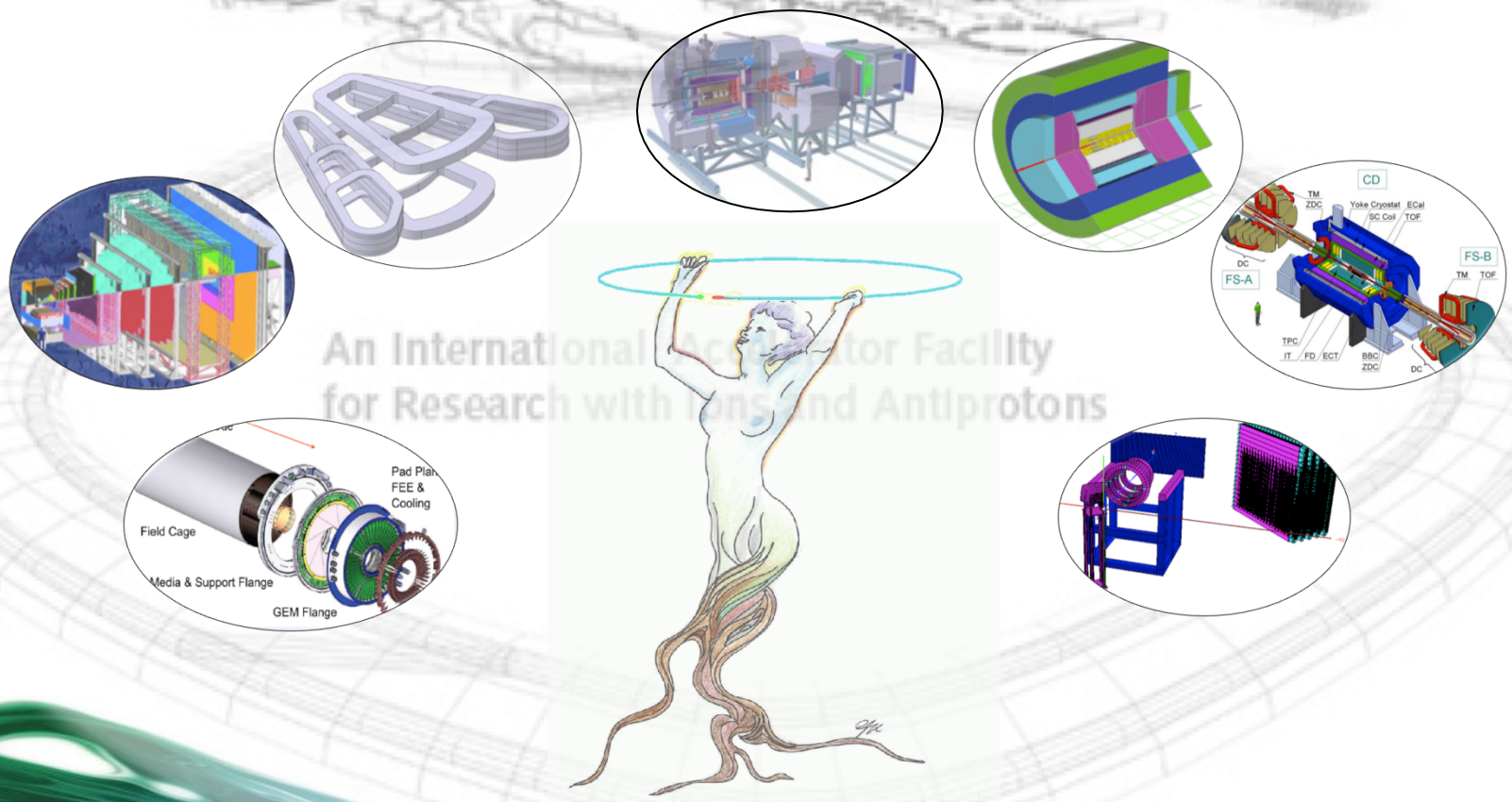
FairRoot framework in a nutshell

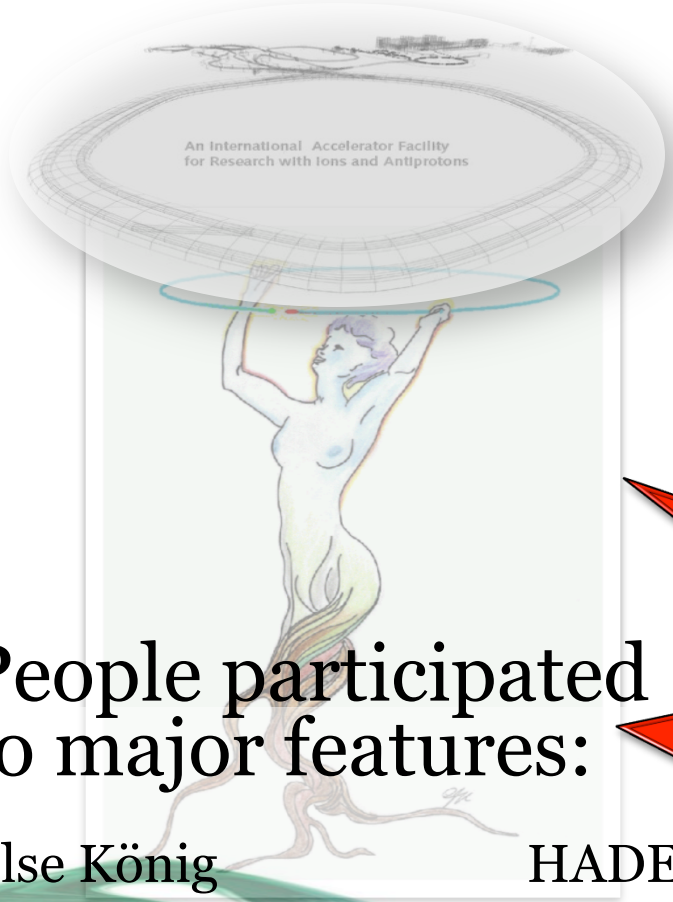


Mohammad Al-Turany
(GSI-Scientific Computing)

FairRoot in a nutshell

- FairRoot Team
- Experiments using FairRoot
- Design of FairRoot
- Hot topics
  - Time based simulation in FairRoot
  - Event source simulation and online reconstruction
- Ongoing work

FairRoot Developers:



Core Team:

Mohammad Al-Turany	SC
Denis Bertini	SC
Florian Uhlig	CBM / SC
Radek Karabowicz	PANDA / SC
Dmytro Kresan	R3B/ SC
Tobias Stockmanns	PANDA

People participated to major features:

Ilse König	HADES
Volker Friese	CBM
Olaf Hartman	PANDA

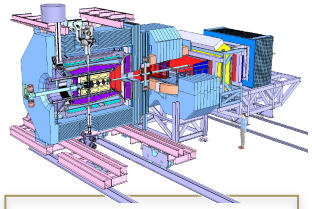
long list of people who have contributed pieces of code to FairRoot since the project started end of 2003

FairRoot : Timeline

Start testing the VMC concept for CBM

2004

First Release of CbmRoot

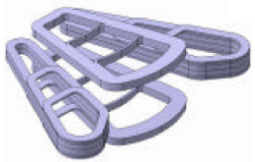


Panda decided to join->

FairRoot: same Base package for different experiments

2006

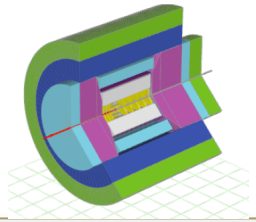
MPD (NICA) start also using FairRoot



R3B joined

2010

ASYEOS joined (ASYEOSRoot)

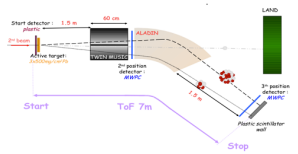


EIC (Electron Ion Collider BNL)

