



nptool v4 Development at SAMURAI

A. Matta, LPC Caen, CNRS/IN2P3
Samurai Workshop, IBS, 16th July 2024



UNIVERSITÉ
CAEN
NORMANDIE



Normandie Université

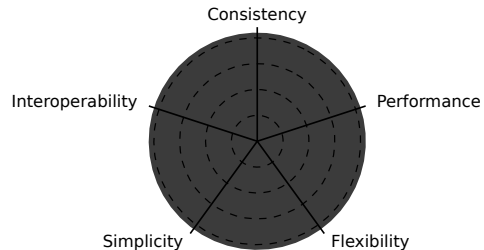
Why a framework?

Mutualisation, Fast & Efficient workflow : extend functionality without explicit call

Optimisation problem

- Performance: Run fast
- Flexibility: do exactly what you want
- Interoperability: w/ frameworks & environment
- Simplicity: Framework does not go in the way
- Consistency: Easy to learn & navigate

Relative priorities



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Interoperability Example

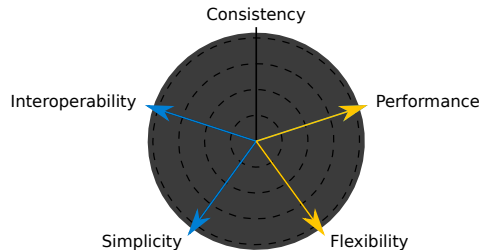
MUGAST-VAMOS-AGATA @ GANIL

3 DAQs + 3 Analysis tools

Data rate: $\sim 1\text{MB/s}$

NIM A, 1014 (2021) 165743

Relative priorities



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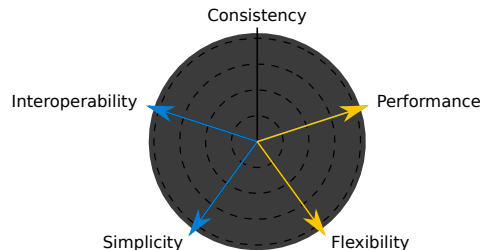
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Performance Example

CBM @ FAIR
Complex DAQs + 1 Analysis tools
Data rate: $\sim 1\text{TB/s}$
Particles 2020, 3(2), 320-335

Relative priorities



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Consistency vs Flexibility

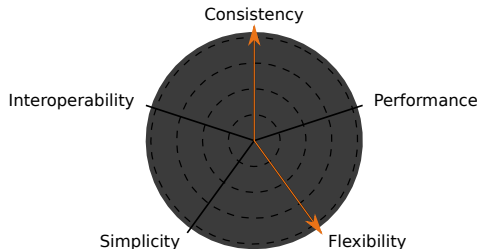
Low energy experiment:

Short lifetime → high turnover

High energy experiment:

Complex algorithm → maximum freedom

Relative priorities



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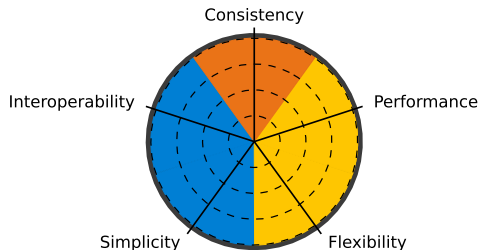
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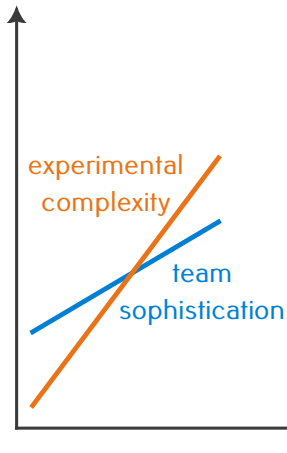
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Why a framework?

Technological gap

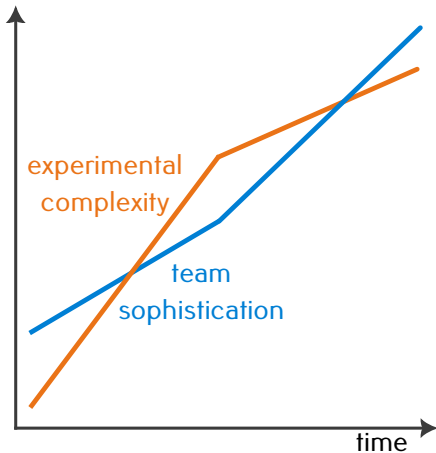


Increased complexity

- Multidetector
- Multi-DAQ
- Short setup time
- Travelling detectors
- Triggerless DAQ
- Shared dataset

Why a framework?

