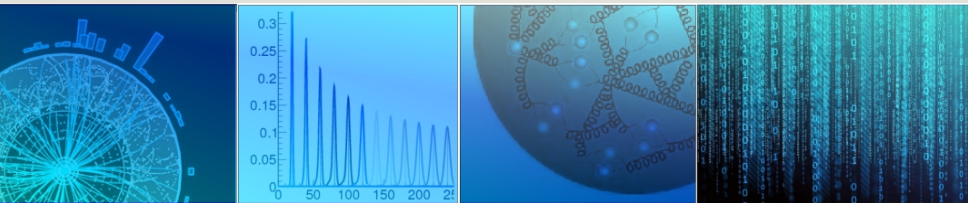


Matrix Element Method Toolkit Tutorial

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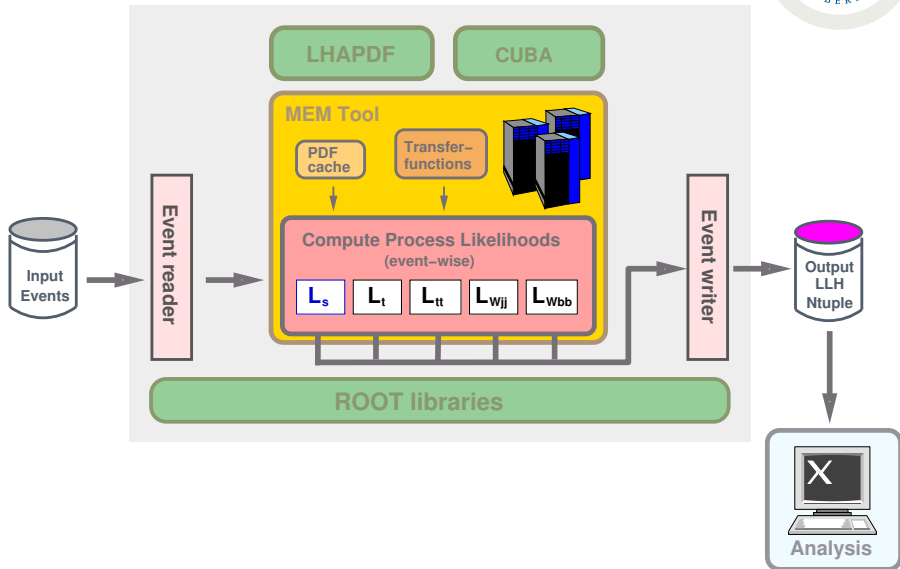


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MEMT_k Layout



Configuration Script



Example for one process only (here $W+\bar{b}\bar{b}$)
more processes can be added easily in the same fashion

```
1 MemMgr *mgr = new MemMgr;
2 mgr->SetCollider(MemMgr::kPP, 8000.);
3 mgr->SetPdfMgr("cteq66");
4
5 MemTFcnSet *tfcn = new MemTFcnSet(MemTFcnAtlasBase::kMC12);
6
7 MemProcWbb *proc_Wbb =
8     new MemProcWbb("Wbb", "WL+LbLbbar", 80.4);
9 proc_Wbb->GetMCMgr()->SetEpsRel(0.05); // Precision of MC integration
10 proc_Wbb->SetTFcnSet(tfcn);
11
12 mgr->AddProcess(proc_Wbb);
13
14 mgr->SetEvtReader(new MemEvtReaderGeneric);
15 mgr->SetInputTreeName("t_mem");
16 mgr->AddInputFile("MyMemInput.root");
17
18 mgr->SetEvtWriter(new MemEvtWriterGeneric);
19 mgr->SetOutputFile("MyMemOutput.root");
20 mgr->SetOutputTree("t_llh", "MEM_Likelihood_Tree");
21
22 mgr->Run();
```

MemMgr

- ▶ Main interface
 - ▶ Handles processes
 - ▶ Responsible for I/O management: Input/output files, event loop, etc.

MemPdfMgr

- ▶ Interface for computing PDFs
 - ▶ Uses LHAPDF
 - ▶ Caching of PDFs available for faster access

```
1 MemMgr *mgr = new MemMgr;  
2 mgr->SetPdfMgr("cteq66", UseCache);  
3  
4 [...]  
5  
6 mgr->AddProcess(proc_Wbb);  
7  
8 mgr->SetEvtReader([..]);  
9 mgr->SetInputTreeName([..]);  
10 mgr->AddInputFile([..]);  
11  
12 mgr->SetEvtWriter([..]);  
13 mgr->SetOutputFile([..]);  
14 mgr->SetOutputTree([..]);  
15  
16 mgr->Run();
```

