Ancillary analysis of AGATA@LNL

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L. Zago
M. Balogh
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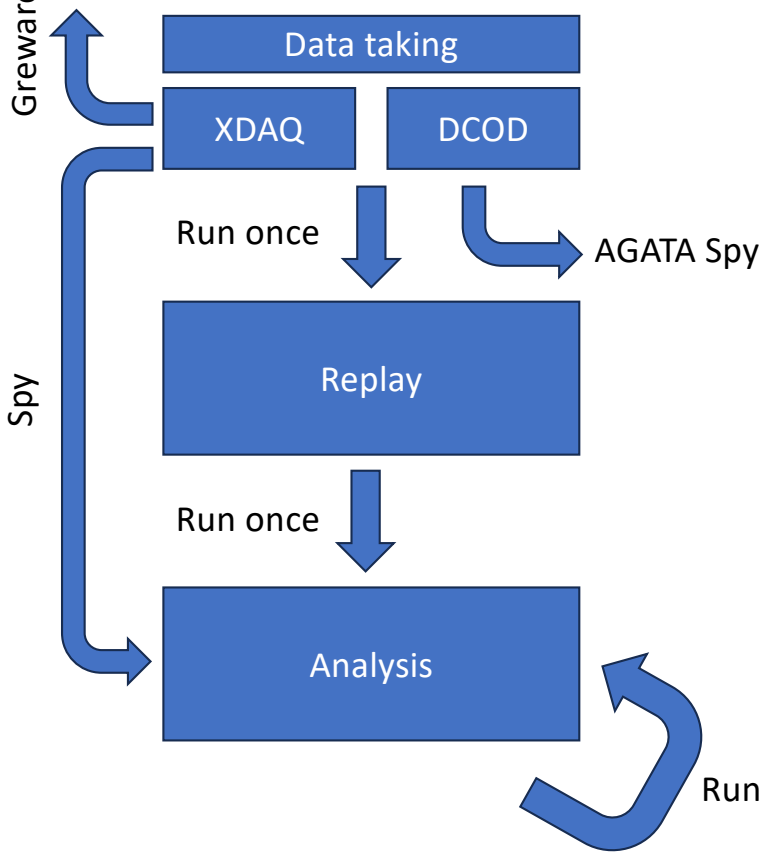
L. Busak
and the **local LNL group**