Technological gap

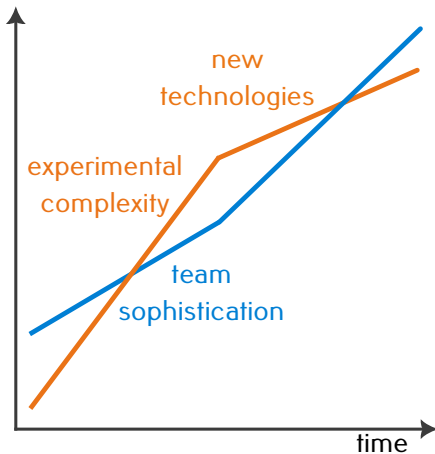


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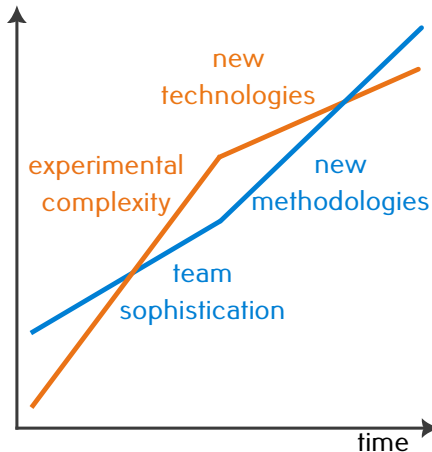
Catching up!

new technologies:

- code (git) & data versionning (dvc?)
- workflow management (snakemake)
- container (apptainer,docker)
- e-logging (elog, or else?)

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new methodologies:

- team analysis
- training material
- simulation for debugging

nptool v4



V1: 2008



V2: 2014



V3: 2016



V4: 2022

Dynamic Loading

MultiThreading

Thirdparty Plugins

nptool v4



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Thirdparty Plugins

V1 originally developed for RRC66 RIPS experiment (2010)

nptool v4



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nptool v4 concept originally presented at ACAT 2021 (IBS)

nptool v4



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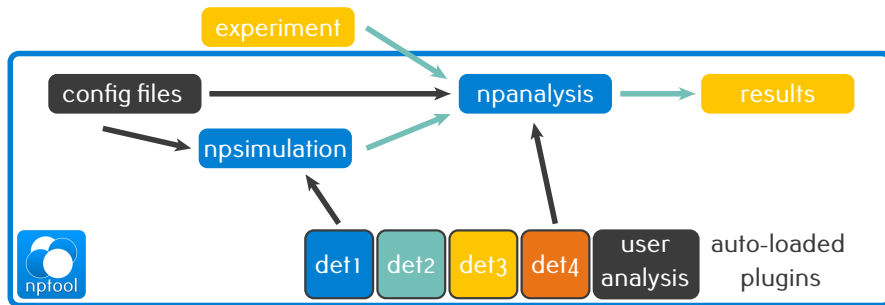
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nptool v4 concept originally presented at ACAT 2021 (IBS)

Working on a more formal Collaboration → Join the npteam!

Key Concept: Analysis & Simulation modular framework (for low energy nuclear physics)

- Repository:
 - gitlab.in2p3.fr/nptool/nptool
- Website:
 - nptool.in2p3.fr
- Open source, open collaboration
 - everybody is welcome!
- User base:
 - V3(2008-now) ~ 100 users
 - V4(2022-now) ~ 20 users
- Support
 - matta@lpccaen.in2p3.fr



nptool v4 : a pip-like experience

Philosophy

- Separate plugin and framework
- Minimum lightweight installation
- Automatic dependencies

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Modular, Open, Lightweight

Plugins

Third party plugins:

- Detectors
- Event generators
- I/O
- Algorithm
- Visualisation

Projects

Third party projects:

- Archivable
- Custom plugins
- Deployable bundle

Repository of :

- Plugins w/ dependencies
- Version compatibility
- Associated citations

Online DB

Empty Shell with :

- Plugin installer
- Config I/O
- Plugin manager

Framework

nptool

nptool v4 : a pip-like experience

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For collaborations

- Control their own repo.
- Easy CI/CD workflow
- Increase visibility with citations management

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For collaborations

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For end users

- Plugins on demand
- Hassle free installation
- Custom projects w/ duplicate plugins
- Open science friendly

