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

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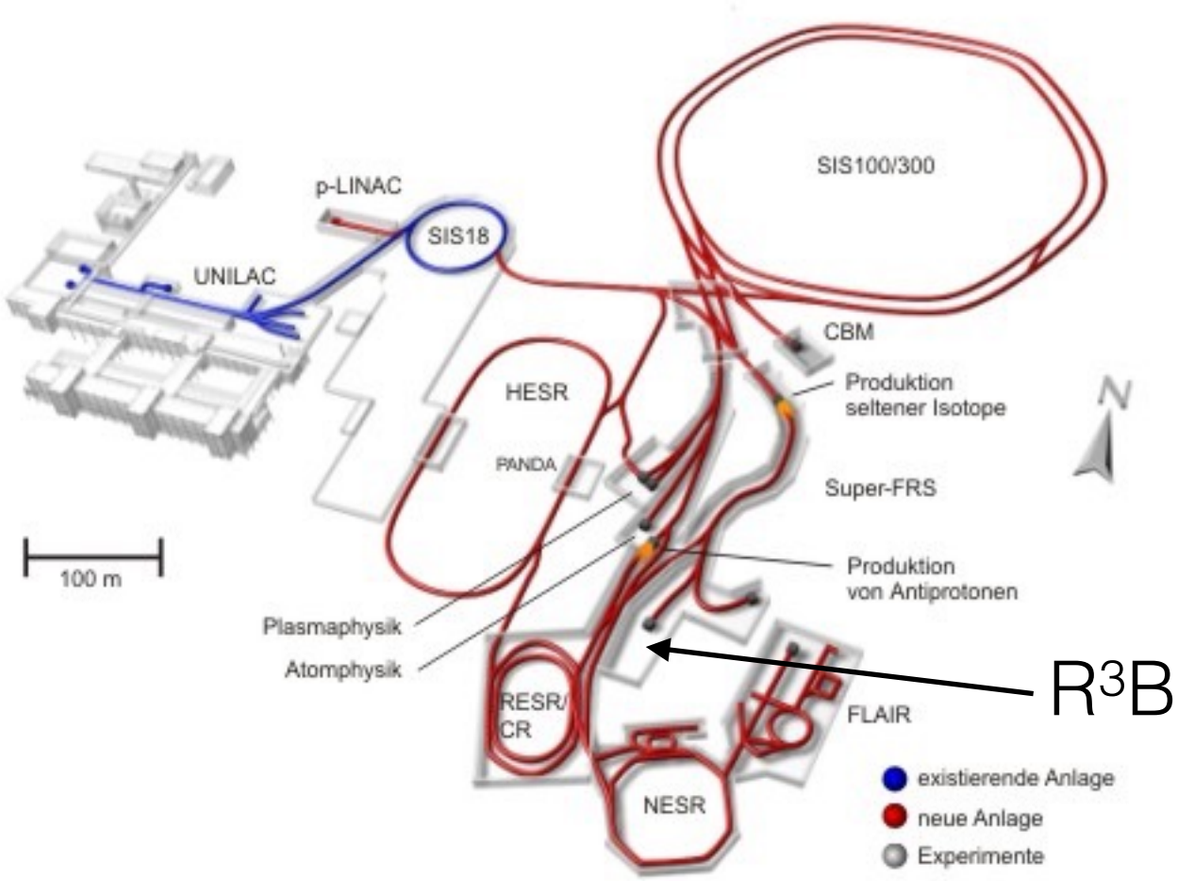
Future FAIR Facility