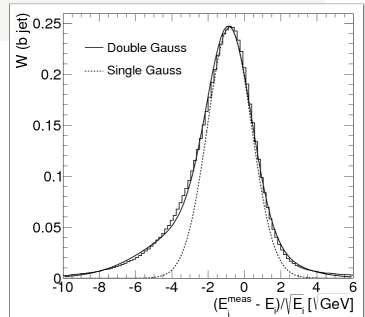
Transfer Functions



- ▶ Transfer functions are organized in sets
- ▶ A set defines transfer functions for all objects (electrons, muons, jets, missing transverse momentum)

```
1 // Pre-defined set for ATLAS analyses
2 MemTFcnSet *tfcn = new MemTFcnSet(MemTFcnAtlasBase::kMC12);
3
4 // Transfer functions can be changed by setter functions
5 tfcn->SetElectronTFcnMagnitude(new MemTFcnDelta(MemTFcnBase::kEnergy));
6 tfcn->SetMuonTFcnMagnitude ([...]);
7 tfcn->SetLightJetMagnitude ([...]);
```

- ▶ Possible parametrisations:
 - ▶ Single Gauss
 - ▶ Double Gauss
 - ▶ δ distribution
- ▶ Parameters can be set | changed using text files





Processes

- ▶ Several processes are already built-in such as W +jets, single-top processes and $t\bar{t}$

```
1 MemProcWbb proc_Wbb =  
2   new MemProcWbb("Wbb", "W_L+L_b_bbar", 80.4);
```

- ▶ Each process inherits from the process base class; new processes can be added by means of inheritance (ME computation and wrapper functions are required)
- ▶ Process class connects four-momenta with matrix element

Phasespace

- ▶ Parametrization of initial and final state momenta
- ▶ Needs to be added for each newly added process

MemMCMgr

- ▶ Interface to CUBA
- ▶ Available Monte Carlo integration algorithms:
 - ▶ VEGAS (importance sampling)
 - ▶ DIVONNE (stratified sampling)
- ▶ Individual configuration of MC integration for each process
⇒ runtime optimization

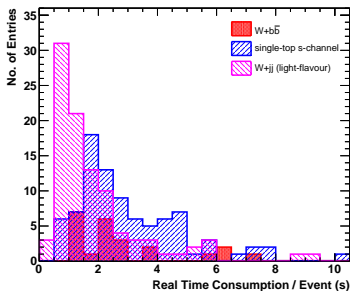
```
1 MemProcWbb *proc_Wbb =  
2   new MemProcWbb( "Wbb", "WL+LbLbbar", 80.4);  
3 proc_Wbb->GetMCMgr()->SetEpsRel(0.05); // 5% accuracy  
4 proc_Wbb->GetMCMgr()->SetMaxEval(1.e6); // Max. integrand evaluations  
5 proc_Wbb->GetMCMgr()->SetNStart(1.e4); // Vegas parameters  
6 proc_Wbb->GetMCMgr()->SetNIncrease(1.e4); // Vegas parameters
```

Monte Carlo Integration (cont'd)



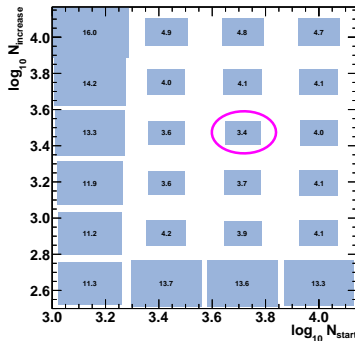
Further means to reduce computation time

- ▶ Different computation time for different processes
⇒ Focus efforts on major ones
- ▶ Investigation of computation time vs. importance sampling frequency



Computation time for different processes

Processing Time (s) vs VEGAS Parameters, Single-Top s-Channel





EvtReader

- ▶ MemEvtReaderGeneric:
flat ROOT ntuple
- ▶ Customizable event reader
class
- ▶ Any input format possible

el_chg	el_e	el_eta	el_n
el_phi	el_pt	evt_nr	evt_weight
jet_btagged	jet_btagw	jet_e	jet_eta
jet_flav	jet_n	jet_phi	jet_pt
met_et	met_phi	mu_chg	mu_e
mu_eta	mu_n	mu_phi	mu_pt
run_nr			

Example input ntuple layout

EvtWriter

- ▶ MemEvtWriterGeneric:
4-momenta + ME likelihoods
- ▶ MemEvtWriterCloneTree:
clones input tree +
ME likelihoods
- ▶ User-defined output format



- ▶ Development of a flexible MEM toolkit
- ▶ Fast and modular code
 - ▶ Easy to use
 - ▶ Easy to extend
 - ▶ Configuration using a single script
- ▶ HTML documentation available

[Quick Links:](#) [ROOT Homepage](#) [Class Index](#) [Class Hierarchy](#)

MemTk - A Matrix Element Method Toolkit

Class Index

FontMetrics_t	
MemEvent	Event class
MemEventSystematics	Event systematic variations class
MemEvtReaderBase	Abstract event reader class
MemEvtReaderD3PDBase	Event reader for D3PDs
MemEvtReaderD3PDMiniML	Event reader for multi lepton D3PDs
MemEvtReaderD3PDSgTop	Event reader for SgTop-D3PDs
MemEvtReaderGeneric	Event reader for ROOT ntuples
MemEvtWriterBase	Abstract base class for writing events

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