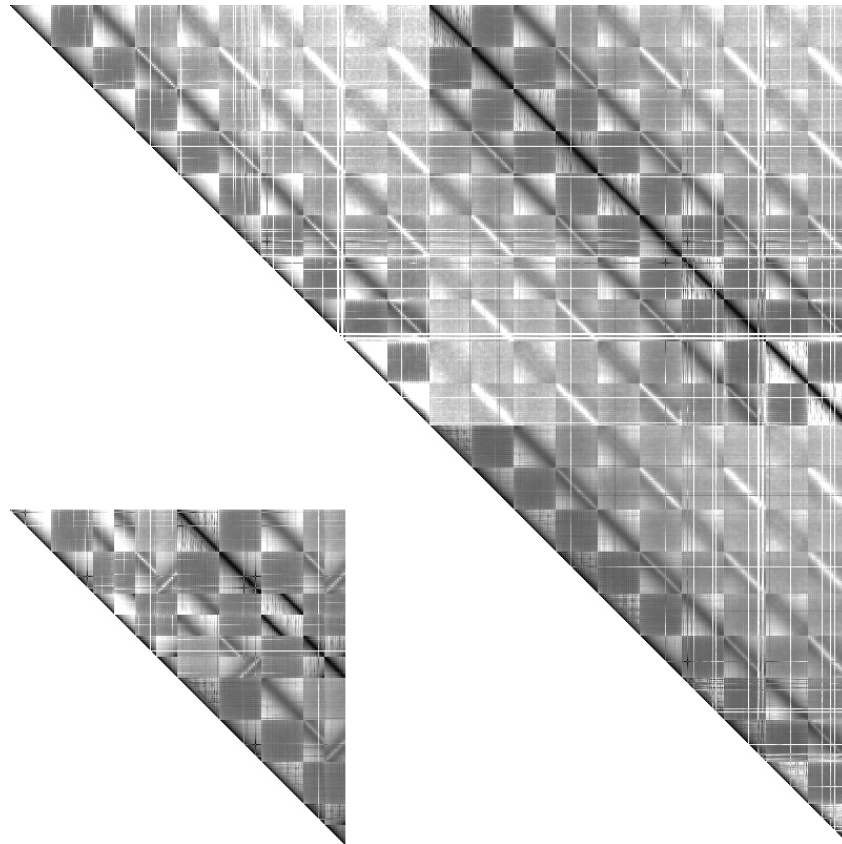
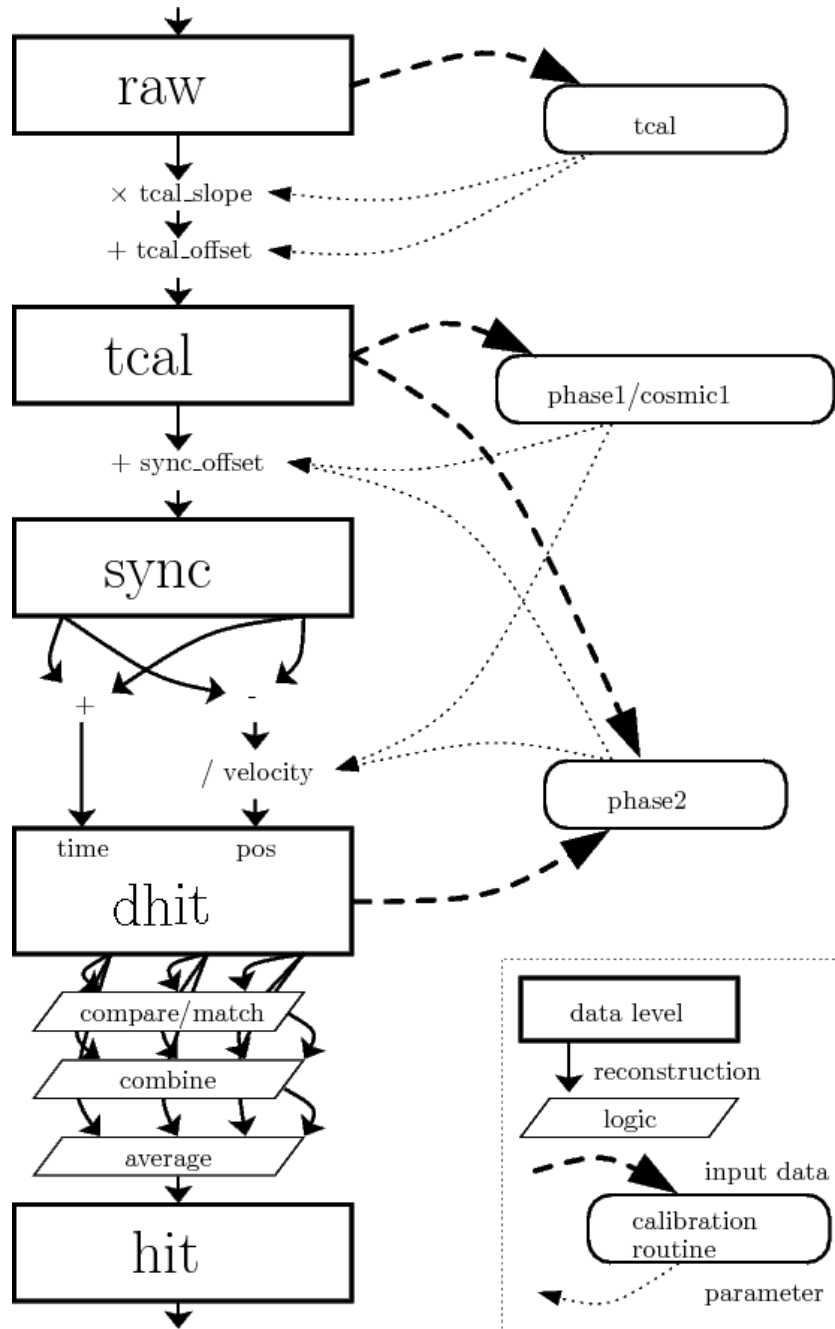


