHC)
  - ➡ GPU
  - ➡ Vectorised cpu implementation
  - ➡ Less Negative events
- Higher precision (NNLO)

HSF WORK

- New C++ matrix-element evaluation
  - ➡ SIMD achieved on cpu
  - ➡ Running efficiently on GPU
- New LO (fortran) phase-space integrator
  - ➡ Choose the same flavour for X event
  - ➡ Allow multi-threading
  - ➡ Ready for SIMD
- Need to updgrade the ME to have madevent additional information
- link the two code

HSF collaboration result



Hel recycling

Implementation ($gg \to t\bar{t}gg$)	MEs / second Double
1-core MadEvent Fortran scalar	3.96E3 (x2.2)
1-core Standalone C++ scalar	1.84E3 **(x1.00)**
1-core Standalone C++ 128-bit SSE4.2 (x2 doubles, x4 floats)	3.36E3 (x1.8)
1-core Standalone C++ 256-bit AVX2 (x4 doubles, x8 floats)	6.86E3 (x3.7)
1-core Standalone C++ "256-bit" AVX512 (x4 doubles, x8 floats)	7.68E3 **(x4.2)**
1-core Standalone C++ 512-bit AVX512 (x8 doubles, x16 floats)	6.52E3 (x3.5)
Standalone CUDA NVidia V100S-PCIE-32GB (TFlops*: 7.1 FP64, 14.1 FP32)	4.89E5 **(x270)**

Multi-process very efficient
Multi-thread not far away
-> more efficient than current CMS work-around

lp:~maddevelopers/mg5amcnlo/3.1.1_lo_vectorization

LO-Speed-up

2102.00773

- Helicity recycling

	$gg \to t\bar{t}$		$gg \to t\bar{t}gg$		$gg \to t\bar{t}ggg$	
	Instructions	Reduction	Instructions	Reduction	Instructions	Reduction
`madevent`	11G	15%	180G	62%	5T	55%
`matrix1`	1G (9.3%)	68%	160G (90%)	64%	4.9T (98%)	55%
└→ ext	76M (<1%)	83%	100M (<1%)	97%	110M (<1%)	98%
└→ int	540M (4.8%)	72%	16G (8.9%)	90%	180G (3.6%)	91%
└→ amp	280M (2.6%)	47%	77G (42%)	63%	1.7T (33%)	69%

- New Multi-Channel

process	old strategy		new strategy		speed-up	default
VBF-like processes	survey	refine	survey	refine		
$pp \to W^+W^+jj\,[g_S = 0]$	13s	**2h12m**/1290	16s	8m1s	16×	new
$pp \to W^+W^-jj, W \to l\nu l[g_S = 0, 13\,\text{TeV}]$	19m0s	9m6s	10m0s	1m43s	2.4×	new
$pp \to W^+W^-jj, W \to l\nu l[g_S = 0, 100\,\text{TeV}]$	10m0s	24m8s	7m0s	18m10s	1.4×	new
$u\bar{d} \to W_L^+W_L^-u\bar{d}[g_S = 0]$	23s	**27h56m**/203	14s	1m53s	792×	new
$u\bar{d} \to W_L^+W_L^-u\bar{d}, W^+ \to d\bar{u}, W^- \to \tau^+\nu_\tau\,[g_S = 0]$	2m0s	**15h52m**/793	1m0s	5m42s	142×	new
$u\bar{d} \to W_T^+W_T^-u\bar{d}, W^+ \to d\bar{u}, W^- \to \tau^+\nu_\tau\,[g_S = 0]$	36s	2m54s	37s	2m28s	1.1×	new
$\mu^+\mu^- \to hhh\bar{\nu}_\mu\nu_e$ [14 TeV]	3s	**8h50m**/641	1s	11s	2653×	new
$\mu^+\mu^- \to t\bar{t}\mu^+\mu^-$ [13 TeV]	20s	**3h6m**/948	6s	25s	362×	new
$\mu^+\mu^- \to W^+W^-\mu^+\mu^-$ [4 TeV]	1m0s	33m26s	16s	15s	66×	new
other processes	survey	refine	survey	refine		
$pp \to W^+[0-4]j$	20m0s	5s	20m0s	4s	1.0×	old
$pp \to t\bar{t}[0-2]j$	38s	32s	38s	19s	1.2×	old
$pp \to 4j$	1m0s	**1h21m**/7003	1m0s	21m5s	3.7×	new
$pp \to t\bar{t}3j$	1h0m	1h36m	2h0m	1h37m	0.71×	old
$pp \to W^+Z$	1s	3s	1s	2s	1.3×	new
$pp \to t\bar{t}h$	<1s	2s	<1s	3s	0.67×	old
$pp \to t\bar{t}hj$	2s	4s	3s	10s	0.45×	old
$pp \to t\bar{t}Z$	1s	4s	1s	4s	1.0×	old
$pp \to W^+W^-jj$ [QCD only]	11s	36s	11s	37s	1.0×	old