Modular, Open, Lightweight

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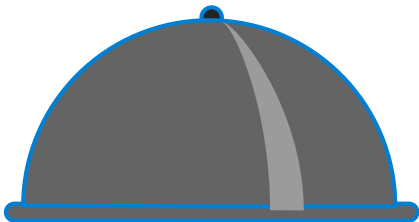
Online DB

Framework

nptool

nptool v4 : publication opportunities

Lifting the lid



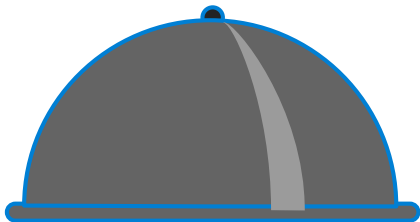
Soft(ware)-power

Framework publication:

- V3: J. Phys. G: Nucl. Part. Phys. 43 045113

nptool v4 : publication opportunities

Lifting the lid



<doi>

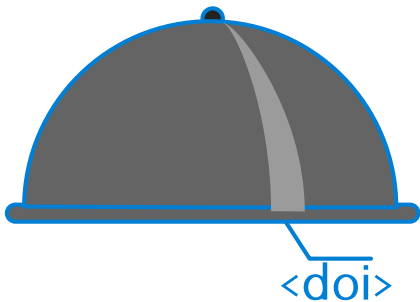
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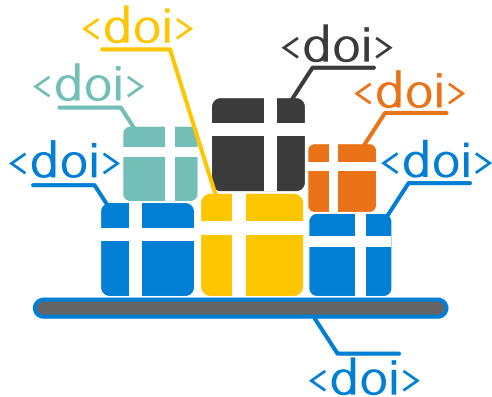
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Lifting the lid



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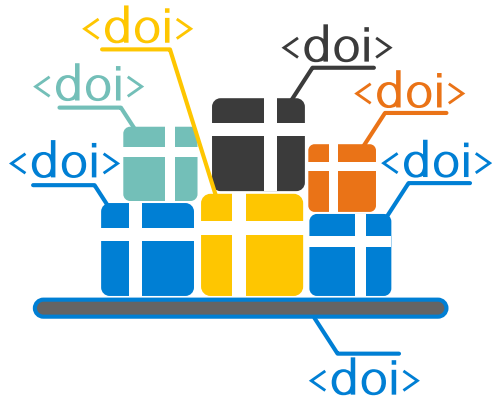
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Plugin publications:

- I/O: DAQ integration
- Detector: Analysis & Simulation
- Algorithms: Crosstalk, Track Reco, PSA, ...

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Where?

- NIM A (IF1.5)
- JOSS (IF4.7)

nptool v4 : available plugins (17)

I/O

- Root (core)
- Faster (LPC Caen)
- MFM (IJCLab/Ganil)
- Mesytec (CEA/DAM)

Facility and Algorithm

- Geant4 (Core)
- PhysicsEssential (Core)
- Trackreco (Core)
- TSA (Core)
- PISA (GRIT)

Detectors

- PFAD (LPC Caen)
- Nebula-Plus (LPC Caen)
- Vendetta (CEA/DAM)
- Fission Chamber (CEA/DAM)
- Must2 (IJCLab)
- Cats (GANIL)
- Exogam (GANIL)
- ZDD (GANIL)