EICRoot

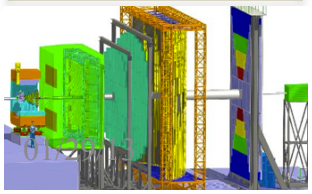
2011

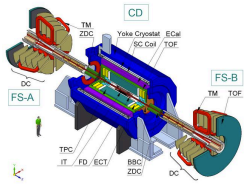
GEM-TPC seperated from PANDA branch (FOPIRoot)

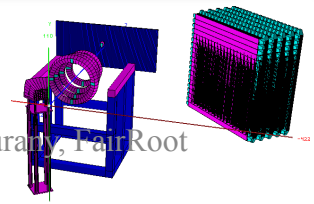


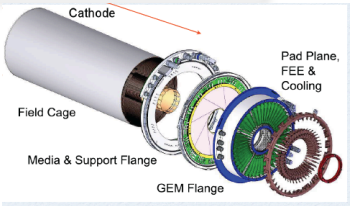
SOFIA (Studies On Fission with Aladin)

2012









Design

Geometry
Virtual MC
G3VMC
Geant3
G4VMC
Geant4

FairRoot

Cuts, processes
Application
IO Manager
Root files
Hits, Digits, Tracks
Track propagation
Run Manager
RTDataBase
Root files
Event Display
Oracle
MySQL
Postgresql
Detector base
Event Generator
Tasks
Magnetic Field
TSQLServer

CbmRoot

STS
TOF
EMC
MVD
Rich
Urqmd
ASCII
Pythia
Hit Producers
digitizers
Dipole Map
const. field
CBM Code

PandaRoot
R3BRoot
MPDRoot (NICA)
ASYEOSRoot
EICRoot
SofiaRoot

Time based simulation: How do events overlap?

- In Detectors:
  - Sensor elements are still blocked from previous hits
  - Electronic is still busy
  - Hits too close in time cannot be distinguished
  - …

- Special problem for CBM and PANDA:
  - Continuous beam with Poisson statistics ➔ many events with short time between them
  - No hardware trigger
  - Complex event reconstruction
  - ➔ Necessary to simulate data stream as realistic as possible

Time based simulation: Implementation

- FairWriteoutBuffer is Special buffer to store detector data between events
- You give the data you want to store an absolute time window this data is active in your detector and can influence later events.
- If the same detector element is hit a second time the data is modified.
- This is an abstract base class where you have to inherit from

Time based simulation: Reading back data

- FairRootManager has new reading algorithms, which make it possible to use the event wise implemented tasks to run on such data streams
- Different algorithms available to extract data:
  - All data up to a given time
  - All data in a time window
  - All data between time gaps of a certain size
- Other algorithms can be (easily) implemented

Event source simulation: A tool for real time testing of online algorithms

FairRoot

Server

Network

Data Client(s)

Reconstruction code (CPU, GPU, FPGA, etc)

