Designing the Computing for the Future Experiments

Stefano Spataro

UNIVERSITÀ DEGLI STUDI DI TORINO
ALMA UNIVERSITAS TAURINENSIS

ISTITUTO NAZIONALE DI FISICA NUCLEARE
Sezione di Torino

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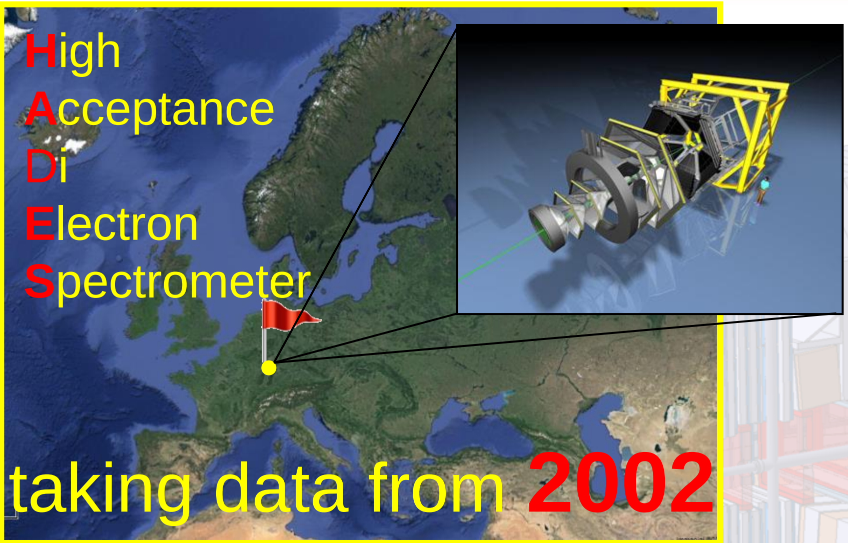
A new experiment, many old questions

How to design a Reconstruction Framework?
starting from scratch, "high efficiency", limited manpower

How to design the best Data Acquisition?
highest data rate, smartest trigger selections, wider physics program

How to use the new computing technologies?
Parallel computing, FPGAs,GPUs, ARM?

My first “computing” experience



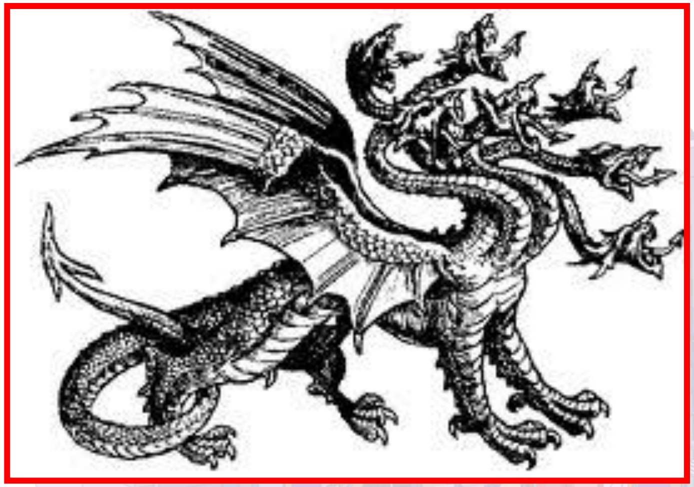
Hades sYstem for Data Reduction and Analysis

A good name to scare students…

HADES
- HSpectrometer
  - HDetector
- HDataSource: Data IO
- HRuntimeDb: Parameter handling
  - HParIo: Parameter IO
- HTaskSet
  - HReconstructor

- Written in C++ and OO (from scratch)
- Based on Root objects
- Geant3 (patched)
- Data input: hdl, geant root, reco root
- Parameters: ASCII, ROOT, Oracle

Hades sYstem for Data Reduction and Analysis



the beginner problems
(me as Diploma student @ 2000)

- Installation of external code
  - CERNLIB
  - GEANT3
  - ROOT
  - Oracle client…
  - Installation of HYDRA
  - Linux compatibility
  - Gcc compatibility
  - Different results in different systems

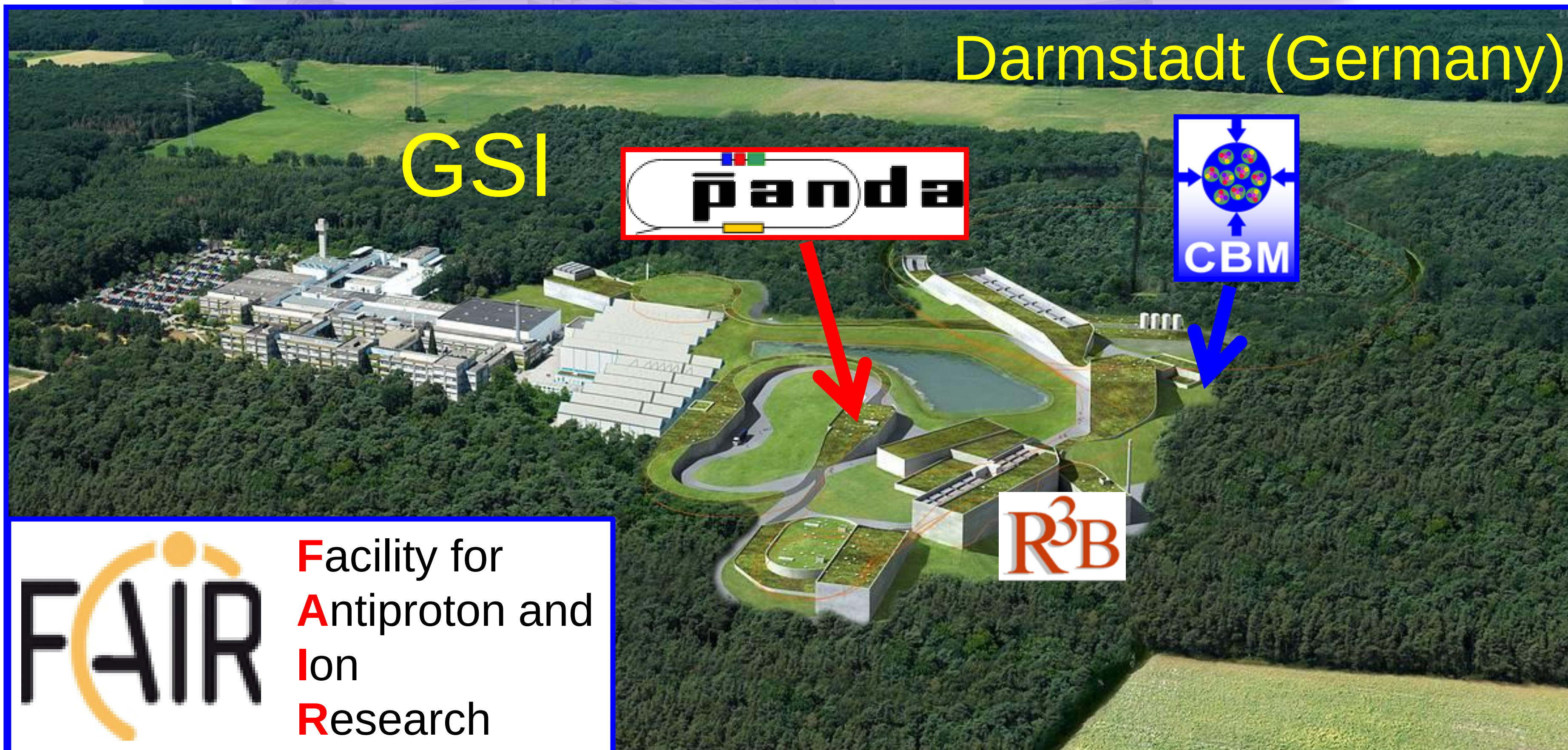
Not easy for a newcomer!

(now it is much better!)

The solution → work remotely at GSI (vi rules)
Production → GSI batch farm

People involved in analysis had to develop parts of reconstruction

Let's speak about future experiments

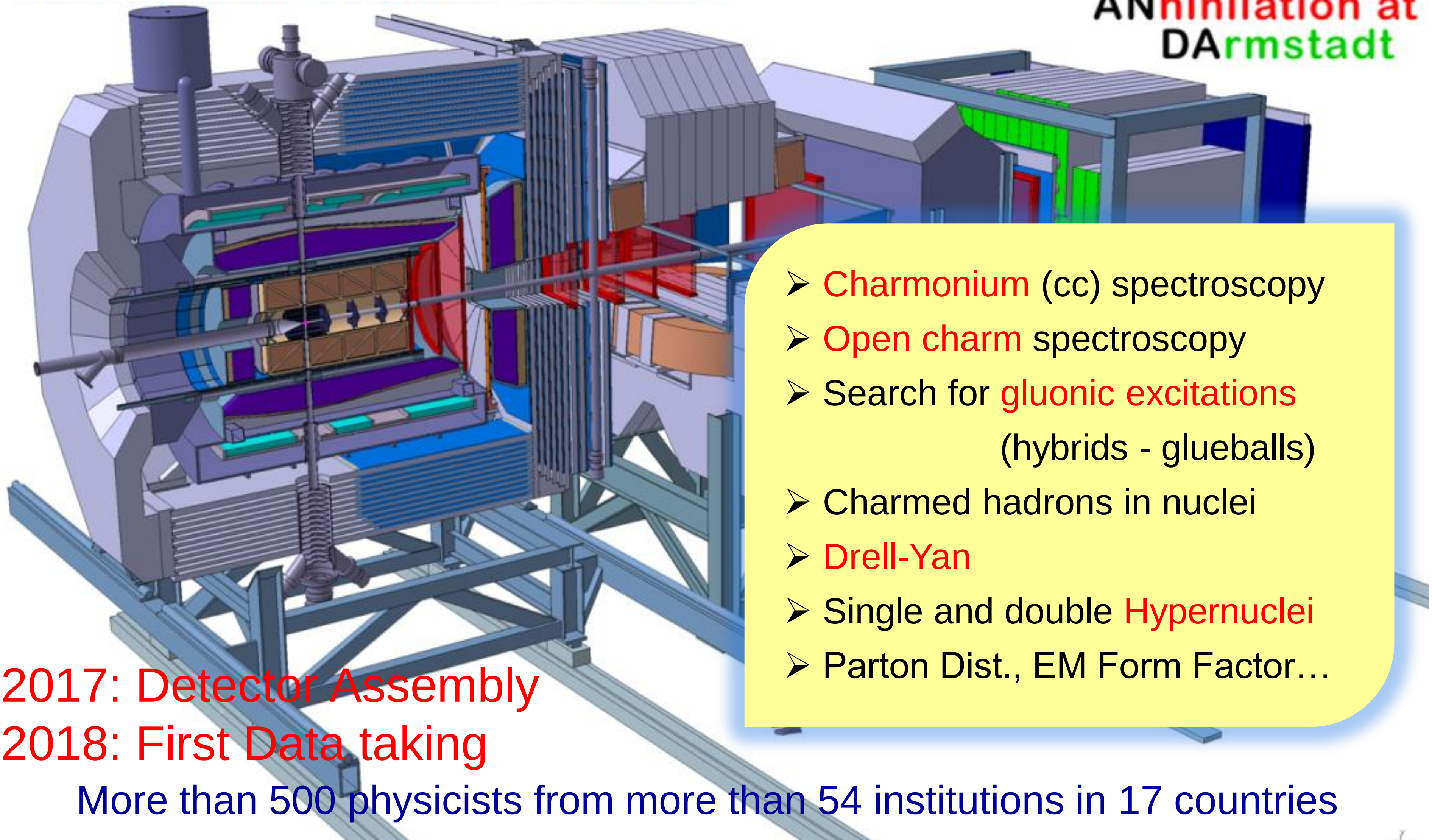


In the upcoming future (taking data from 2018) …

$\bar{p}p$, $\bar{p}A$ collisions

1.5⇒15 GeV/c ($\bar{p}$ momentum)

Anti-Proton ANnihilation at DArmstadt



- Charmonium (cc) spectroscopy
- Open charm spectroscopy
- Search for gluonic excitations (hybrids - glueballs)
- Charmed hadrons in nuclei
- Drell-Yan
- Single and double Hypernuclei
- Parton Dist., EM Form Factor…

2017: Detector Assembly

2018: First Data taking

More than 500 physicists from more than 54 institutions in 17 countries

Few considerations about "software" and "manpower"

not easy to have new people working on software developements
for not running experiments

How a boss can "divert" potential developers…

- w/o data no publications, no conferences, no good CV
- In your PhD you should do physics and not programming
- The "detector" developments are more actractive, experimental tests…
- Programming is only for "experts"
- Do something else, wait till somebody will prepare the code for you
(analysis of some running experiments)

How a boss usually attacks the currently working developers…

- Why the reconstruction is not ready yet???
(my student has to finish his thesis !!!)

Software manpower is extremely limited, busy also with other activities, but the things to be implemented are endless…

What do you need for a reconstruction software?

- ✓ Data objects format
- ✓ Geometry handling
- ✓ I/O Manager
- ✓ Database connection (which DB?)
- ✓ Simulation of physics processes (G3, G4, Fluka, ?)
- ✓ Event Display
- ✓ Advanced Analysis Tools

The basic features do not depend on detector specifics

Somebody else has already done the job

No need to reinvent the wheel!

The (Panda) Solution

Use a framework already used by other experiments

- Less software developments for your computing group
- More people using the same code → better debug
- Share of the same tools by larger community

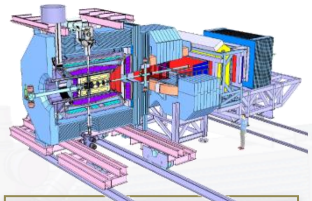
Up to now PANDA has changed software framework two times

The third seems the "long-lasting" solution

→ PandaRoot since 2006

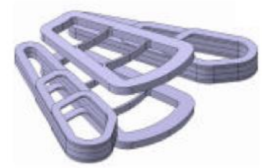
The FairRoot History

Start testing the VMC concept for CBM

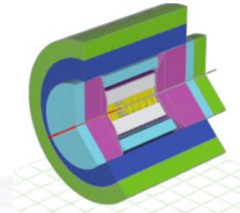


Panda decided to join->

FairRoot: same Base package for different experiments

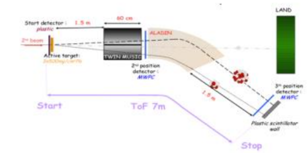


R3B joined



EIC (Electron Ion Collider BNL)

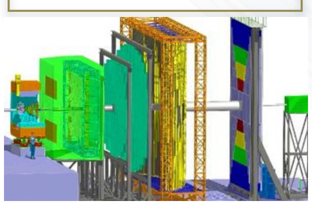
EICRoot



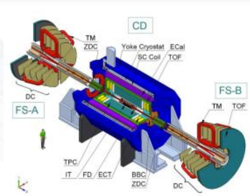
SOFIA (Studies On Fission with Aladin)

2004 | 2006 | 2010 | 2011 | 2012 | 2013

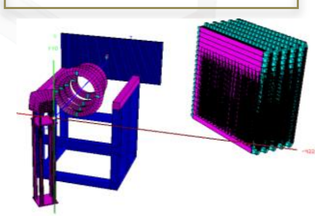
First Release of CbmRoot



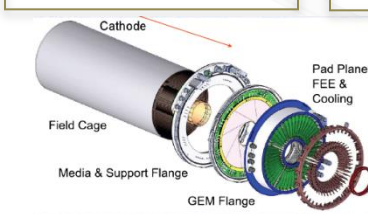
MPD (NICA) start also using FairRoot



ASYEOS joined (ASYEOSRoot)



GEM-TPC seperated from PANDA branch (FOPIRoot)