Facility for Antiproton and Ion Research

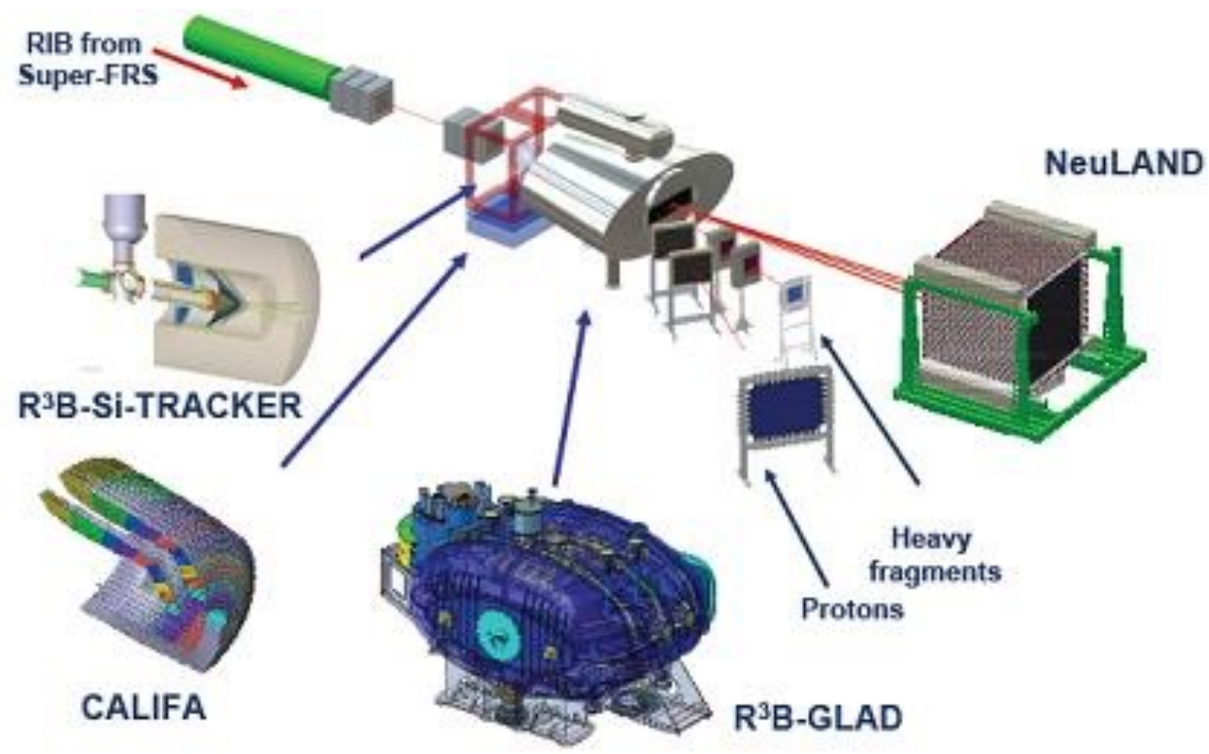


- Financed by a joint international effort of 10 member states
- Will host basic research for about 3000 scientist from 50 countries

- 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

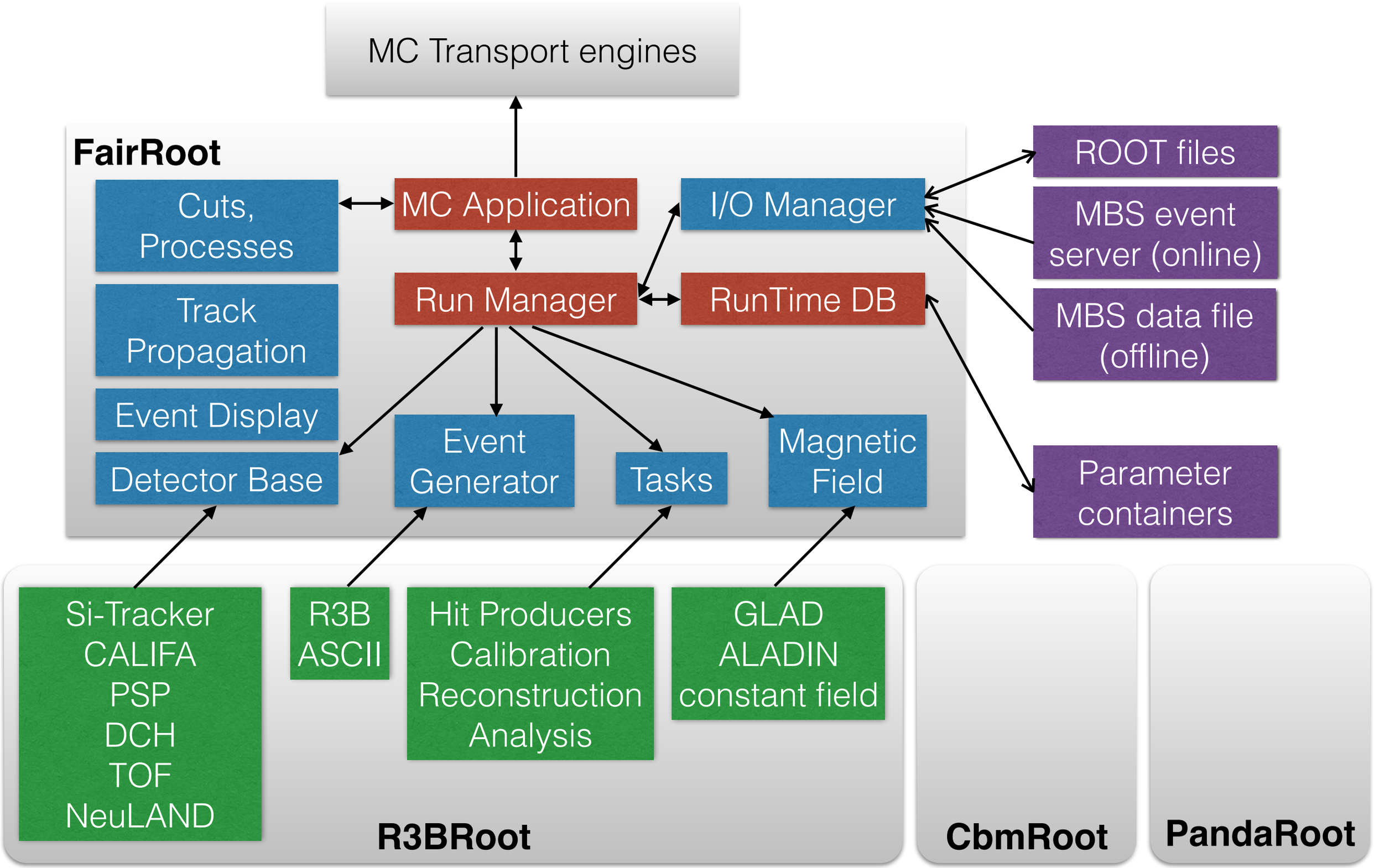
R3BRoot / FairRoot

- 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/


MC Transport engines
FairRoot
Cuts, Processes
MC Application
I/O Manager
ROOT files
MBS event server (online)
MBS data file (offline)
Track Propagation
Run Manager
RunTime DB
Event Display
Detector Base
Event Generator
Tasks
Magnetic Field
Parameter containers
Si-Tracker
CALIFA
PSP
DCH
TOF
NeuLAND
R3B ASCII
Hit Producers
Calibration
Reconstruction
Analysis
GLAD
ALADIN
constant field
R3BRoot
CbmRoot
PandaRoot