Online-Nearline workflow



- Ancillary event building
- Ancillary PSA
- …

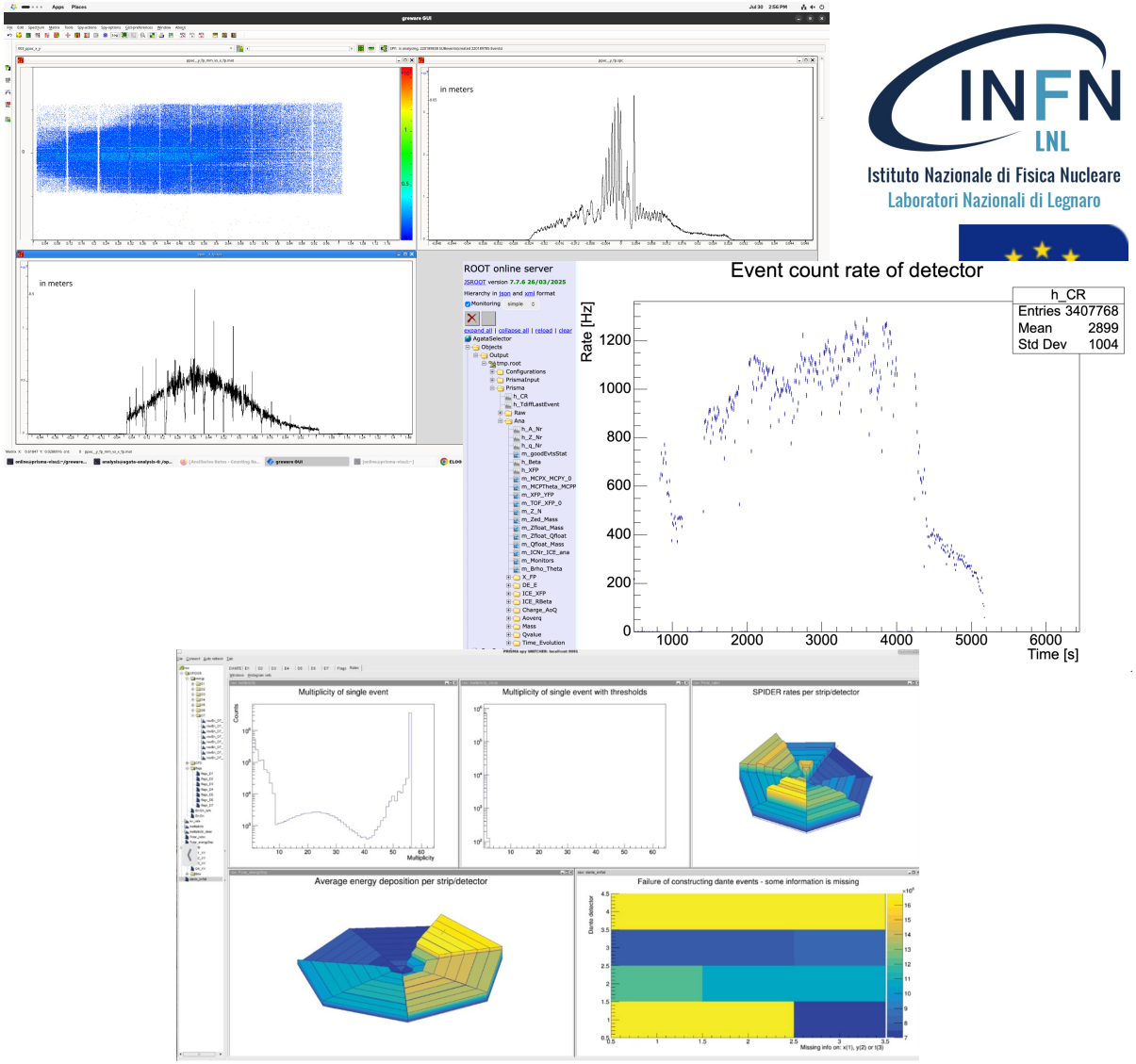
- AGATA pre-processing
- AGATA PSA
- …

- Post PSA
- Calibrations (AGATA only)
- Event building and merging

- Ancillary analysis
- High level analysis
- optimization

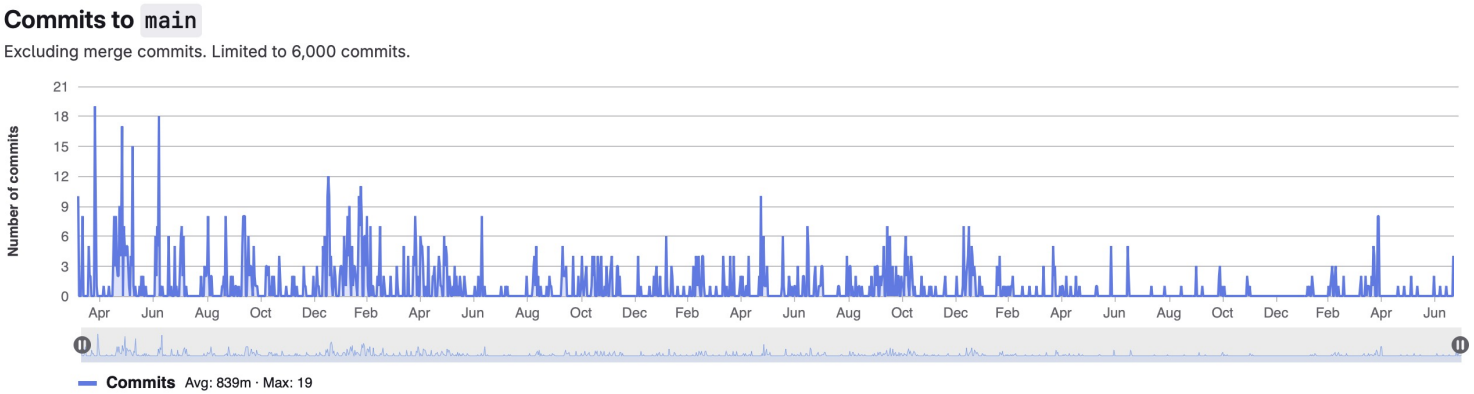
Ancillary SPY

- GREWARE
  - Stable and fast
  - Well known by users and maintained for PRISMA
  - It currently does not run the same analysis
- Agataselector (**new development!**):
  - Currently spies only PRISMA data
  - Runs the same analysis as the nearline and offline
  - JSRoot is convenient but sometimes slow
- LNLspy (developed by M. Balogh):
  - ROOT-based ser friendly interface
  - Could be integrated with the selector



Overview

- Local team effort to provide the users with a comprehensive that handles **nearline and offline analysis**
- **Unique codebase, debugged and cross checked by users and local team**
- Modular and configurable
- **13 detectors present in the analysis**
- 59 experiments up to date and 3 commissioning analyzed
- Well maintained codebase



- Total: **1321 commits**
- Average per day: **0.8 commits**
- Authors: **45**

The repository

AgataSelector

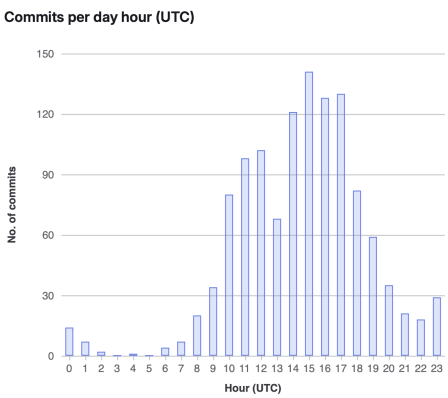
main agataselector Find file Code

- Has a DOI: DOI 10.5281/zenodo.8329198

May 07, 2025

Update file PRISMA_README.md
Filippo Angelini authored 4 months ago 42eb99ee

- Contains tests for:
  - Check for compilation
  - Check for data integrity:
    - Doppler correction quality (mean and sigma of commissioning 1 data)
    - Data loss



Project information

Data analysis code for the AGATA+ancillary data based on the ROOT framework.

data analysis Physics

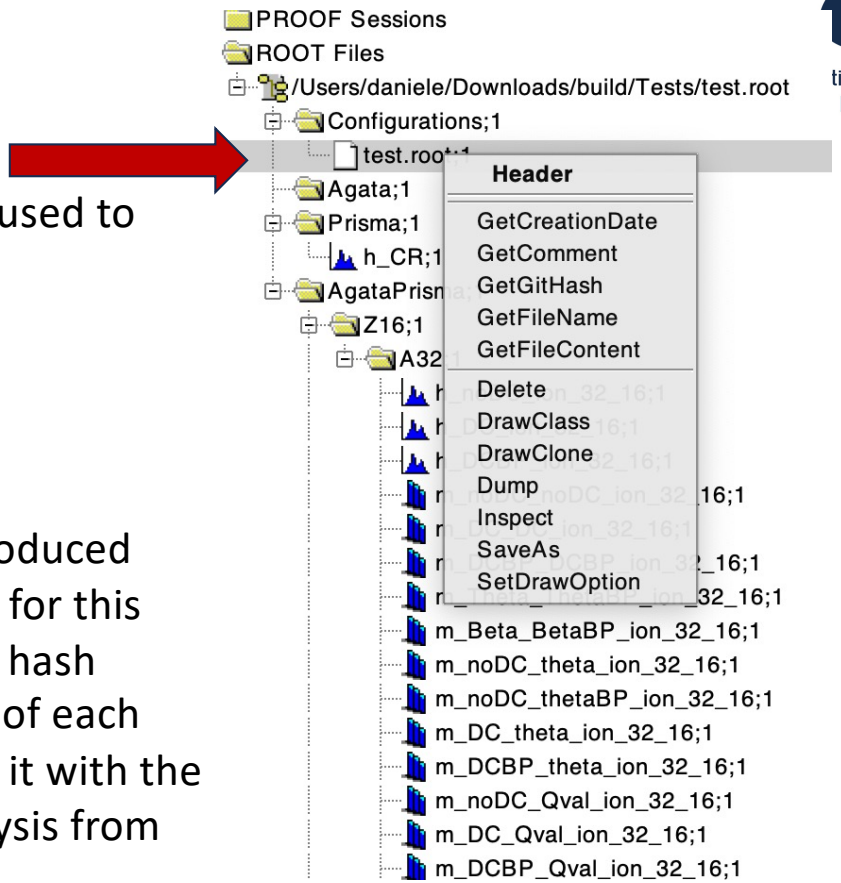
1,558 Commits

7 Branches

6 Tags

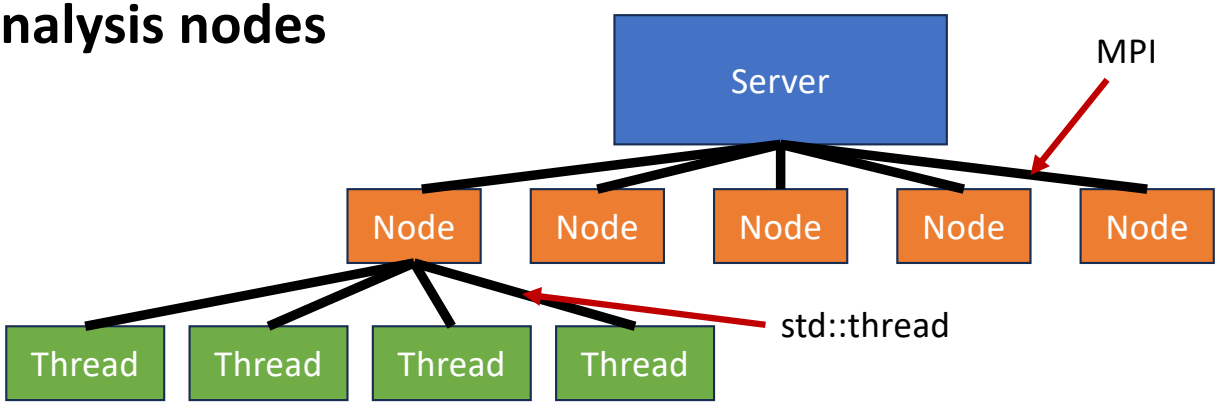
Reproducibility

- The output files contain the parameters used to generate it:
  - The entire selector.conf
  - The lookup tables
  - The git hash
  - The date of creation
- This means that the analysis can be reproduced simply by printing the selector.conf used for this specific file and checking out the correct hash
- The nearline analysis and configurations of each experiment can be recalled by compiling it with the right flags, so the user can start the analysis from day 1.



