

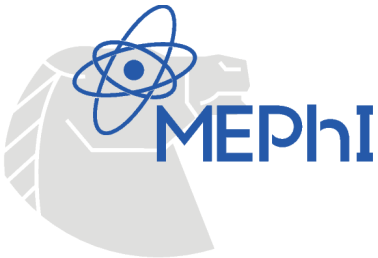
McDst: a unified storage format for heavy ion collision simulated data

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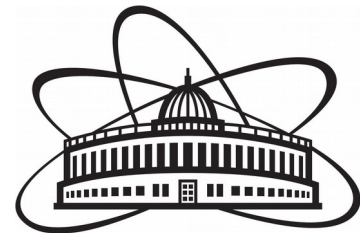
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Outline

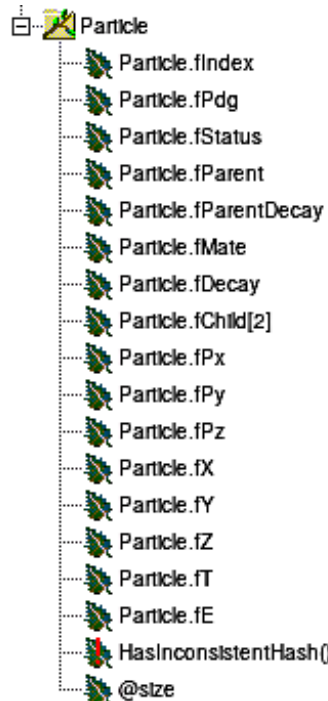
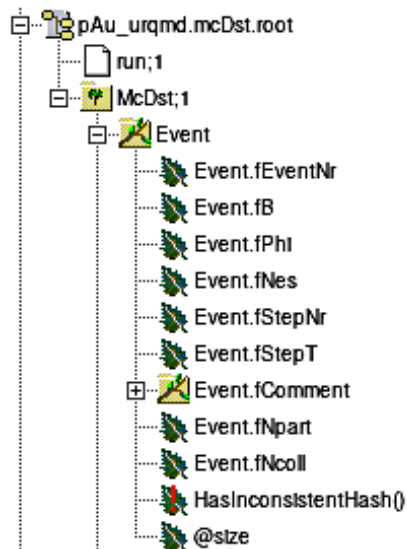
- Motivation
- McDst data format
- McDst reader
- Quality assurance of McDst data
- MC-to-McDst converters
- Package source code

Motivation

- Variety of Monte Carlo event generators with not standardized output.
- Same algorithms for processing generated data.
- Easy way to process event and particle information.