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

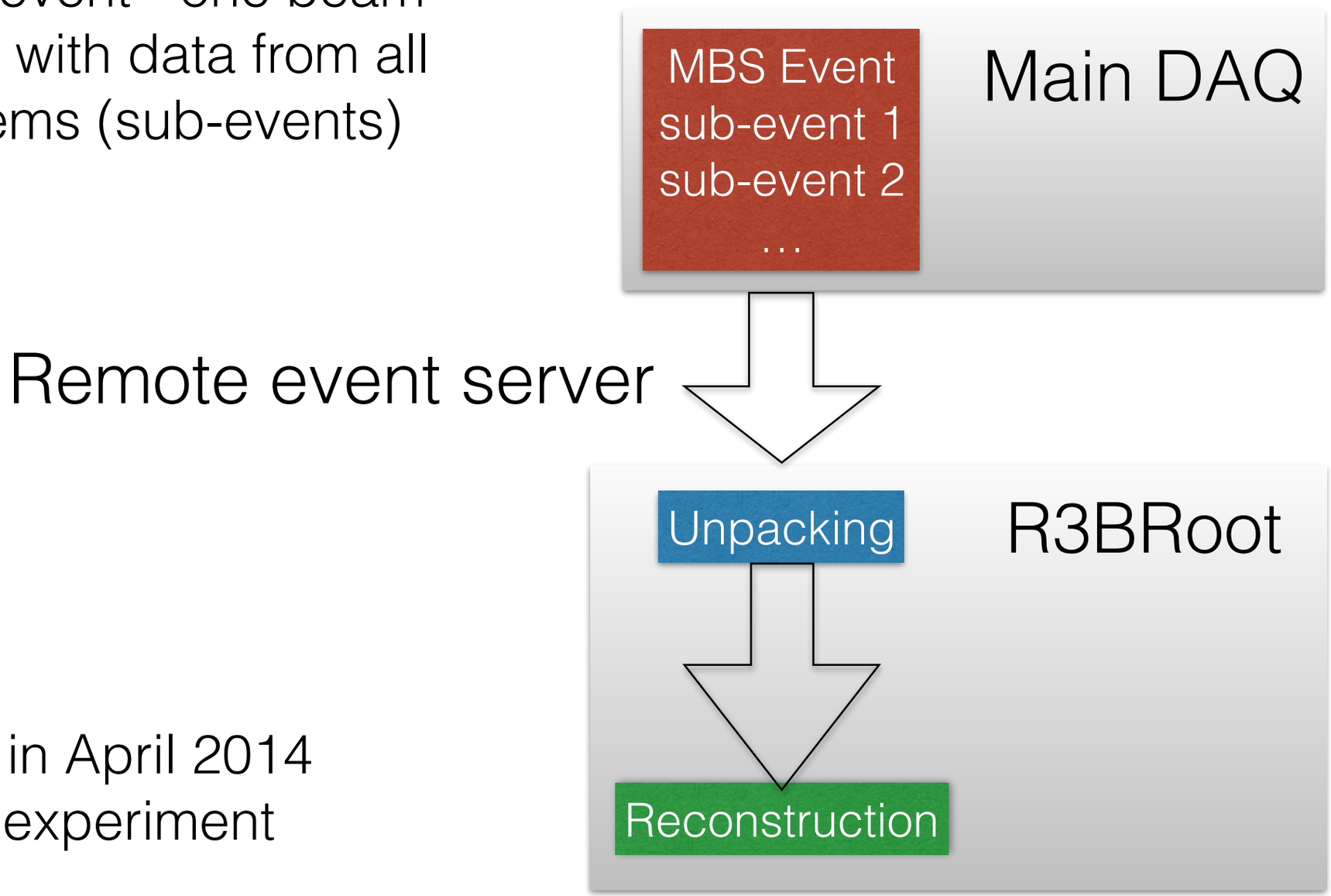
The same reconstruction algorithms are to be used for real data

