High-Energy Jet Interaction Monte Carlo for the Future Generations: HIJING++

Wigner GPU Day 2018

Gábor Bíró

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Collaborators

Gergely Gábor Barnaföldi
Gábor Papp
Péter Lévai
Miklós Gyulassy
Szilveszter Harangozó
Xinnian Wang
Benwei Zhang
Guoyang Ma

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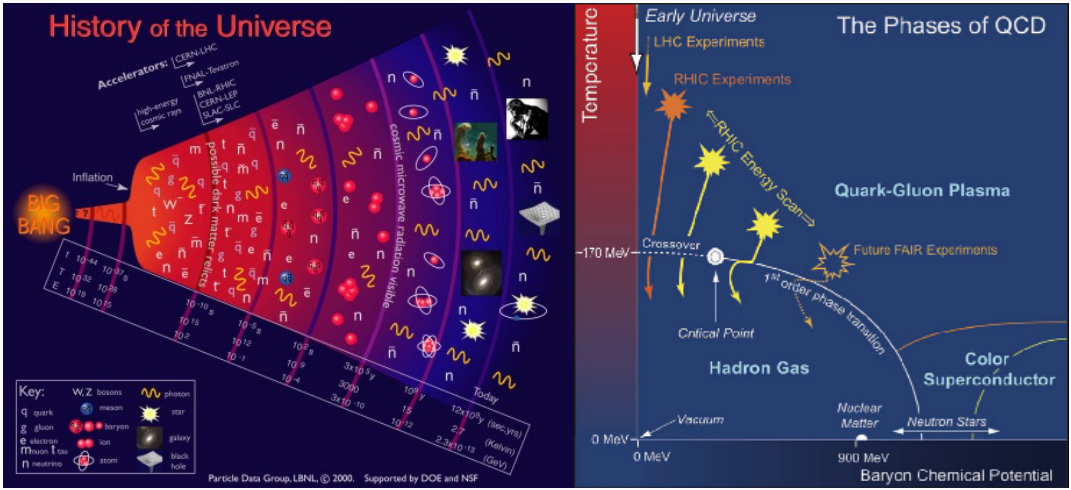
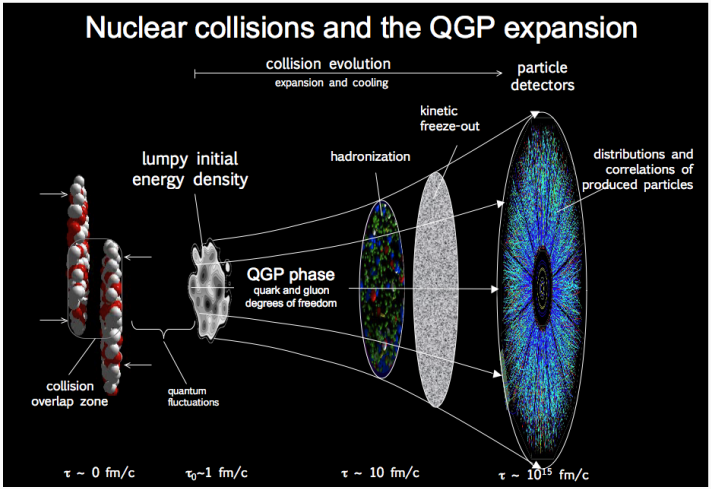
- ÚNKP-17-3 New National Excellence Program of the Ministry of Human Capacities

Heavy-ion physics



Source: https://www.phy.duke.edu/, arXiv:1308.3328



Source: http://icc.ub.edu/

Heavy
Ion
Jet
INteraction
Generator

核易经

Hé – yì – jīng

"Nuclear change theory"; Book of Changes, "Originally a divination manual in the Western Zhou period (1000–750 BC)"

First, FORTRAN version: 1991, Miklós Gyulassy, Xin-Nian Wang

X.N. Wang, M. Gyulassy, *Phys. Rev. D***44**, 3501 (1991).