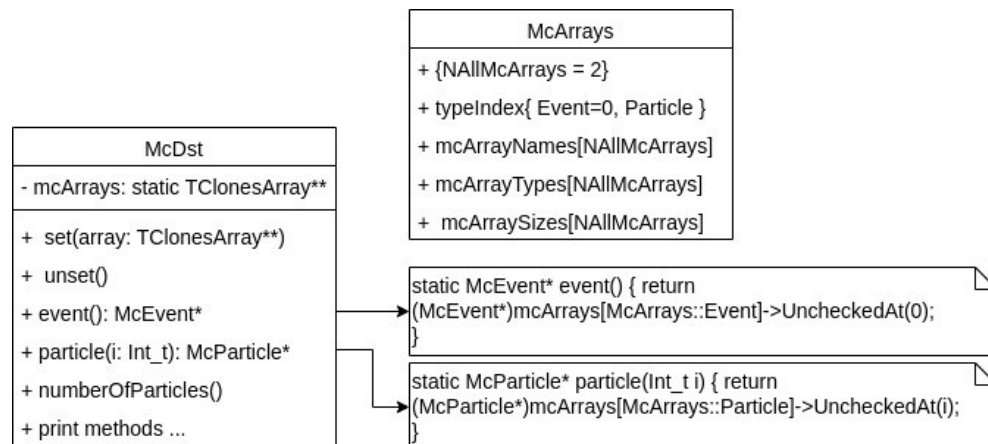
McDst format

McDst structure



ROOT
Data Analysis Framework

Class diagram



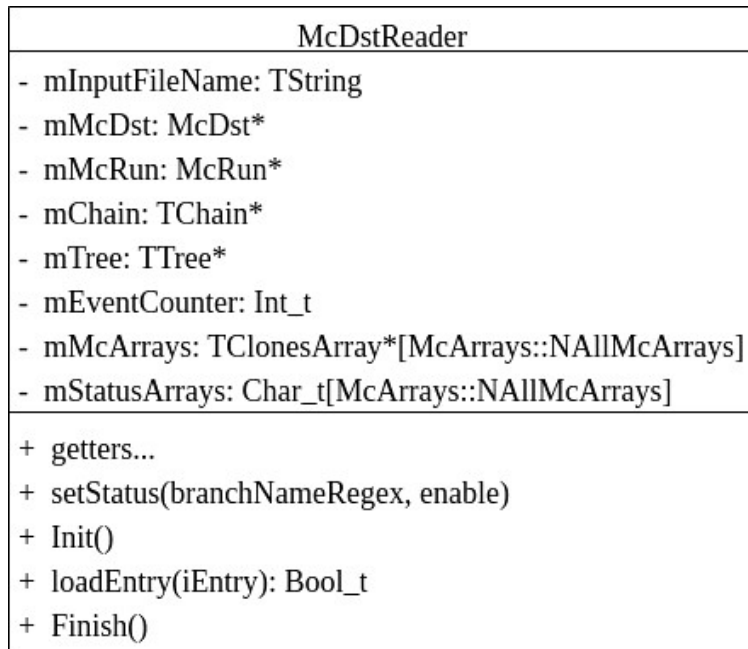
Reading mcDst.root files [1]

```
1 //macros/analyseMcDst.C
2 void analyseMcDst(const Char_t *inFile = "../test.mcDst.root", const Char_t *oFileName = "oProcTest.root") {
3     // Initialize reader
4     McDstReader* myReader = new McDstReader(inFile);
5     myReader->Init();
6     // Configure to read concrete branches
7     myReader->setStatus("*",0);
8     myReader->setStatus("Event",1);
9     myReader->setStatus("Particle",1);
10
11     Long64_t events2read = myReader->chain()->GetEntries();
12     TFile *oFile = new TFile(oFileName, "RECREATE");
13
14     // Event histogramming
15     TH2D *hImpactParVsNch = new TH2D("hImpactParVsNch", "Impact parameter vs. Nch;Nch;Impact parameter (fm)",
16                                     300, -0.5, 599.5, 130, 0., 13.);
17     TH1D *hSqrtSnn = new TH1D("hSqrtSnn", "Collision energy;#sqrt{s_{NN}} (GeV);Entries", 100, 150., 250. );
18     // Track histogramming
19     TH1D *hPz = new TH1D("hPz", "p_{z} of particle;p_{z} (GeV/c);Entries", 402, -201., 201.);
20     TH1D *hPionMom = new TH1D("hPionMom", "Momentum of #pi;p (GeV/c);Entries", 100, 0., 2.);
```

Reading mcDst.root files [2]