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

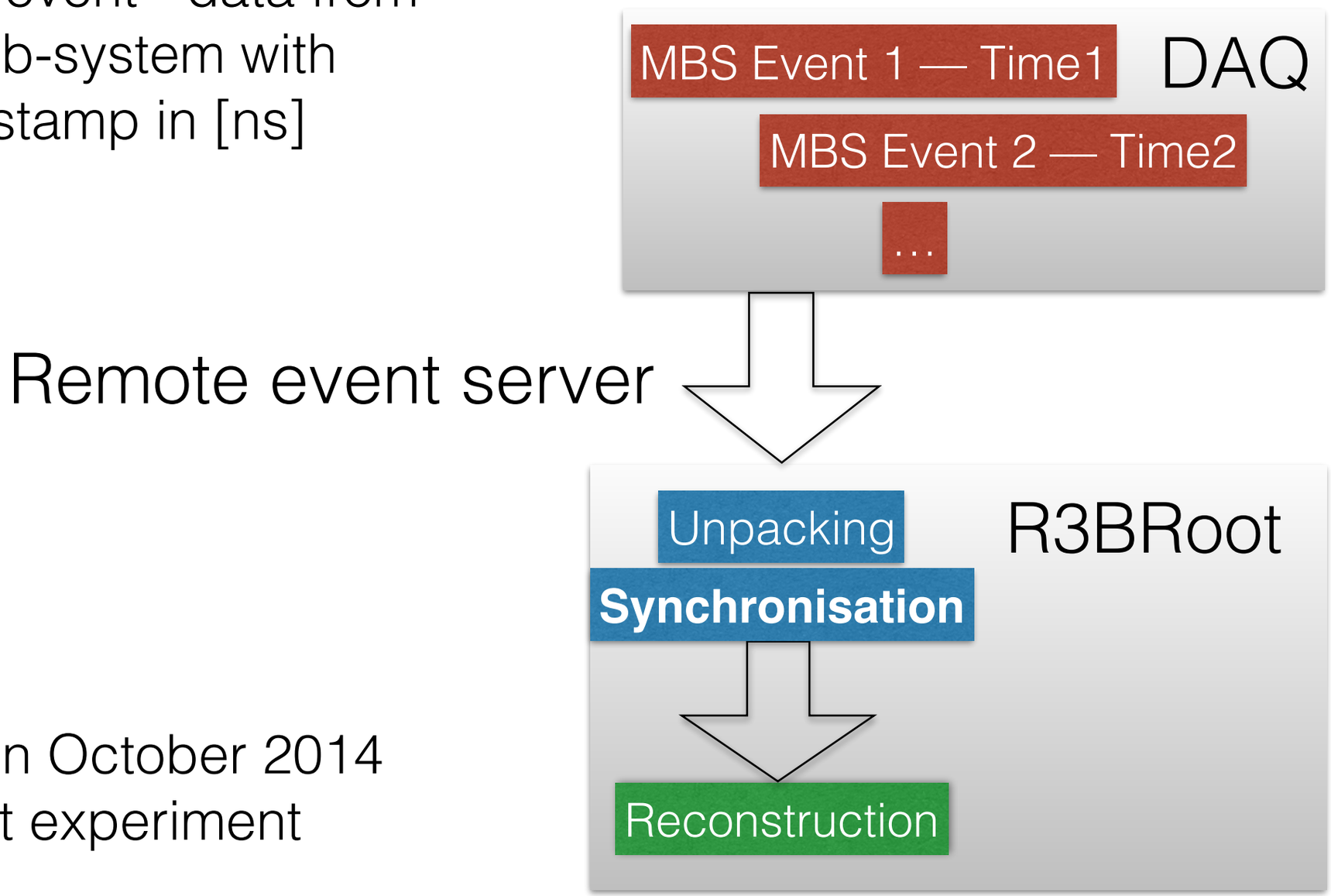
One MBS event - one beam interaction with data from all sub-systems (sub-events)



Used in April 2014 test experiment

Asynchronous data flow

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



Used in October 2014 test experiment

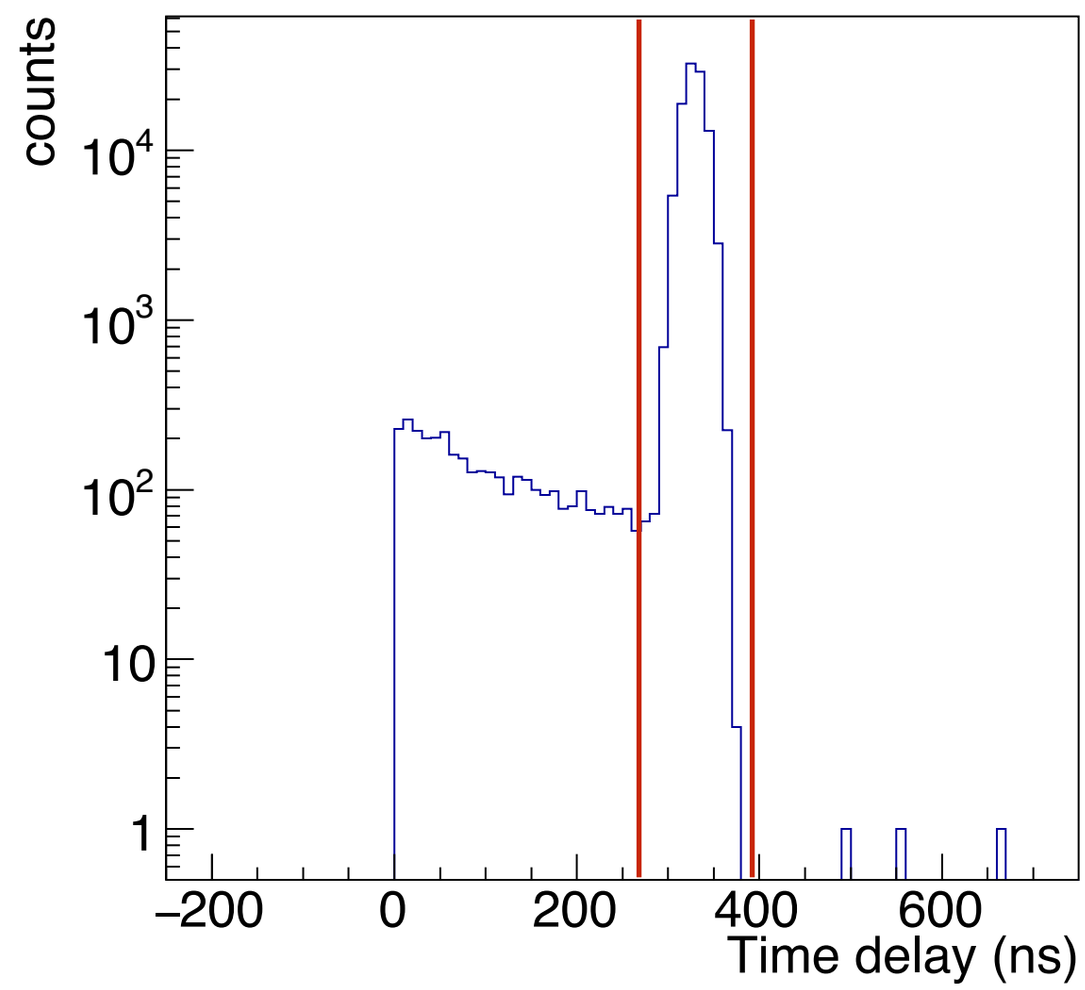
Online synchronisation (stitching)