nptool v4 : modular workflow

in2p3



github



in2p3



TUD



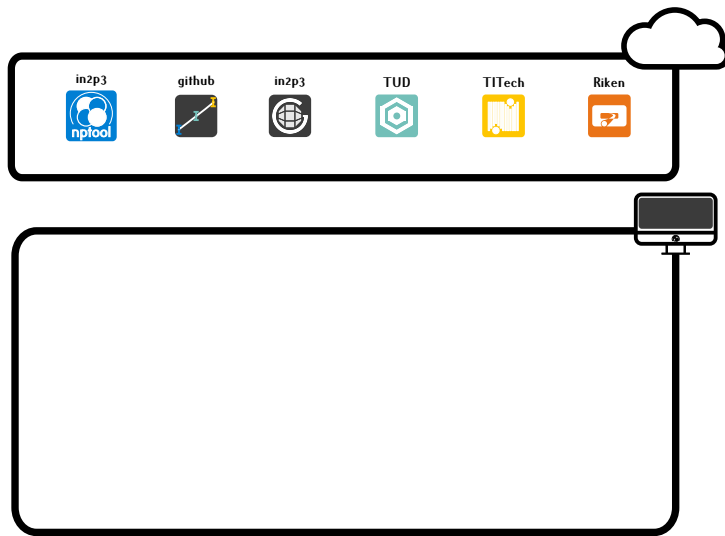
TITech



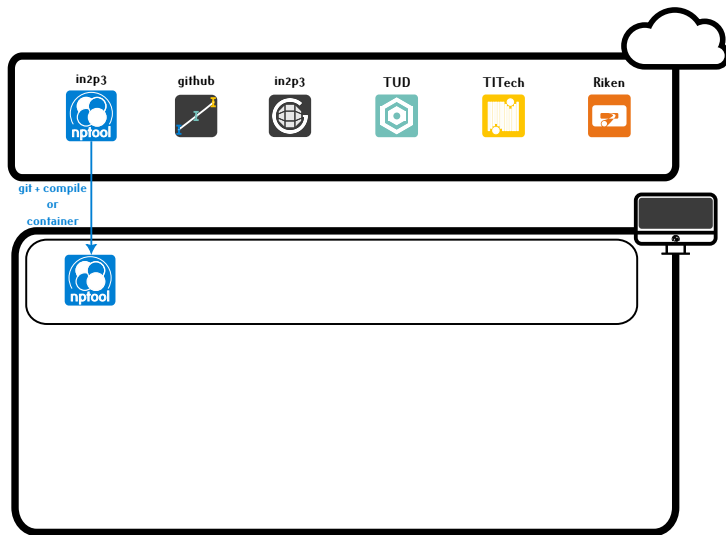
Riken



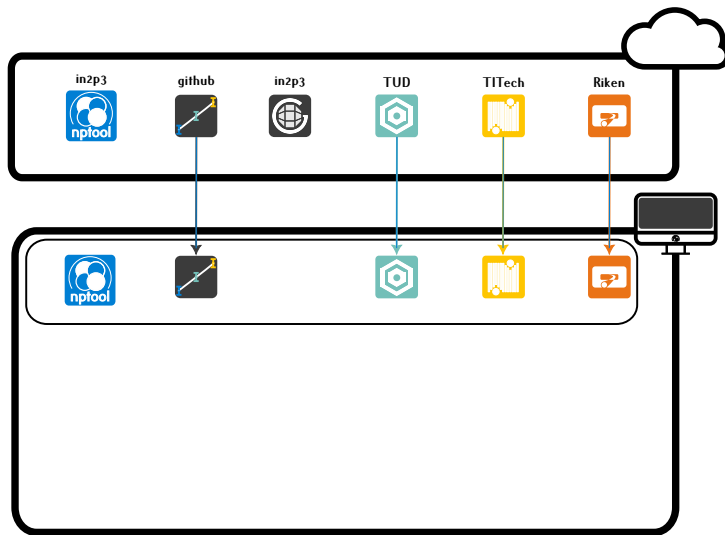
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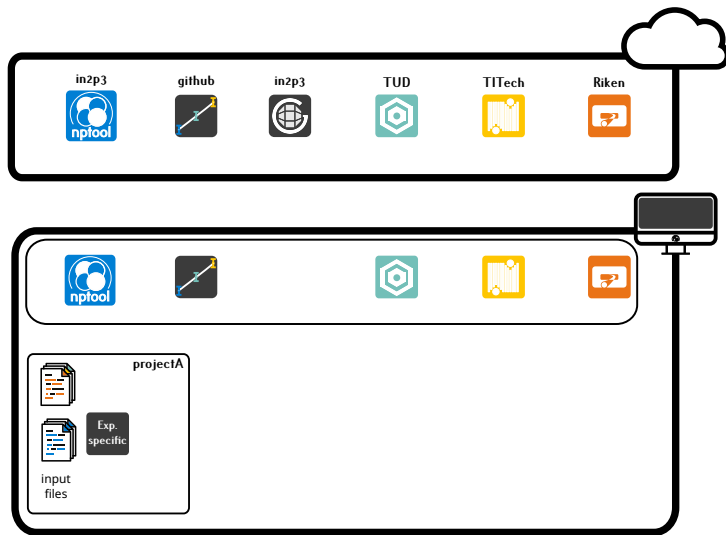