R^3B analysis: LAND02 ?
Past, present and **future**
experiments



Håkan T. Johansson, Chalmers, Göteborg

land02



Since 2003

For **S245!** – with other/more experiments in mind

10+ past, present & future(?) exp'ts

(S034, S135, S188, S233, S221, ...)

S245, **S287**, S295

S223, S318, S296, S327

...?

Batch mode operation!

Setup, configuration & parameters via text files

S245 – first publication

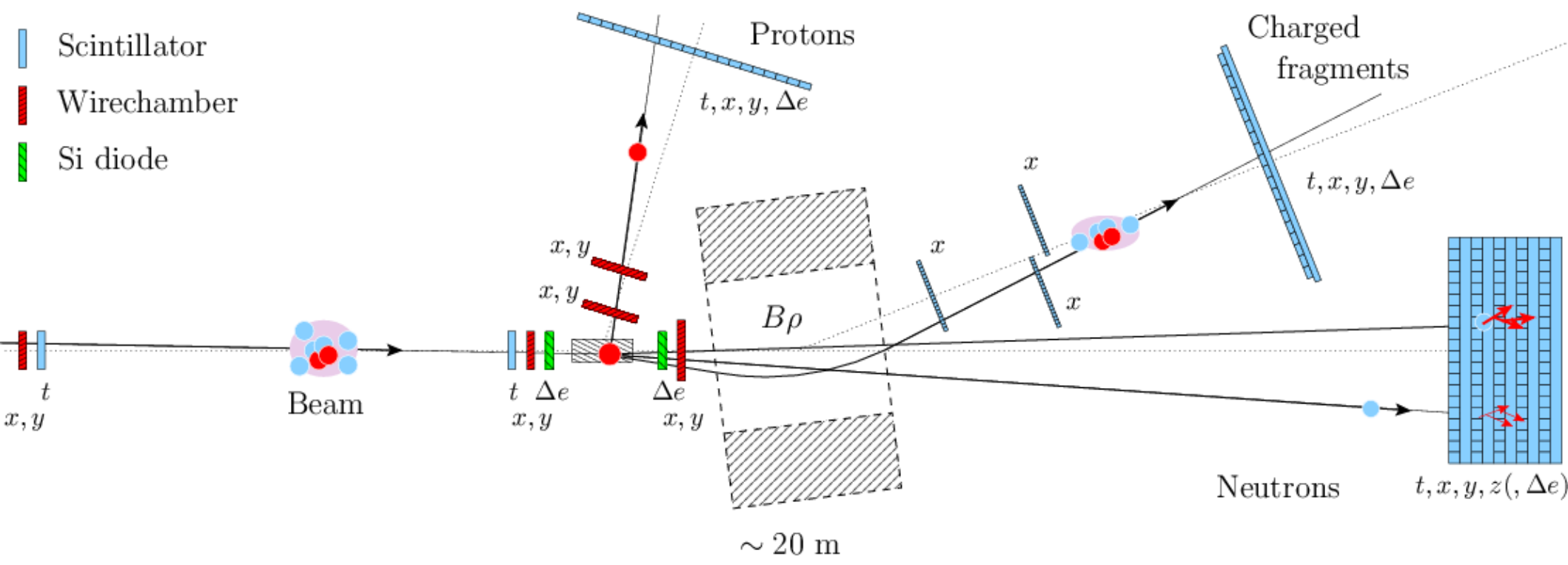
from land02

Lithium isotopes beyond the dripline

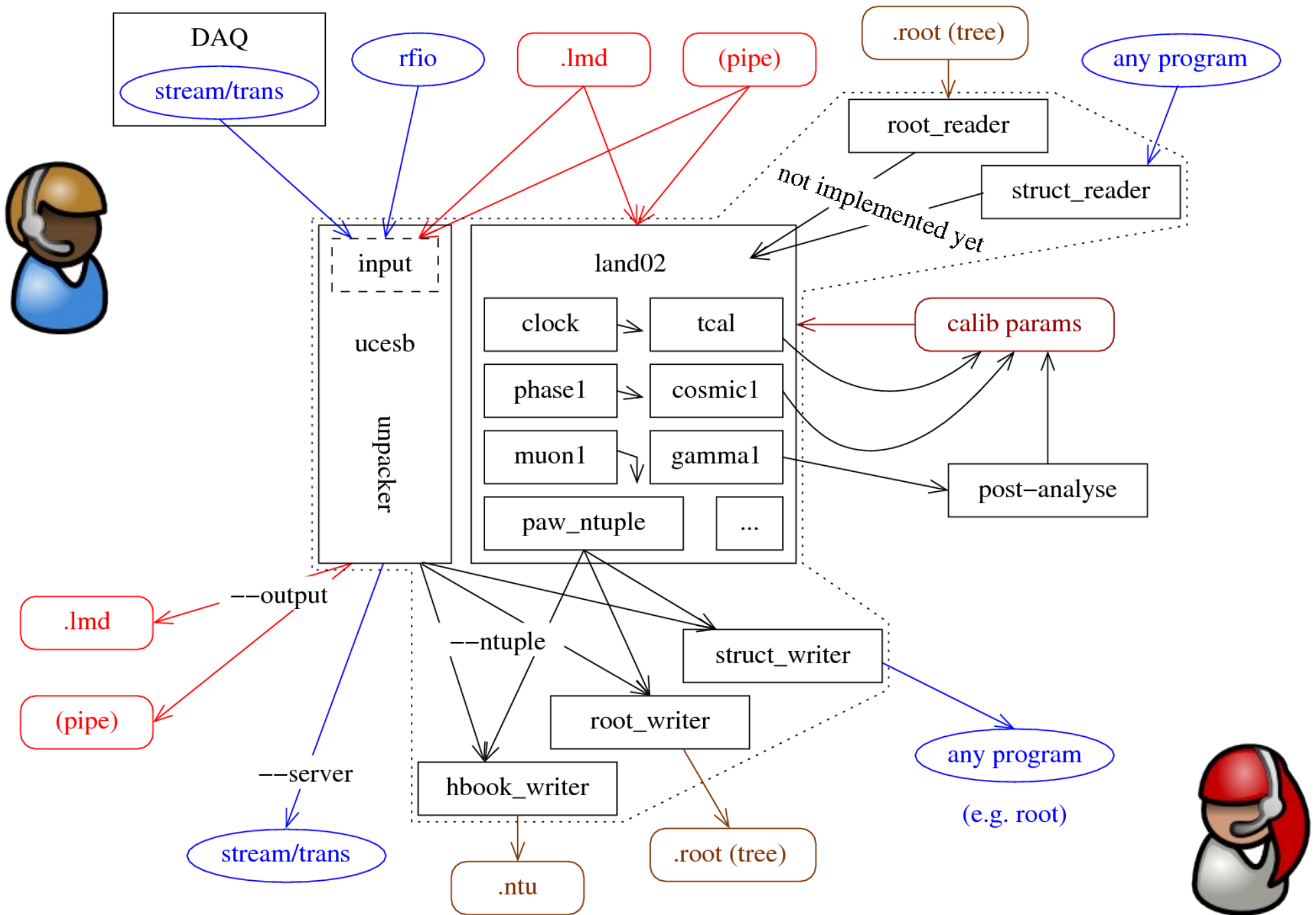
Yu. Aksyutina, H.T. Johansson, et. al.