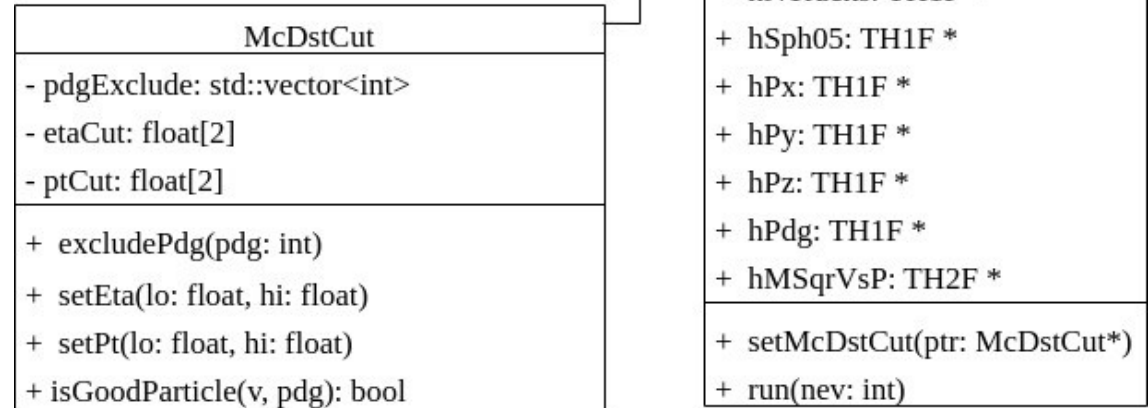
```
21
22 // Run info
23 hSqrtSnn->Fill( myReader->run()->nnSqrtS() );
24
25 // Event analysis
26 for(Long64_t iEvent=0; iEvent<events2read; iEvent++) {
27     myReader->loadEntry(iEvent);
28     McDst *dst = myReader->mcDst();
29
30     // Retrieve event info
31     McEvent *event = dst->event();
32
33     // Track analysis
34     Int_t nTracks = dst->numberOfParticles();
35     for(Int_t iTrk=0; iTrk<nTracks; iTrk++) {
36         // Retrieve i-th track info
37         McParticle *particle = dst->particle(iTrk);
38         if ( particle->charge() ) {
39             NumOfCharged++;
40             hPtVsEta->Fill( particle->eta(), particle->pt() );
41             if ( particle->pdg() == 211 ) {
42                 hPionMom->Fill( particle->ptot() );
43             }
44         }
45     } //for(Int_t iTrk=0; iTrk<nTracks; iTrk++)
46
47     hImpactParVsNch->Fill( NumOfCharged, event->impact() );
48 } //for(Long64_t iEvent=0; iEvent<events2read; iEvent++)
49
50 oFile->Write();
51 oFile->Close();
52
53 myReader->Finish();
54 }
```

Class diagram



Data QA example

```
1 // macros/mcdstqa.C
2 void mcdstqa(const char *ifile = "../test.mcDst.root",
3             const char *ofile = "../qa_mcdst.root")
4 {
5     //...
6
7     McDstQA qa(ifile, ofile);
8     // Configure the cut
9     McDstCut cut;
10    cut.excludePdg(-211);
11    // Set the cut
12    qa.setMcDstCut(&cut);
13    // Start filling histograms
14    qa.run();
15 }
```



Converters

To convert Monte Carlo data simulated by particular heavy ion collisions generators a set of converters provided.

Implemented converters:

- ✓ HIJING → McDst
- ✓ Pythia8 → McDst
- ✓ UrQMD → McDst
- ✓ ...

```
(TFile *) 0x56395284a2e0
root [1] gSystem->Load("libMcDst.so")
(int) 0
root [2] McRun::Class()->IgnoreTObjectStreamer()
root [3] McRun* run_ = (McRun*) file0->Get("run")
Warning: Default constructor of McRun should not be used!
(McRun *) 0x56395319fd40
root [4] run_>print()
-----
-I-                Run Header                -I-
Generator                : UrQMD30400
Comment                  :
op 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
op 0 0 0 0 0 0 1 0 1 0 0 0 * 0 2 1
op 0 0 0 1 1 0 0 0 0 0 0 0 0 0 1 0
op 0 5 0 0 0 0 0 0 0 0 0 0 1 0 1 0
pa 0.1000E+01 0.5200E+00 0.2000E+01 0.3000E+00 0.0000E+00 0.3700E+00 0.00
pa 0.2700E+00 0.4900E+00 0.2700E+00 0.1000E+01 0.1600E+01 0.8500E+00 0.15
pa 0.9000E+00 0.5000E+02 0.1000E+01 0.1000E+01 0.1000E+01 0.1500E+01 0.16
pa 0.4200E+00 0.1080E+01 0.8000E+00 0.5000E+00 0.0000E+00 0.5500E+00 0.56
pa 0.5000E+00 0.1000E+01 0.1000E+01 0.1000E+01 0.1000E+01 0.1000E+01 0.16
pa 0.2000E+00 0.2000E+03 0.1000E+01 0.5000E+01 0.1000E+01 0.1000E+11 0.16
Decayer                  :
Projectile mass          : 2
Projectile charge        : 1
Projectile momentum (AGeV/c) : 99.9956
Target mass              : 197
Target charge            : 79
Target momentum (AGeV/c) : -99.9956
Minimal impact parameter (fm) : 0
Maximal impact parameter (fm) : 10.13
Impact parameter weighting : 1
Minimal azimuthal angle (rad) : 0
Maximal azimuthal angle (rad) : 0
Cross-section (mb)       : 3220.8
Requested number of events : 20000
-----
root [5] █
```