HIJING++ Monte Carlo event generator

- Pairwise nucleon interactions ((in)elastic scattering (Pythia), diffraction, gluon radiation, Lund fragmentation...)
- Key importance for detector design and validation, testing new physics
- Up to date, the community still uses the (more-or-less) original FORTRAN code
- Challenge: software simulation of 600 million real collision in each second (HiLumiLHC: multiple of this)
- Target audience: the whole heavy ion community (large collaborations and BSc students as well)
- Gergely Gábor Barnaföldi, Gábor Papp, Péter Lévai, Szilveszter Harangozó, Miklós Gyulassy, Xin-Nian Wang, Ben-Wei Zhang, Guoyang Ma

Solid C++ foundations

- User friendly usage (C++14 compiler, cmake, LHAPDF6, Pythia8)
- Many optional extension (ROOT, FastJet, Rivet)
- Easily parallelizable

main.cc:

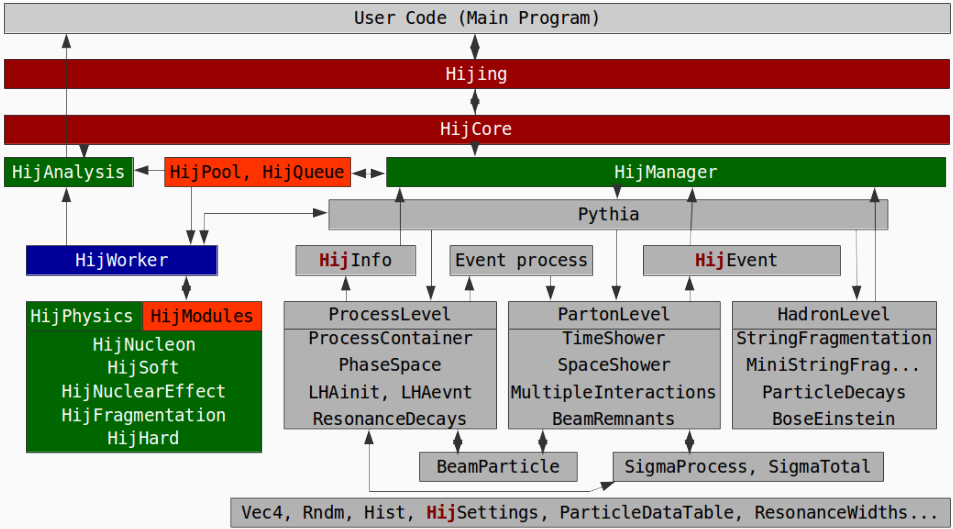
```
#include "Hijing.hpp"

using namespace Hijing3;

int main(int argc, char* argv[])
{
  Hijing hijing;
  if(argc==1)
    hijing.readFile("testSettings.cmnd");
  else
    hijing.readFile(argv[1]);

  hijing.init();
  hijing.start();
}
```

testSettings.cmnd:

```
PDF:pSet = GRV98lo
! PDF:pSet = nCTEQ15

Hijing:threads = 3
Beams:eCM    = 8160
Hijing:NuclearEffects = on

Main:numberOfEvents = 50000
Hijing:idA = P
Hijing:aproj = 1
Hijing:zproj = 1
Hijing:idB = A
Hijing:atarg = 208
Hijing:ztarg = 82
(...)
```

Highly customizable through run parameters stored in xml files

HIJING++ OUTLINE



In the xml:

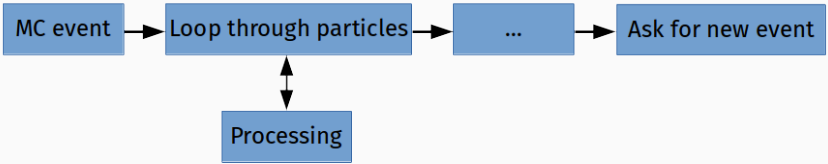
```
<word name="Hijing:Quenching" default="HijQuenching_GLV0">
Select the jet quenching definition: GLV model version 0.
</word>
```