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

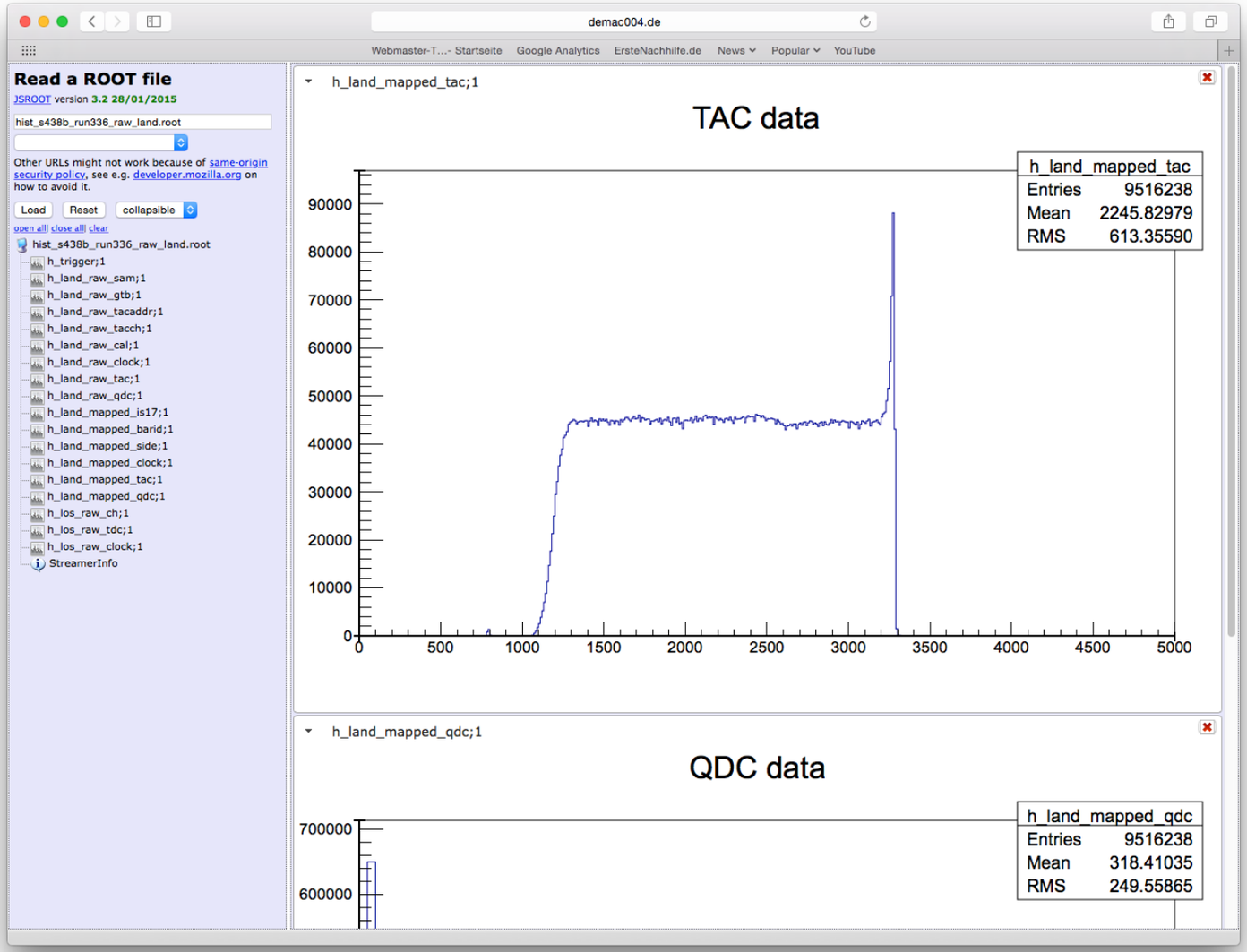


April 2014 test beam

Test of Neutron detector data taking

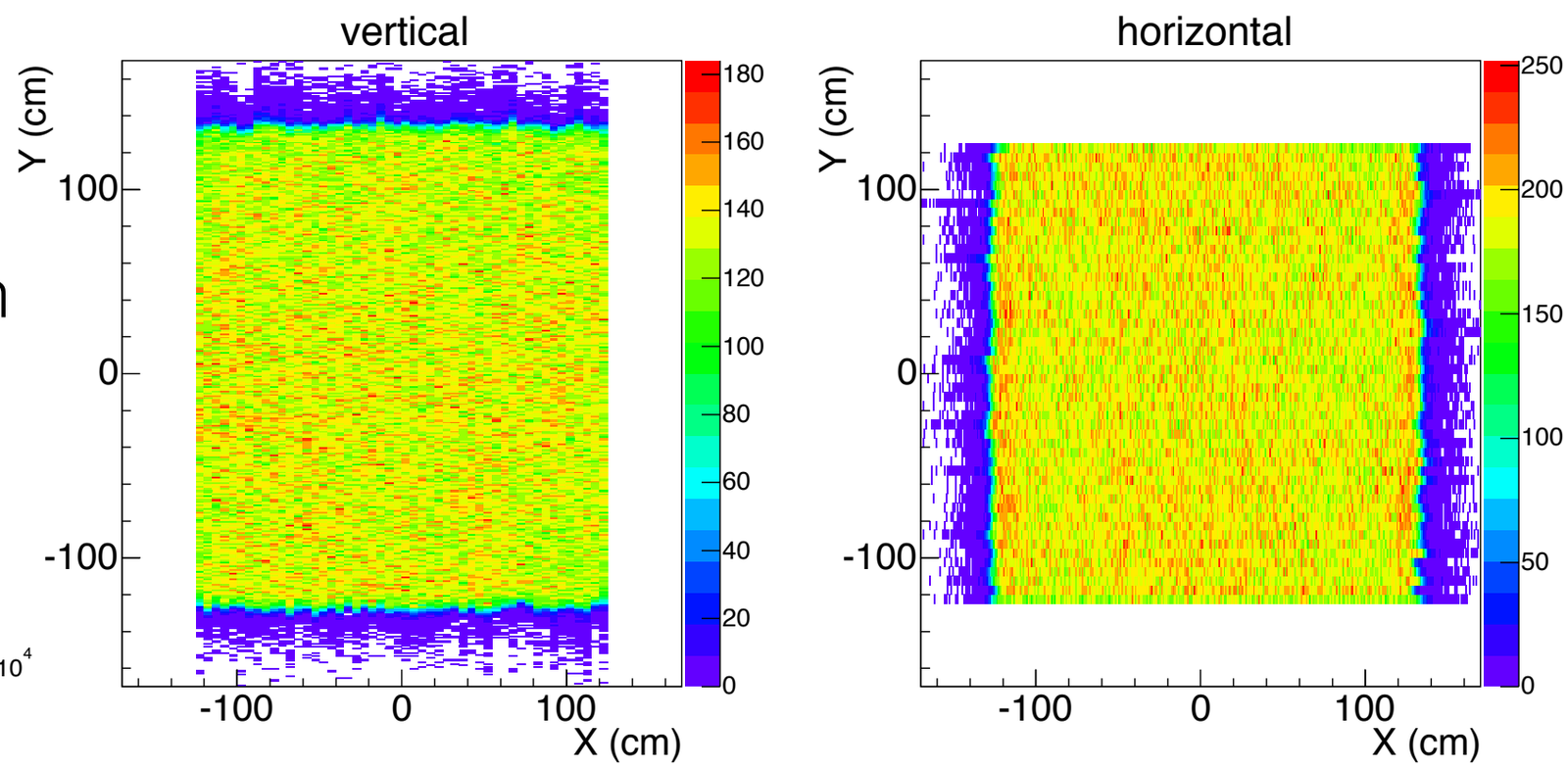