Physics Letters B, Vol 666, Issue 5, pp 430-434

¹²Li
¹⁰Li
¹³Li



(ucesb)/land02 interaction



More data – more trouble?

More (new) detectors

More channels:

Better intensity:

Higher event-rates ?

DAQ will evolve:

Higher data-rates

Spill: 890 TrigType: 13 Sat Aug 30 08:04:47 2008

#	ID	Raw	#	ID	B. DT	A. DT	A. Red	FC	effDT	Red	2^n
1:	Min. bias	59352	#	1: Good Beam	59350	37676	294	0%	36.5%	128.1	7
2:	NTF	58180	#	2: GP+NTF	51527	33953	531	0%	34.1%	63.9	6
3:	LAND	5906	#	3: GP+CB OR	42764	28195	0	-	34.1%		off
4:	LANDcosm	5906	#	4: GB+CB Sum	808	535	535	0%	33.8%	1.0	0
5:	VETO	159	#	5: GP+TFW	3978	2601	2601	0%	34.6%	1.0	0
6:	TFW	15854	#	6: GB-pileup	52830	34802	1088	0%	34.1%	32.0	5
7:	CB OR	360971	#	7: PIX	0	0	0	-	-		-
8:	TFW cosm	15840	#	8: GP+LAND	877	586	586	0%	33.2%	1.0	0
9:	NTF cosm	58299	#	9: CB muon	0	0	0	-	-		-
10:	CB Sum	2660	#	10: LANDcosm	0	0	0	-	-		-
11:	FRS S8	662377	#	11: TFW cosm	0	0	0	-	-		-
12:	CB dlyOR	360815	#	12: CB gamma	4	0	0	-100.0%			-
13:	CB dlySum	2660	#	13: Clock	1021	811	50	0%	20.6%	16.2	4
14:	PIX	2	#	14: TCAL	1021	760	95	0%	25.6%	8.0	3
15:	!pileup	53275	#	15: BOS	0	0	0	-	-		-
16:	Spill ON	0	#	16: EOS	1	1	1	0%	0.0%	1.0	0

Accepted physics: 4870 476.7 Hz Duration: 10215 ms

offspill/calib: 146 14.3 Hz

4587 cur (exp)

4590 within 2 us: 0.001 (0.012) Within pileup reject: 0.110

4597 within 4 us: 0.002 (0.023)