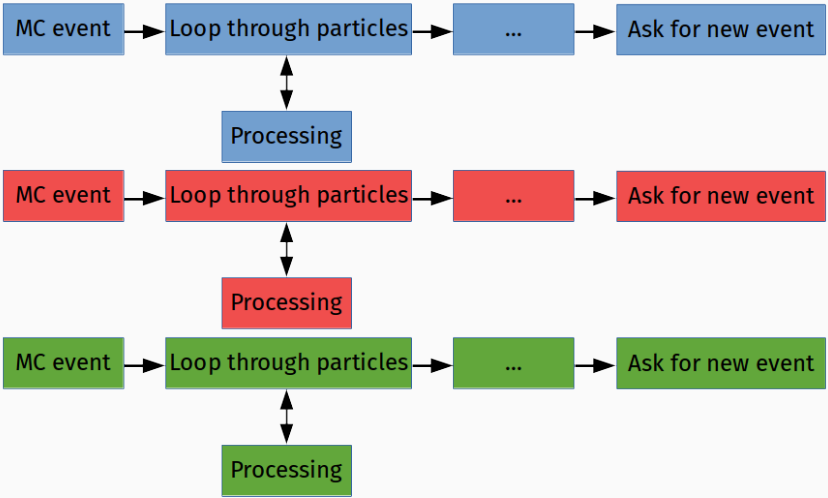
Building the HijModules:

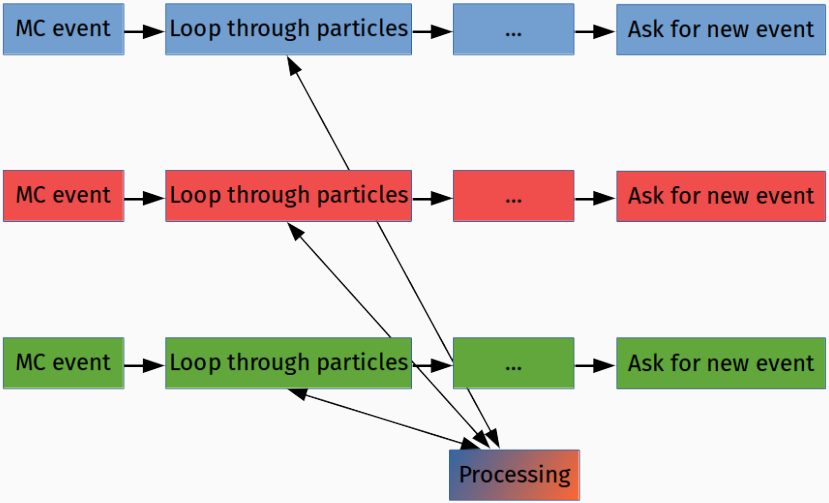
```
unique_ptr<IHijQuenching> ModuleFactory::makeQuenching(const string &name) {
    if (name == "HijQuenching_GLV0")
      return move(make_unique<HijQuenching_GLV0>());
    if (name == "HijQuenching_GLV1")
      return move(make_unique<HijQuenching_GLV1>());
}
```

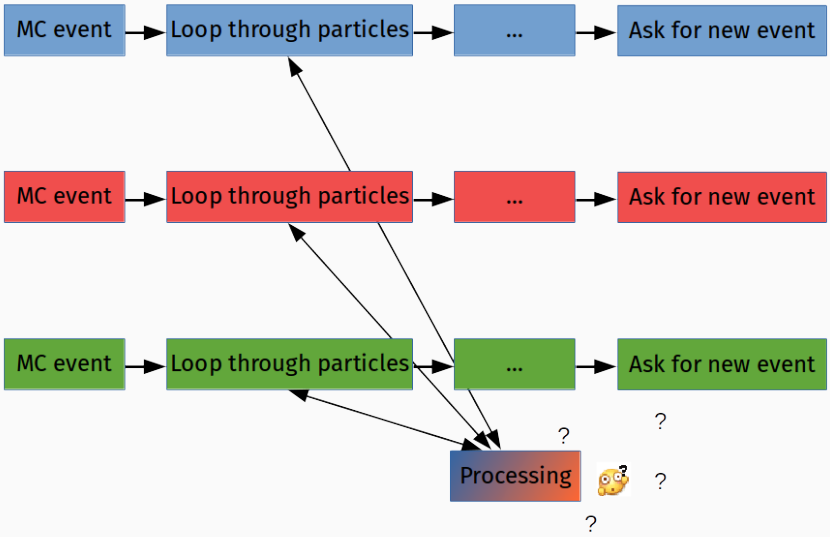
At user level, in testSettings.cmnd:

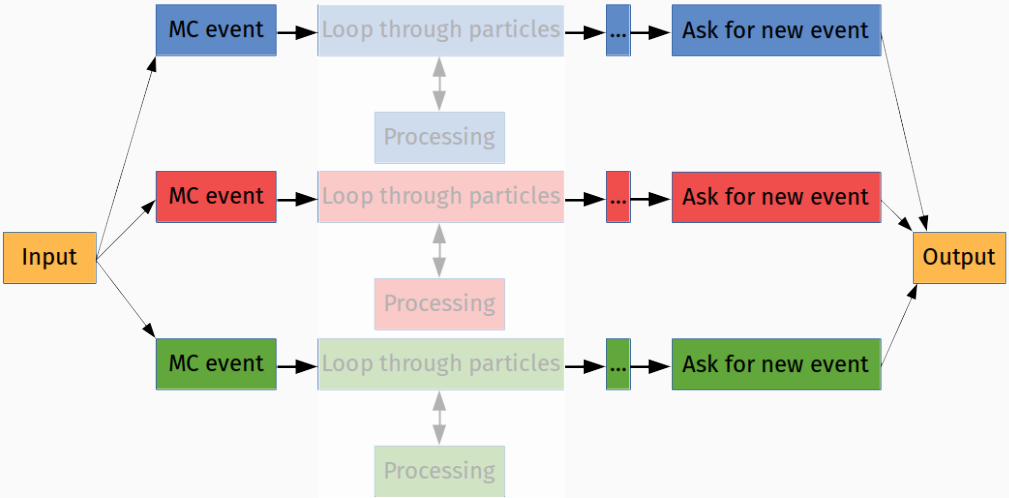
```
Hijing:Quenching = HijQuenching_GLV0
```