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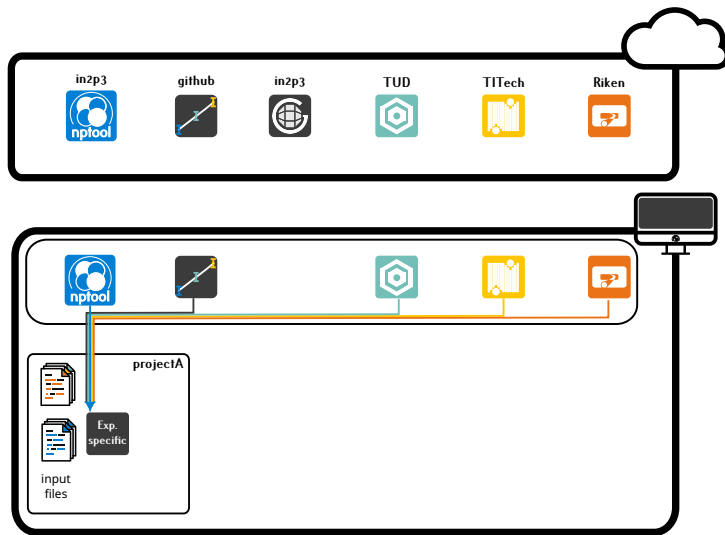
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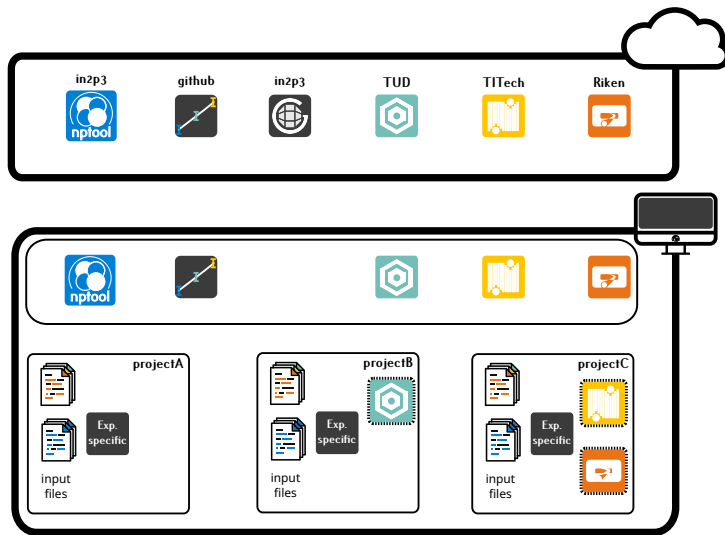
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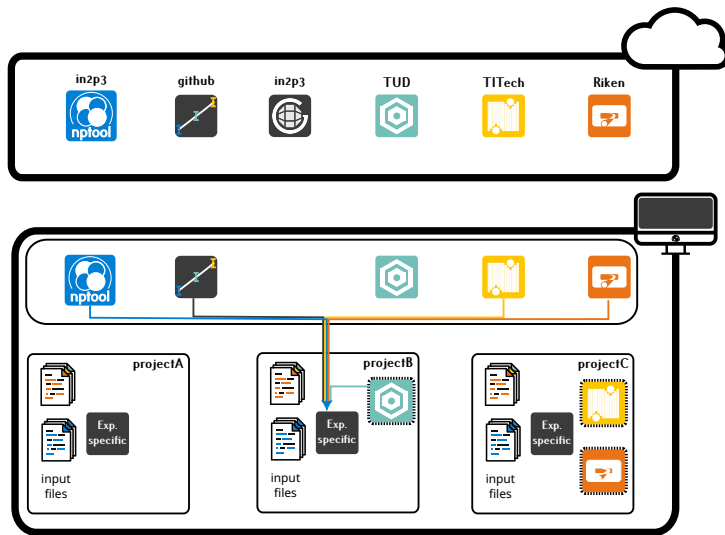
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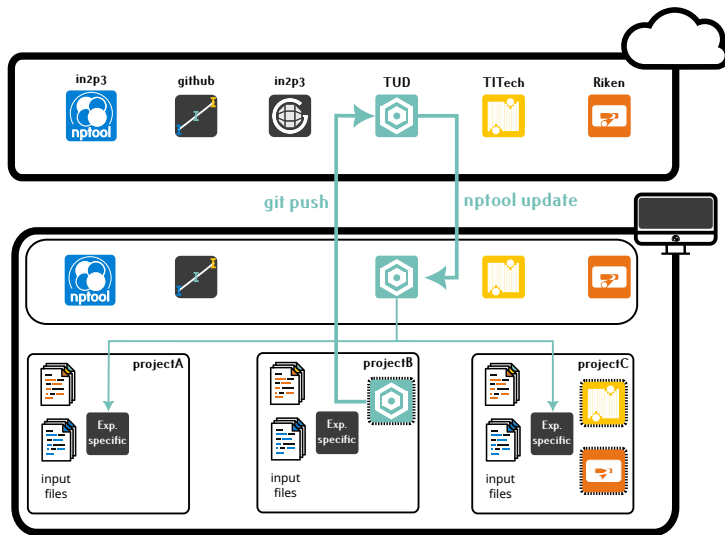