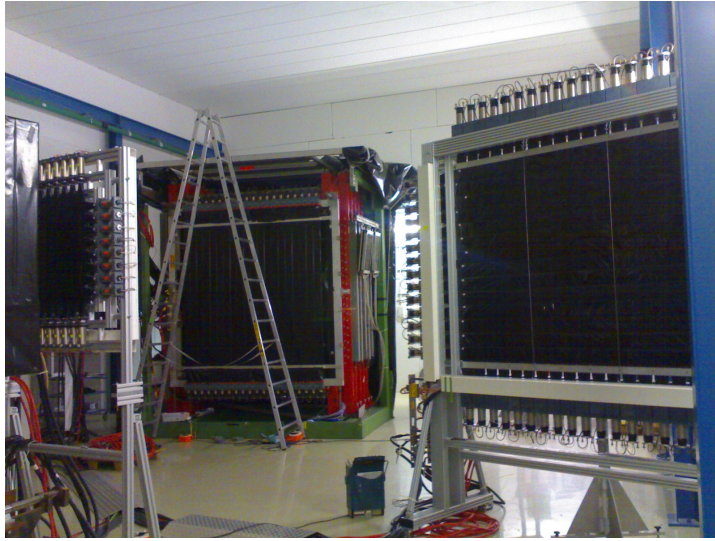
4615 within 10 us: 0.006 (0.059)

0 within DT: 0.000 (2.579) DT: 21.64% avg: 440 us

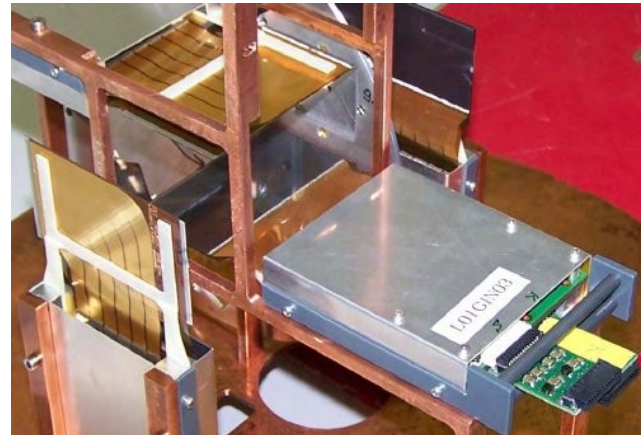
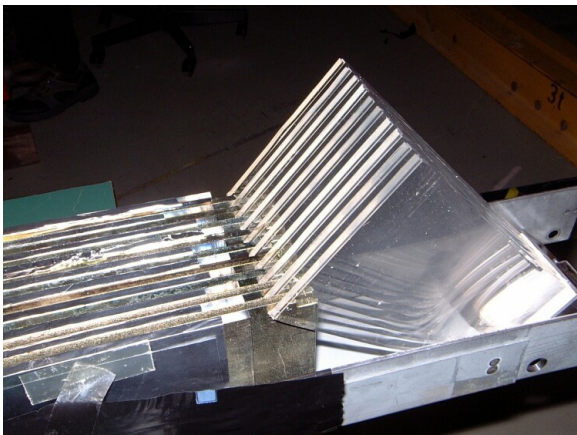
==> Be prepared

R³B has a blessing

The ongoing LAND/R³B experimental programme (and tests)