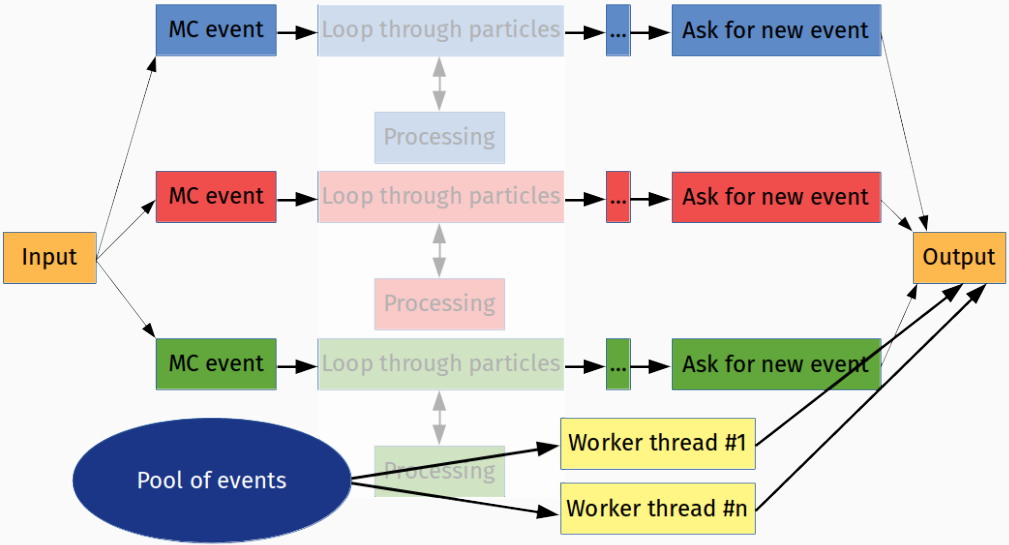

MC event
Loop through particles
...
Ask for new event
Processing

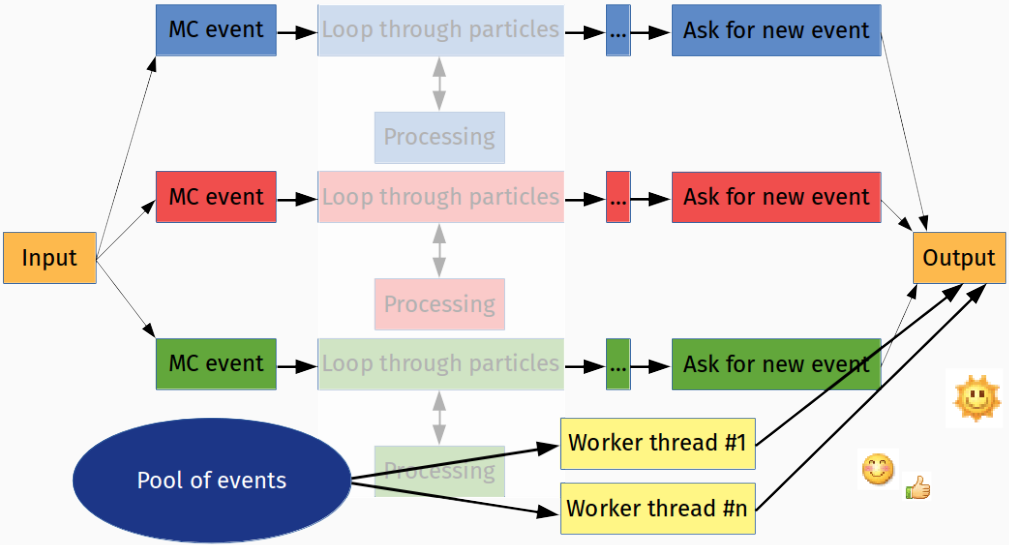

MC event
Loop through particles
...
Ask for new event
Processing
MC event
Loop through particles
...
Ask for new event
Processing
MC event
Loop through particles
...
Ask for new event
Processing


MC event
Loop through particles
...
Ask for new event
MC event
Loop through particles
...
Ask for new event
MC event
Loop through particles
...
Ask for new event
Processing


MC event
Loop through particles
...
Ask for new event
MC event
Loop through particles
...
Ask for new event
MC event
Loop through particles
...
Ask for new event
?
?
Processing
?
?


MC event
Loop through particles
...
Ask for new event
Processing
MC event
Loop through particles
...
Ask for new event
Input
Output
Processing
MC event
Loop through particles
...
Ask for new event
Processing

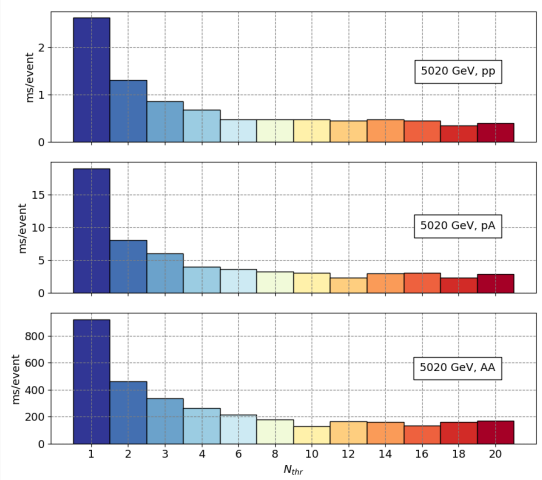

MC event
Loop through particles
...
Ask for new event
Processing
MC event
Loop through particles
...
Ask for new event
Input
Output
Processing
MC event
Loop through particles
...
Ask for new event
Pool of events
Processing
Worker thread #1
Worker thread #n

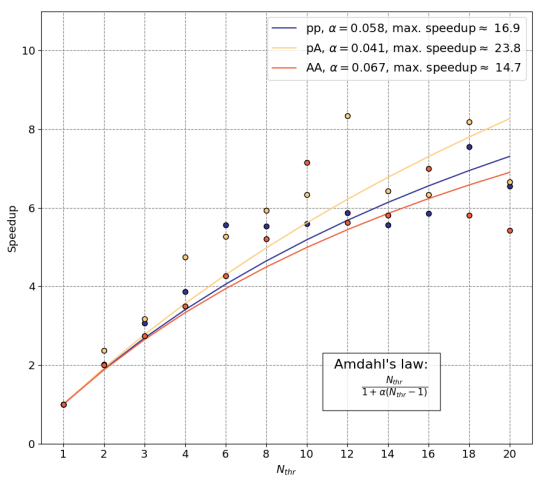

MC event
Loop through particles
...
Ask for new event
Processing
MC event
Loop through particles
...
Ask for new event
Input
Output
Processing
MC event
Loop through particles
...
Ask for new event
Processing
Pool of events
Worker thread #1
Worker thread #n