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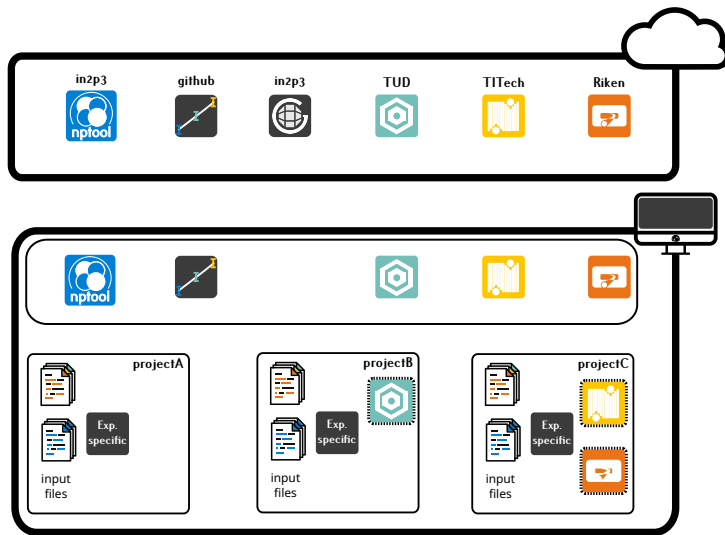
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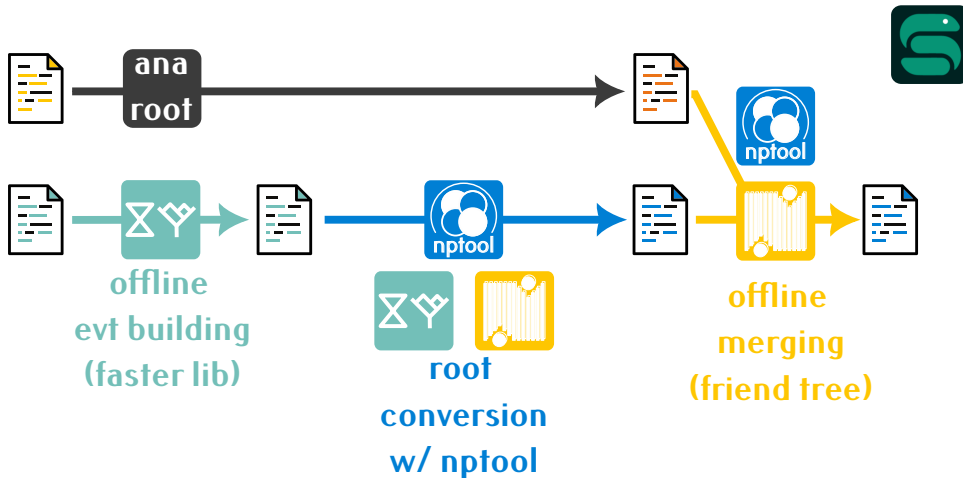
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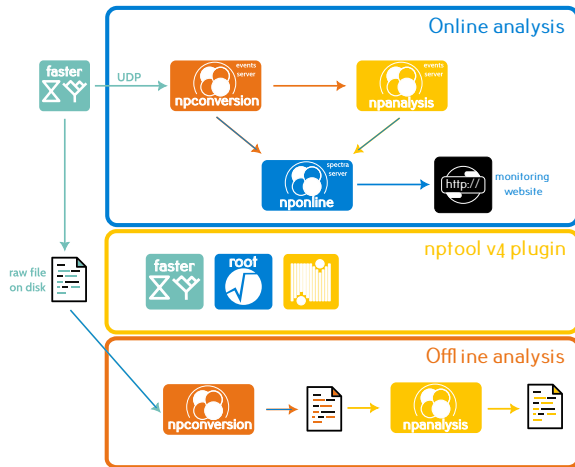