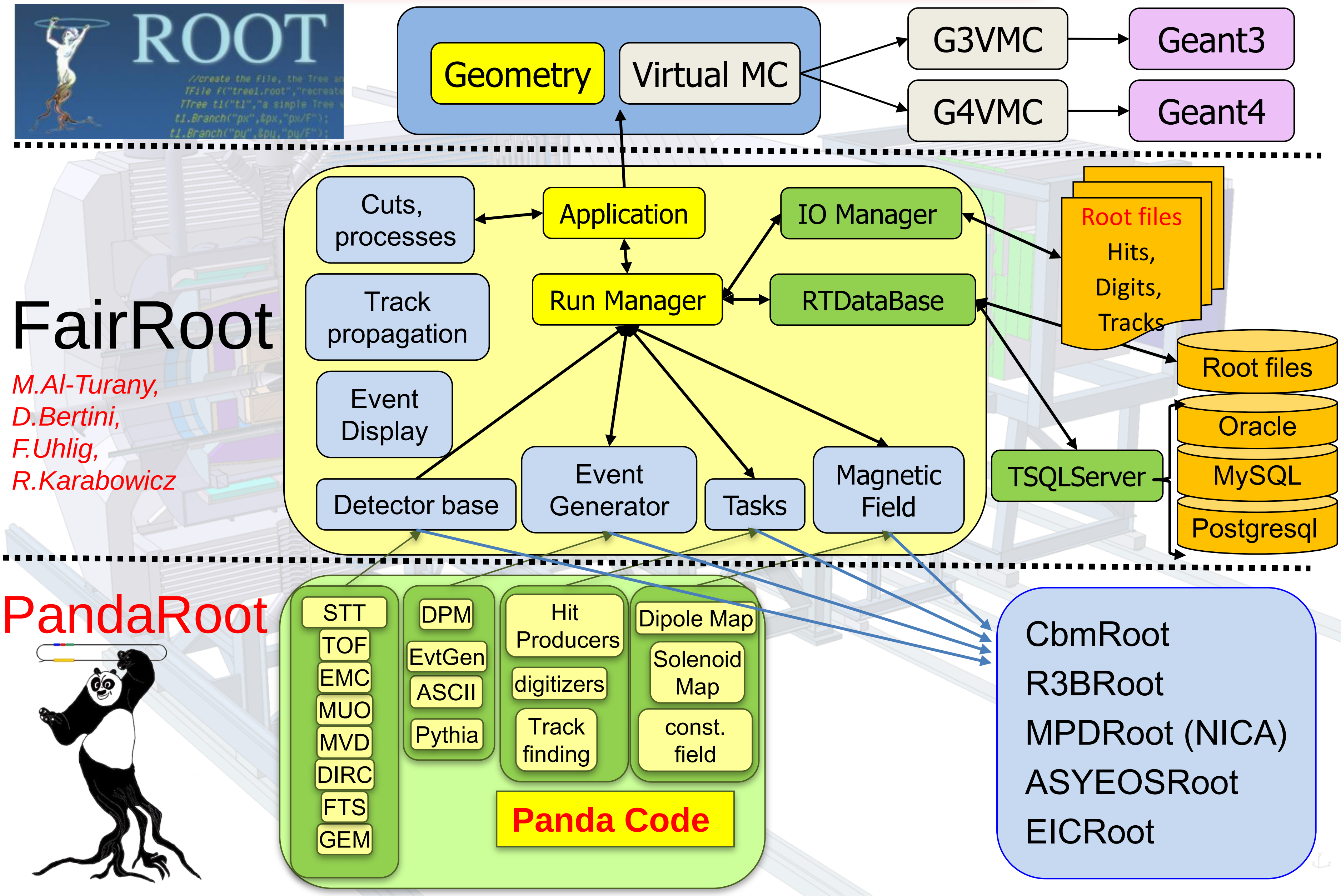


ENSAR-ROOT

Collection of modules used by structural nuclear phsyics exp.

M. Al-Turany

The PandaRoot Code Design



Data and Analysis Structure

- ✓ No executable

  Root macros to define the experimental setup, the tasks for reco/analysis, the configuration

- ✓ No fixed simulation model

  Different simulation models with the same user code (VMC)

- ✓ No fixed output structure

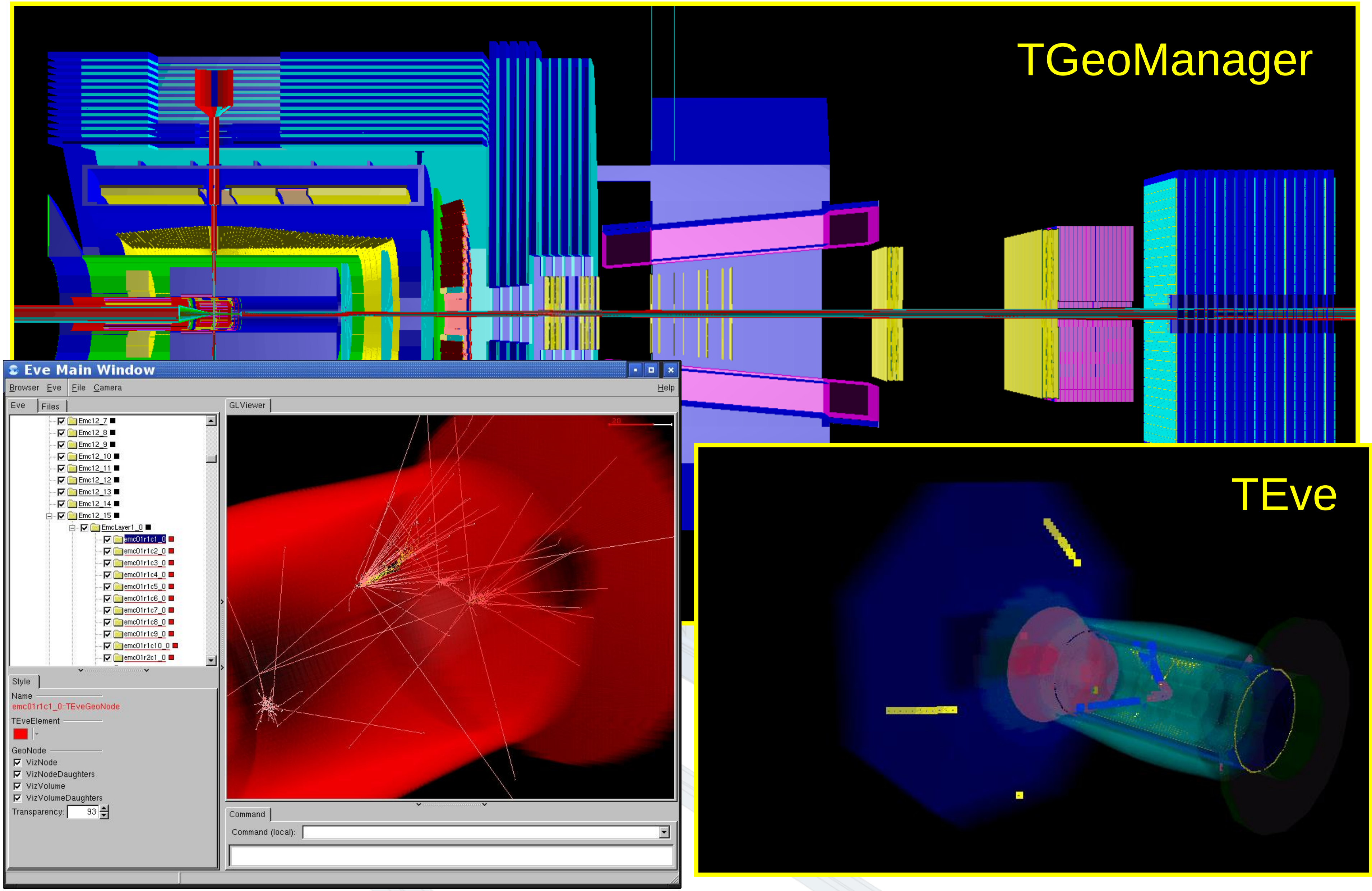
  Dynamic event structure based on Root TFolder and TTree

For more information:

- ✓ **Extending the FairRoot framework to allow for simulation and reconstruction of free streaming data**
  Mohammad AL-TURANY on 14 Oct 2013 from 16:10 to 16:30
- ✓ **An Event Building scenario in the trigger-less PANDA experiment**
  Radoslaw KARABOWICZ on 14 Oct 2013 from 16:45 to 17:05

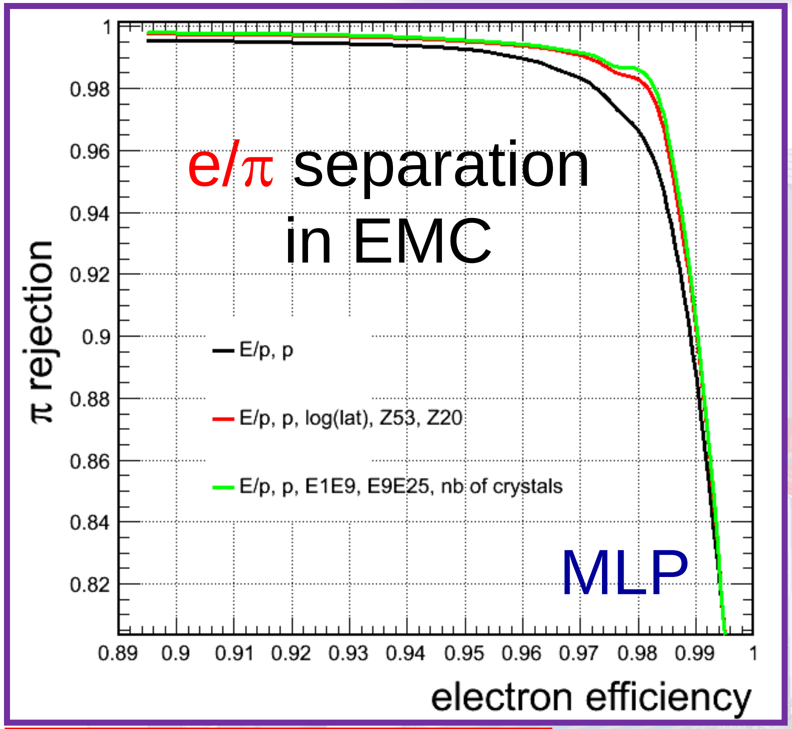
ROOT Geometry and Event Display

Oh Yes! IT'S FREE



MultiVariate Particle Identification

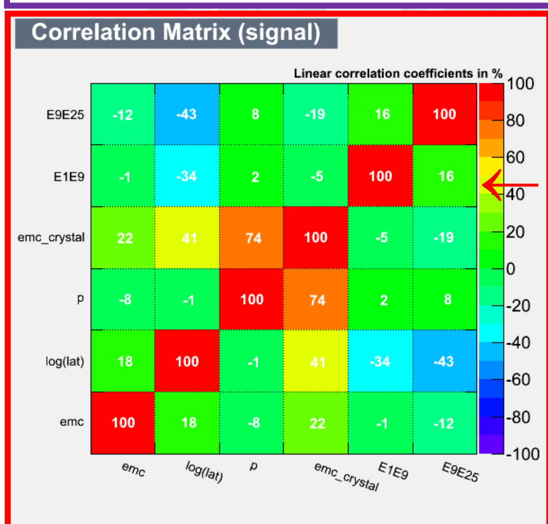
Oh Yes! IT'S FREE



implementation of
ROOT TMVA methods

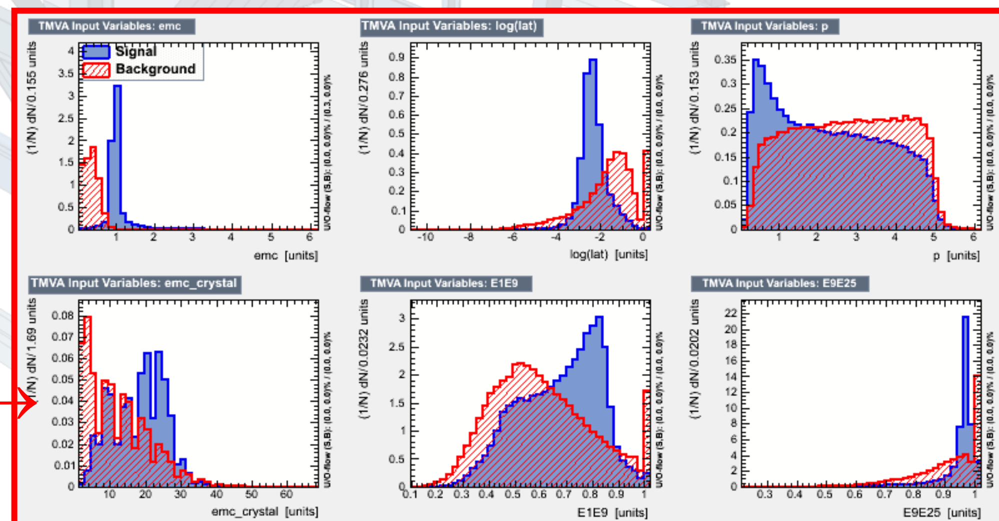
- ✓ K- Nearest Neighbors (KNN)
- ✓ Learning Vector Quantization (LVQ)
- ✓ Multi Layer Perceptron (MLP)
- ✓ …

➤ EMC shower shape analysis

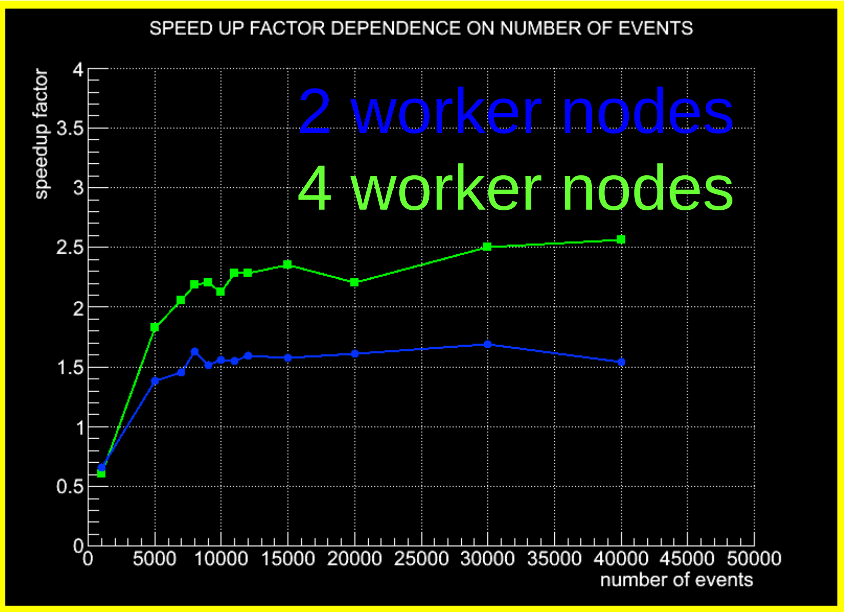


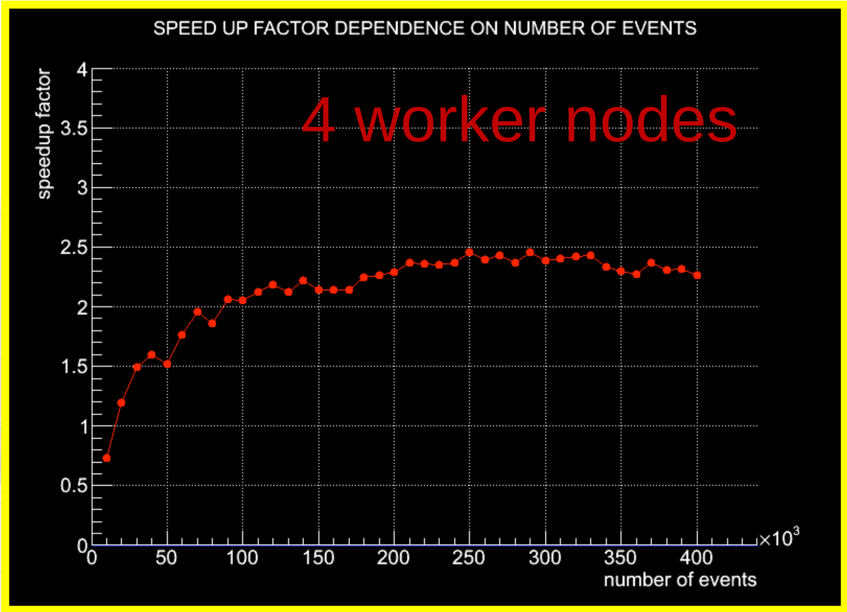
Correlation ←

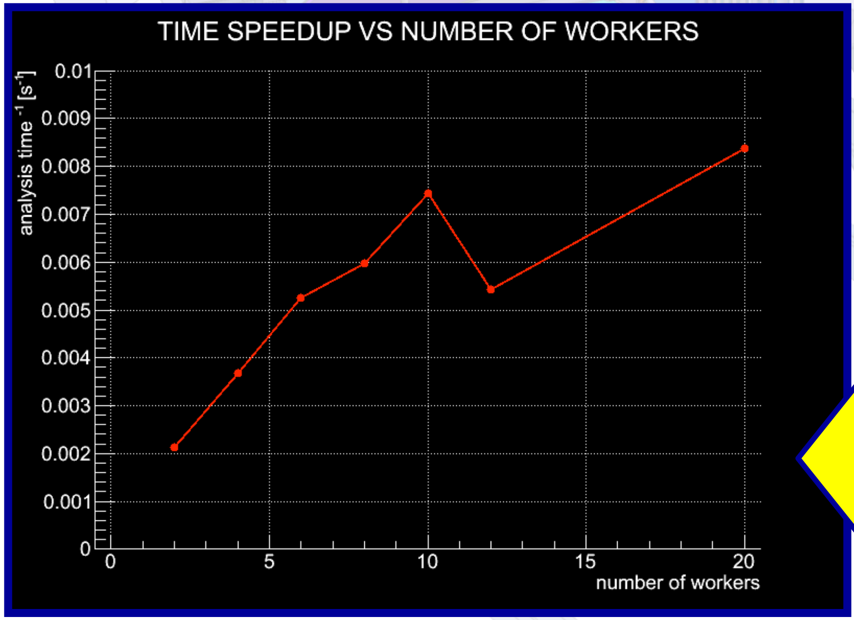
Variables →



Tracking on Proof on Demand







a lot of work to modify the code to make it “Proof compatible”