Distributed analysis

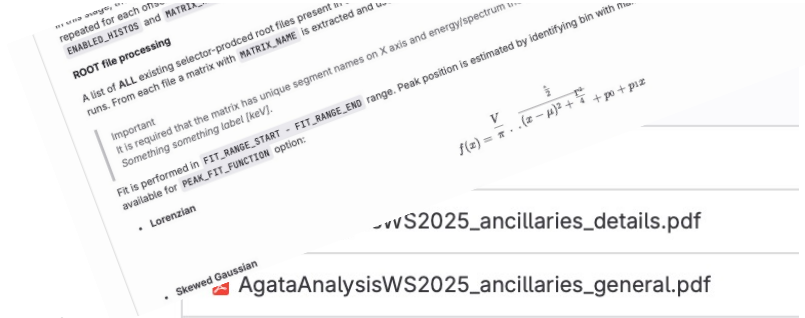
- MPI-based parallelization on multiple machines (boost-mpi)
- Needs to be compiled with "cmake -DCMAKE_CXX_COMPILER=mpic++ -DUSE_MPI=On ."
- Very simple server/worker structure
- Allows to run the full analysis multiple times during the nearline **thanks to the AGATA analysis nodes**

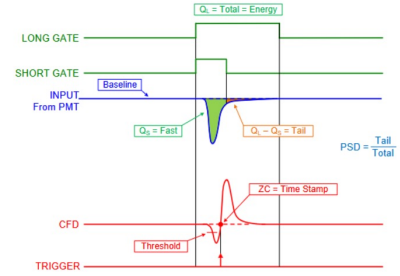


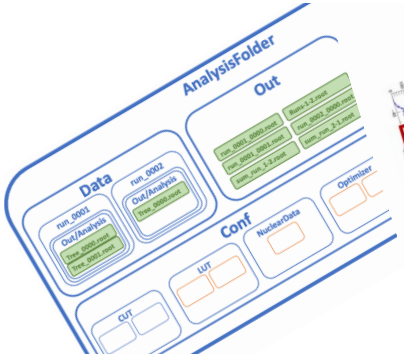
Documentation

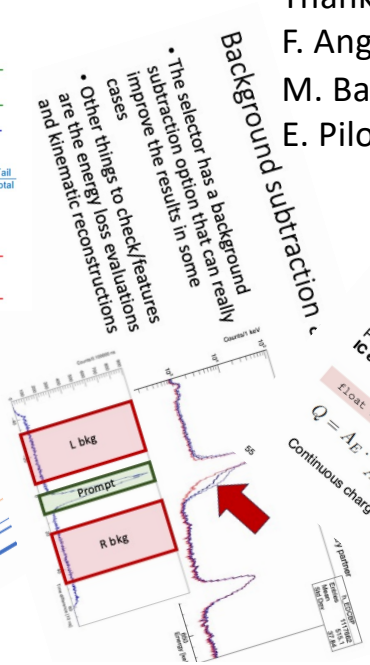
Approx. 300 slides and several **README.md** with the introduction and the details of the ancillary analysis from the latest AGATA Analysis workshop 2025 (thanks to Jérémie).
This complements the detailed AGATA LLP+GLP guides.

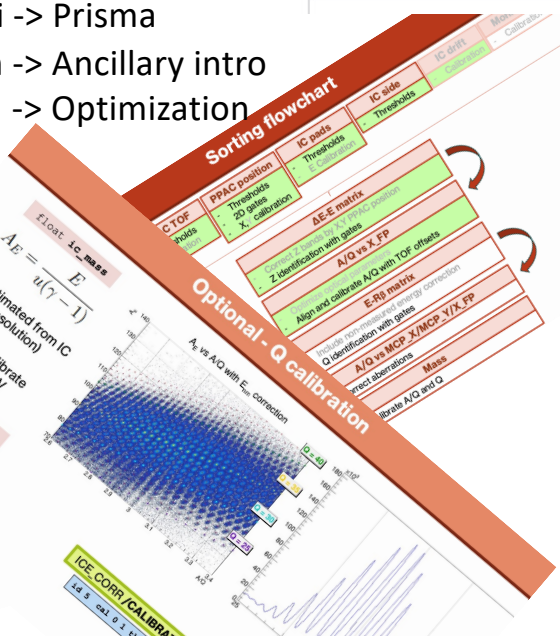
Thanks to:
F. Angelini -> Prisma
M. Balogh -> Ancillary intro
E. Pilotto -> Optimization

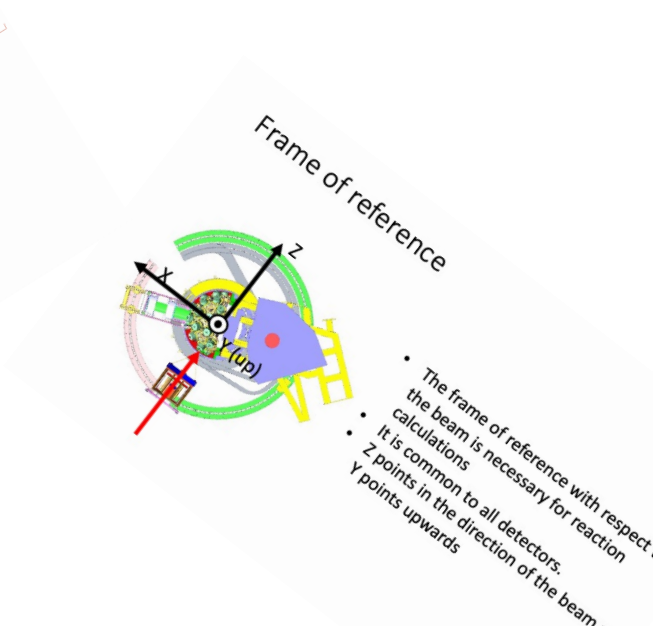












Configuration of the analysis

- Based on a configuration file and Lookup tables
- These files can be modified multiple times since analyzing an entire experiment often does not require more than 2 hours (depending on computing capabilities)

Board | channel | map | thr low | thr high| various par | …| time offset | ncal | cal par 1 | …

LUT_LABR.dat 1.16 KiB Edit

```
#LaBr Co+Cs
#board (V1730)  channel map     name    thr_lo  thr_hi  theta    phi     TimeOffset      npar_gl p0_gl   p1_q2   npar_qs p0_qs   p1_qs
1       0       0       D0      0       16000   90.422684  124.92098    0       2       -8.590549465 0.5683940043  2     -16.614035 0.584031
1       1       1       D1      0       16000   84.308418  97.489398    0       2       4.994643769  0.441859949    2  10.570262 0.443247
1       2       2       D2      0       16000   90.572804  73.768608    0       2       -4.882700373 0.4567364497   2  -9.782321 0.473778
1       3       3       D3      0       16000   99.968116  51.748253    0       2       -2.68135951  0.4616749283   2  -9.040133 0.473527
1       4       4       D4      0       16000   93.353077  26.901224    0       2       -3.368474921 0.4774816369   2  0.609657 0.481297
1       9       9       D5      0       16000   94.007297  1.3778600    0       2       0            1              2  0        1
1       5       5       D6      0       16000   99.883486  -28.723198   0       2       10.52197059  0.4435828877   2  18.918459 0.444711
1       6       6       D7      0       16000   86.180070  -45.908423   0       2       12.53667474  0.4240481389   2  28.411274 0.421525
1       7       7       D8      0       16000   91.699165  -66.505287   0       2       16.78408614  0.3897415818   2  35.049303 0.387539
1       8       8       D9      0       16000   85.591641  -95.344627   0       2       -12.39452343 0.4289130669   2  -38.673472 0.452371
##########
1       15      15      monitor 0       16000   0                       0       0       2       0         1        2   0         1
```