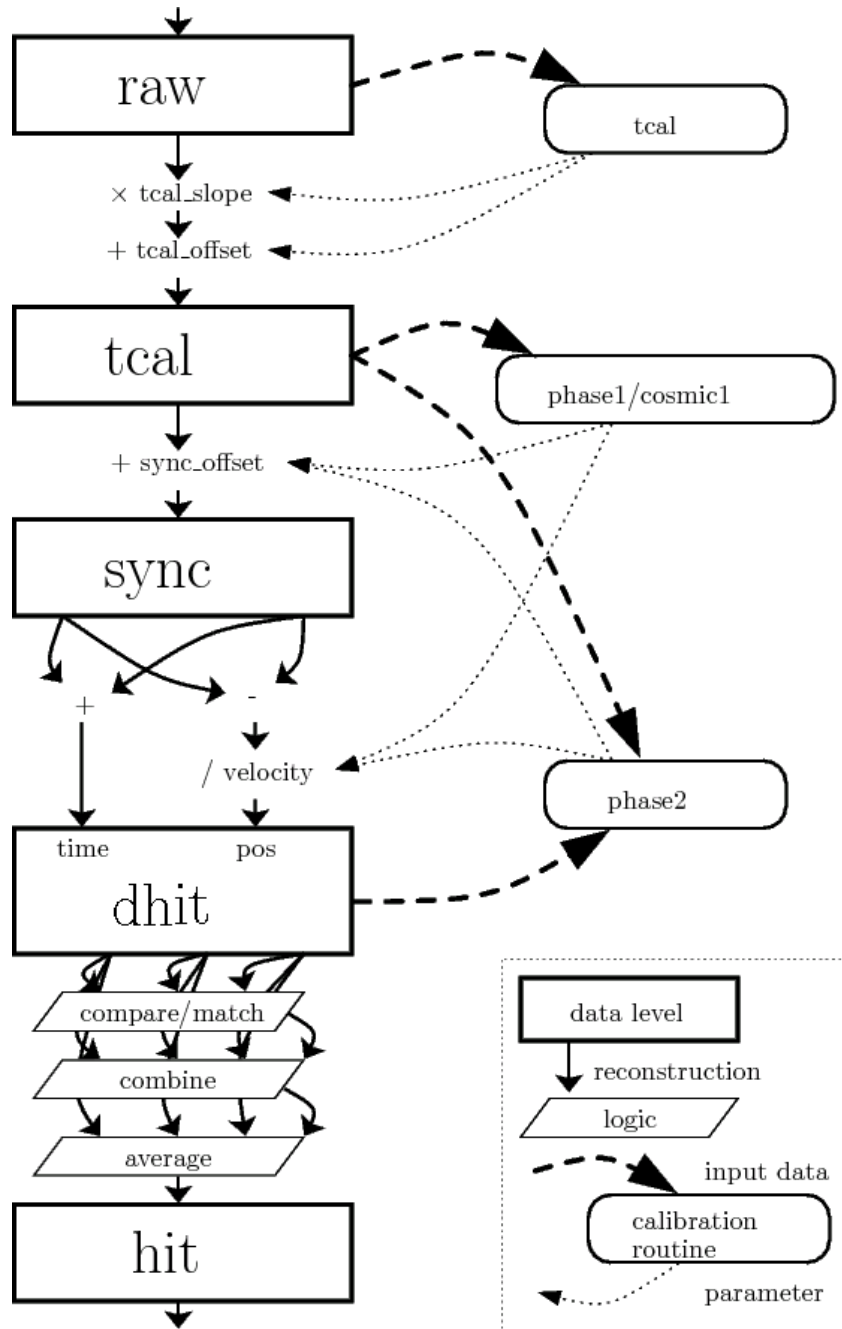


makes **live** and **sharp** testing of **equipment** and **methods**



under **realistic** conditions possible

land02 – focus and goal



Since 2003:

Batch mode operation!