item 1
item 2
Circular Buffer
free space
item n
growth

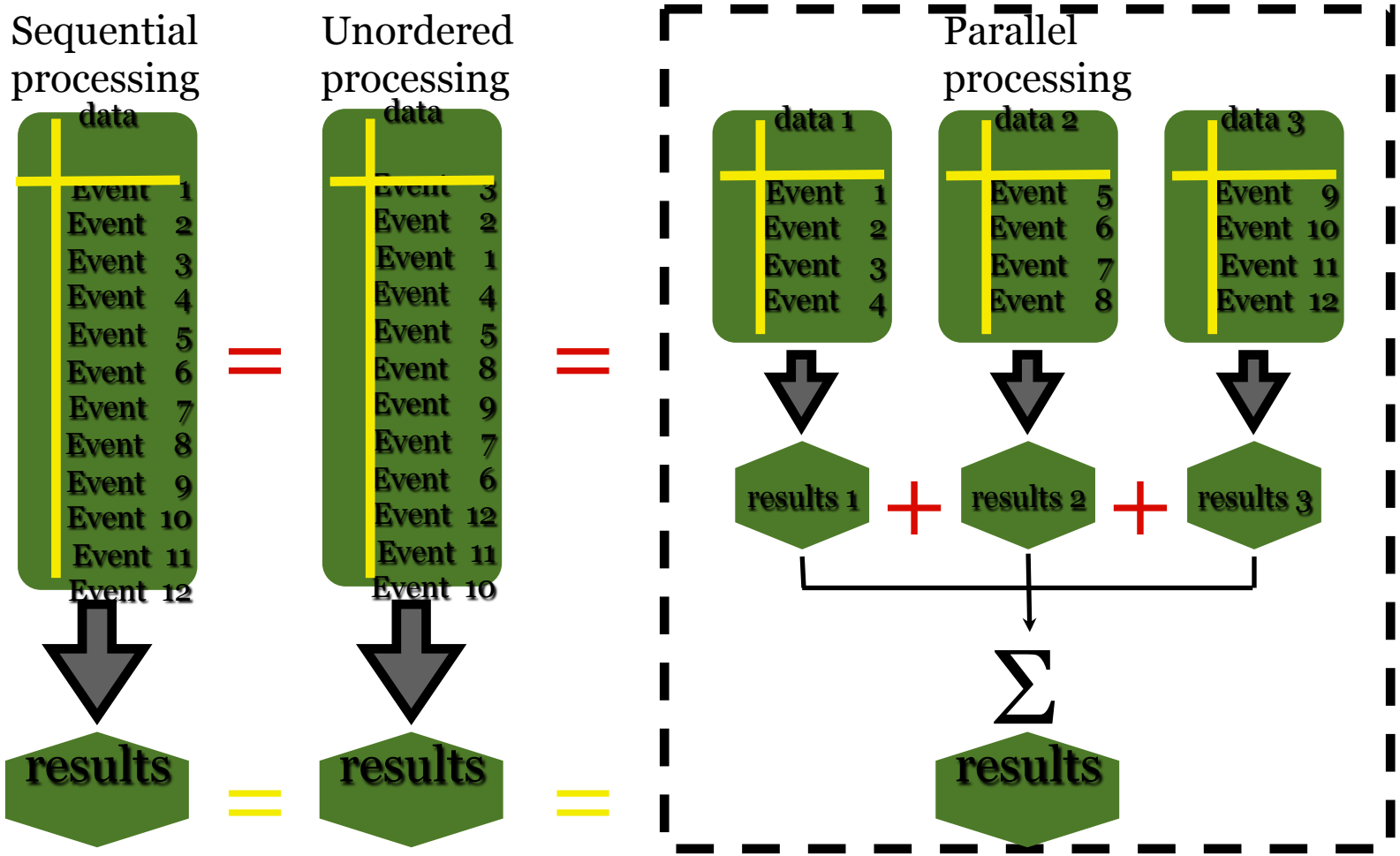
(Push Architecture)
With Bandwidth limiting and performance measuring capabilities

Current Projects

- Implementation and testing the slow control database of LAND detector with the new database interface of FairRoot/R3BRoot
- In Collaboration with FZJ and Giessen University (Panda collaboration) improve the existing Track Finder/Fitter for PANDA central tracker on GPUs
- Event source simulation and online reconstruction based on “Message Queue” concept is under development

Backup

Trivial parallelism: PROOF



In FairRoot change one line in the macro to use it:

FairRunAna *fRun = new FairRunAna();

To FairRunAna *fRun = new FairRunAna("proof");