KEYWORD | value(s) | unit of measure | comment

```
#Format: | KEYWORD | value(s) | Unit of measure | Comment |
#Comments are ignored unit of measure # means none
#------------------------------------------------------------

#------------------------------------------------------------
DETECTORS_PRESENT
MCP                     NO      #               EXOTIC Mcps are present YES/NO
SAURONFW                NO      #               Sauron Forward is present YES/NO
EUCLIDES                NO      #               Euclides is present YES/NO
LABR                    NO      #               Labr is present YES/NO
OSCARUP                 NO      #               Oscar Up is present YES/NO
SPIDER                  NO      #               Spider is present YES/NO
OSCARDOWN               NO      #               Oscar Down is present YES/NO
AGATA                   NO      #               Agata is present YES/NO
SAURONBW                NO      #               Sauron Backward is present YES/NO
DANTE                   NO      #               Dante is present YES/NO
EXSSIDE                 NO      #               EXSSIDE Forward is present YES/NO
PRISMA                  NO      #               Prisma is present YES/NO
#------------------------------------------------------------

#------------------------------------------------------------
REPLAY_CONF
ENABLED_HISTOS                  enabled_histos.conf     #               File name with list of enabled histogr
SUM_ALL_PATTERN                 runs                    #               Sum of all hadded files pattern
TREE_NAME                       TreeMaster              #               Input tree name
SUM_FILE_PATTERN                sum                     #               Hadded file pattern
OUT_FILE_PATTERN                run_                    #               Output file pattern
IN_FILE_PATTERN                 Tree_                   #               Input file pattern
REPLAY_DIR_PATTERN              run_                    #               Replay directory pattern
IN_SUB_PATH                     /Out/Analysis           #               Input sub path
CONF_PATH                       ./Conf                  #               Replay conf folder path
OUT_PATH                        ./Out                   #               Output path
IN_PATH                         ./Data                  #               Input path
#------------------------------------------------------------

#------------------------------------------------------------
REACTION_CONF
REACTION_POSITION       0.5     #                       Position of the reaction in the taget 0->front 0.5->mi
ENERGY                  0       MeV                     Beam energy
TARGET                  1 1     #                       Target ion A Z
BEAM                    1 1     #                       Beam ion A Z
ION                     1 1     #                       Fragment of interest for binary reaction calculation:
#------------------------------------------------------------

#------------------------------------------------------------
TARGET_CONF
ELOSS_TABLE_TYPE                0       #               Type of eloss table 0 -> SRIM, 1-> Geant4, 2 -
DEG_DISTANCE                    0       um              Degrader distance in um
DEG_THICKNESS                   0       mg/cm2          Degrader thickness in mg
ROTATIONZ                       0       deg             Target rotation on the Z axis in degrees
ROTATIONX                       0       deg             Target rotation on the X axis in degrees
TILT                            0       deg             Target tilt in degrees; Negative values for cl
THICKNESS                       0       mg/cm2          Target thickness-density in mg/cm2 or units al
DEG_PRESENT                     NO      #               Degrader present YES/NO
DEG_MATERIAL                    none    #               Degrader material
MATERIAL                        none    #               Target material
DEG_POS                         AFTER                   Degrader position BEFORE/AFTER
#------------------------------------------------------------
```

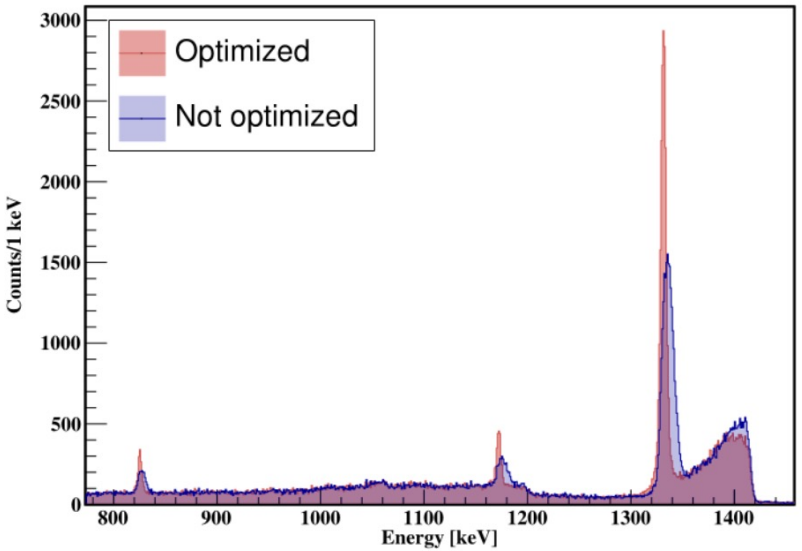
The UserSelector

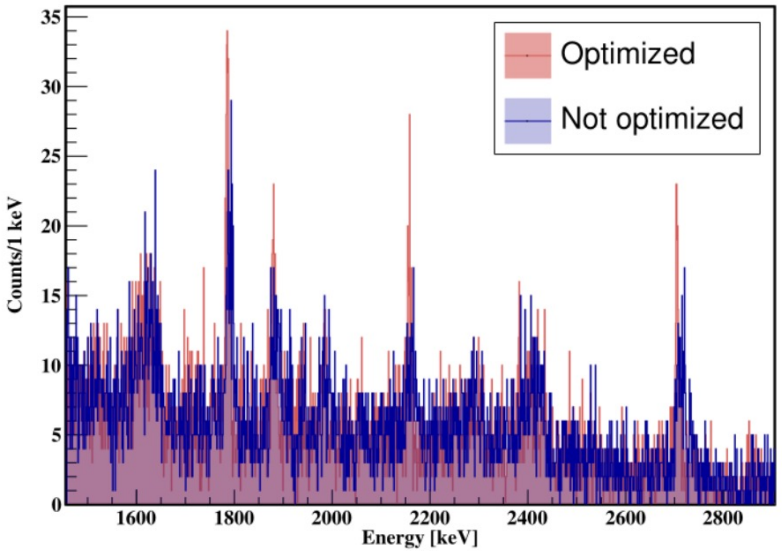
- The code can be personalized for a specific experiment if something non-standard is needed
- The standard analysis can be accessed by the user and does not affect other experiments
- One can recall the configuration and specific code of the nearline analysis as by compiling the selector with an experiment-specific cmake option

h UserSelector.h 592 B

```
1  #pragma once
2  #include "AgataSelector.h"
3
4  class UserSelector : public AgataSelector {
5    public:
6      explicit UserSelector(const std::string& option
7          : AgataSelector(options){};
8      Bool_t Process(Long64_t entry) override;
9      void   SlaveBegin(TTree* tree) override;
10     void   SlaveTerminate() override;
11
12   private:
13     // USER variable and histogram definition secti
14
15     // unsigned long long timeRef = 0;
16
17     struct UserHistograms {
18         std::vector<TObject*> ptrs;
19         TDirectory*           dir{nullptr};
20         // TH1D *h_agataCR = nullptr;
21
22     } userHistograms;
23 };
24
```

