Online / Offline Reconstruction of Trigger-less Readout in the R3B Experiment at FAIR

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Future FAIR Facility

Facility for Antiproton and Ion Research

- Financed by a joint international effort of 10 member states
- Will host basic research for about 3000 scientist from 50 countries
  - Atomic, Plasma physics and applications
  - Compressed Baryonic Matter
  - Nuclear structure, Astrophysics and Reactions
  - Anti-proton annihilation, Hadron physics
R³B Experiment

Reactions with Rare Radioactive Beams

Collaboration include 50 institutes and covers broad physics program:

- Experimental reaction studies with exotic nuclei far off stability
- Nuclear structure and dynamics
- Astrophysical aspects and technical applications
R3BRoot / FairRoot

• FairRoot is a framework, which includes basic functionality for simulation and data analysis software of FAIR experiments (talk by F. Uhlig, Tue 15:15)

http://fairroot.gsi.de/

• R3BRoot includes experiment-specific implementation of:
  ‣ detectors geometry and response
  ‣ event-generators
  ‣ magnetic fields
  ‣ reconstruction algorithms
  ‣ physics analysis

http://r3broot.gsi.de/
Simulations for R³B

R3BRoot was used for the feasibility studies within Technical Design Reports of detector sub-systems:

- Silicon Tracker
- Gamma and proton spectrometer (CALIFA)
- Proton and Fragment tracking detectors
- Neutron ToF spectrometer (NeuLAND)
- Fragment ToF spectrometer

The same reconstruction algorithms are to be used for real data
Data analysis for R$^3$B

• Was successfully applied for test of data taking (online) and physics analysis of neutron detector (offline) in R$^3$B test experiments at GSI in April and October 2014

• Operates with Multi-Branch System (MBS) for Data Acquisition, developed at GSI. Data sources are:
  
  ‣ MBS remote event server (online)

  ‣ MBS data file (offline)

• The same calibration and reconstruction routines are used in both cases
Data flow — triggered

One MBS event - one beam interaction with data from all sub-systems (sub-events)

Used in April 2014 test experiment
Asynchronous data flow

One MBS event - data from one sub-system with time-stamp in [ns]

Remote event server

Used in October 2014 test experiment

MBS Event 1 — Time1
MBS Event 2 — Time2
...

DAQ

Unpacking

Synchronisation

R3BRoot

Reconstruction
Online synchronisation (stitching)

Stitching is done after unpacking (operate with R3BRoot structures) and before mapping and calibration.

Realised using buffering of events from sub-systems.

Synchronisation based on time-stamp with user-defined window.

Distribution of time delay between gamma and neutron detectors.
April 2014 test beam

Test of Neutron detector data taking

Test of remote web monitoring based on ROOT JavaScript, encapsulated into HTML code

Calibration and reconstruction of hit velocity (requires also data from start counter)
Results

Position calibration with cosmics

Separation of gammas and protons
October 2014 test beam

• Test two systems in asynchronous mode: prototype of gamma spectrometer (CALIFA) and prototype of neutron detector (NeuLAND)

• 4-times more channels in NeuLAND - allows to test physics analysis algorithms developed for simulations

• Use CALIFA as a trigger for beam-target interaction
Gamma detector as trigger

Requiring at least one hit in CALIFA allows to select signal events.
Results

More elaborated physics analysis requires energy calibration of gamma spectrometer — work in progress
Conclusions

• Successful test-application of R3BRoot / FairRoot framework to online / offline reconstruction of R³B experimental data — currently 4 sub-systems included

• Resulted in multiple fixes and improvements of the code

• Successful test of online event-builder, based on time stamps

• Ongoing work in extending support for other sub-systems and accomplishing calibration algorithms for first physics run in 2017