GPUs usage in FairRoot

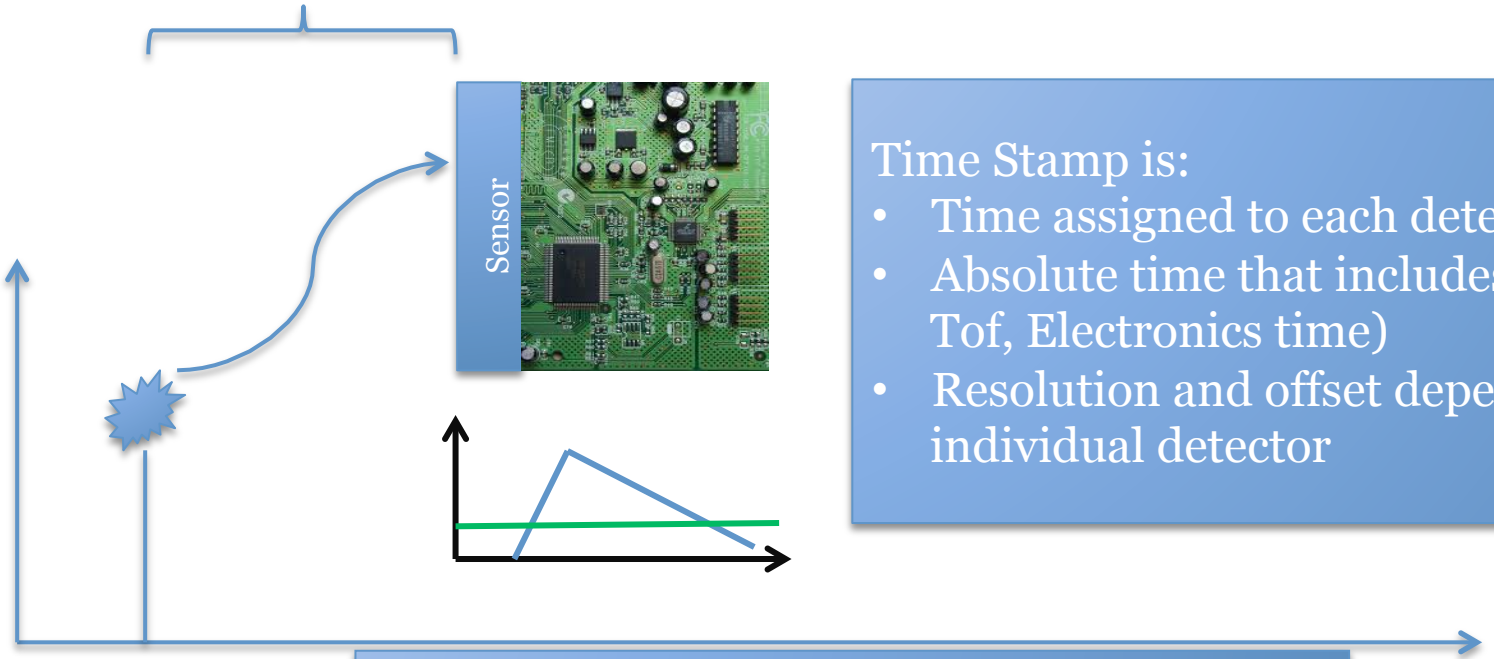
- CUDA is fully integrated into the FairRoot build system
- CMake creates shared libraries for cuda part
- FairCuda is a class which wraps CUDA implemented functions so that they can be used directly from ROOT CINT or compiled code
- Similar to FairCuda we could do: FairOpenCL, but till today we did not see one single working algorithm in OpenCL for any experiment! As soon as this change we can easily support it.

Using FairRoot for Real Data (Online/Offline)

- FairRoot was designed from the beginning to combine simulation and analysis in one tool.
- Using the same internal structure the user can compare easily at any time/level the real data with the simulation
- MBS-LMD data input is used by the **ASYEOS** group:
  - Reader and Unpacker are simply standard FairTasks
  - After Unpacker the same code is used for reconstruction and analysis of simulated or real data
- MBS API is completely available inside FairRoot and the unpackers can communicate directly with MBS in case this is needed!