PoD on external CPUs with SSH (4CPUs)+(8CPUs)+(8CPUs)

R. Karabowicz

Compiled and running on many Linux distributions and on MAC OS X

- The release was tested on:
  - MAC OS X 10.6.x with gcc 4.2.1 (64 bit)
  - MAC OS X 10.7.x with gcc (64 bit)
  - MAC OS X 10.8.x with llvm-gcc 4.2 and gfortran-4.7 from hpc.sourceforge.net (64 bit)
  - MAC OS X 10.8.x with clang 4.0 and gfortran-4.7 from hpc.sourceforge.net (64 bit)
  - Suse 12.1 with gcc 4.6.2 (32 and 64 bit)
  - Suse 12.2 with gcc 4.7.1 (32 and 64 bit)
  - Fedora 17 with gcc 4.7.0 (32 and 64 bit)
  - Fedora 17 with gcc 4.7.2 (64 bit)
  - Ubuntu 12.04 with gcc 4.6.3 (32 and 64 bit)
  - Ubuntu 12.10 with gcc 4.7.2 (64 bit)
  - Debian Squeeze with gcc 4.4.5 (64 bit)
  - Debian wheezy with gcc 4.7.2 (64 bit)

Everybody in his desktop, laptop, local farm can run the code w/o problems (hopefully)

Using a set of self-configurating scripts (CMake) and regular checks (DashBoard)

Quality Assurance

Central SVN repository

Dedicated test server

2. SVN triggers test server

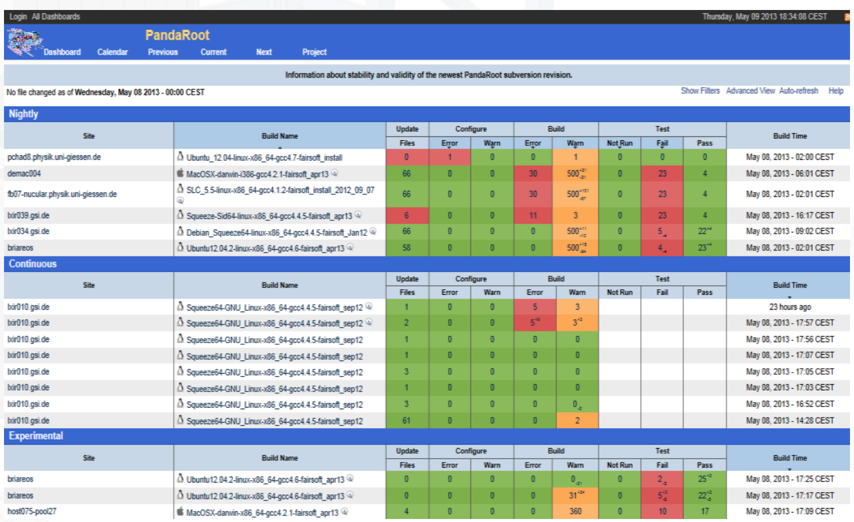
3a. Update of local copy

3b. Configure, build and test on local machine

4. Send results automatically to central web page

5. Dashboard prepare and display results

1. Developer commit code



Login All Dashboards — Thursday, May 09 2013 18:34:08 CEST

PandaRoot

Dashboard Calendar Previous Current Next Project

Information about stability and validity of the newest PandaRoot subversion revision.

No file changed as of **Wednesday, May 08 2013 - 00:00 CEST**

Show Filters Advanced View Auto-refresh Help

Nightly

Site	Build Name	Update Files	Configure Error	Configure Warn	Build Error	Build Warn	Test Not Run	Test Fail	Test Pass	Build Time
pchad8.physik.uni-giessen.de	Ubuntu_12.04-linux-x86_64-gcc4.7-fairsoft_install	0	1	0	0	1	0	0	0	May 08, 2013 - 02:00 CEST
demac004	MacOSX-darwin-i386-gcc4.2.1-fairsoft_apr13	66	0	0	30	500	0	23	4	May 08, 2013 - 06:01 CEST
fb07-nucular.physik.uni-giessen.de	SLC_5.5-linux-x86_64-gcc4.1.2-fairsoft_install_2012_09_07	66	0	0	30	500	0	23	4	May 08, 2013 - 02:01 CEST
bir039.gsi.de	Squeeze-Sid64-linux-x86_64-gcc4.4.5-fairsoft_apr13	6	0	0	11	3	0	23	4	May 08, 2013 - 16:17 CEST
bir034.gsi.de	Debian_Squeeze64-linux-x86_64-gcc4.4.5-fairsoft_Jan12	66	0	0	0	500	0	5	22	May 08, 2013 - 09:02 CEST
briareos	Ubuntu12.04.2-linux-x86_64-gcc4.6-fairsoft_apr13	58	0	0	0	500	0	4	23	May 08, 2013 - 02:01 CEST

Continuous

Site	Build Name	Update Files	Configure Error	Configure Warn	Build Error	Build Warn	Test Not Run	Test Fail	Test Pass	Build Time
bir010.gsi.de	Squeeze64-GNU_Linux-x86_64-gcc4.4.5-fairsoft_sep12	1	0	0	5	3				23 hours ago
bir010.gsi.de	Squeeze64-GNU_Linux-x86_64-gcc4.4.5-fairsoft_sep12	2	0	0	5	3				May 08, 2013 - 17:57 CEST
bir010.gsi.de	Squeeze64-GNU_Linux-x86_64-gcc4.4.5-fairsoft_sep12	1	0	0	0	0				May 08, 2013 - 17:56 CEST
bir010.gsi.de	Squeeze64-GNU_Linux-x86_64-gcc4.4.5-fairsoft_sep12	1	0	0	0	0				May 08, 2013 - 17:07 CEST
bir010.gsi.de	Squeeze64-GNU_Linux-x86_64-gcc4.4.5-fairsoft_sep12	3	0	0	0	0				May 08, 2013 - 17:05 CEST
bir010.gsi.de	Squeeze64-GNU_Linux-x86_64-gcc4.4.5-fairsoft_sep12	1	0	0	0	0				May 08, 2013 - 17:03 CEST
bir010.gsi.de	Squeeze64-GNU_Linux-x86_64-gcc4.4.5-fairsoft_sep12	3	0	0	0	0				May 08, 2013 - 16:52 CEST
bir010.gsi.de	Squeeze64-GNU_Linux-x86_64-gcc4.4.5-fairsoft_sep12	61	0	0	0	2				May 08, 2013 - 14:28 CEST

Experimental

Site	Build Name	Update Files	Configure Error	Configure Warn	Build Error	Build Warn	Test Not Run	Test Fail	Test Pass	Build Time
briareos	Ubuntu12.04.2-linux-x86_64-gcc4.6-fairsoft_apr13	0	0	0	0	0	0	2	25	May 08, 2013 - 17:25 CEST
briareos	Ubuntu12.04.2-linux-x86_64-gcc4.6-fairsoft_apr13	0	0	0	0	31	0	5	22	May 08, 2013 - 17:17 CEST
host075-pool27	MacOSX-darwin-x86_64-gcc4.2.1-fairsoft_apr13	4	0	0	0	360	0	10	17	May 08, 2013 - 17:09 CEST

6. In case of problems Dashboard sends an E-mail to Developer and Administrator

7. Developer check results

Login All Dashboards — Thursday, May 09 2013 18:34:08 CEST

PandaRoot

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		Files	Error	Warn	Error	Warn	Not Run	Fail	Pass	
pchad8.physik.uni-giessen.de	Ubuntu_12.04-linux-x86_64-gcc4.7-fairsoft_install	0	1	0	0	1	0	0	0	May 08, 2013 - 02:00 CEST
demac004	MacOSX-darwin-i386-gcc4.2.1-fairsoft_apr13	66	0	0	30	500^{+21}_{-21}	0	23	4	May 08, 2013 - 06:01 CEST
fb07-nucular.physik.uni-giessen.de	SLC_5.5-linux-x86_64-gcc4.1.2-fairsoft_install_2012_09_07	66	0	0	30	500^{+101}_{-87}	0	23	4	May 08, 2013 - 02:01 CEST
lxir039.gsi.de	Squeeze-Sid64-linux-x86_64-gcc4.4.5-fairsoft_apr13	6	0	0	11	3	0	23	4	May 08, 2013 - 16:17 CEST
lxir034.gsi.de	Debian_Squeeze64-linux-x86_64-gcc4.4.5-fairsoft_Jan12	66	0	0	0	500^{+11}_{-10}	0	5_{-4}	22^{+4}	May 08, 2013 - 09:02 CEST
briareos	Ubuntu12.04.2-linux-x86_64-gcc4.6-fairsoft_apr13	58	0	0	0	500^{+15}_{-94}	0	4_{-4}	23^{+4}	May 08, 2013 - 02:01 CEST

Continuous

Site	Build Name	Update	Configure		Build		Test			Build Time
		Files	Error	Warn	Error	Warn	Not Run	Fail	Pass	
lxir010.gsi.de	Squeeze64-GNU_Linux-x86_64-gcc4.4.5-fairsoft_sep12	1	0	0	5	3				23 hours ago
lxir010.gsi.de	Squeeze64-GNU_Linux-x86_64-gcc4.4.5-fairsoft_sep12	2	0	0	5^{+5}	3^{+3}				May 08, 2013 - 17:57 CEST
lxir010.gsi.de	Squeeze64-GNU_Linux-x86_64-gcc4.4.5-fairsoft_sep12	1	0	0	0	0				May 08, 2013 - 17:56 CEST
lxir010.gsi.de	Squeeze64-GNU_Linux-x86_64-gcc4.4.5-fairsoft_sep12	1	0	0	0	0				May 08, 2013 - 17:07 CEST
lxir010.gsi.de	Squeeze64-GNU_Linux-x86_64-gcc4.4.5-fairsoft_sep12	3	0	0	0	0				May 08, 2013 - 17:05 CEST
lxir010.gsi.de	Squeeze64-GNU_Linux-x86_64-gcc4.4.5-fairsoft_sep12	1	0	0	0	0				May 08, 2013 - 17:03 CEST
lxir010.gsi.de	Squeeze64-GNU_Linux-x86_64-gcc4.4.5-fairsoft_sep12	3	0	0	0	0_{-2}				May 08, 2013 - 16:52 CEST
lxir010.gsi.de	Squeeze64-GNU_Linux-x86_64-gcc4.4.5-fairsoft_sep12	61	0	0	0	2				May 08, 2013 - 14:28 CEST

Experimental

Site	Build Name	Update	Configure		Build		Test			Build Time
		Files	Error	Warn	Error	Warn	Not Run	Fail	Pass	
briareos	Ubuntu12.04.2-linux-x86_64-gcc4.6-fairsoft_apr13	0	0	0	0	0_{-31}	0	2_{-3}	25^{+3}	May 08, 2013 - 17:25 CEST
briareos	Ubuntu12.04.2-linux-x86_64-gcc4.6-fairsoft_apr13	0	0	0	0	31^{+24}	0	5^{+2}_{-2}	22^{+2}_{-2}	May 08, 2013 - 17:17 CEST
host075-pool27	MacOSX-darwin-x86_64-gcc4.2.1-fairsoft_apr13	4	0	0	0	360	0	10	17	May 08, 2013 - 17:09 CEST

Nightly → all nights
Continuous → each commit
Experimental → on demand

Also compatibility with “stable” data sample
…and Rule Checker

Where to run my simulation?

HADES	GSI Batch Farm	Not very "flexible"
panda Physics Book (older framework)	Several batch farms (Bochum, GSI, Lyon, Orsay)	analyses running locally

Distributed computing

In 2003 the future was GRID!

The usual computing problems

- Not a lot of manpower to develop middleware
- Too early to buy machines for the production
- Need to run simulation years before data taking

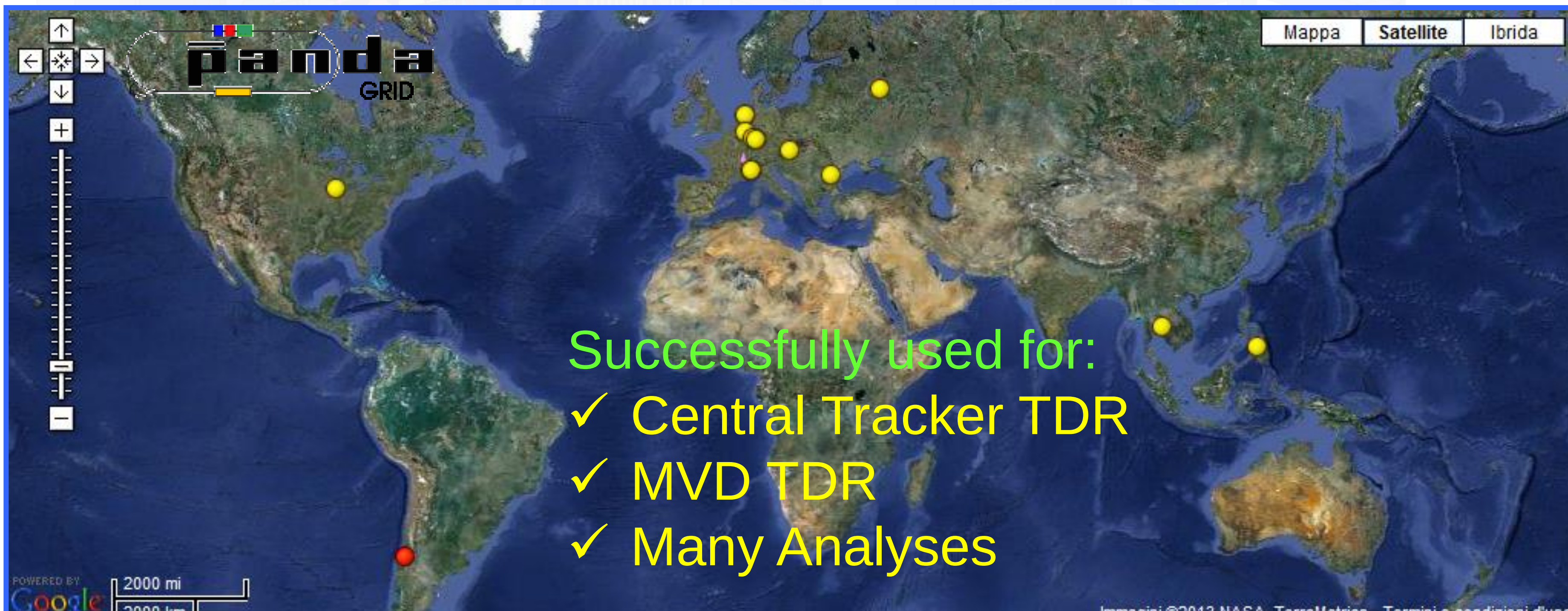
PandaGrid: an Alien2-based GRID

Why Alien?