nptool v4 : Nebula-Plus & SAMURAI DAQ interactions



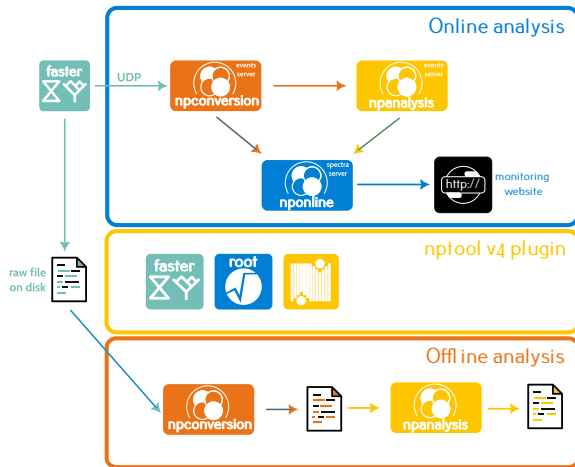
nptool v4 analysis model

A. Matta, F. Flavigny, D. Etasse, V. Girard-Alcindor, C. Lenain, P. Morfouace



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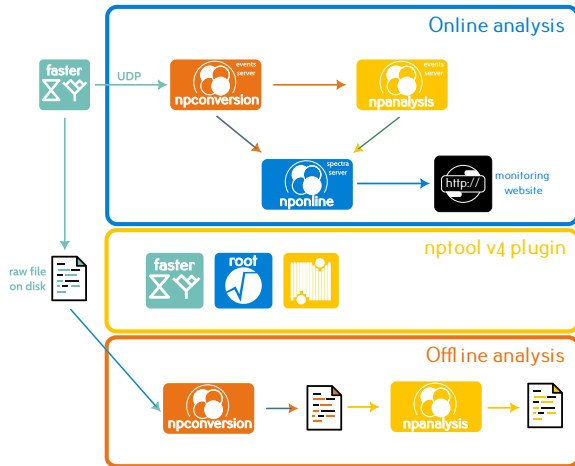


Tested and deployed:

- RIKEN (STRASSE/Nebula-Plus)
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nptool v4 Benefits:

- Support any DAQ system
- Remote computing ready
- handle large number of channels
- distributed computing
- multi-user friendly
- git and snakemake friendly

nptool v4: example of features

Detector file

```
nebula-plus:  
pos:  -132 0 0 cm  
nbars: 22  
veto: 0  
  
nebula-plus:  
pos:  -132 0 13 cm  
nbars: 22  
veto: 0  
  
nebula-plus:  
pos:  -132 0 84.5 cm  
nbars: 23  
veto: 0  
  
nebula-plus:  
pos:  -132 0 97.5 cm  
nbars: 23  
veto: 0
```

Matching detector code

```
void NebulaPlusDetector::ReadConfiguration(nptool::InputParser parser) {  
    auto blocks = parser.GetAllBlocksWithToken("nebula-plus");  
    vector<string> info = {"pos", "nbars", "veto"};  
    int i = 0;  
    for (auto block : blocks) {  
        if (block->HasTokenList(info)) {  
            nptool::message("green", "", "", "NebulaPlus Layer");  
            i++;  
            int NbrOfBars = block->GetInt("nbars");  
            vector<double> Pos = block->GetVector3("pos", "cm");  
            AddLayer(Pos, NbrOfBars);  
        }  
  
        else {  
            std::string msg = "Missing token for NebulaPlus blocks";  
            std::string tip = "Expected token list: ";  
            for (auto token : info)  
                tip += token + ", ";  
            throw(nptool::Error("NebulaPlusDetector", msg, tip));  
        }  
    }  
}
```

nptool v4: example of features

Custom input flags for plugin

```
if (nptool::Application::GetApplication()->HasFlag("--faster-ignore-single")) {  
    message("green", "faster", "faster::FasterInput", "Set to ignore singles");  
    m_ignore_single = true;  
    if (nptool::Application::GetApplication()->HasFlag("--faster-build-single")) {  
        message("green", "faster", "faster::FasterInput", "Ignored single will be build anyway");  
        m_build_single = true;  
    }  
}
```

```
npanalysis -detector nebula.yaml -input faster,s47.pid,run01.fast  
-output root,DataTree,run01.root -faster-ignore-single
```