Time of flight (tof)

Automatically stored in the MC points of each detector



Time Stamp is:

- Time assigned to each detector hit
- Absolute time that includes (Event time, Tof, Electronics time)
- Resolution and offset depends on individual detector

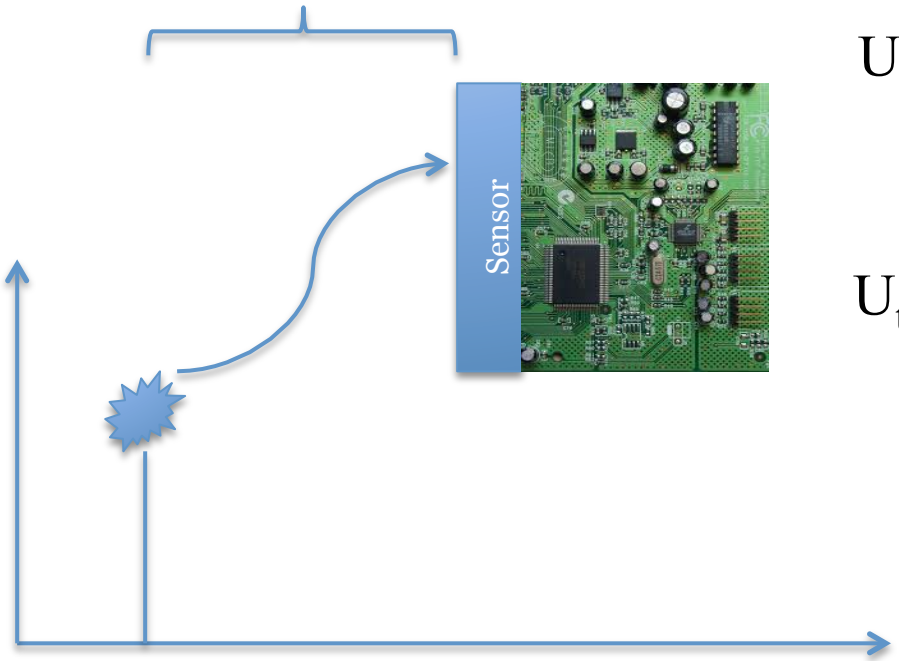
Event Time

Assigned to Events in digitization

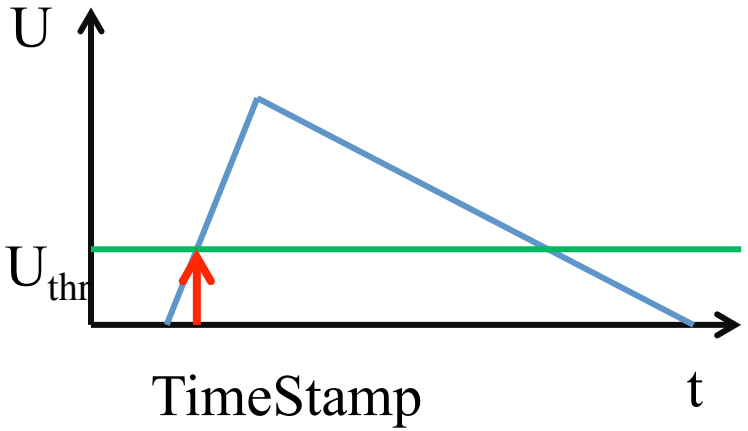
FairRunAna:SetEventMeanTime(Double_t)

FairRootManager::GetEventTime()

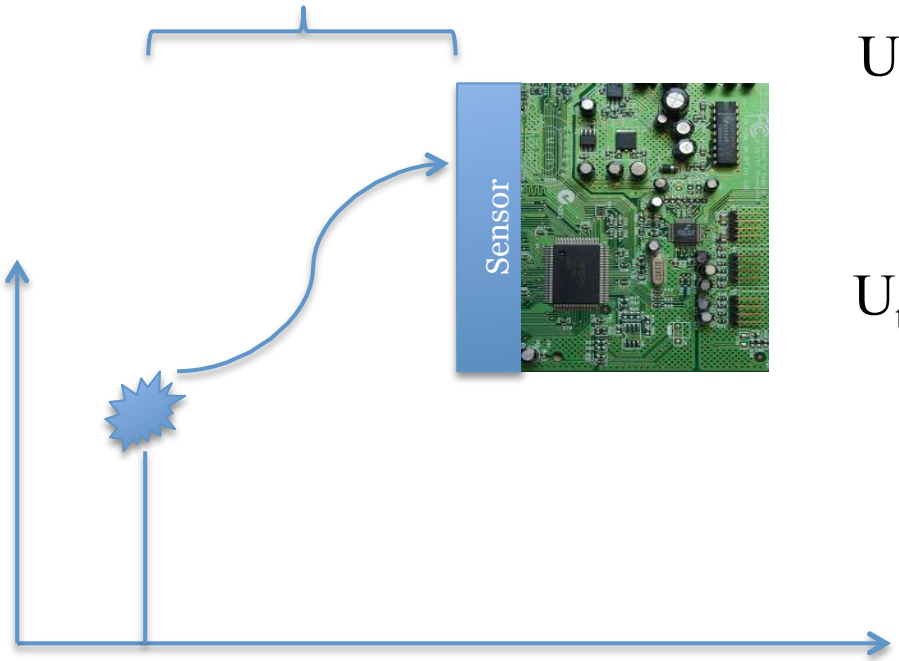
Time of flight
(tof)