Analysis interface

```
hijing.newAnalysis("root", "HardCollision", "pTdata_hard", 50, 0.0001, 20.0);

hijing.newAnalysis("root", "SoftProcess", "proj_pxpy", 100, -15.0, 15.0, 100, -15.0, 15.0, "p_{x,Proj}", "p_{y,Proj}");

hijing.newAnalysis("ascii","SoftProcess", "proj_pz_ascii",100, -5000.0, 15000.0);

hijing.newAnalysis("root", "raw","EventEnd","raw data");

auto myEventFilter = [&](const Event &event) {
    return true;
};

auto myHadronFilter = [&](const Particle &particle, const Event &event) {
    return particle.isFinal() && abs(particle.id()) == 211;
};

hijing.analysisBranches("raw data", "n", "b", "pT");

hijing.analysisFilter("raw data", myEventFilter, myParticleAccept);

hijing.analysisProperties("pTdata_hard","final","pT","ID1","ID2");

hijing.analysisProperties("proj_pz_ascii","final","pz");
```

HIJING++ SPEED TESTS





HIJING++ DOCUMENTATION BASED ON THE XML FILES

Home

Last edited by **Gábor Bíró** about 20 hours ago

Welcome to HijWiki!

For install, visit the install instructions.

For the tunable parameters, go to the index page.

Example mains:

- main01: short description
- main02: short description
- main03: short description
- main04: short description
- main05: short description

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UpdateHistory

Bibliography

Version 3.1.1 last updated on 2018.03.12.

Hijing++ v3.1.X

The following environment variables need to be set:

```
export PYTHIA8="/path/to/Pythia8"
export PYTHIA8DATA="/path/to/Pythia8/share/Pythia8/xmldoc"
export LHAPDF6="/path/to/LHAPDF6"
```

Clone the project from master branch:

```
git clone ssh://git@gitlab.kfki.hu:2222/biro.gabor/Hijing3.git
cd Hijing3 && mkdir build && cd build
cmake ../
make -jN
```

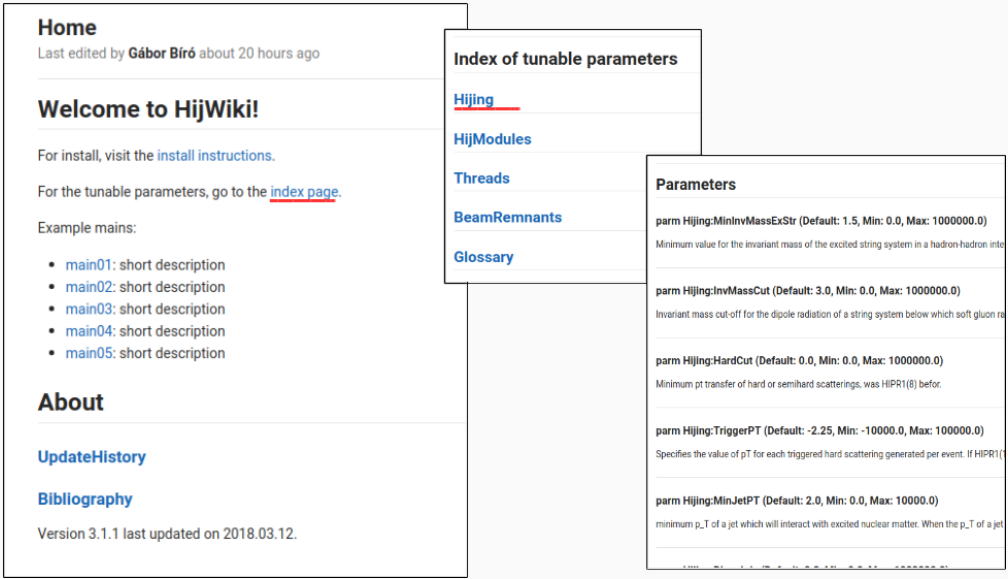
If cmake didn't find something, add the path in flag, e.g.

```
-DLHAPDF6=/path/to/lhapdf6
-DPYTHIA8=/path/to/pythia8
```