NLO Optimization

MadEvent is more optimised

- We test (are testing) many idea at LO
  - ➡ Group subprocesses (hard)
  - ➡ Phase-space trick (medium)
  - ➡ Helicity Recycling (easy)
  - ➡ Multi-Channel (easy)
  - ➡ Multi-threading (easy)
  - ➡ GPU (very hard)
  - ➡ SIMD (likely easy)
- We should pick those(some) and implement them at NLO

Other project (related to me)

- Rivet/Contur interface [MCNet]
  - ➡ Close to be ready to merge

- DIS@NLO [STRONG 2020]
  - ➡ Not yet started DIS
  - ➡ focused on elastic photon at NLO so far

- Heavy ion collision [Strong 2020]
  - ➡ With HS

- pyrate (RGE, with Benj)

- Color/machine learning/future collider/...
  - ➡ See dedicated talk

Conclusion

- MG5aMc is in a good state
  - ➡ Many development
  - ➡ CMS/ATLAS are happy

- We have challenge in front of us
  - ➡ Bzr/git transition
  - ➡ We need a new paper (documentation)
  - ➡ We need to implement speed-up at NLO
  - ➡ We need a funding replacing MCnet

- MG5-Meeting
  - every first friday of the month (10am)

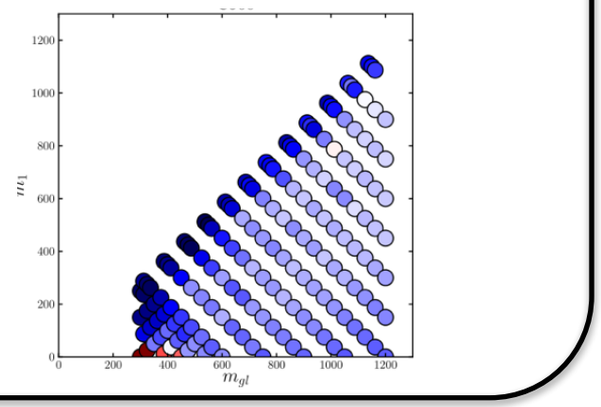
LO Feature

LO Feature

Auto-Width

$$\Gamma = ?$$

Parameter scan



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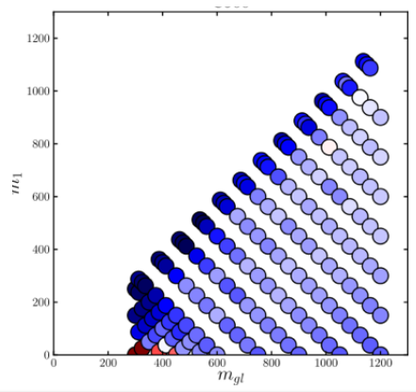
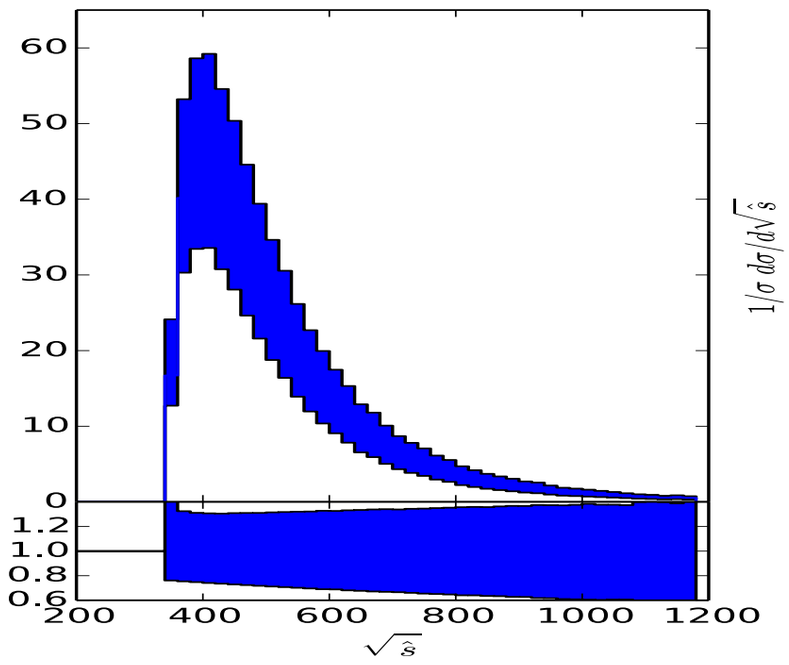
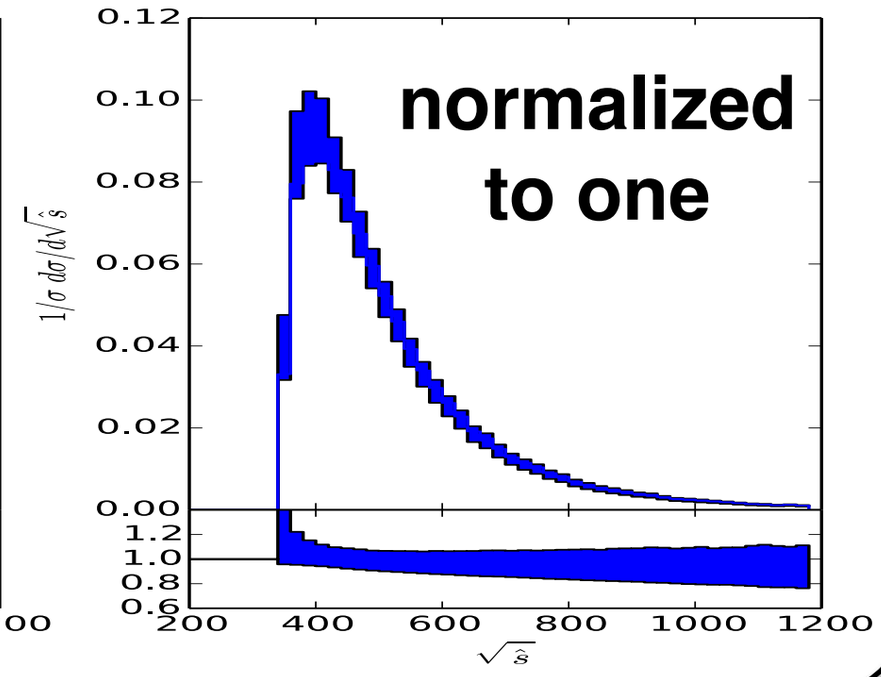


Systematics





BSM re-weighting

$$|M_{new}|^2 / |M_{old}|^2$$

LO Feature

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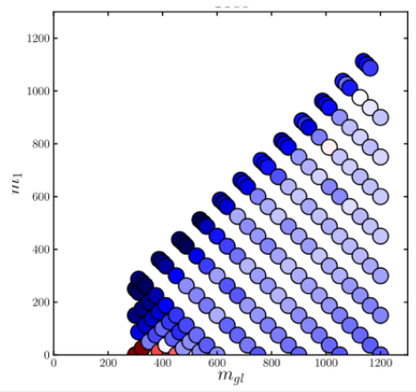