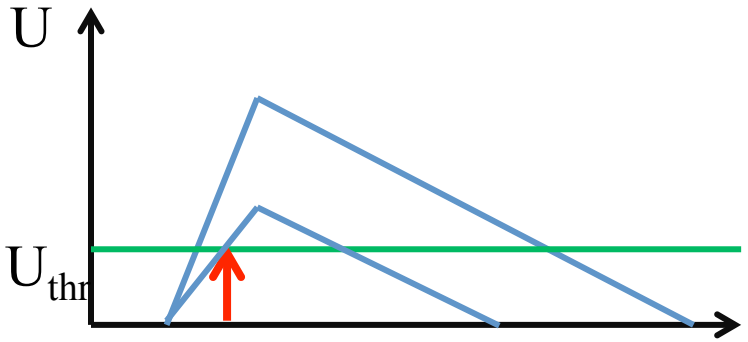
Event
Time



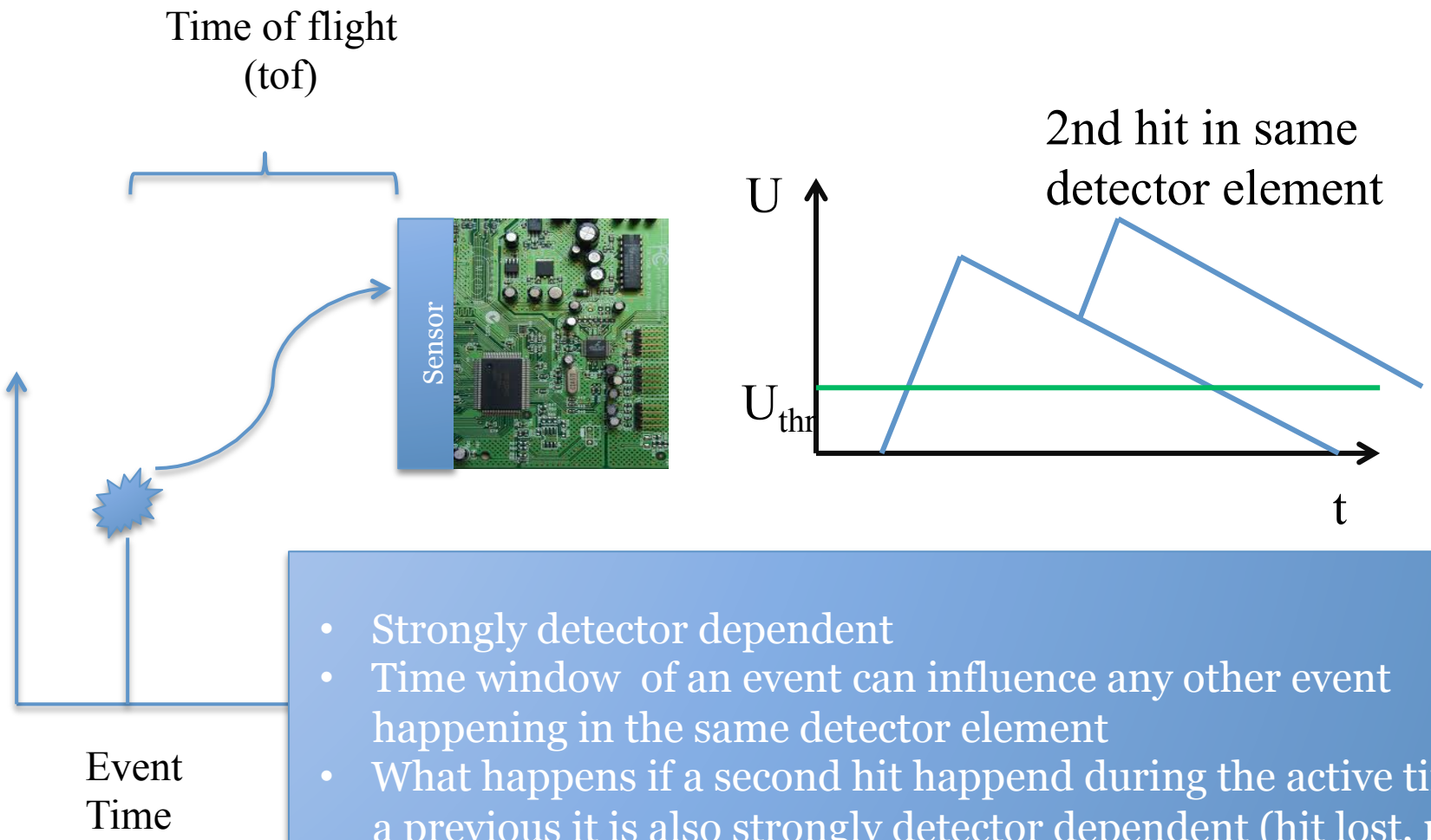
Time of flight
(tof)