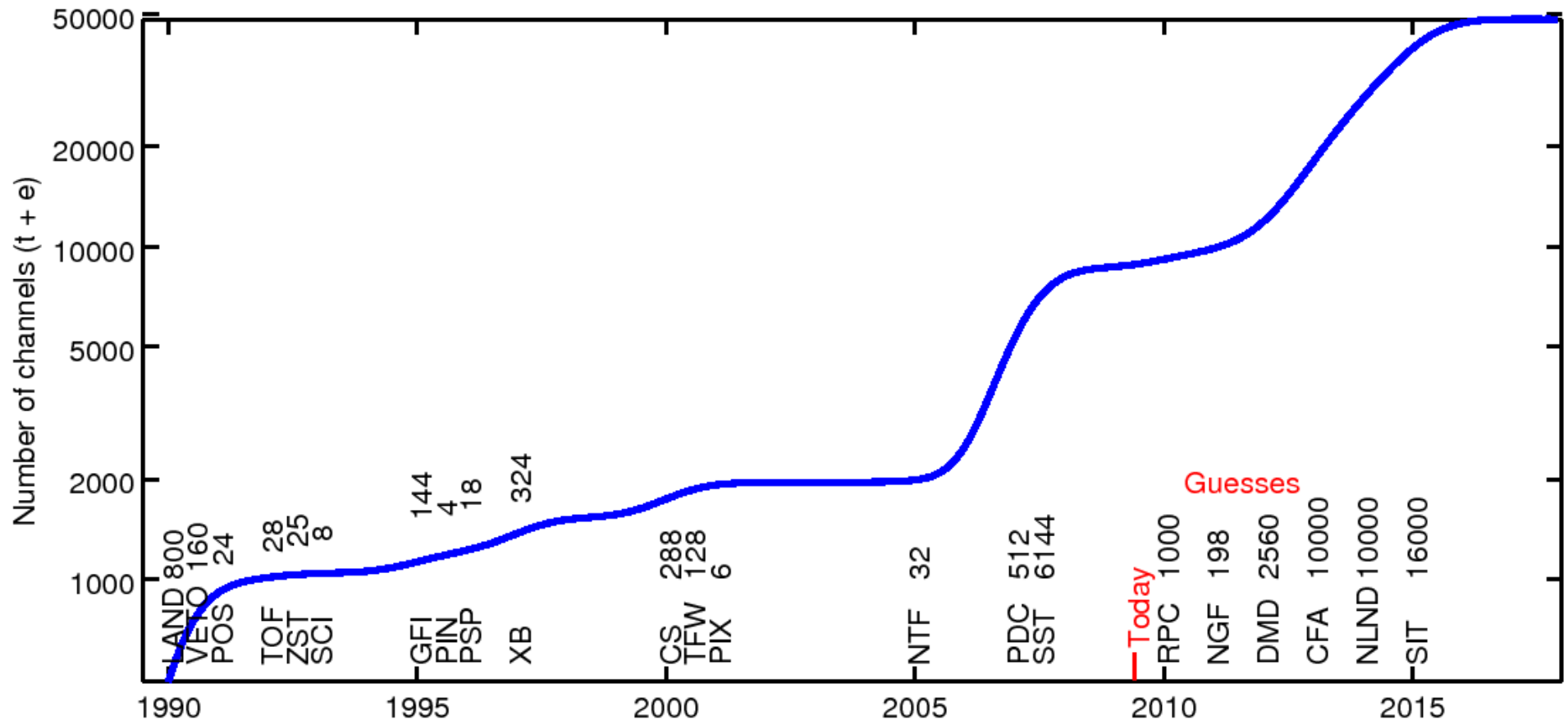
Focus on **calibration**
(reconstruction is 'easy' - straight-forward)

Purpose: calculations
from **unpacking** to **momenta**
(not an analysis framework PAW/ROOT)