- It can run on all platforms (source distribution)
- Several Panda institutions were hosting Alien sites

✓ "Reuse" of currently existing manpower
✓ Use of parts of already existing resources
✓ Strong collaboration with Alien developers

Beta-tester
(now 2.20)



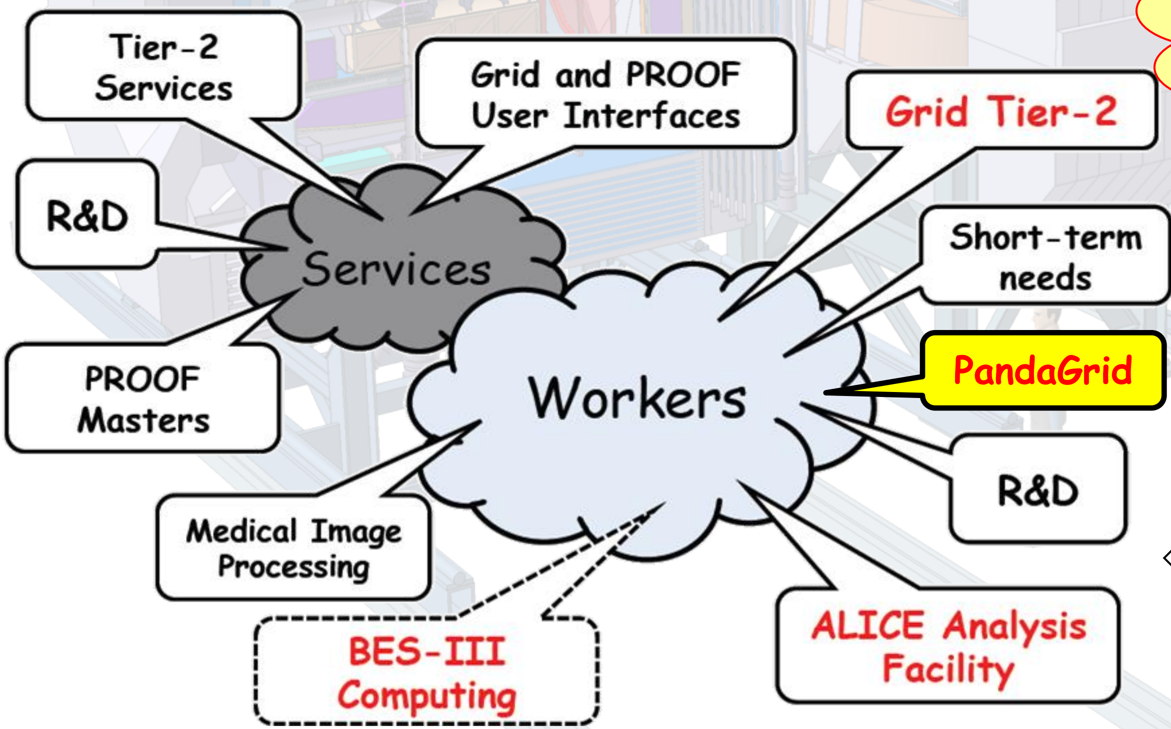
What is now the future of our distributed computing?

No further developments for Alien2 ⇒

- Alien3?
- PanDa?
- Big batch farm?

Still some time before taking decisions for PandaGrid

Cloud computing will help us

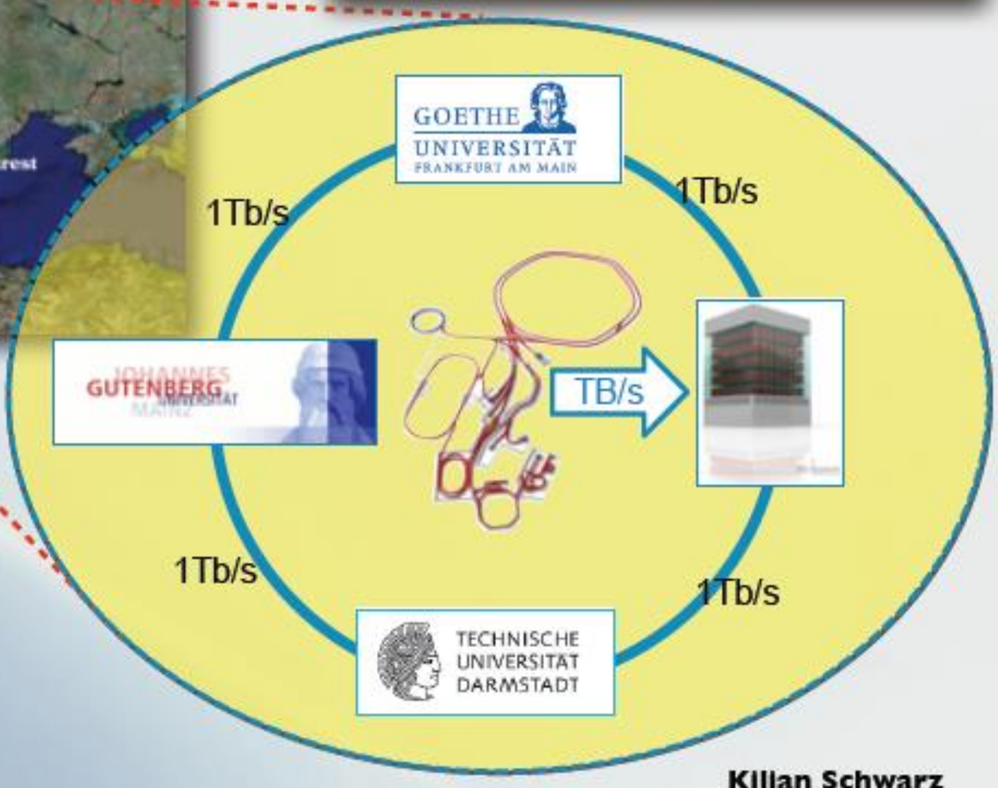


Torino Private Cloud (S. Bagnasco et al.)

Distributed T0/T1 centre embedded in Grid/Cloud

APPA
CBM
LQCD
NuStar
Panda (66k cores,12PB disks,12PB/y tape)

in 2018
300000 cores + grid
40 PB disk
40PB/y archive

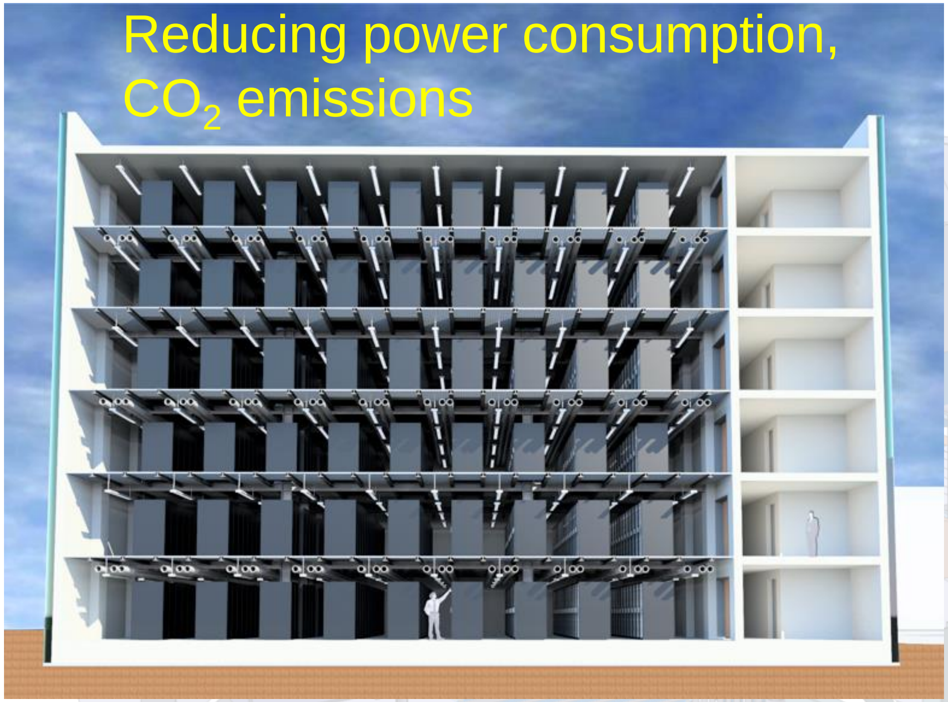


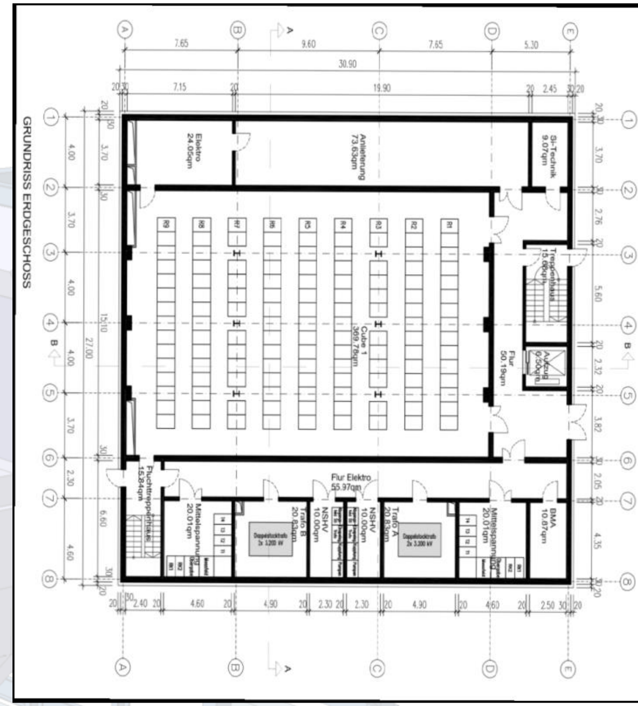
computing center for high-energy, hadron, nuclear, and atomic physics

serve >20 collaborations

The FAIR Tier-0 Green Cube

Reducing power consumption, CO_2 emissions



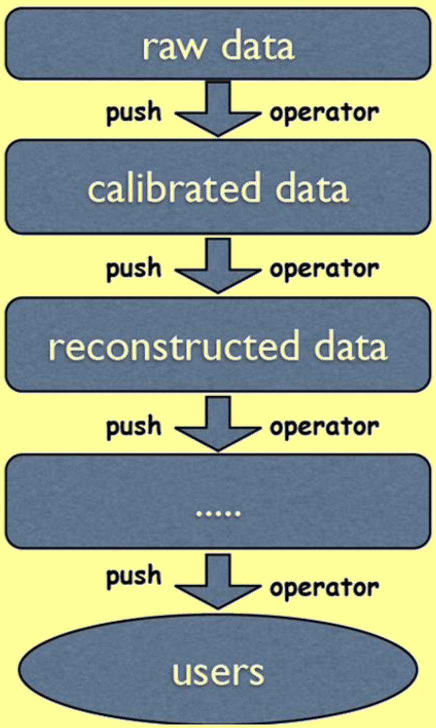


V. Lindenstruth

Alternative ways for data processing and mining?

not only HEP experiments deal
with larga amount of data

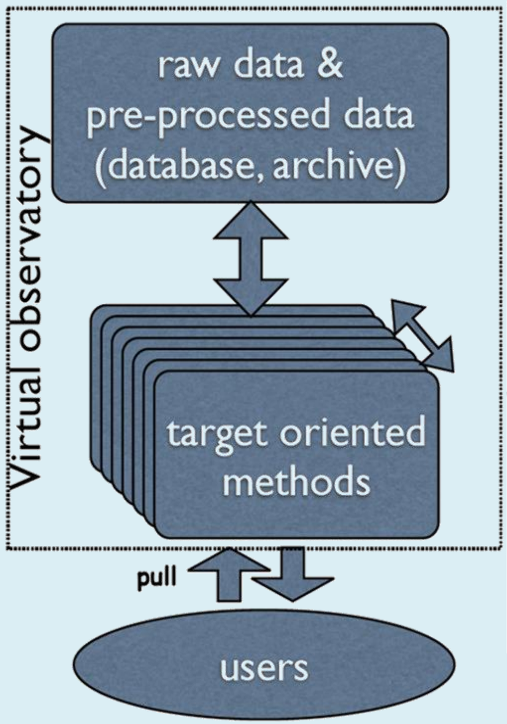
The *Waterfall* model



Forward chaining
“Tier” architecture
Driven by raw data
Process in pipeline
Operators push data
Results in release
Static archive
Raw data is obsolete

Standard in HEP

The *Target* model

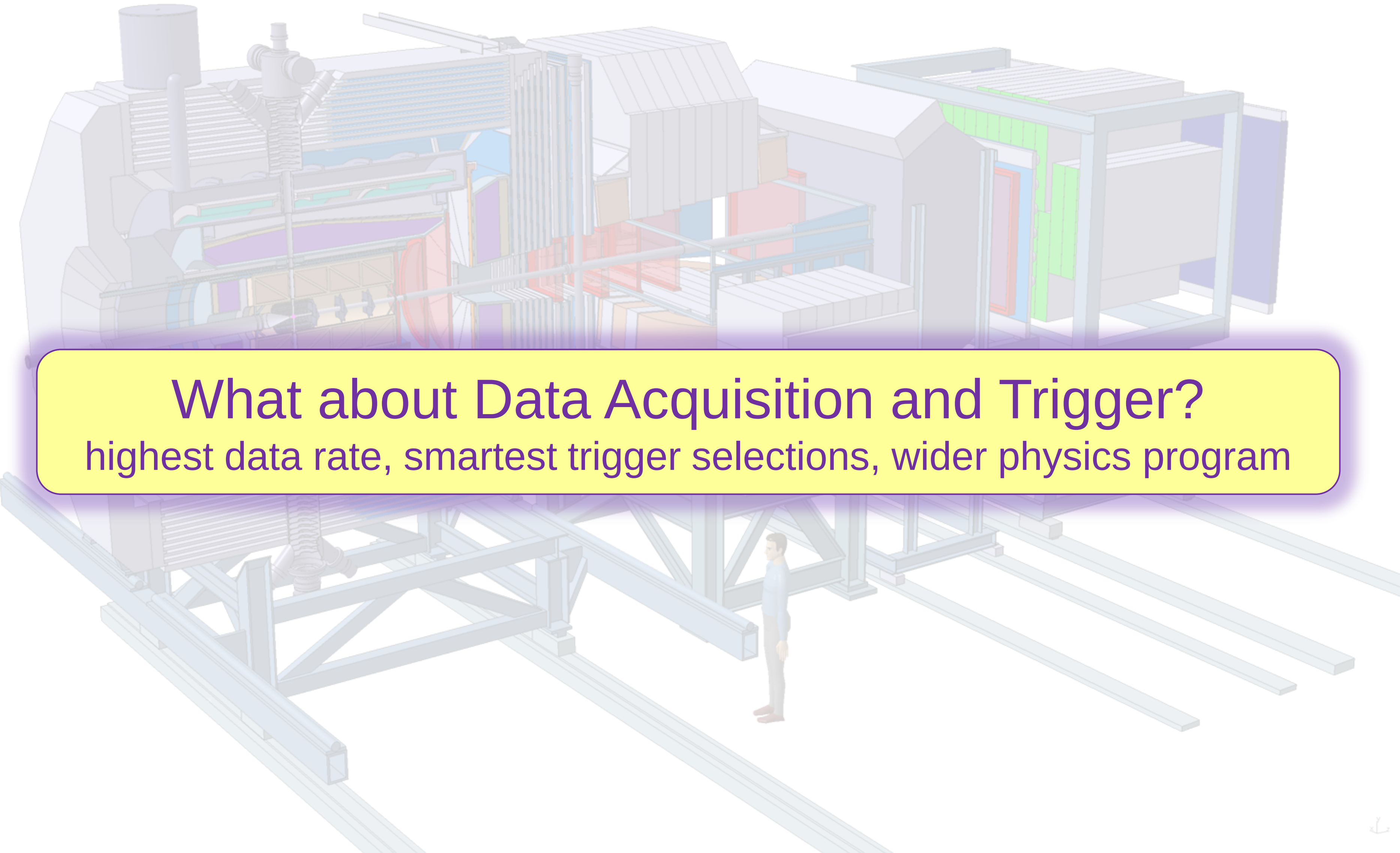


Backward chaining
“Target” architecture
Driven by user query
Process on-the-fly
Users pull data
Information system
Dynamic archive
Raw data is sacred

Used in Astronomy

Edwin Valentijn et al. (Astro-WISE, target)

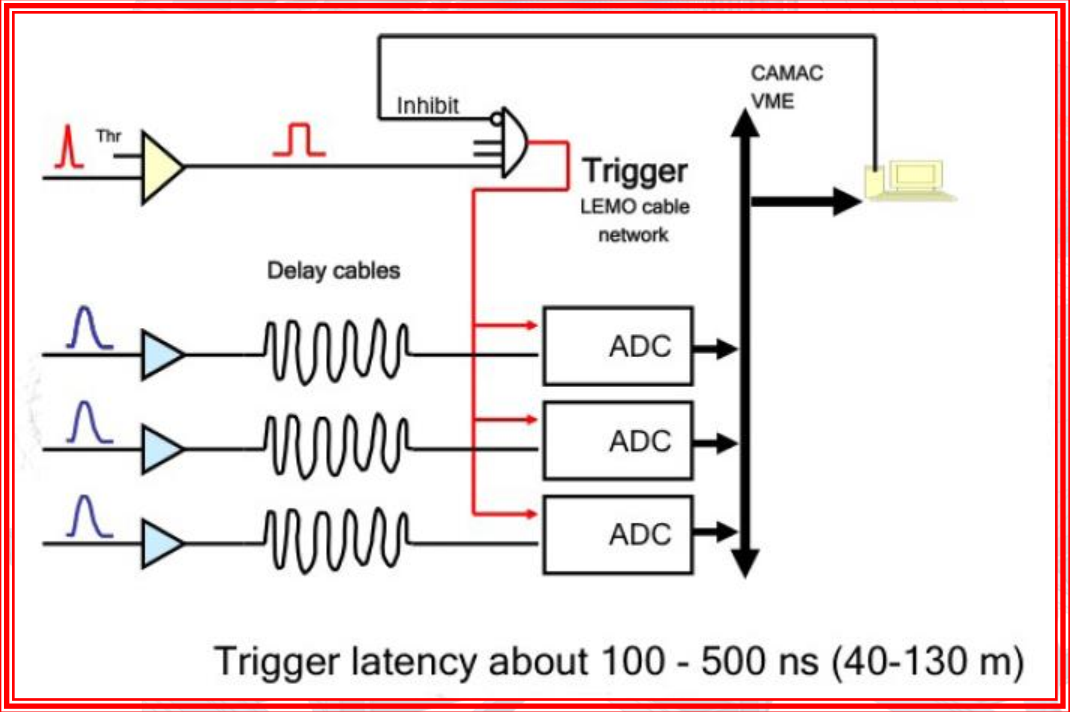
Could it work also for HEP?