The optimization procedure



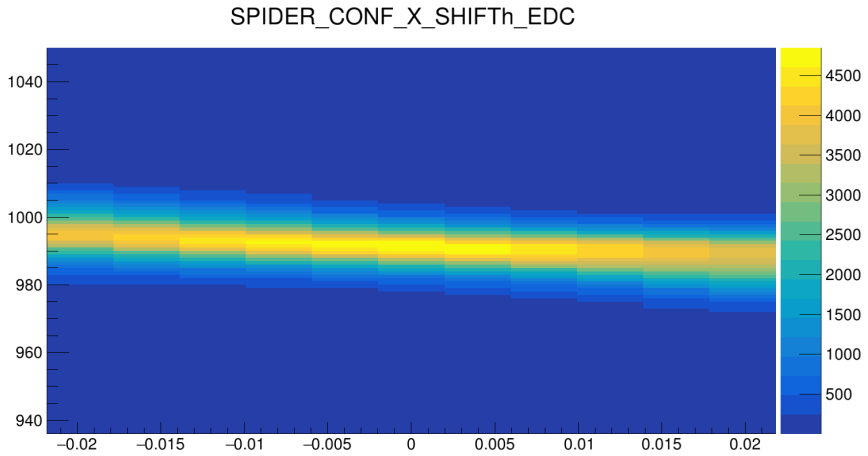


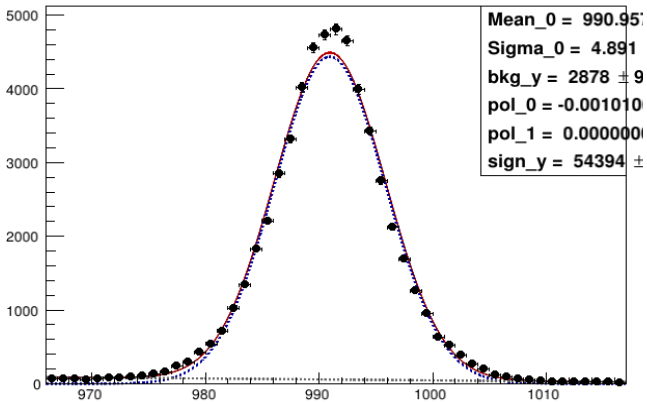
- Remarkable improvements are possible with the optimization but are experiment dependent.
- The selector contains a procedure to find the optimal parameters by running

  RunSelector - -optimize 2

Optimization details

- The optimization has three options:
  - Scan a parameter within some limits
  - Fit + simultaneous variation of any parameter of the configuration file
  - Lookup table automatic optimization: two options are available and documented (developed by M. Balogh)

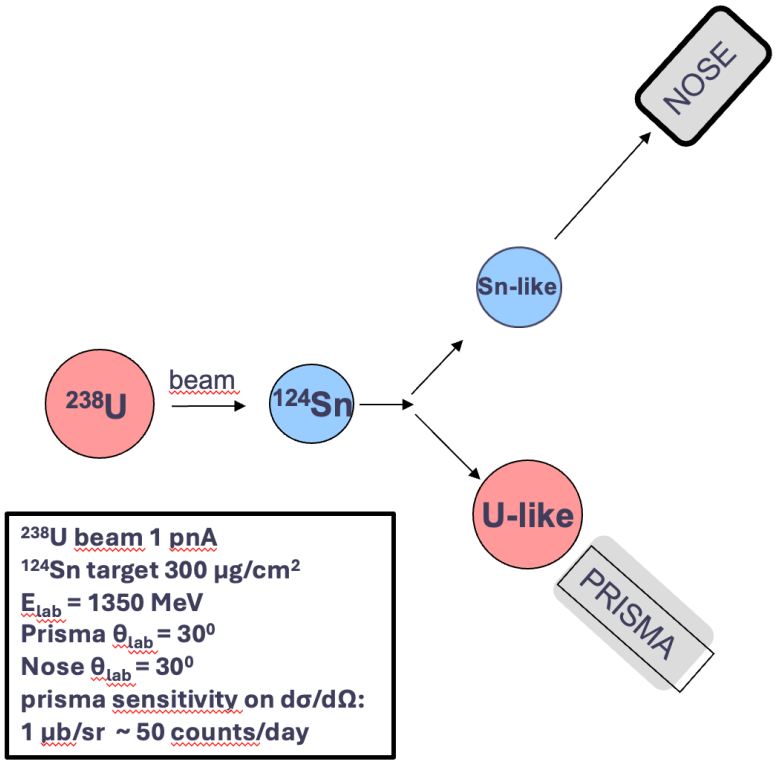




Some recent results from the nearline analysis of the ^{238}U beams

Recent additions: the NOSE

- Kinematic coincidence between PRISMA and NOSE
- Bragg chamber (Z-id) and PPAC (X-Y and time)
- Especially useful to reject fission events

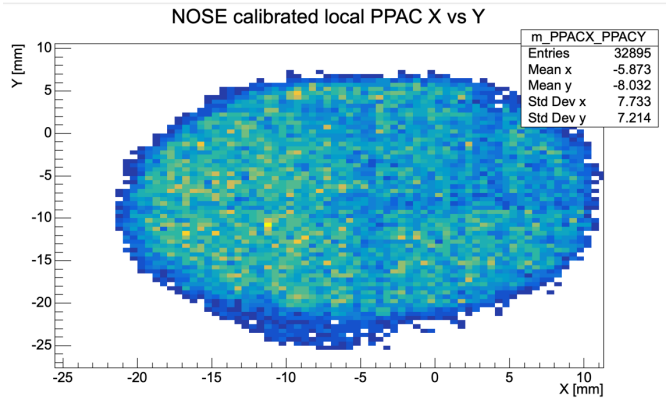


New implementation!

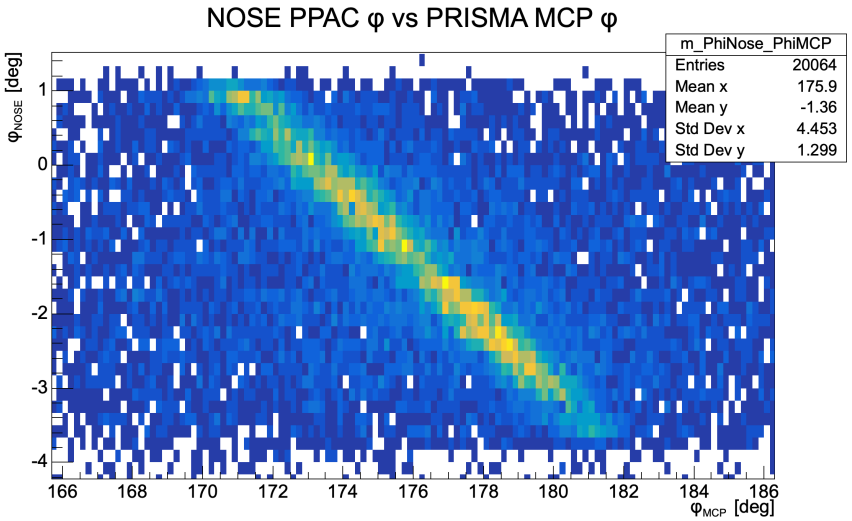
- NOSE analysis
- PRISMA-NOSE coincidence
- PRISMA-NOSE-AGATA coincidence

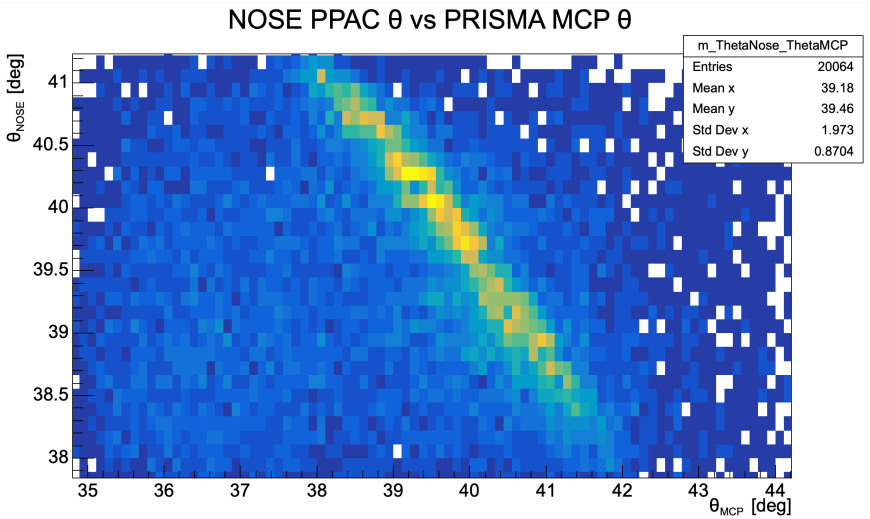
Courtesy of **F. Galtarossa, L. Corradi and B. Sulignano**