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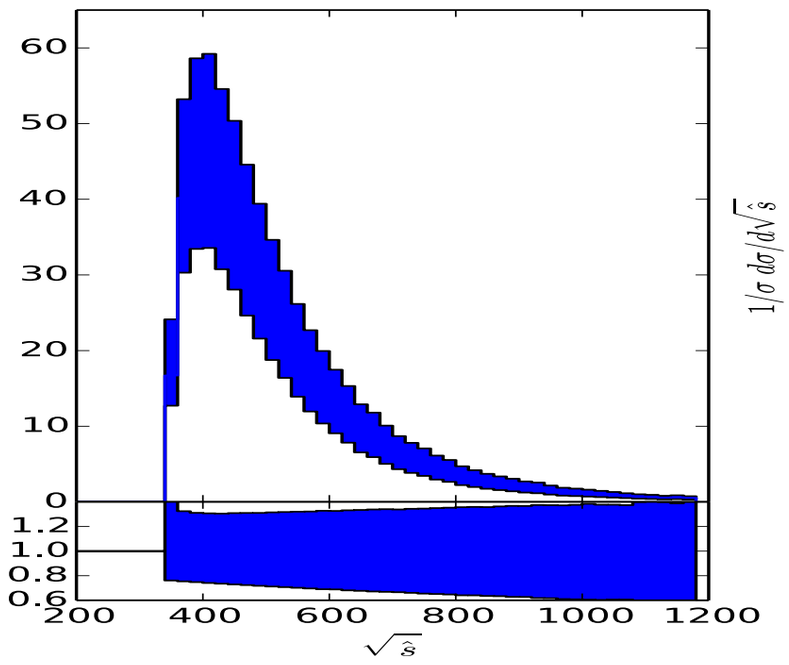
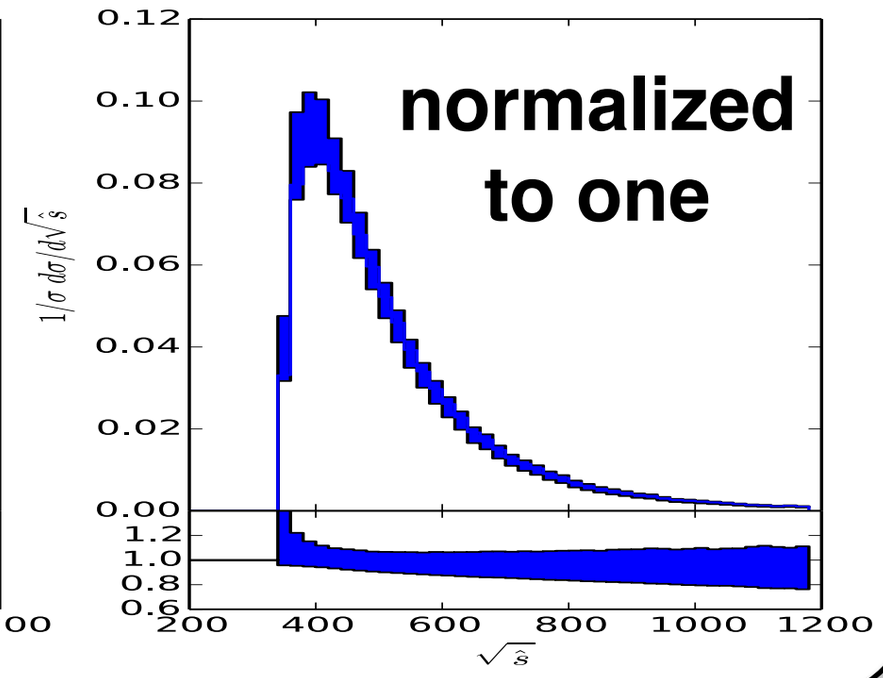
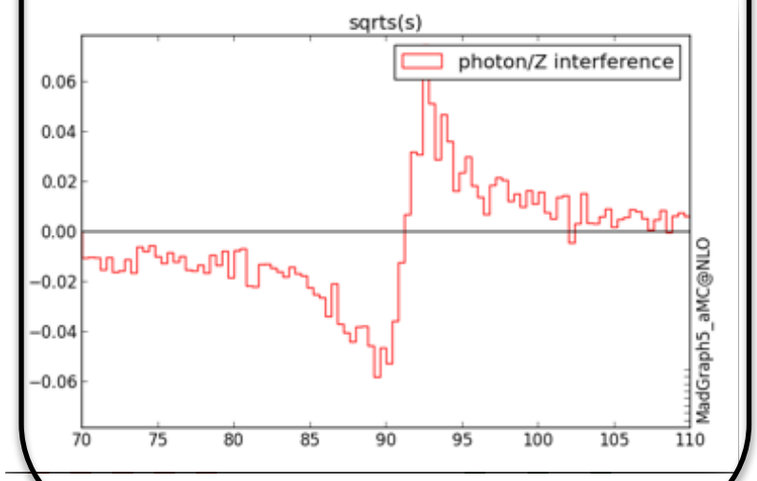