What about Data Acquisition and Trigger?

highest data rate, smartest trigger selections, wider physics program

Traditional Data Acquisition



increasing the interaction rate

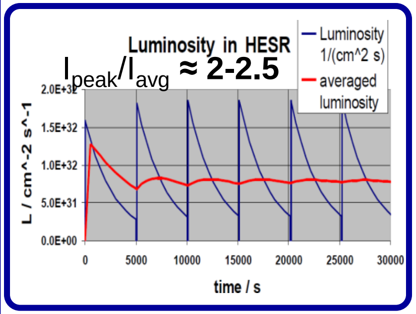
⇩

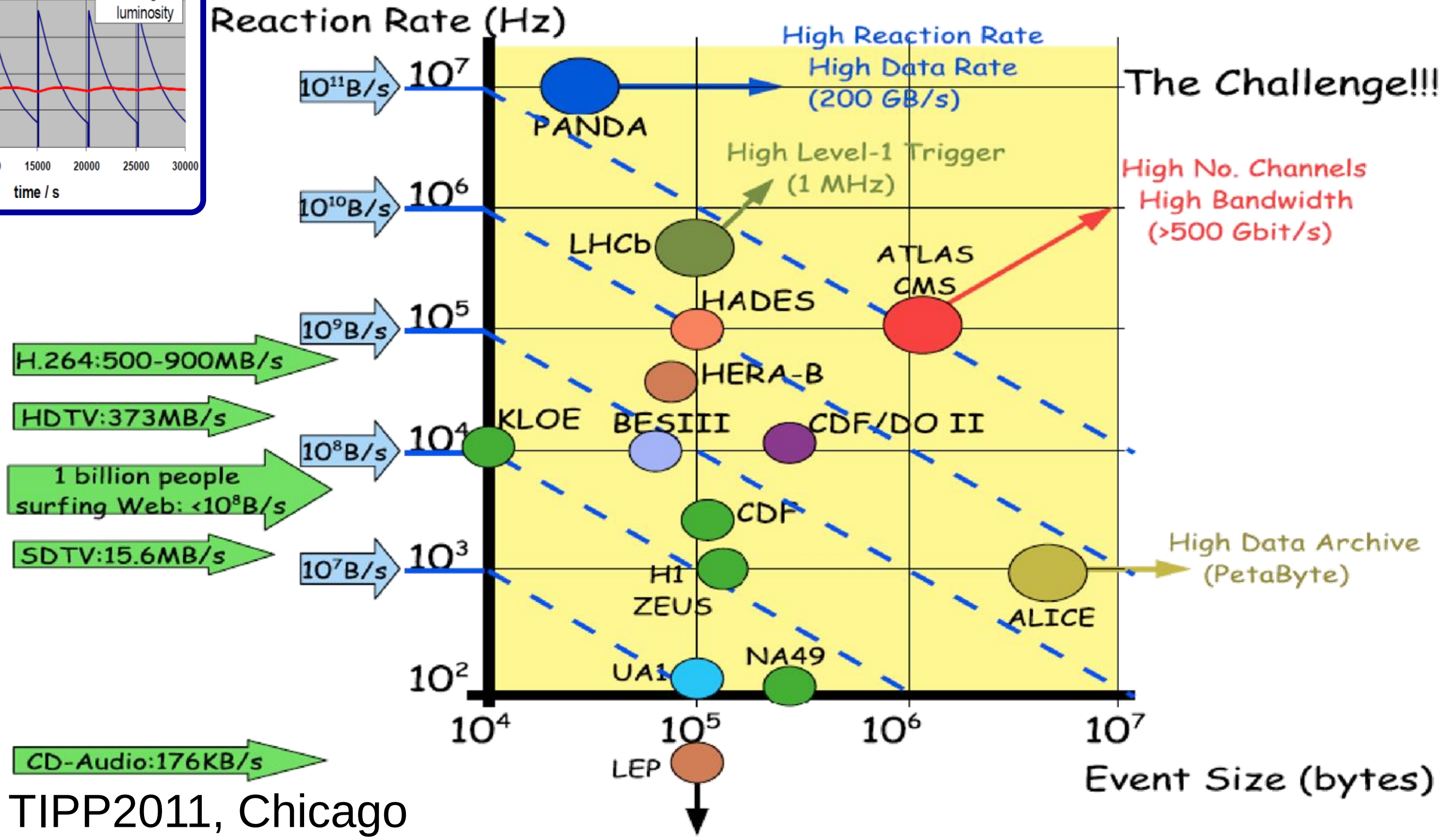
the number of pile-ups increases

- A first fast selection creates the event
- High level algorithms decide which event to store

Data Acquisition Challenges

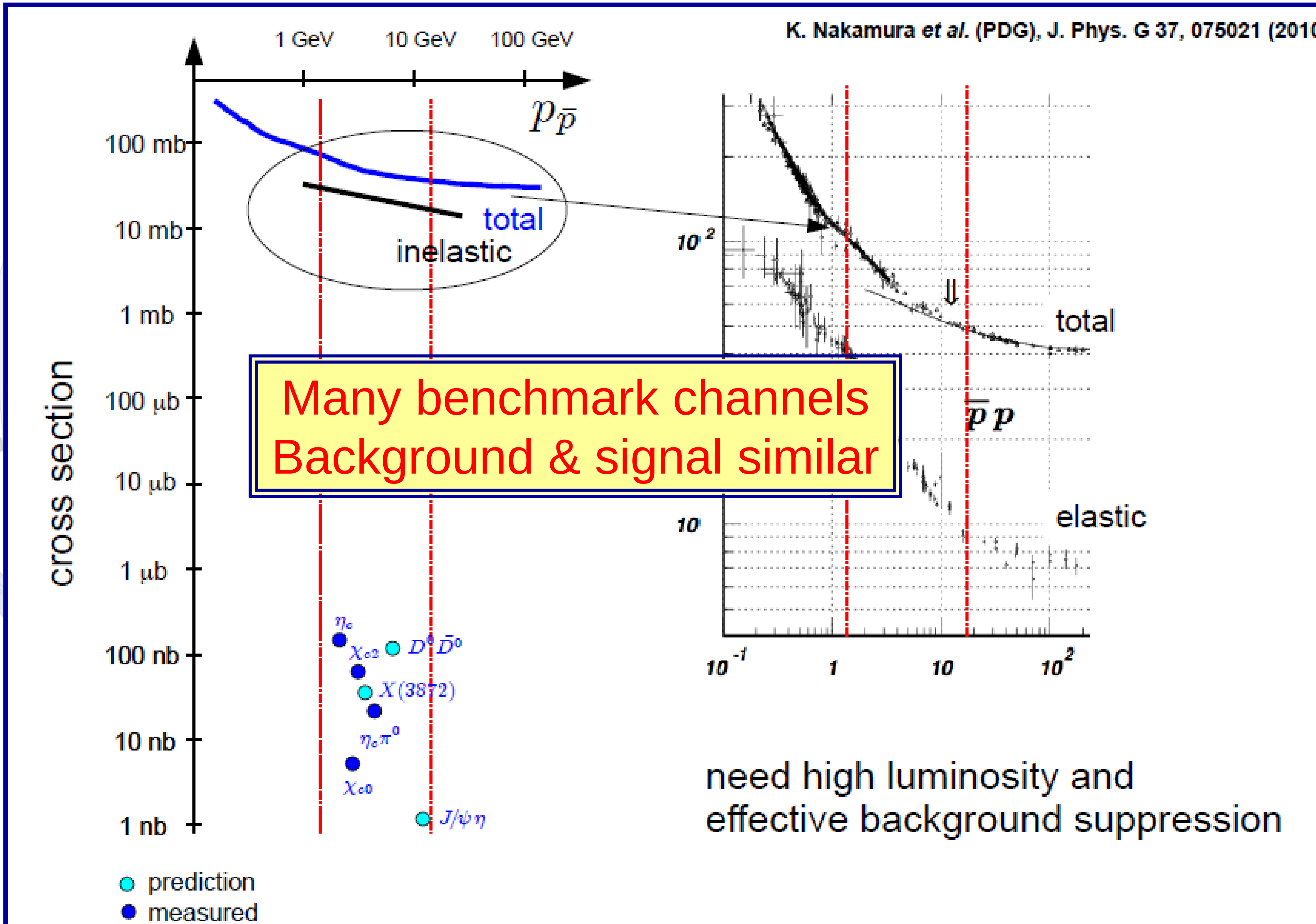
- Interaction rates of 20 MHz (50 MHz peak)
- Event size of ~15 kB
- Data rates after front end preprocessing: 80GB/s - 300GB/s





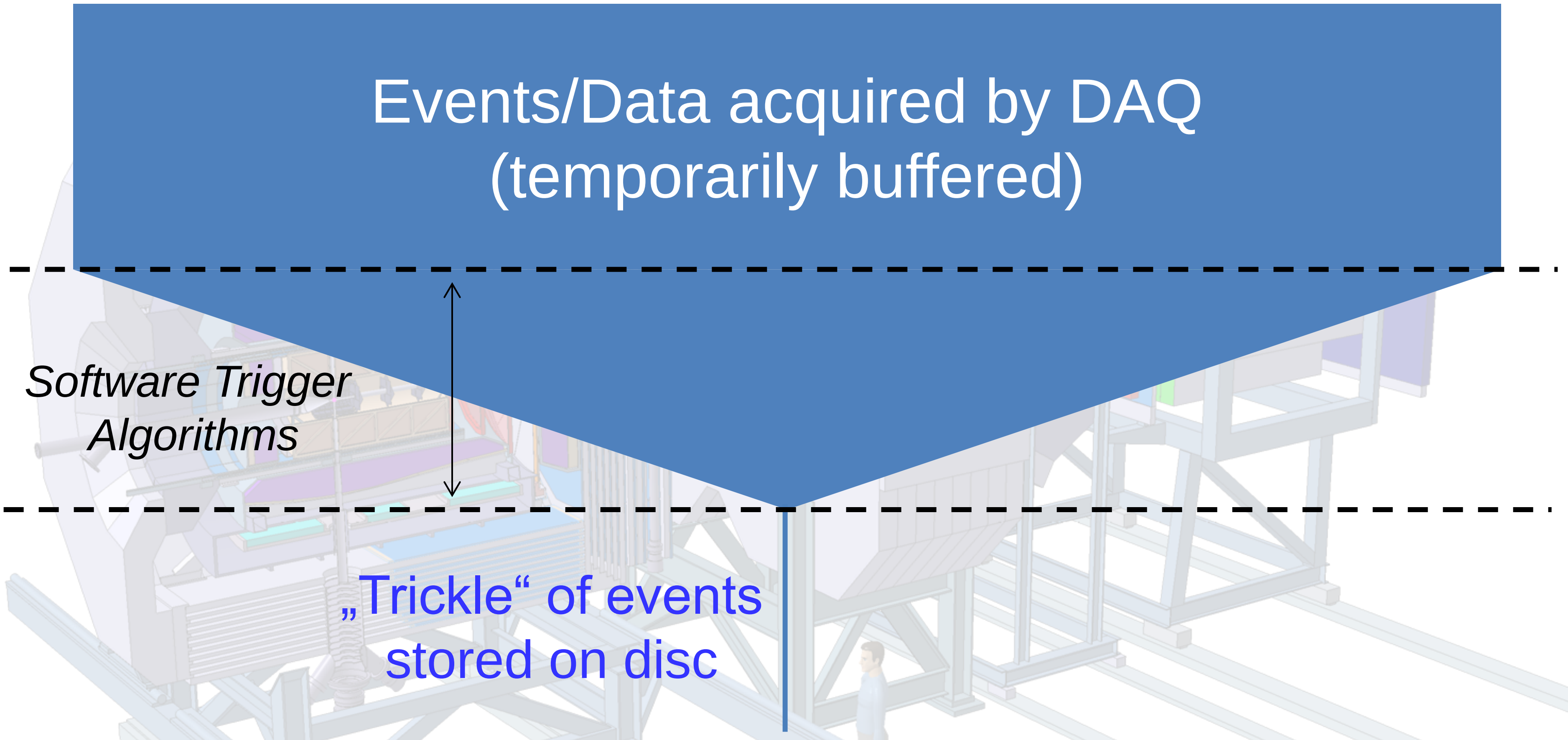
H.Xu, TIPP2011, Chicago

Where is our signal?



Many benchmark channels
Background & signal similar

need high luminosity and
effective background suppression



- Required reduction factor: ~1/1000 (all triggers in total)
- A lot of physics channel triggers → even higher reduction factor required

Selection criteria used in the Physics Report Analyses

Channel	TRK	NEUT	Excl.	mult	PID	p	E	ang.	inv M	dist cut	veto	4C	Vtx C	Mass C	Sig Eff[%]
J/psi pi+ pi-	4	0	x		e, pi				x				J/psi pi+ pi-		***30***
J/psi pi0 pi0	2	4	x		e		g		x		J/psi eta pi0	x	J/psi		***17***
chi_c1,2 gam	2	2	x		e		g		x			x	J/psi		***30***
J/psi gam	2	1	x		e				x			x	J/psi		***40***
J/psi eta	2	2	x		e				x			x	J/psi		***40***
h_c -> 3gam	0	3	x	3n			g	h_c	x			x			***8***
h_c -> 2phi gam	4	1	x		K		g		x		pi0	x			***8***
D+ D-	6	0	x		?	D			x	z(D)		x	D+-		***8***
D*+ D*-	6	0	x		?	D*			x	z(D*)		x	D0	D0	***14***
eta_c1 eta	2	7	x		e				x			x		chi, pi0, eta	***7***
eta_c1 eta	4	8	x		K, pi				x		>1 comb/ev	x	K pi	D0, D0*, eta, pi0	***5***
J/psi omega	4	2	x		e, pi				x			x	J/psi pi+pi-	J/psi, pi0	***15***
f2(2230) -> 2phi	4	0	x		K				x			x	phi		***20***
Ds Ds(2317)	3	0			K, pi			K	x				Ds, phi		***20***
Xi- Xi+ pi0	6	2	x		p, pi		g		x	d(IP-Xi)	>1 comb/ev	x	Lam,Xi+-	Xi Xi pi0	***16***
Lam Lam	6	0	x		p, pi				x	d(IP-Xi)			Lam		***11 … 23***
Xi- Xi+	6	0	x		p, pi				x				Lam, Lam pi		***19***

no multiplicity cuts

PID!

few kinematic cuts (except mass)

a lot of fitting!