Test of remote web monitoring based on ROOT JavaScript, encapsulated into HTML code

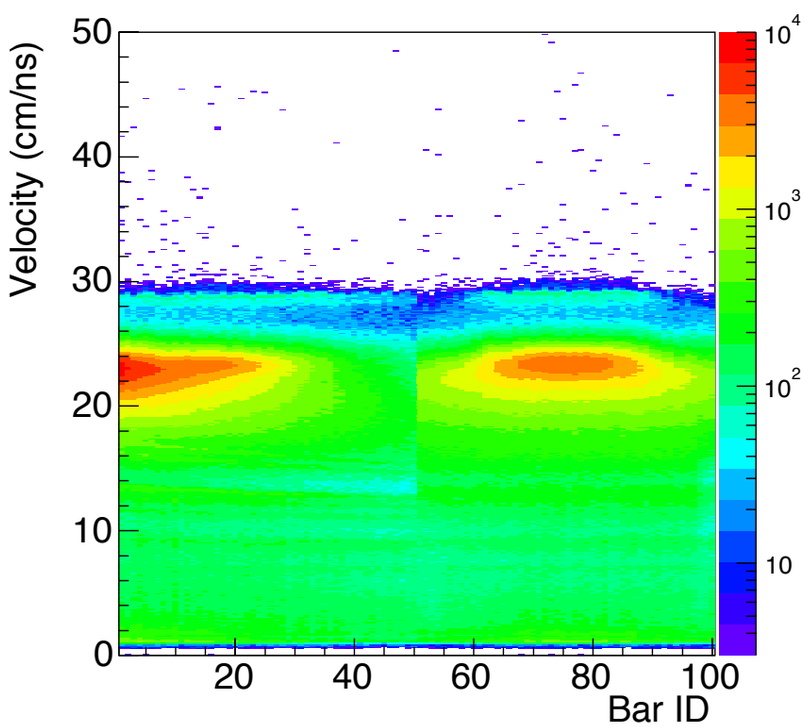
Calibration and reconstruction of hit velocity (requires also data from start counter)