McDst demo [1]

```
LXTerminal
File Edit Tabs Help
mcdst demo: root.exe out_11688210.mcdst.root

-----
| Welcome to ROOT 6.22/00                               https://root.cern |
| (c) 1995-2020, The ROOT Team; conception: R. Brun, F. Rademakers |
| Built for linuxx8664gcc on Jun 14 2020, 15:54:05 |
| From tags/v6-22-00@v6-22-00 |
| Try '.help', '.demo', '.license', '.credits', '.quit!/.q' |
-----

root [0]
Attaching file out_11688210.mcdst.root as _file0...
Warning in <TClass::Init>: no dictionary for class McEvent is available
Warning in <TClass::Init>: no dictionary for class McParticle is available
Warning in <TClass::Init>: no dictionary for class McRun is available
(TFile *) 0x5620309eedf0
root [1] .ls
TFile**      out_11688210.mcdst.root UrQMD
TFile*       out_11688210.mcdst.root UrQMD
KEY: McRun   run;1 Run Header
KEY: TTree   McDst;1 UrQMD tree
root [2] McDst->GetEntries()
(long long) 20000
root [3] McDst->Show(6)
=====> EVENT:6
Event          = 1
Event.fEventNr = 7
Event.fB       = 8.610000
Event.fPhi     = 0.000000
Event.fNes     = 1
Event.fStepNr  = 0
Event.fStepT   = 200.000000
Event.fComment = 0 0 0 0 0 0 0 0
Particle       = 199
Particle.fIndex = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19
Particle.fPdg  = 2212, 2112, 2212, 2212, 2212, 2212, 2212, 2212, 2212, 2212, 2212, 2212, 2212, 2212, 2212, 2212, 2212, 2212
Particle.fStatus = 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
Particle.fParent = 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535
Particle.fParentDecay = 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
Particle.fMate   = 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535, 65535
Particle.fDecay  = 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
Particle.fChild[2] = 0, 0
0 0
```


McDst demo [4]