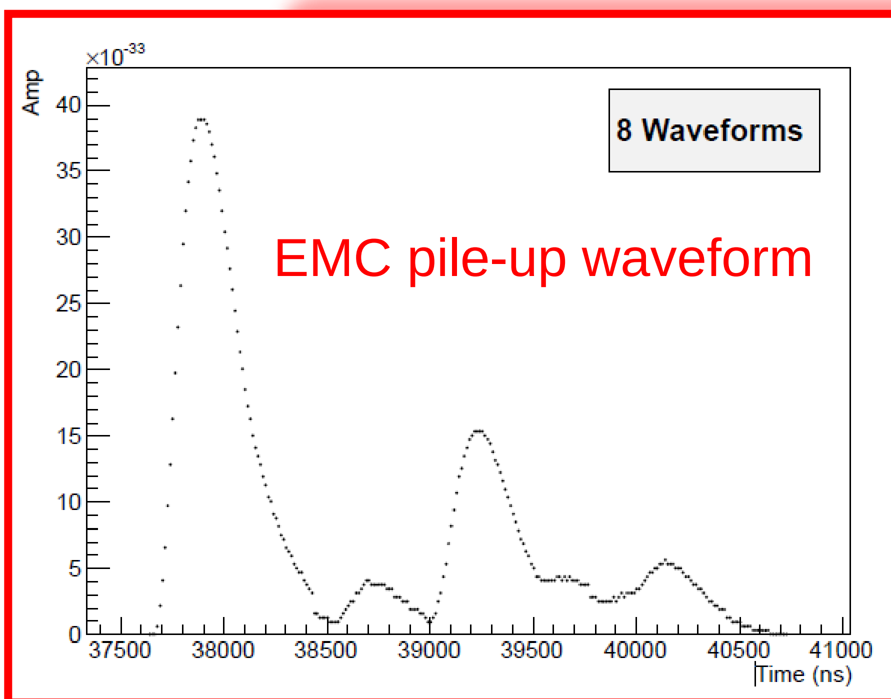
K.Götzen

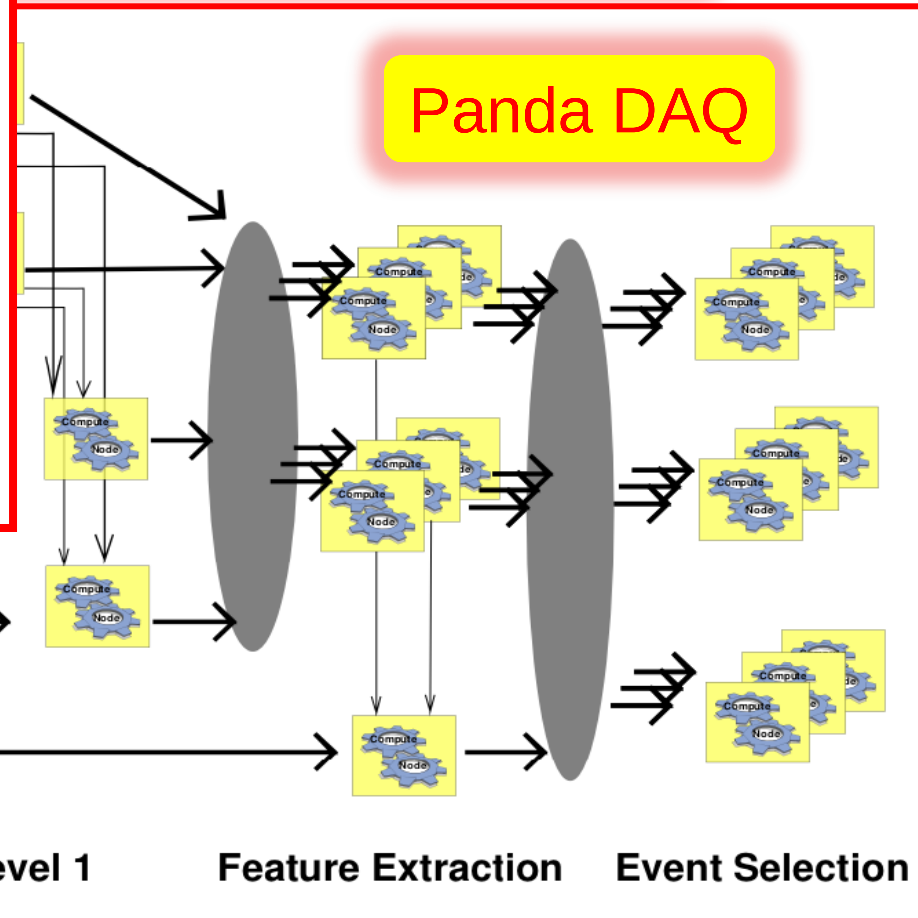
Physics Book criteria:

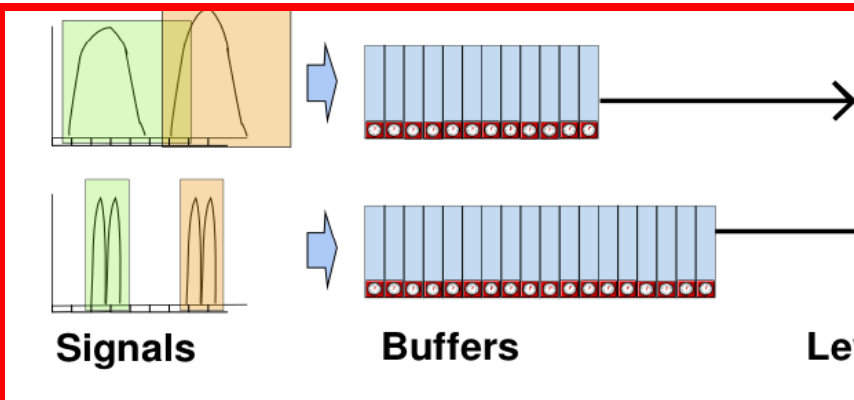
- J/psi (→ base for many charmonia)
  - Invariant Mass: Tracking/Momentum
  - Electron ID: Tracking, cluster energy, track/cluster match
  - Muon ID: Tracking, Muon detector information
  - Vertex: Tracking
- D/Ds Mesons
  - Pi0s: EMC clusters
  - Inv. Mass: Tracking
  - Kaon, Pion ID: dE/dx, DIRC info (w/ track match), ToF (track match)
  - Vertex: Tracking
- Baryons
  - Inv. Mass: Tracking
  - proton, pion ID: DIRC info (w/ track match)
  - Vertex: Tracking
- Full events: 4C fitting

Tracking & momentum
→ **key information**

Data Acquisition







continuous sampling DAQ
flash ADC

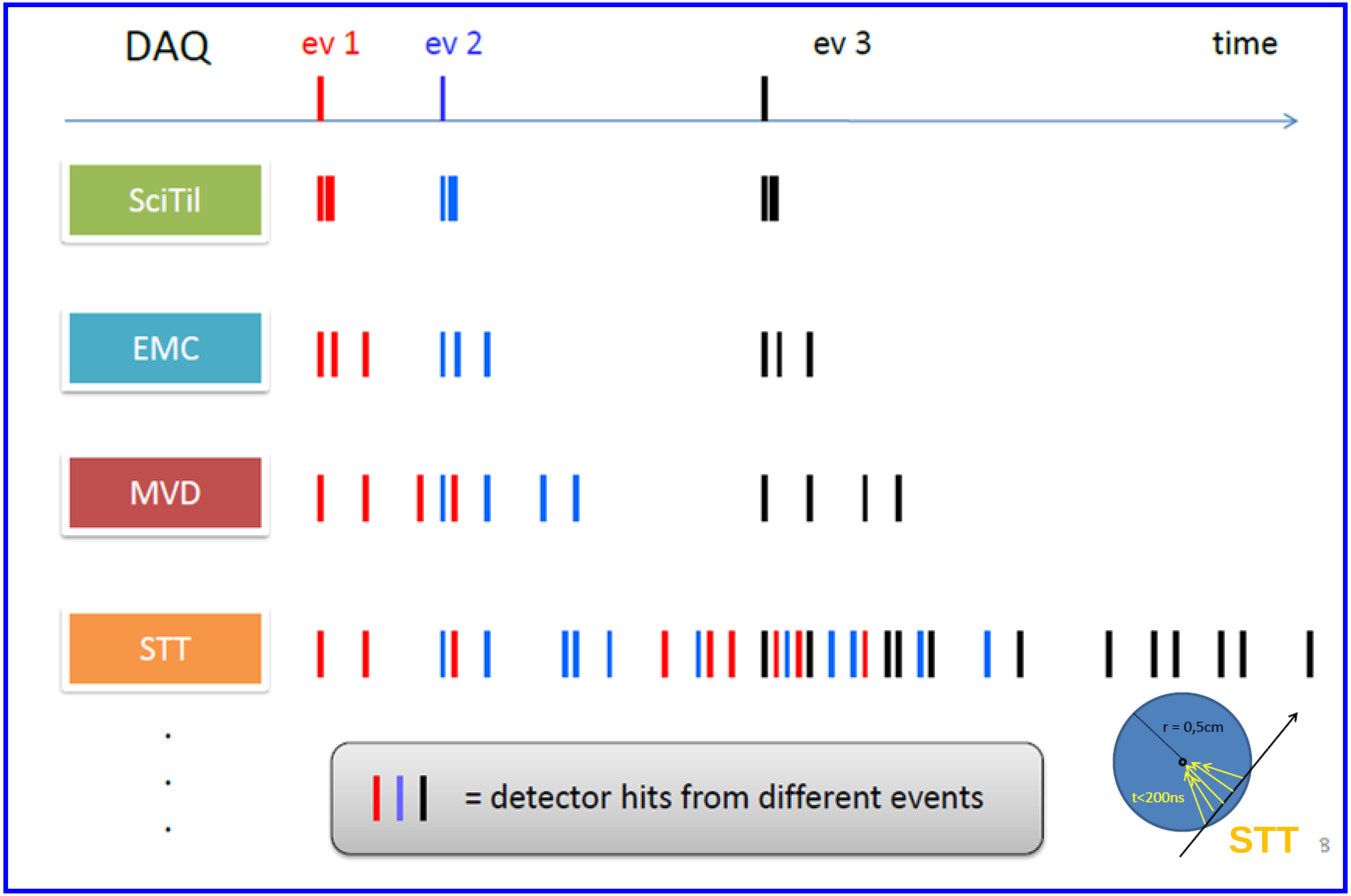
self-triggered
detector front-end

each signal get a time stamp **(155.52 MHz)**
high quality clock distributed

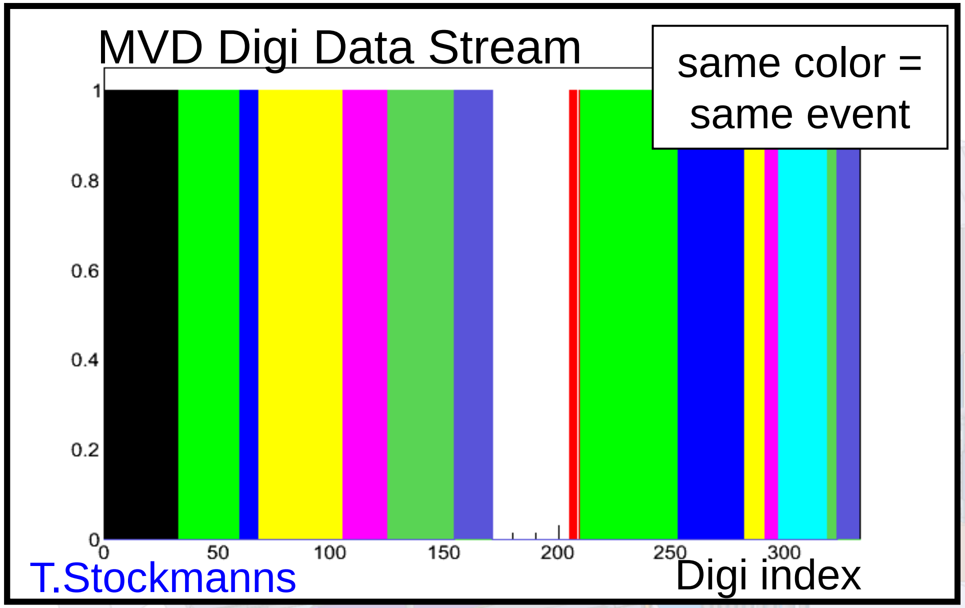
front-end feature extraction
(signal amplitude, shape, …)

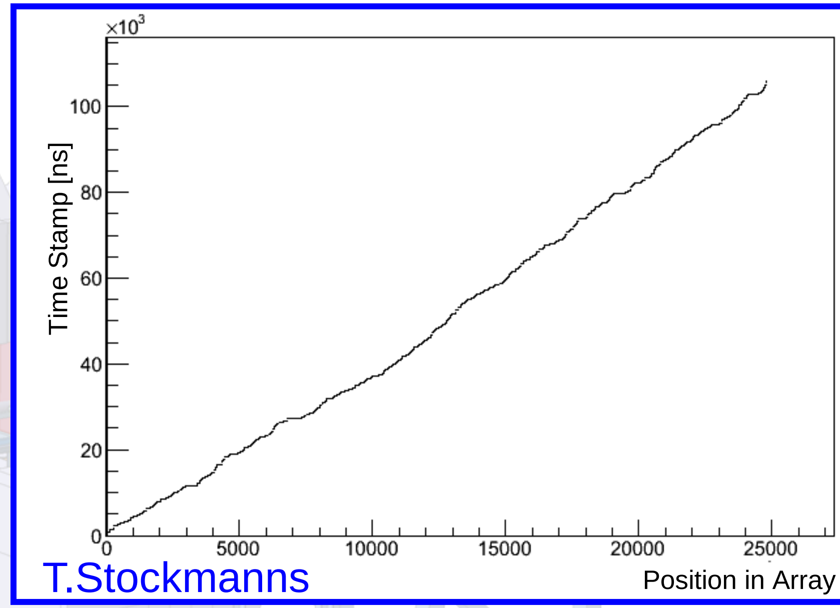
Time Dependent Simulation

slow transition from event based to time ordered simulation



Time Based Simulation

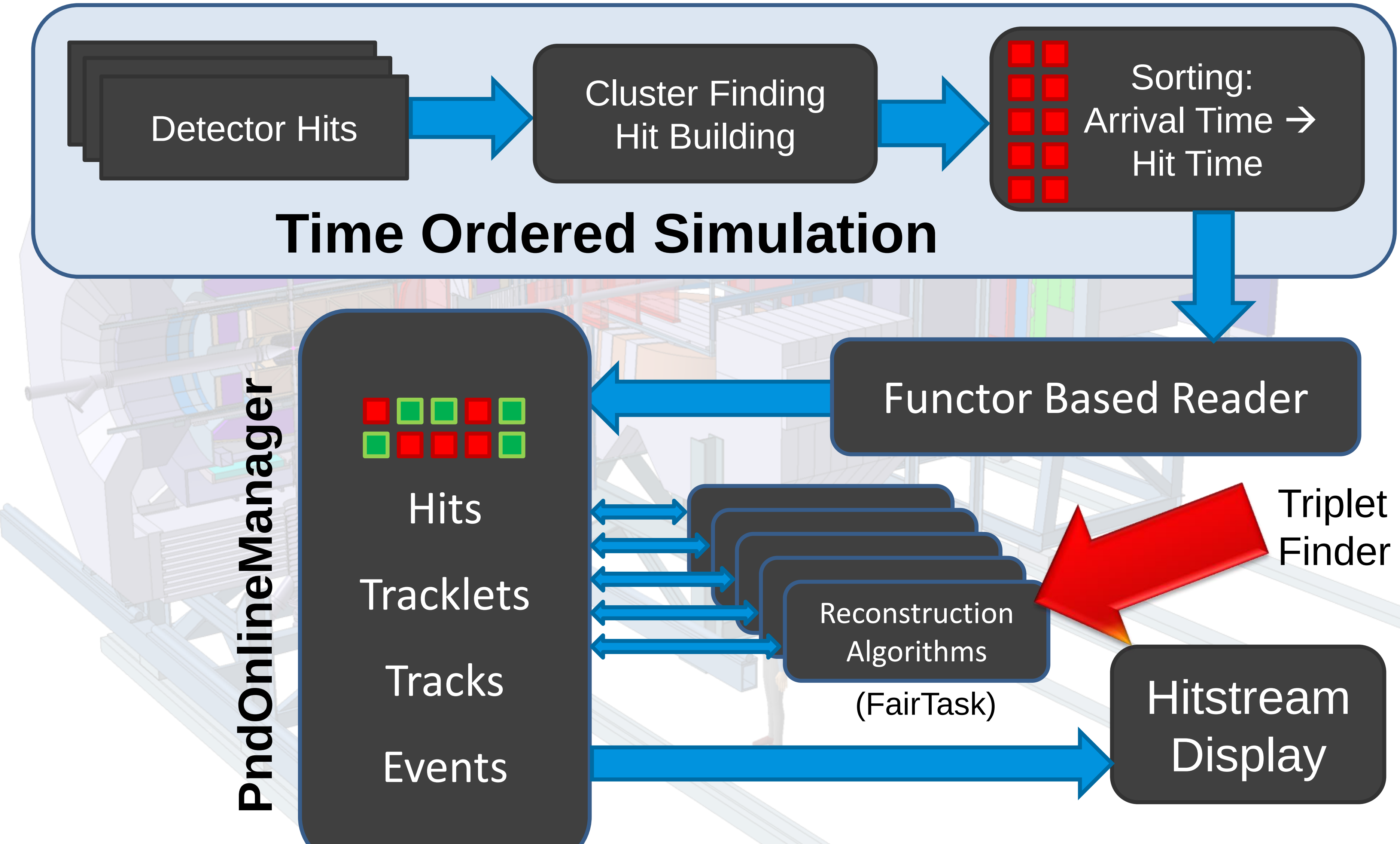




- Randomized Digi Data
- Sorting Digi Data using Time Stamps + Drift Time, ToT…
- Event Building – t0 determination

✓ **An Event Building scenario in the trigger-less PANDA experiment**
Radoslaw KARABOWICZ on 14 Oct 2013 from 16:45 to 17:05