Results

Position calibration with cosmics



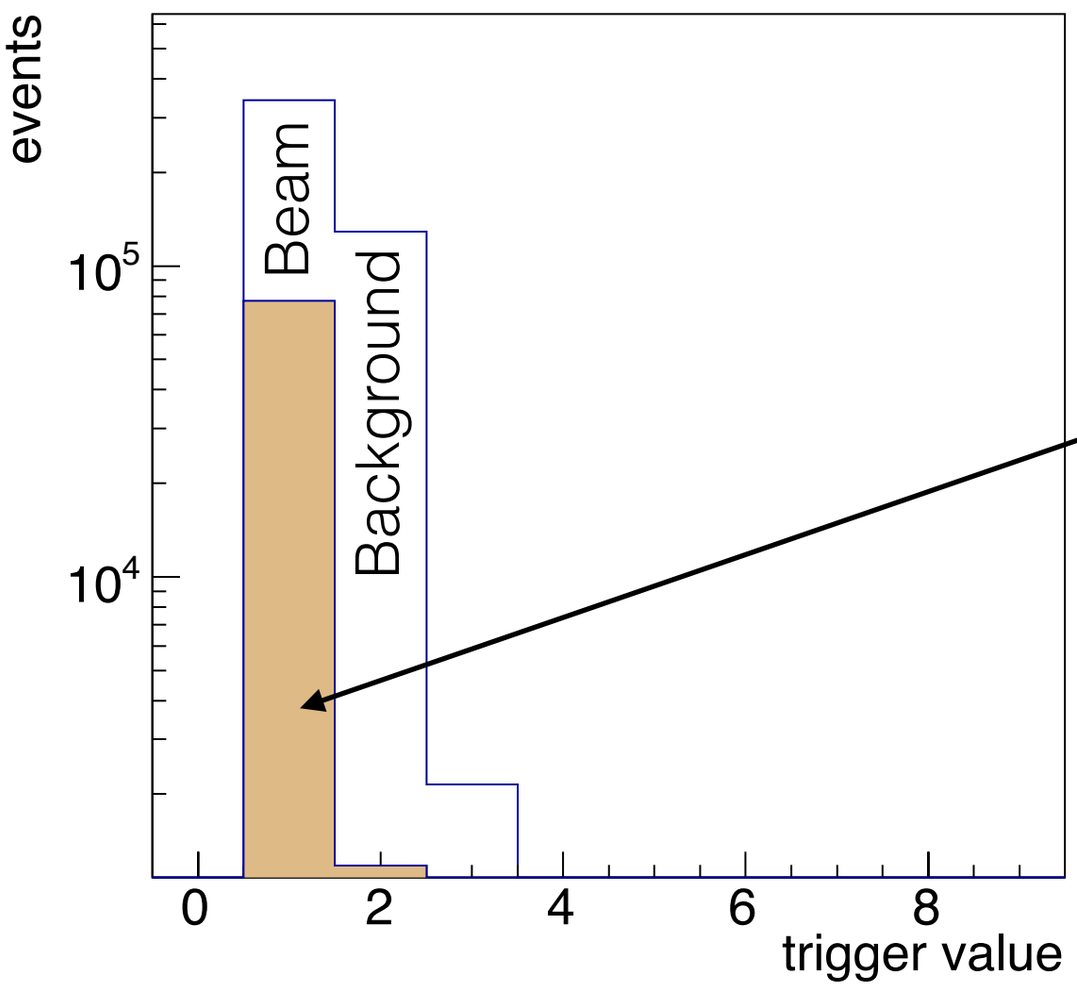


Separation of gammas and protons

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

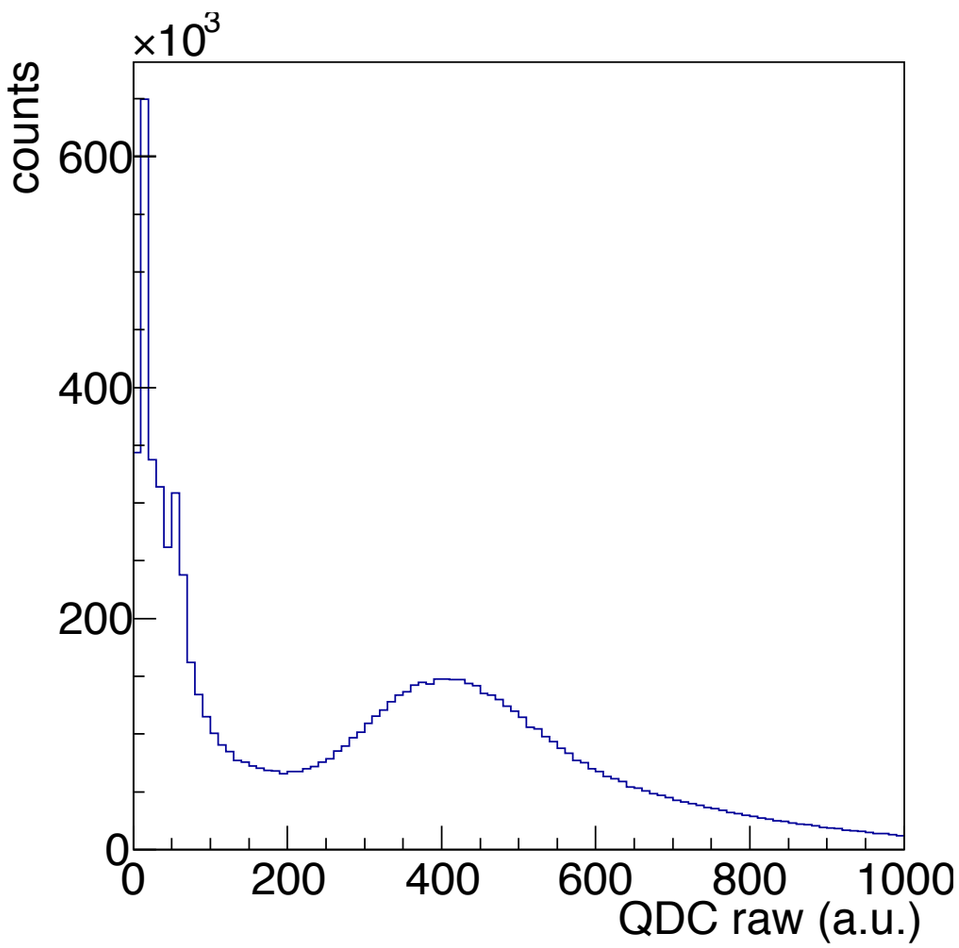
Gamma detector as trigger