PRISMA-NOSE coincidence



- The kinematics correlations are clear!
- The correlation of tof and energy allows the separation of heavy and light fragments



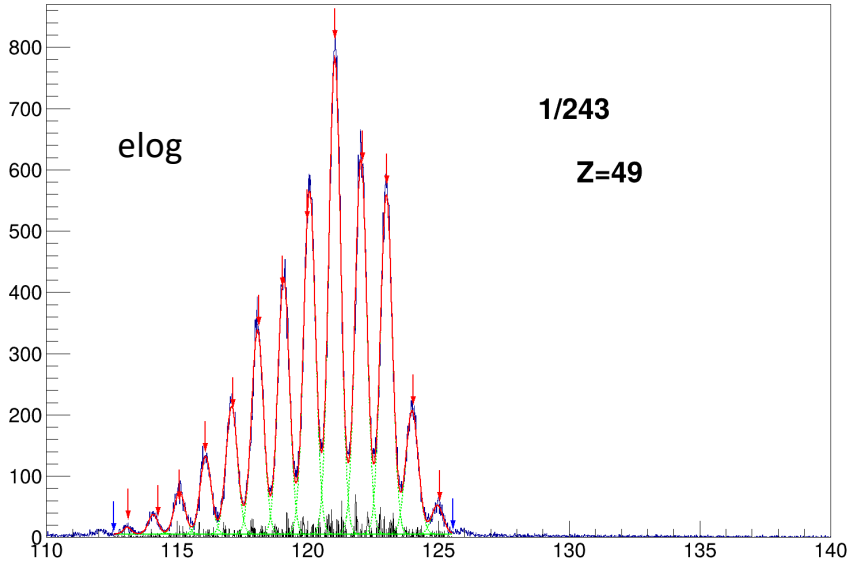


INFN LNL
azionale di Fisica Nucleare
tori Nazionali di Legnaro

AGATA
ADVANCED GAMMA TRACKING ARRAY

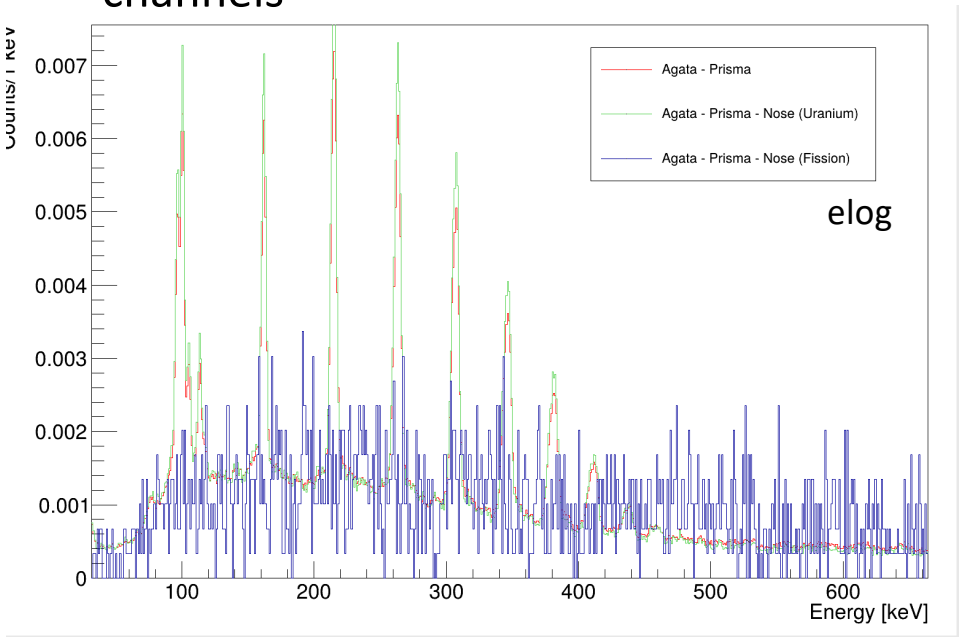
Improvements on the PRISMA analysis

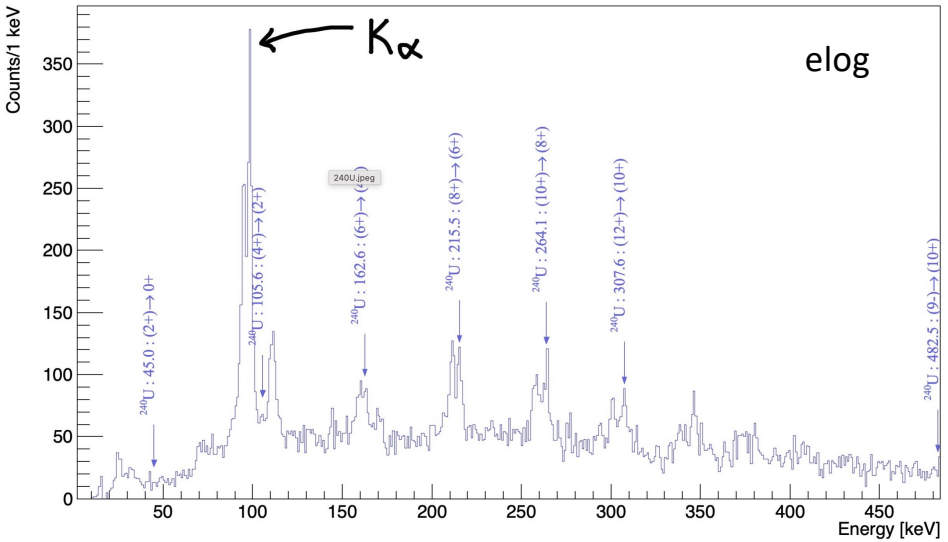
- Recent improvements on the interactive procedure (gate-setting, calibration, thresholds, ..) thanks to L. Busak and F. Angelini
- It can now read directly raw data
- Faster and more streamlined procedure
- Great mass resolution already in the nearline

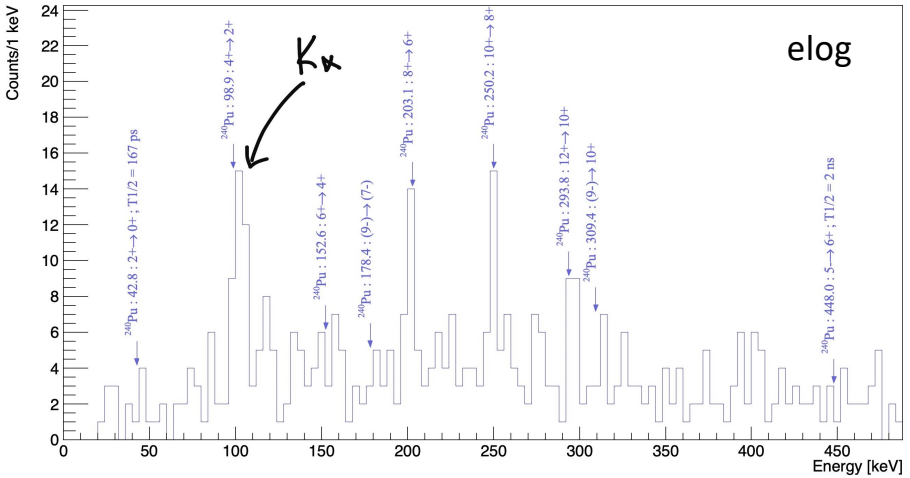


AGATA-PRISMA-NOSE coincidence

- Great fission rejection performance
- The background is reduced especially in for the transfer channels