Continuous Online Tracking

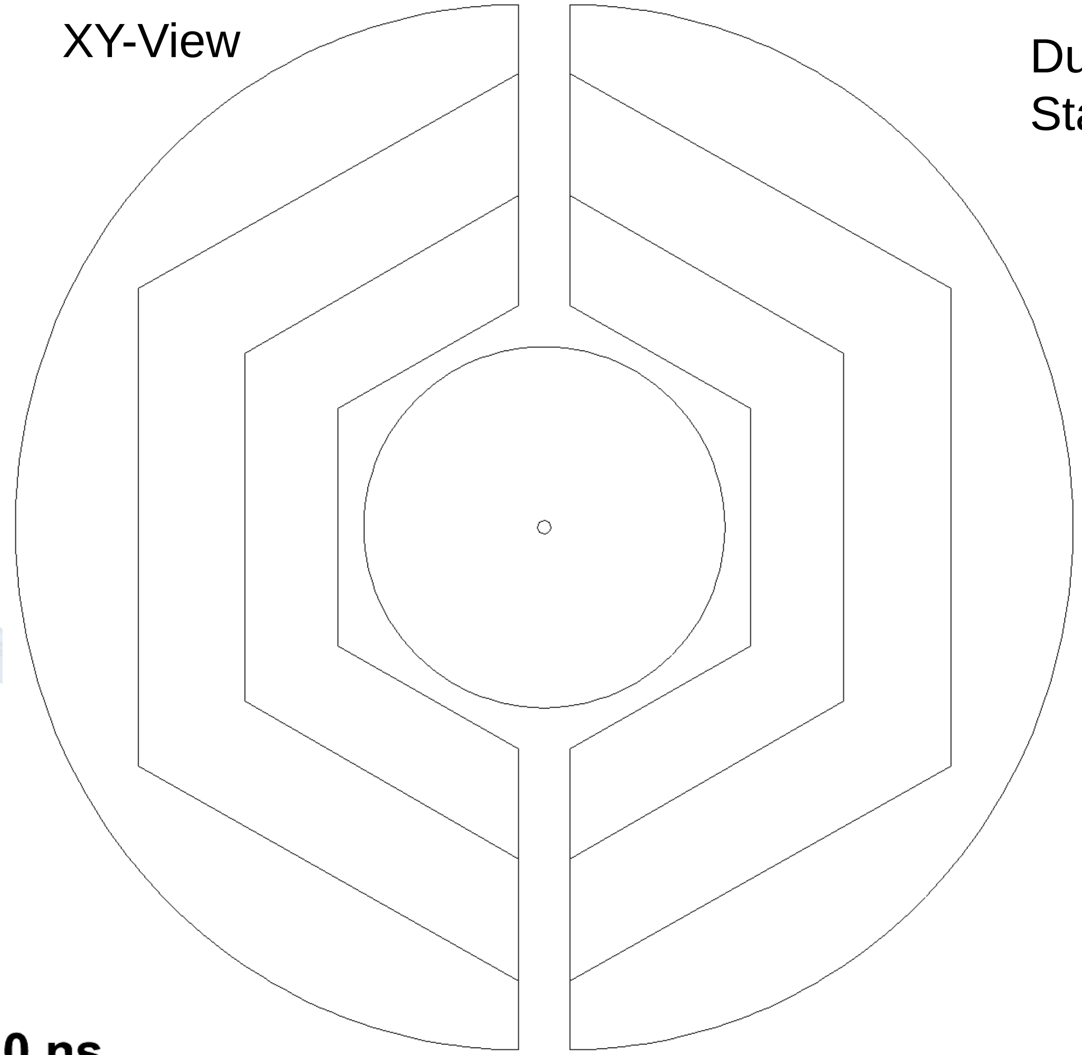


Marius C. Mertens

Hitstream Display

15 GeV/c DPM, 50 ns mean time

XY-View



0 ns

Dual Parton Model (DPM):
Standard p̄p background generator

Black circles: Early isochrone
Blue circles: Early skewed isochrone
Green circles: Close isochrone
Red circles: Late isochrone
Black dots: MVD hits
Green dots: MVD hits r/z > 0.3
Black+Red dots: Triplets/Skewlets
Yellow tracks: Vetoed
Blue tracks: Accepted

Marius C. Mertens

How to deal with continuous data stream?

No possibility to pre-filter events (lvl1)

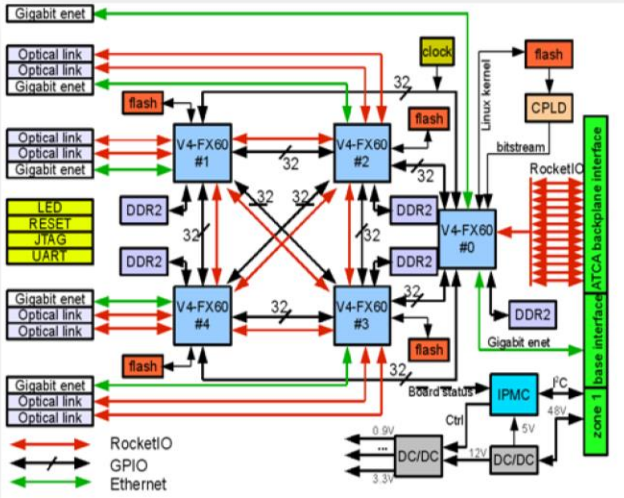
algorithms run continuously

- More power to online computing
- The (almost) whole offline reconstruction should run also online
- Algorithms as fast as possible
- (of course) Concurrency is the key!

need for more intelligence in online computing

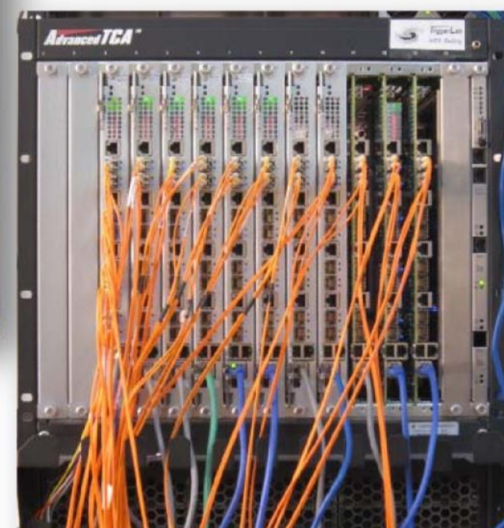
!

The Compute Node



An universal high performance platform prepared for multiple applications .
ATCA standard (Full Mesh topology in backplane) and FPGA-based

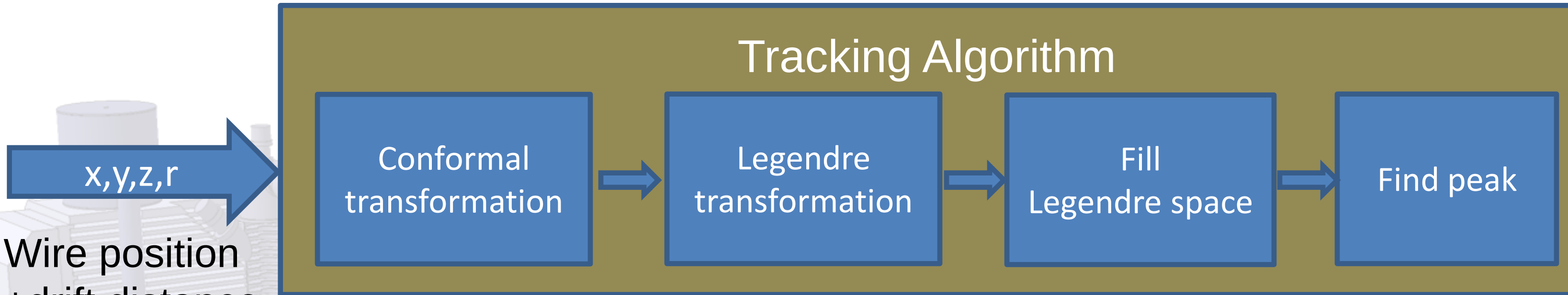
5x Virtex-4 FX60-10/-11 FPGA
13x 2/3.125Gbps to backplane for interconnection
5x Gigabit Ethernet
8x 2/6.25Gbps Optical Links for data input
2 GB 400MHz DDR2 SDRAM
Real time Linux/vxworks



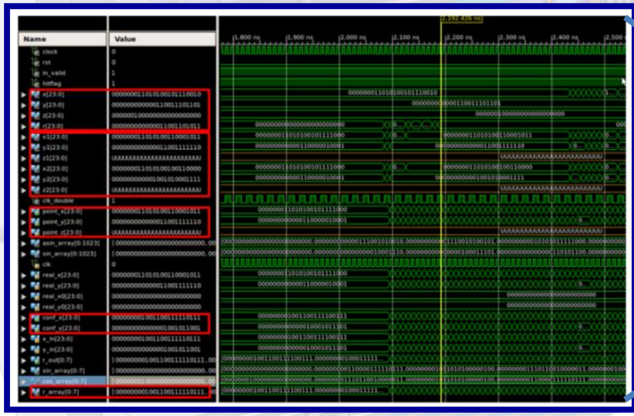
the actual version for Panda online computing

what is intended to be used later in Panda still to be decided

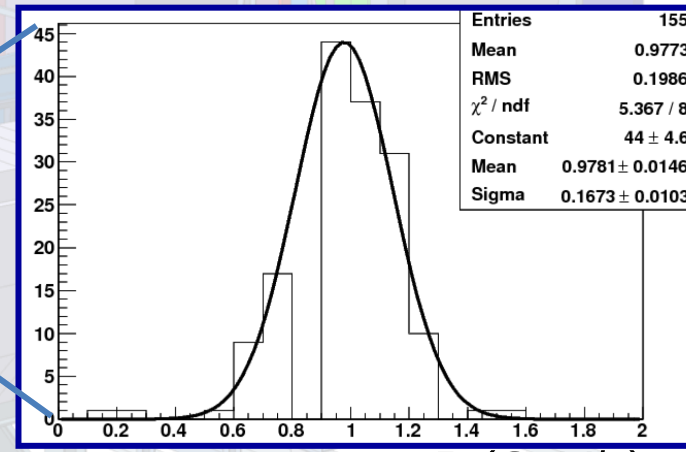
Tracking in VHDL (FPGA)



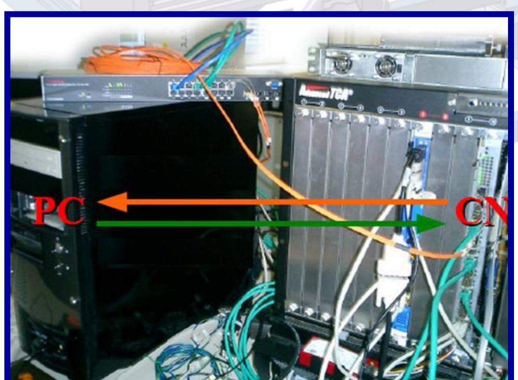
Wire position +drift distance



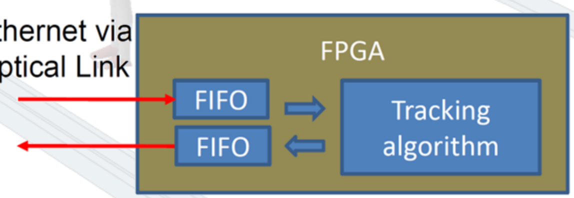
Simulation with ISim



Pt(GeV/c)



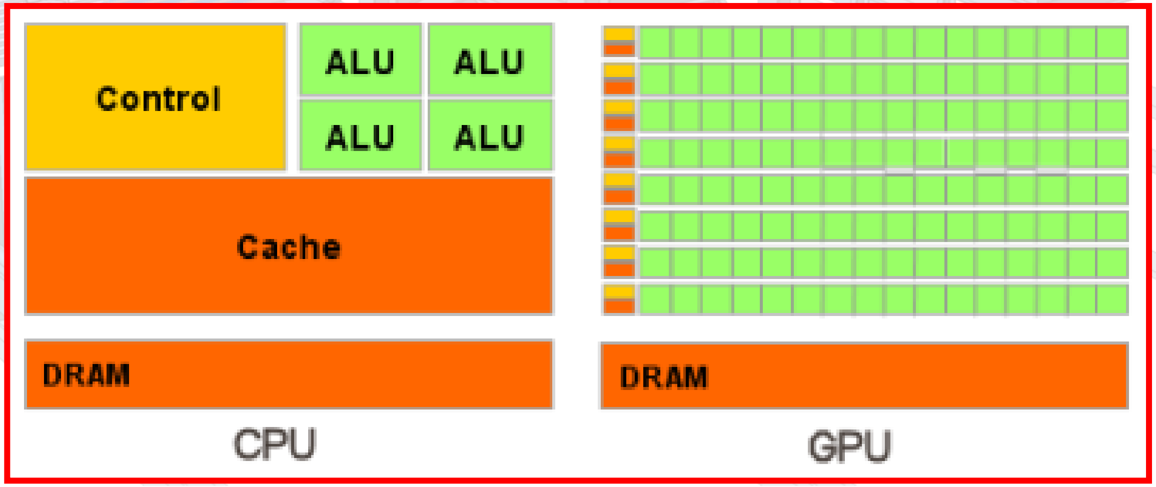
And tests with PC as data source and receiver



Y.Liang

CPUs and GPUs

- GPU threads are extremely lightweight
- CPUs can execute 1-2 threads per core, while GPUs can maintain up to 1024 threads per multiprocessor (8-core)
- CPUs use SIMD (single instruction is performed over multiple data) vector units, and GPUs use SIMT (single instruction, multiple threads) for scalar thread processing. SIMT does not require developers to convert data to vectors and allows arbitrary branching in threads.

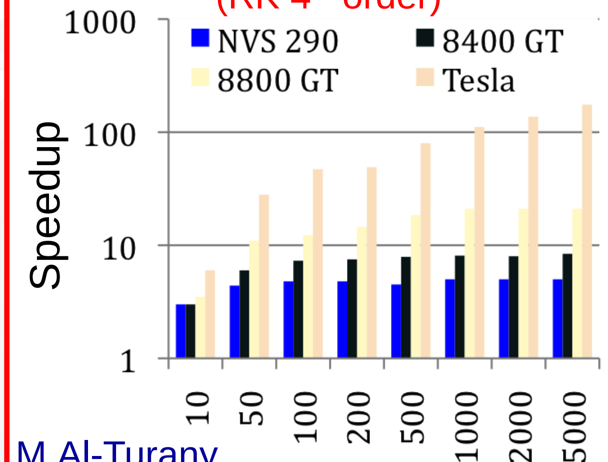


Panda GPU Activities

In the past…

- ✓ **GPUs for event reconstruction**
  CHEP 2010 – Mohammad Al-Turany
- ✓ **Track Finding in a High-Rate Time Projection Chamber Using GPUs**
  CHEP 2010 – Felix Böhmer
- ✓ **Track finding and fitting on GPUs, first steps toward a software trigger**
  CHEP 2012 – Mohammad Al-Turany

Track Propagation with Panda Field (RK 4th order)

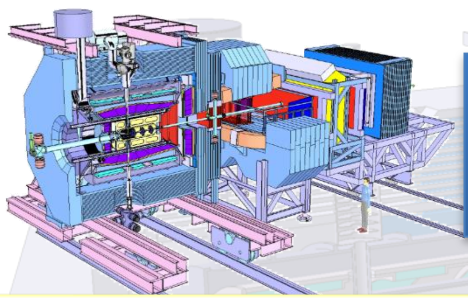


M.Al-Turany

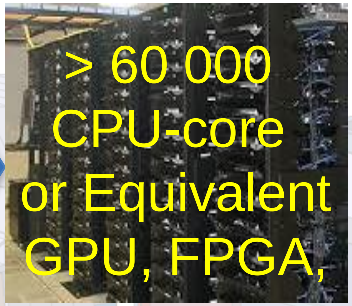
Currently

- ✓ **Possibility to run Cuda directly from PandaRoot (FairCUDA)**
- ✓ **Direct collaboration with NVIDIA**
- ✓ **Algorithm Developments of:**
  - GPU Hough Transform Tracker
  - GPU Riemann Track Finder
  - GPU Triplet Finder