Event
Time

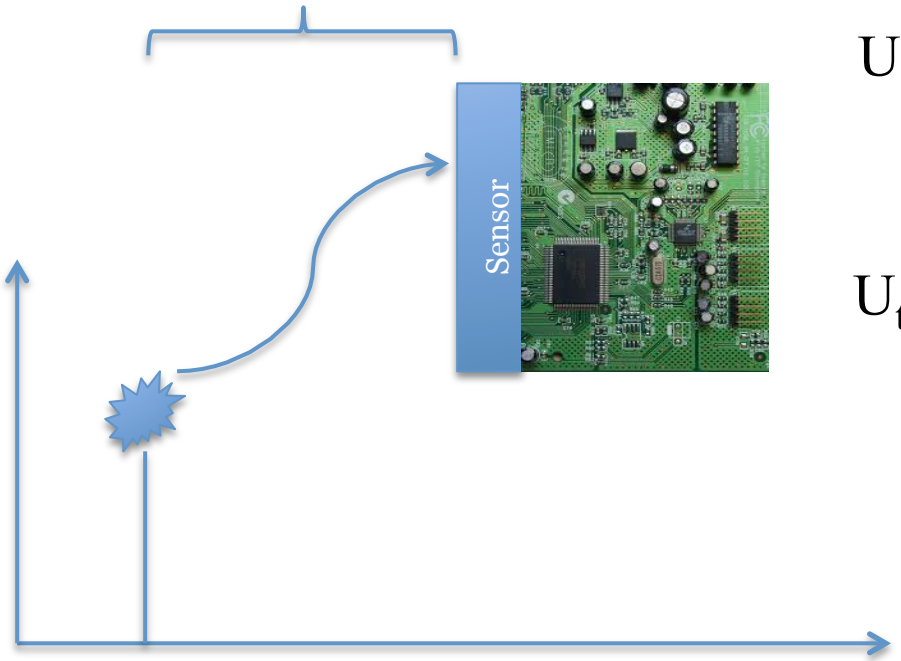


TimeStamp is
charge dependent



- Strongly detector dependent
- Time window of an event can influence any other event happening in the same detector element
- What happens if a second hit happend during the active time of a previous it is also strongly detector dependent (hit lost, new hit modified, old hit modified, new hits created, …)

Time of flight
(tof)



Event
Time