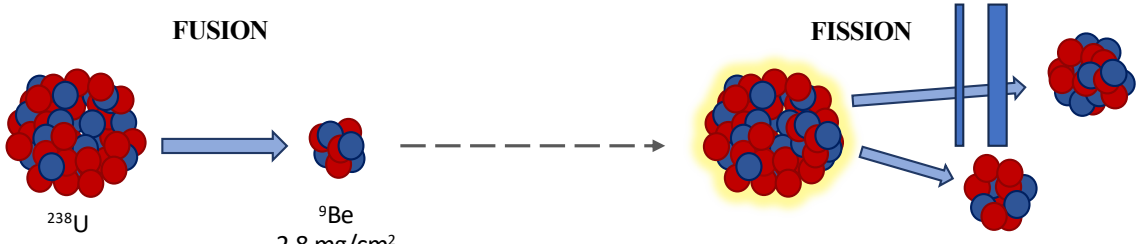




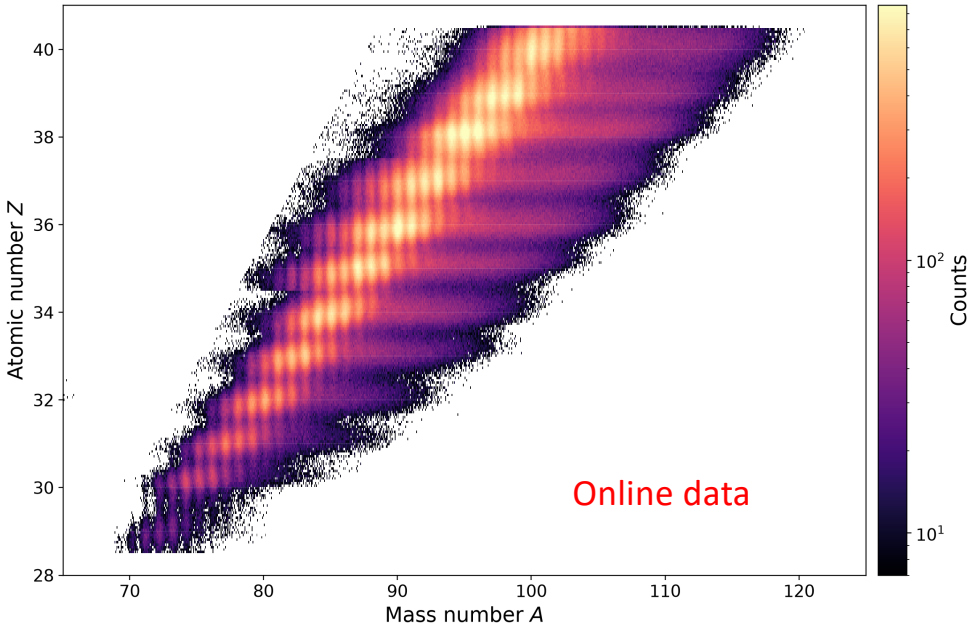


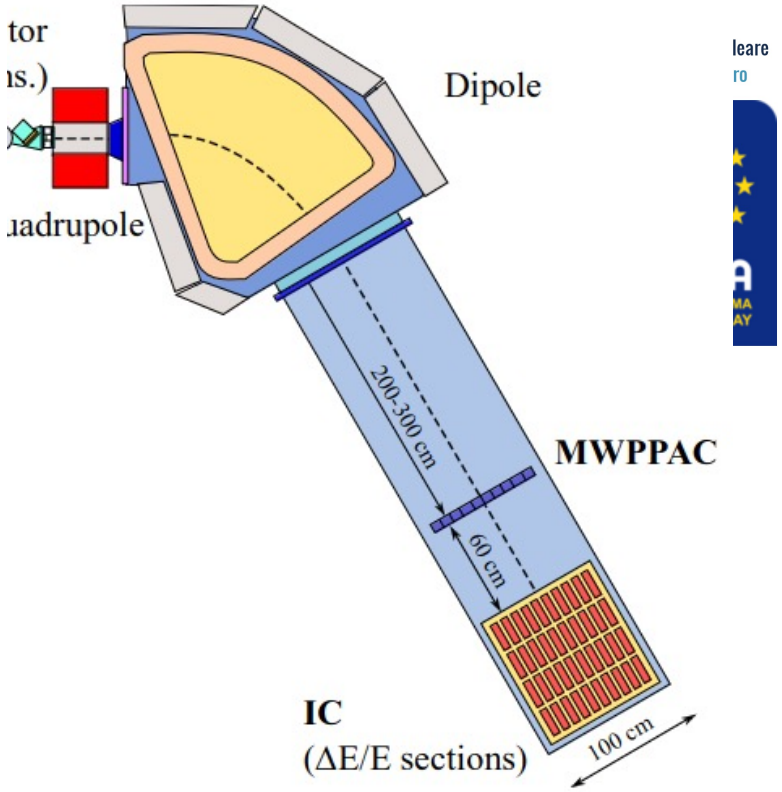
Fusion-fission and lifetime measurements

^{238}U beam at LNL!