The Online Reconstruction and analysis

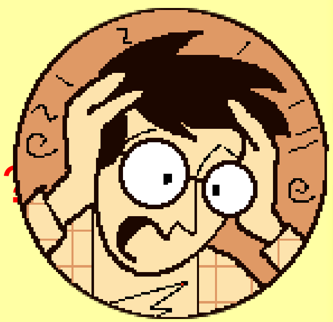


300 GB/s
20M Evt/s



< 1 GB/s
25K Evt/s

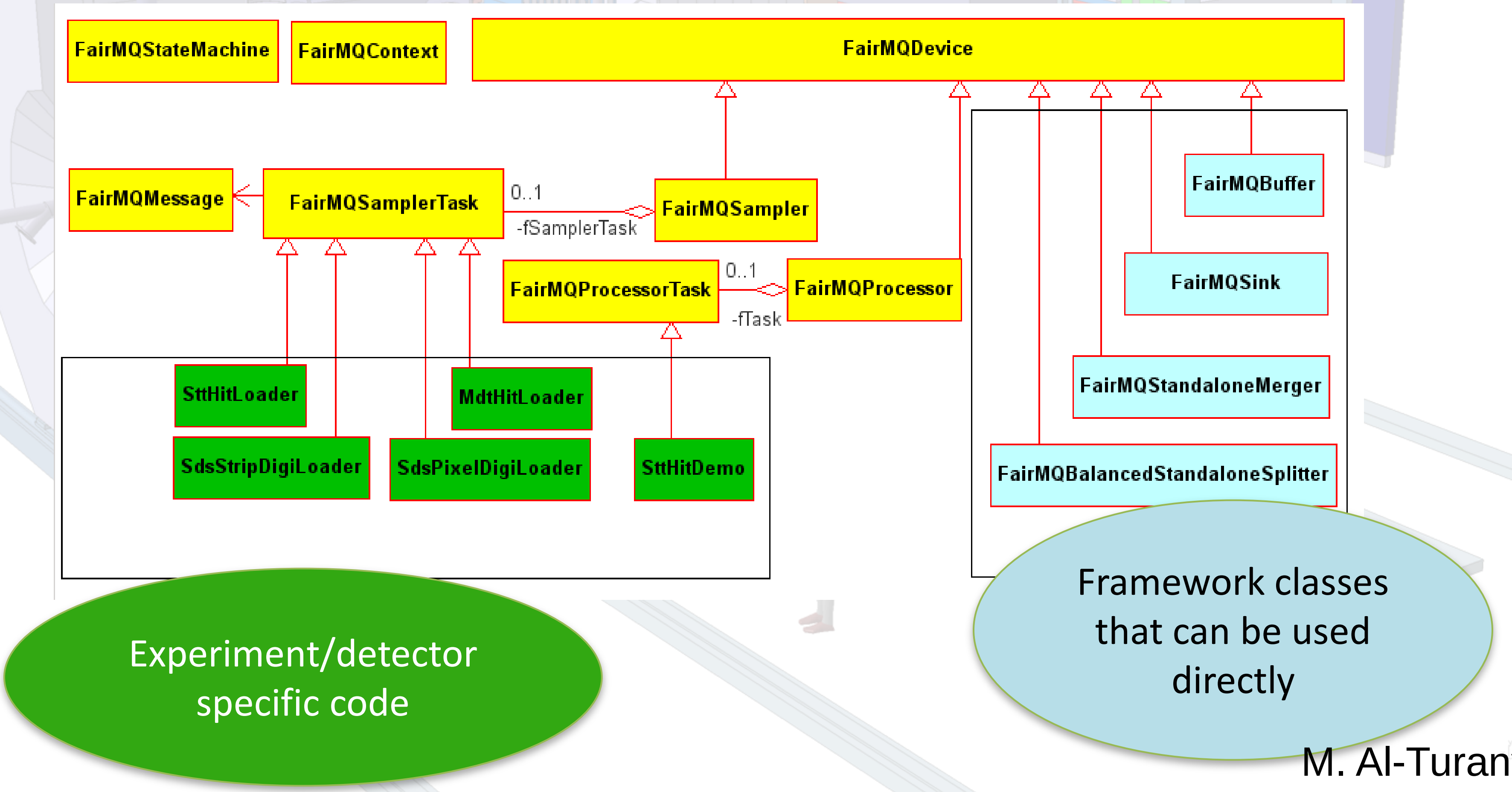
How to distribute the processes?
How to manage the data flow?
How to recover processes when they crash?
How to monitor the whole system?
……



- Highly flexible: different data paths should be modeled.
- Adaptive: Sub-systems are continuously under development and improvement
- Should works for sim and real data: developing and debugging the algorithms
- It should support all possible hardware (CPU, GPU, FPGA, ARR?)
- It has to scale to any size! With minimum or ideally no effort.

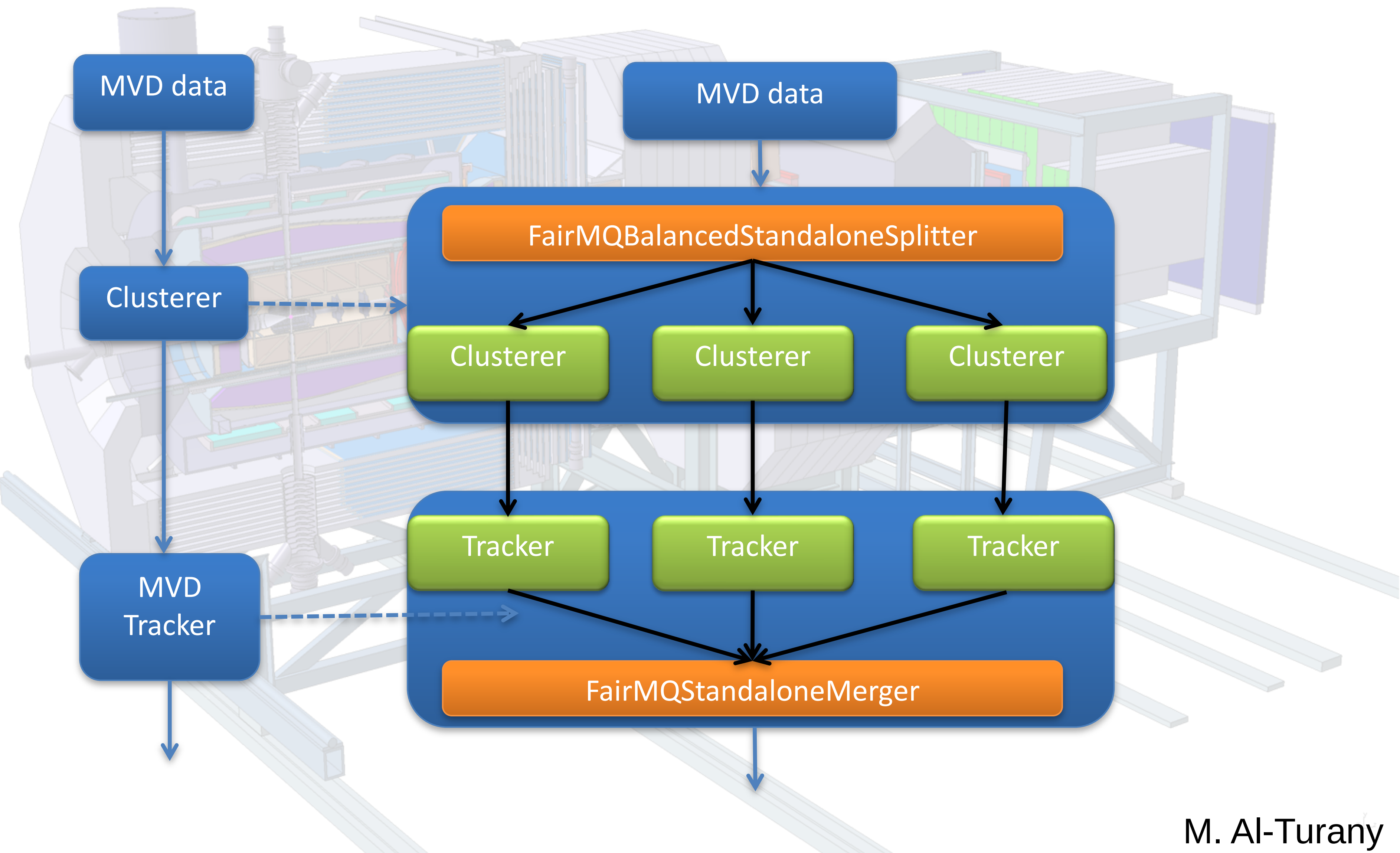
ØMQ (zeromq)

- A socket library that acts as a concurrency framework
- Messaging library, allowing to design a complex communication system without much effort



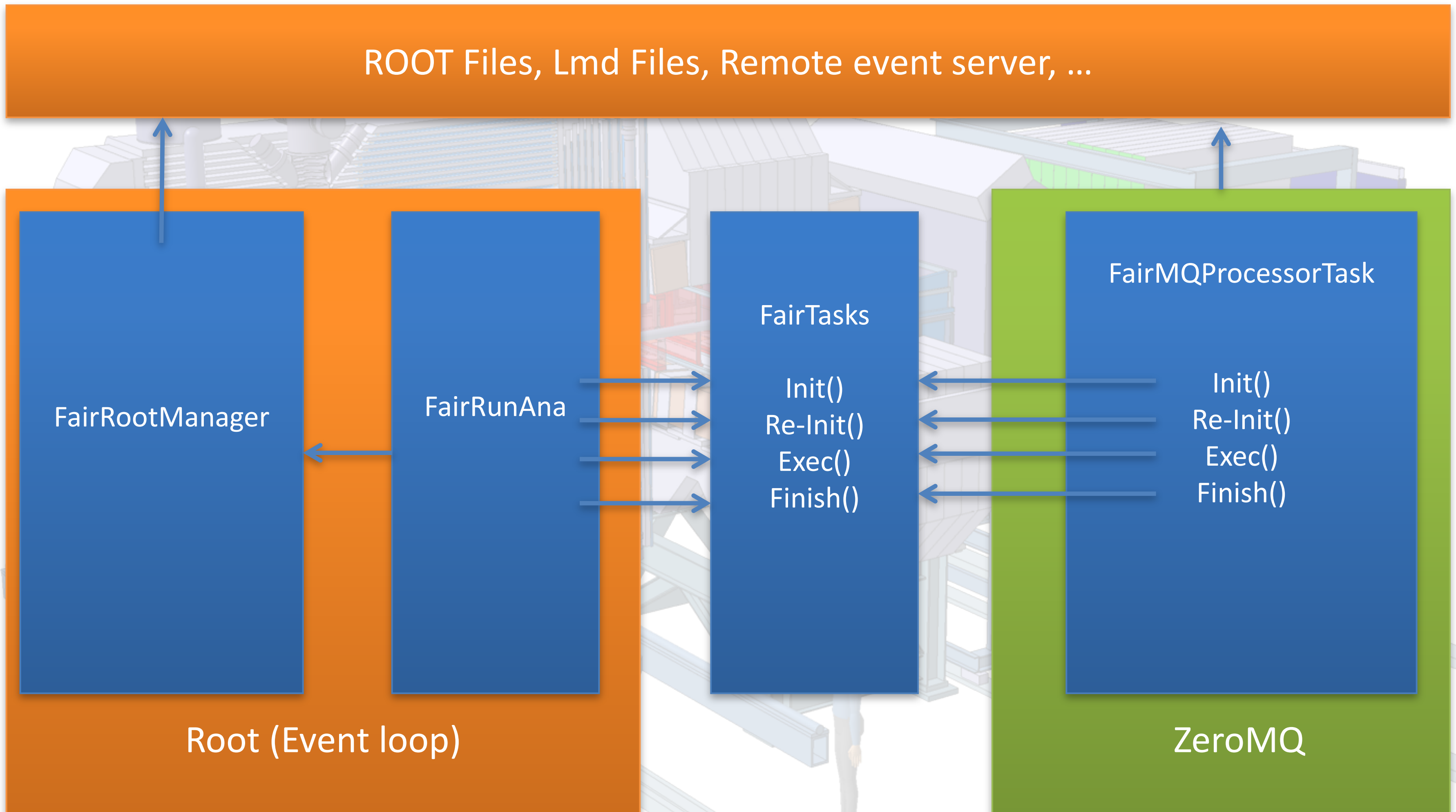
M. Al-Turany

ØMQ (zeromq)



M. Al-Turany

Integrating the existing software



✓ **Extending the FairRoot framework to allow for simulation and reconstruction of free streaming data**

Mohammad AL-TURANY on 14 Oct 2013 from 16:10 to 16:30

Summary

✓ Panda benefits from the LHC experiences and from the new IT technologies
✓ Taking data from 2018, still some time to take final decisions
✓ The trigger-less data acquisition is the real challenge

Reconstruction

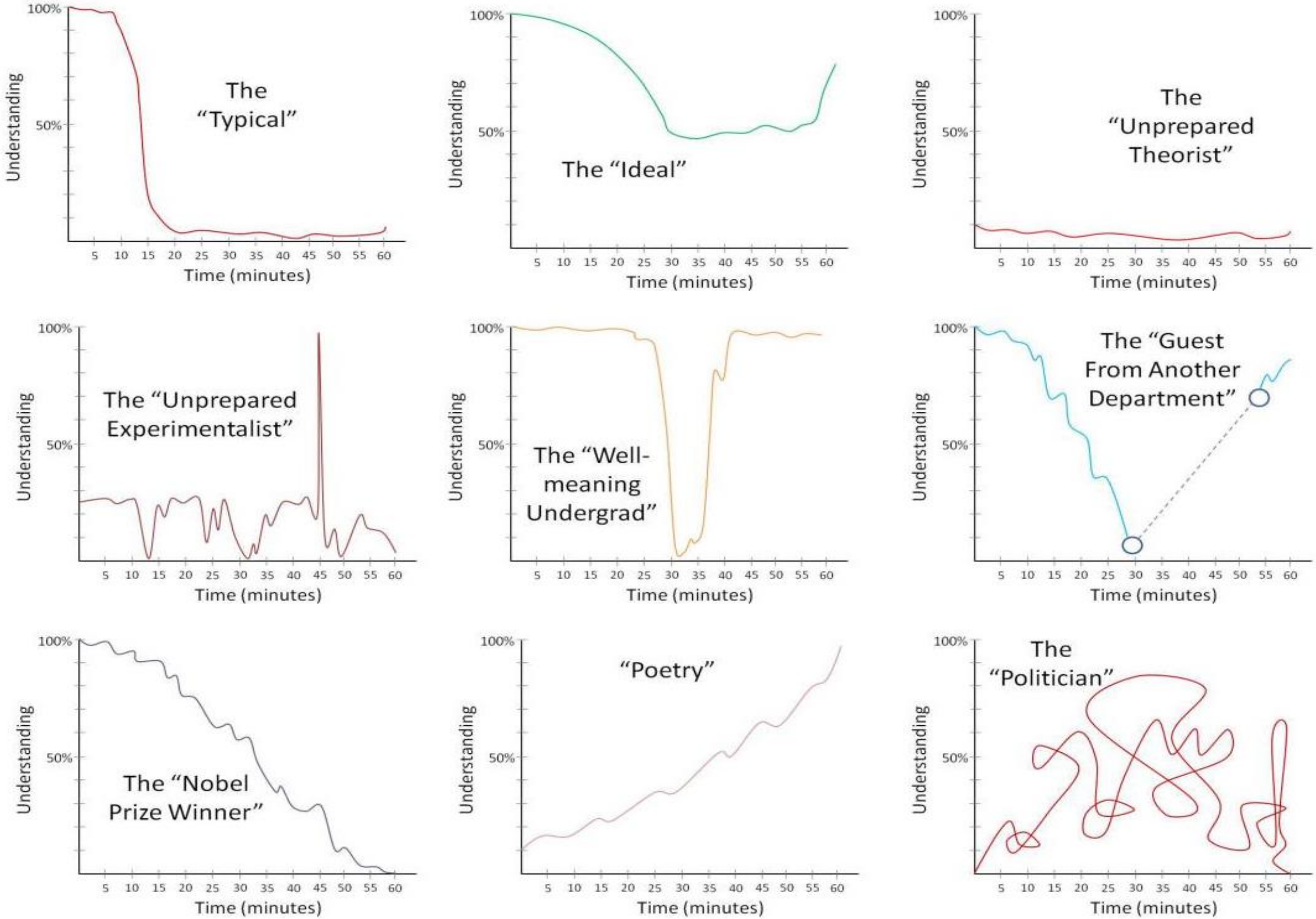
- PandaRoot is our framework for simulation, reconstruction and analysis
- Dynamic data structure, macro driven, supported on many OS
- Advantages from a large developer community and from 3rd part packages
- Time based simulation under realization (new concept!)
- High importance of Online algorithms

Computing Model

- The MONARC model good starting point but updated by new technologies
- Grid, Cloud, Proof, computing on FPGAs and on GPUs…
- Multi-core CPUs and many-core GPUs → importance of scalable software
- More democratic and flexible models

✓ With LHC upgrade higher data rates and more need of software parallelization
✓ Many points in common with LHC experiments, mutual benefits?

The 9 kinds of physics seminar



http://manyworldstheory.com/2013/10/03/the-9-kinds-of-physics-seminar/