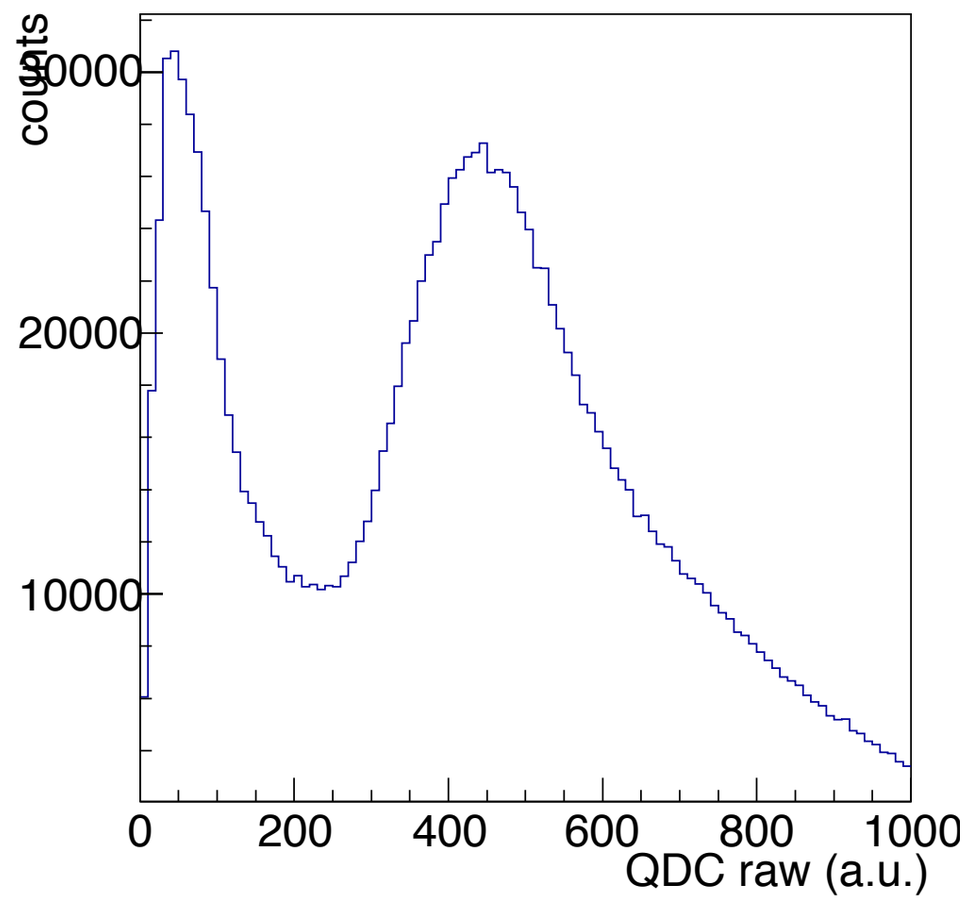
Requiring at least one hit in CALIFA allows to select signal events

Results

Raw neutron data



After applying trigger



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 R^3B 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