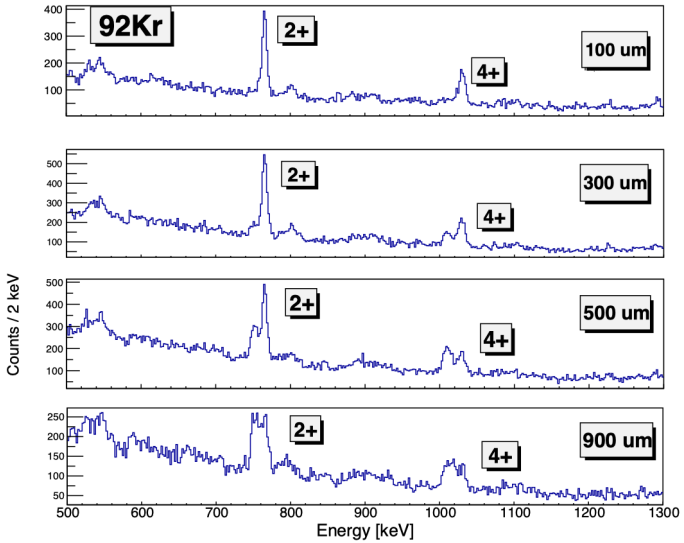
Fission yield identified by PRISMA



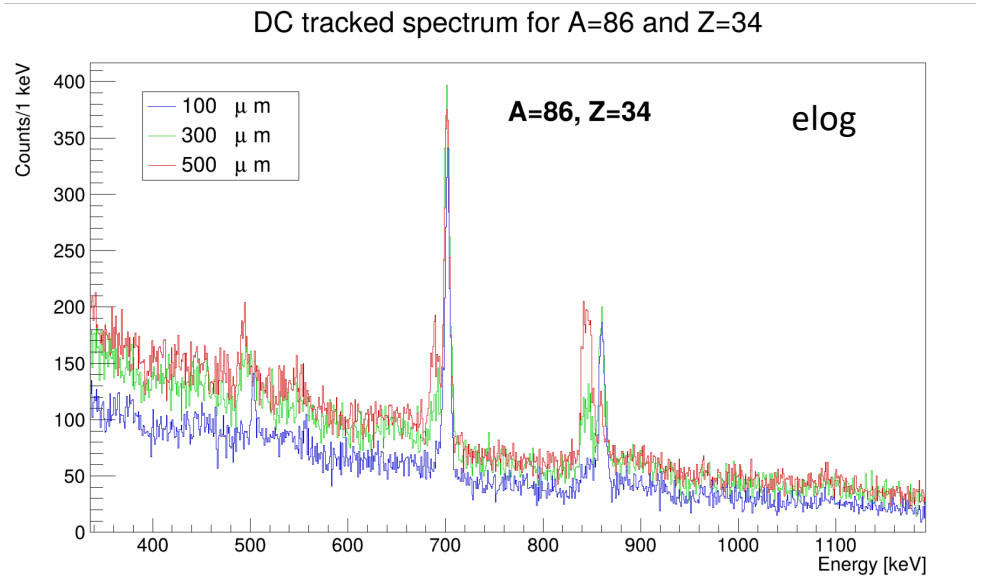


Courtesy of A. Gottardo, J.J. Valiente Dobon, M. Camaño, F. Angelini, D. Stramaccioni

AGATA-PRISMA coincidences



Thanks to the online analysis of F. Angelini, L. Busak, M. Del Fabbro, B. Gongora, E. Pilotto, B. Greaves, and many other nearline experts

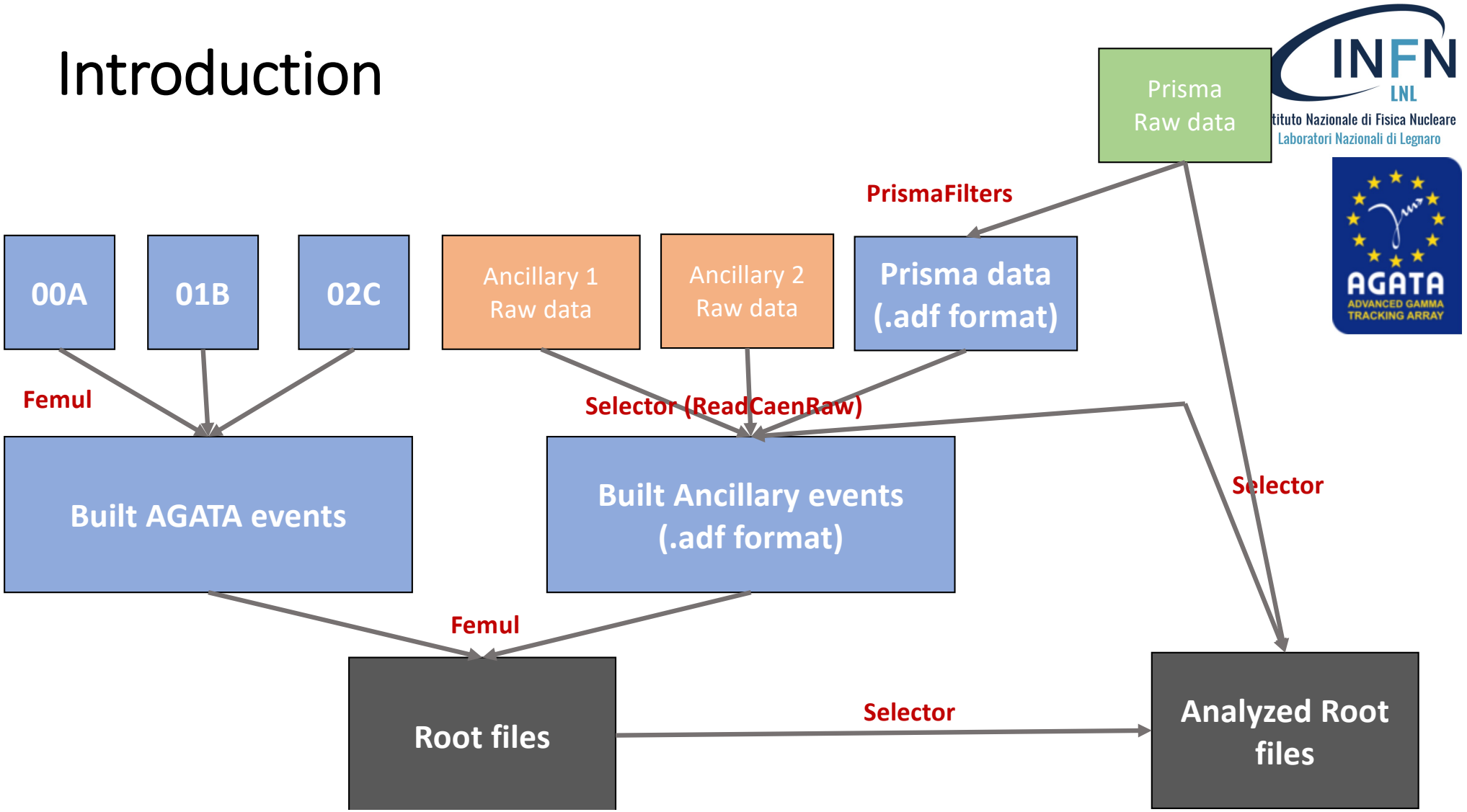


Perspectives

- We plan to switch to DAEMULE (developed by Guillaume Baulieu) for the ZD campaign in the nearline
- The analysis of NEDA and PARIS will be integrated and developed with the existing codebase

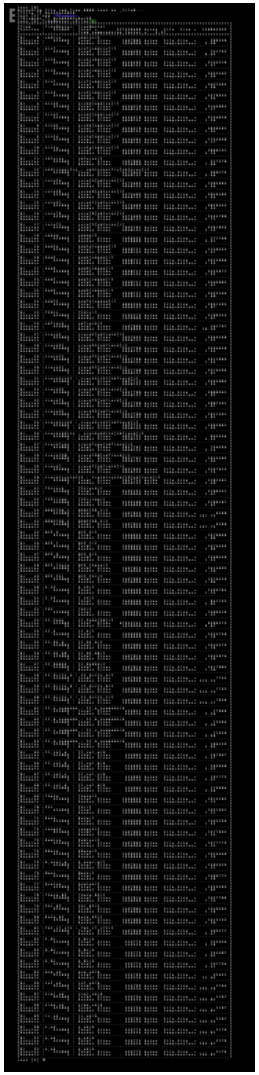
Thanks to all people that have contributed with solving bugs, improvements and new functionalities!

Introduction



The output

- The selector produces ROOT files containing:
  - Histograms (each analysis is contained within a folder):
    - Single detector analysis
    - Coincidence analysis
  - TTrees of:
    - High level data of a single detector. For instance, Spider provides things such as excitation energy or angles
    - Doppler correction based on the analysis of the agata+ancillary coincidence
- The analysis code handles kinematic reconstruction, energy loss, event selection, time and energy gates, optimization procedures
- It can be distributed on multiple machines if compiled with MPI



The starting point

- Femul produces a root file containing MANY leaves
- The analysis procedure is common to all experiments and there is little benefit of repeating the same steps over and over
- **The users can profit from a collaborative project for a quicker analysis**
- The code was created for a quick near-line analysis and has since evolved with more refinements with full analysis capabilities