Further optional flags:

```
-DWITH_ROOT=[ON|OFF] (default: ON)
-DWITH_FASTJET=[ON|OFF] (default: OFF)
-DBUILD_EXAMPLES=[ON|OFF] (default: ON)
-DMULTITHREAD=[ON|OFF] (default: ON)
```

HIJING++ DOCUMENTATION BASED ON THE XML FILES



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Index of tunable parameters

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Threads

BeamRemnants

Glossary

Parameters

parm Hijing:MinInvMassExStr (Default: 1.5, Min: 0.0, Max: 1000000.0)

Minimum value for the invariant mass of the excited string system in a hadron-hadron inte

parm Hijing:InvMassCut (Default: 3.0, Min: 0.0, Max: 1000000.0)

Invariant mass cut-off for the dipole radiation of a string system below which soft gluon ra

parm Hijing:HardCut (Default: 0.0, Min: 0.0, Max: 1000000.0)

Minimum pt transfer of hard or semihard scatterings, was HIPR1(8) befor.

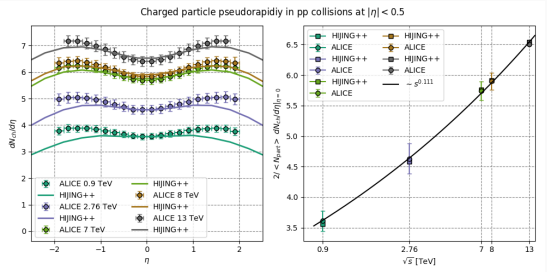
parm Hijing:TriggerPT (Default: -2.25, Min: -10000.0, Max: 100000.0)

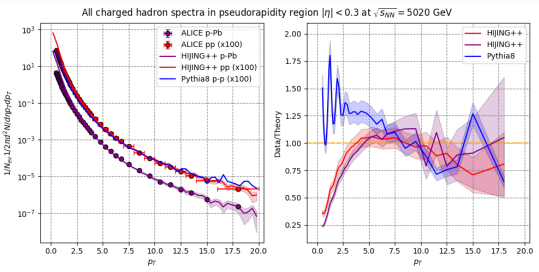
Specifies the value of pT for each triggered hard scattering generated per event. If HIPR1(

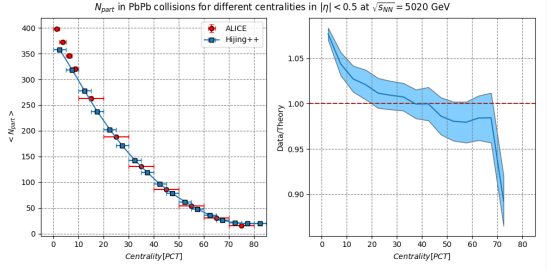
parm Hijing:MinJetPT (Default: 2.0, Min: 0.0, Max: 10000.0)

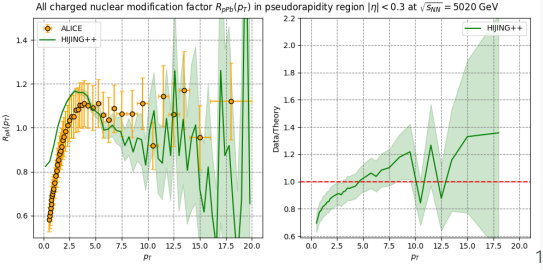
minimum p_T of a jet which will interact with excited nuclear matter. When the p_T of a jet

HIJING++ PHYSICS BENCHMARKS









Thank you for your attention!

2 Quark Matter 2018 posters

First Results with HIJING++ on High-energy Heavy Ion Collisions, arXiv:1805.02635

Predictions for p+Pb Collisions at $\sqrt{s_{NN}} = 8.16$ TeV: Nucl.Phys. A972 (2018) 18-85, arXiv:1707.09973

Strangeness in Quark Matter 2017 poster

First Results with HIJING++ in High-Energy Heavy-Ion Collisions: Nucl.Part.Phys.Proc. 289-290 (2017) 373-376, arXiv:1701.08496