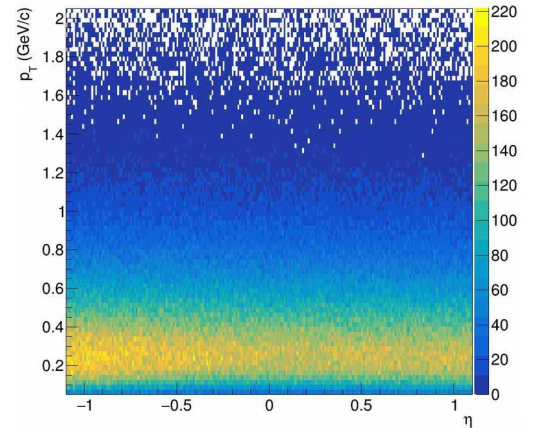
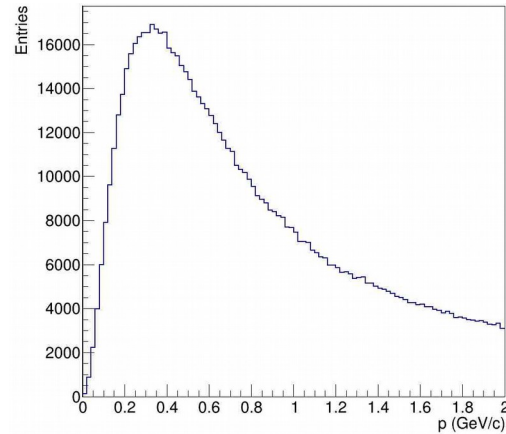
```
LXTerminal
File Edit Tabs Help
root [6] gSystem->Load("libMcDst.so")
(int) 0
root [7] McRun::Class()->IgnoreTObjectStreamer()
root [8] McRun* _run = (McRun*)_file0->Get("run")
Warning: Default constructor of McRun should not be used!
(McRun *) 0x55f71902cf20
root [9] _run->print()
-----
-I-          Run Header          -I-
Generator          : UrQMD30400
Comment           :
op 0 0 0 0 1 0 0 0 0 0 0 0 0 0
op 0 0 0 0 0 0 1 0 1 0 0 0 * 0 2 1
op 0 0 0 0 1 1 0 0 0 0 0 0 0 1 0
op 0 5 0 0 0 0 0 0 0 0 0 1 0 0
pa 0.1000E+01 0.5200E+00 0.2000E+01 0.3000E+00 0.0000E+00 0.3700E+00 0.0000E+00 0.9300E-01 0.3500E+00 0.2500E+00 0.0000E+00 0.5000E+00
pa 0.2700E+00 0.4900E+00 0.2700E+00 0.1000E+01 0.1600E+01 0.8500E+00 0.1550E+01 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
pa 0.9000E+00 0.5000E+02 0.1000E+01 0.1000E+01 0.1000E+01 0.1500E+01 0.1600E+01 0.0000E+00 0.2500E+01 0.1000E+00 0.3000E+01 0.2750E+00
pa 0.4200E+00 0.1080E+01 0.8000E+00 0.5000E+00 0.0000E+00 0.5500E+00 0.5000E+01 0.8000E+00 0.5000E+00 0.8000E+06 0.1000E+01 0.2000E+01
pa 0.5000E+00 0.1000E+01 0.1000E+01 0.1000E+01 0.1000E+01 0.1000E+01 0.1000E+01 0.1000E+01 0.1000E+01 0.1000E+01 0.7000E+00 0.3000E+01
pa 0.2000E+00 0.2000E+03 0.1000E+01 0.5000E+01 0.1000E+01 0.1000E+11 0.1000E+01 0.1000E+01 0.0000E+00 0.1000E+11 0.2000E+01 0.5500E+00

Decayer           :
Projectile mass   : 2
Projectile charge : 1
Projectile momentum (AGeV/c) : 99.9956
Target mass       : 197
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Minimal impact parameter (fm) : 0
Maximal impact parameter (fm) : 10.13
Impact parameter weighting : 1
Minimal azimuthal angle (rad) : 0
Maximal azimuthal angle (rad) : 0
Cross-section (mb) : 3220.8
Requested number of events : 20000
-----
root [10]
```

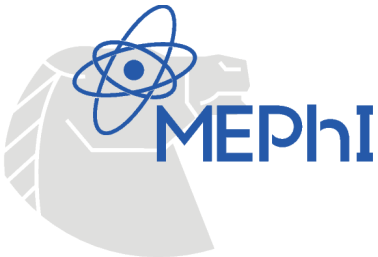
Sources and guides



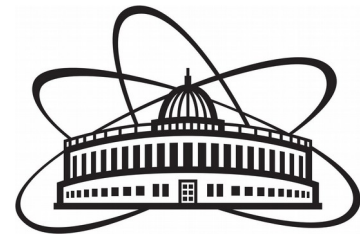
<https://github.com/nigmatkulov/McDst>



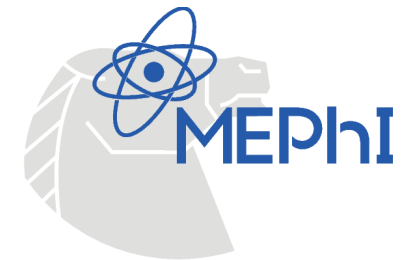
Thank you for your attention!