Interference



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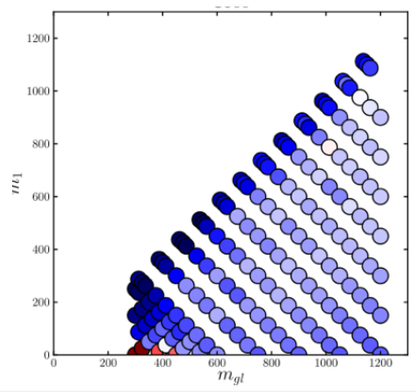

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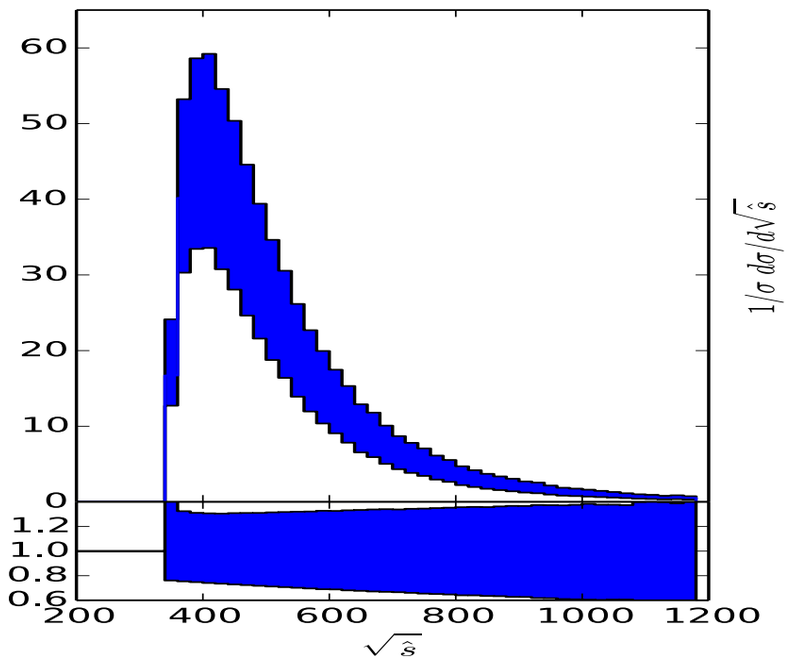