nptool v4: example of features

Multithreading made easy

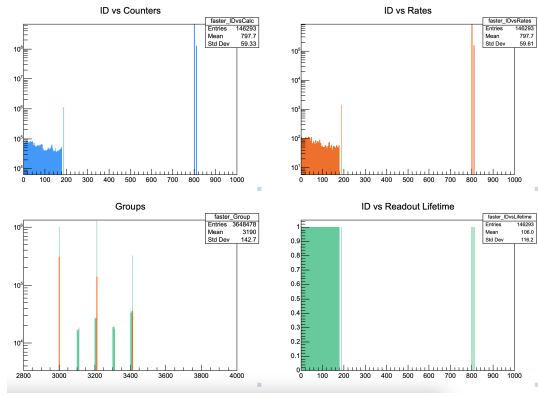
```
// Wait for previous read to be done
if (blocknbr > 1)
    read1.wait();
// launch next read
read0 = app->submit([&infile, &packet0] {
    infile >> packet0;
    packet0.reshape(8);
});

// analyse previous packet
systemts = packet1.GetSystemTS();
for_each(packet1.GetFrames().cbegin(), packet1.GetFrames().cend(), treat_func);
break;
```

Templated interface to threadpool: function, method or lambda submission

Faster online analysis with nptool v4

Online canvas

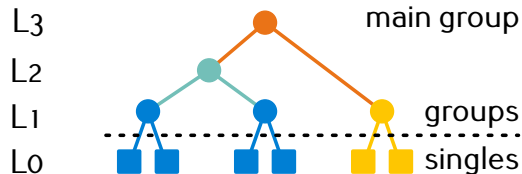


→ standard online solution for faster

Highlights

- Global DAQ monitoring
 - total count per channel
 - rate & lifetime per channel
 - Arbitrary level Trigger content
- Auto histo for "orphan" labels

Faster software trigger

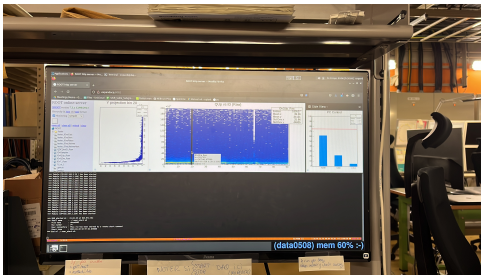


Nebula-Plus online analysis with nptool v4

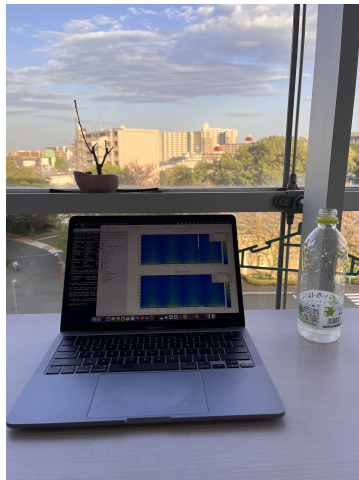
Highlights

- Transcontinental online analysis
- Raw & analysed histogramms
- On the fly addition (PC monitoring)
 - via project analysis

Somewhere in B3F ...



... meanwhile monitoring with a view



PFAD offline analysis with nptool v4

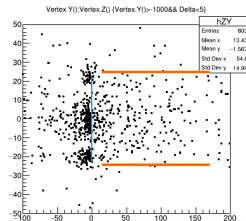
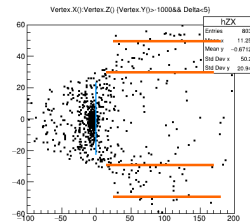
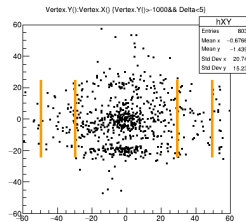
Highlights

- Event building with Autobahn
 - ✓ multithreaded (nptool threadpool)
 - ✓ support online (nptool I/O)
 - ✓ support compression
 - ✗ still issues with hyperTS reconstruction ...
- ✓ online/offline event building
- ✓ online/offline analysis
- ✓ online control spectra
- ✗ ... no merging yet

Tracking time in PFAD

- 14bit@180Mhz : reset every 100 μ s
- Test Hit every 4.8 μ s
- Track TS and count cycles $\rightarrow$ 64bit HyperTS
 - ✓ anormal test Hit insertion
 - ✗ missing test Hit

Vertex reconstruction



nptool v4 : road map

new features

- Full simulation framework (VGA, by Nov24)
- Porting Strasse Simulation (TB/FF/AM, by Jan25)
- Porting of QFS and Samurai (AM by March25)
- MESYTEC DAQ (PM, by Nov24)
- Data version control (AM Jan25)

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- Continuous deployment with docker (FF Jan25)
- OnlineDB API & website (AM ?)

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- ✓ Website tutorial
- ✓ Supporting video
- ✓ In person coding week