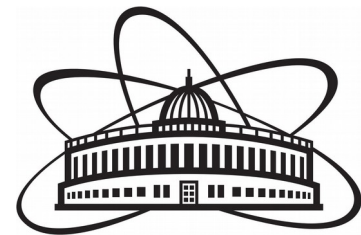
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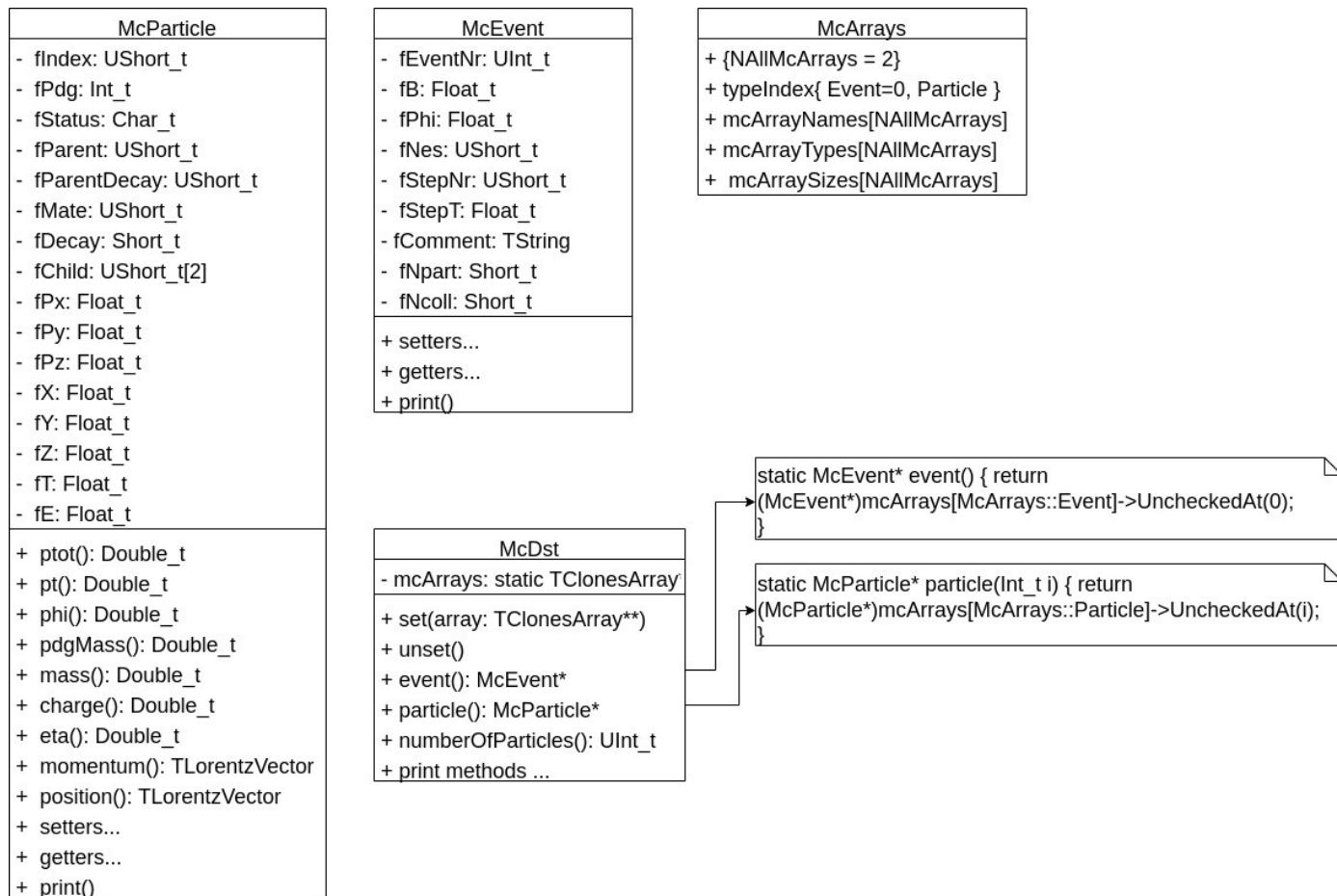
Backup slides



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McDst class diagram [1]



McDst class diagram [2]