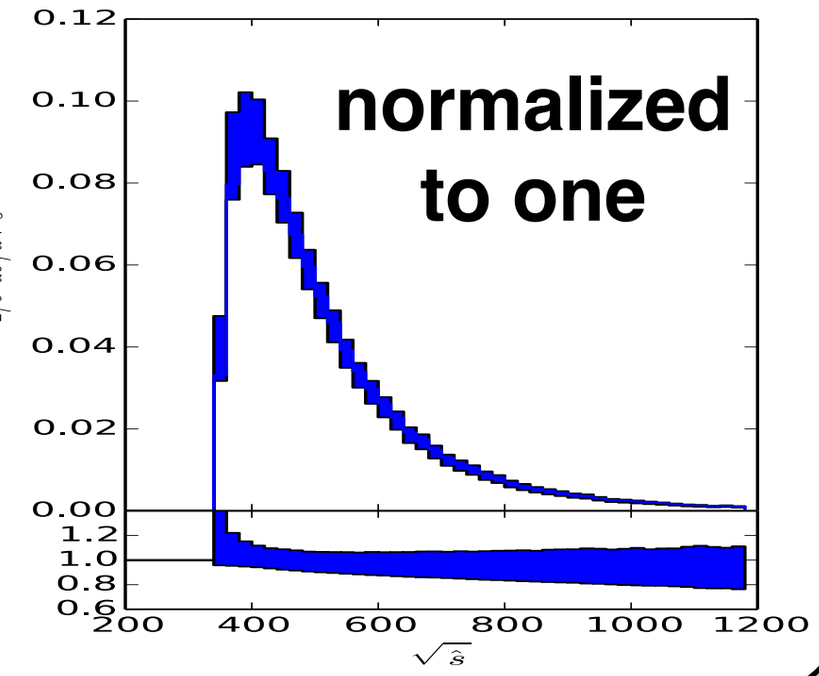

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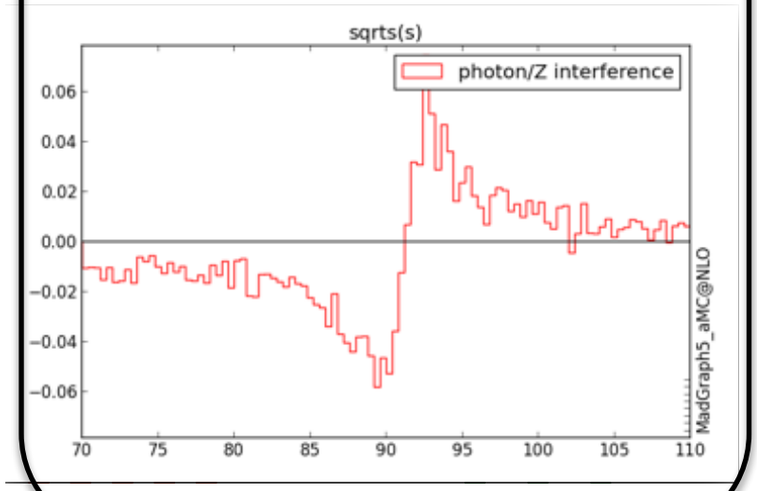
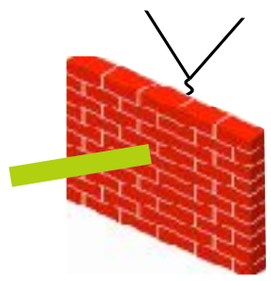


Plugin



Interface

MadAnalysis 5

BSM re-weighting

$$|M_{new}|^2 / |M_{old}|^2$$

LO Feature

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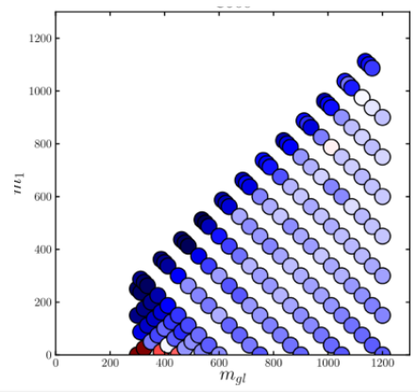

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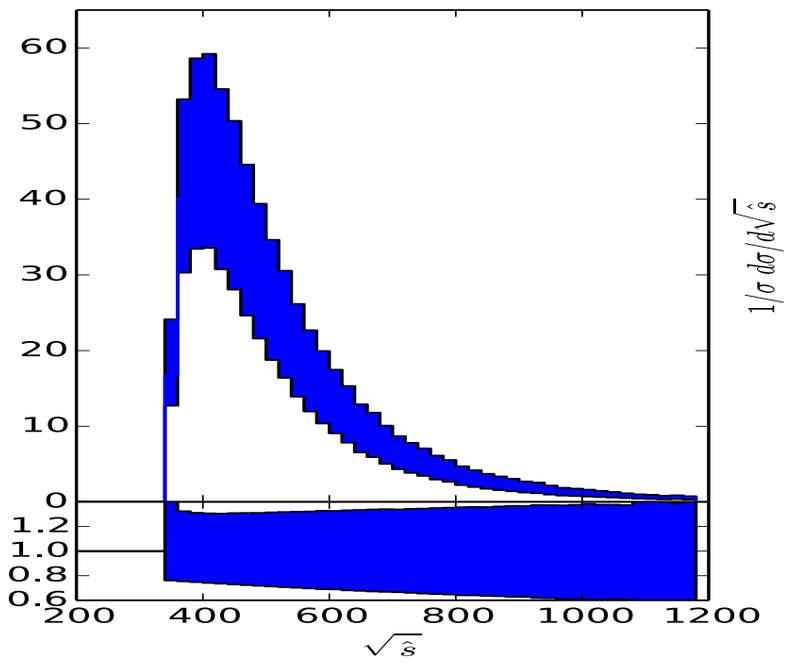

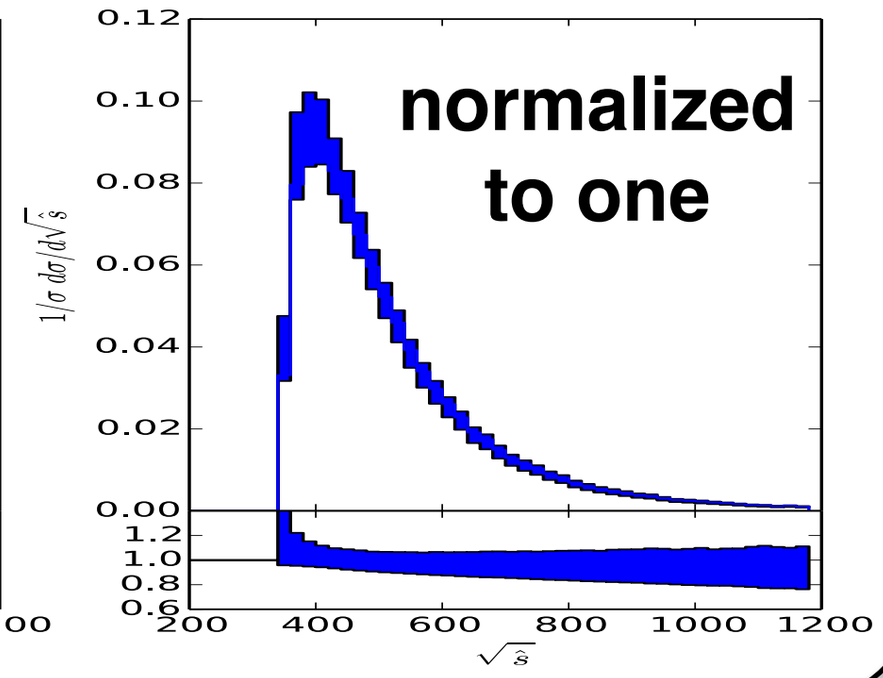

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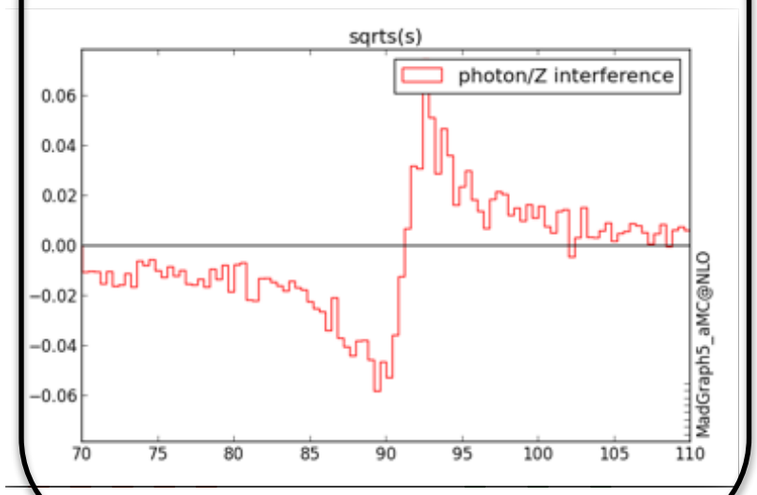

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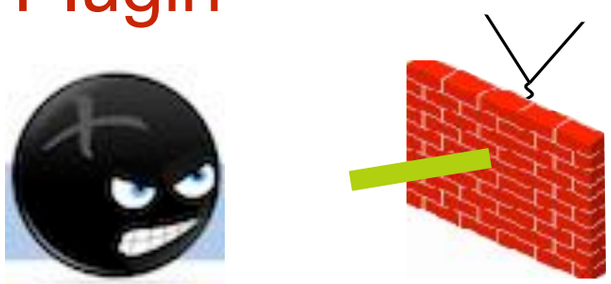
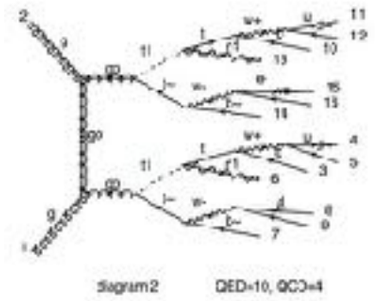


Narrow-width



Interface

MadAnalysis 5

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