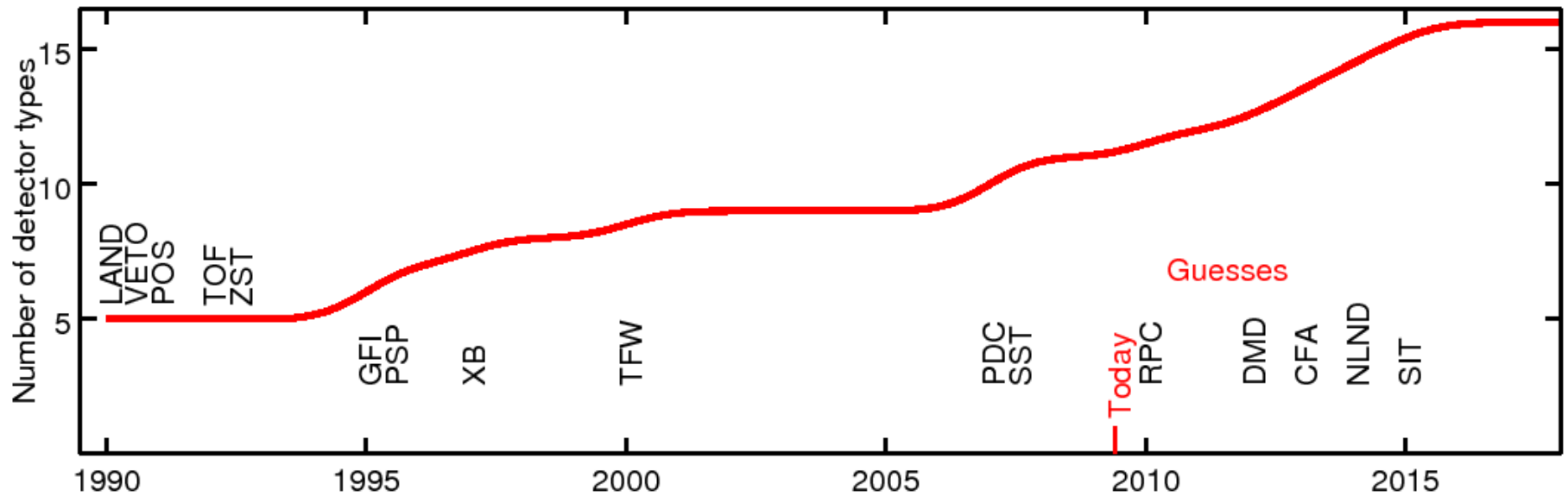
Calibration is multi-dimensional
(collect event data with 'special' properties)
(rarely just single-channel histograms)

Processing time matters! 15 min good,
2 h acceptable, 24 h unbearable

History I – channel counts



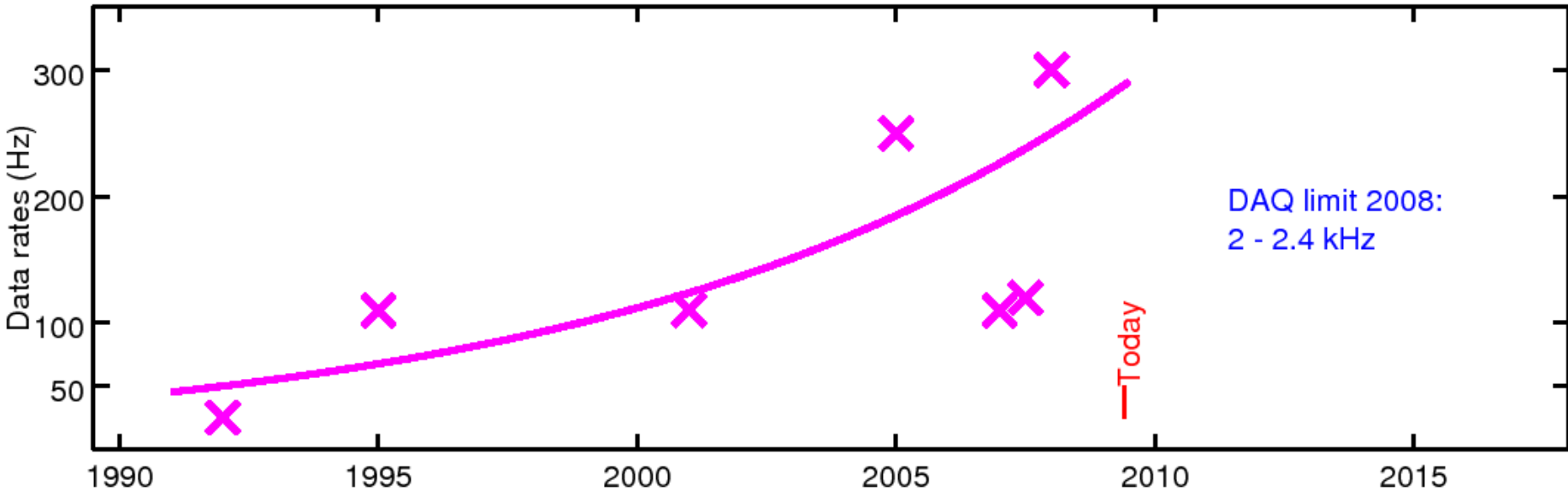
History II – detector types



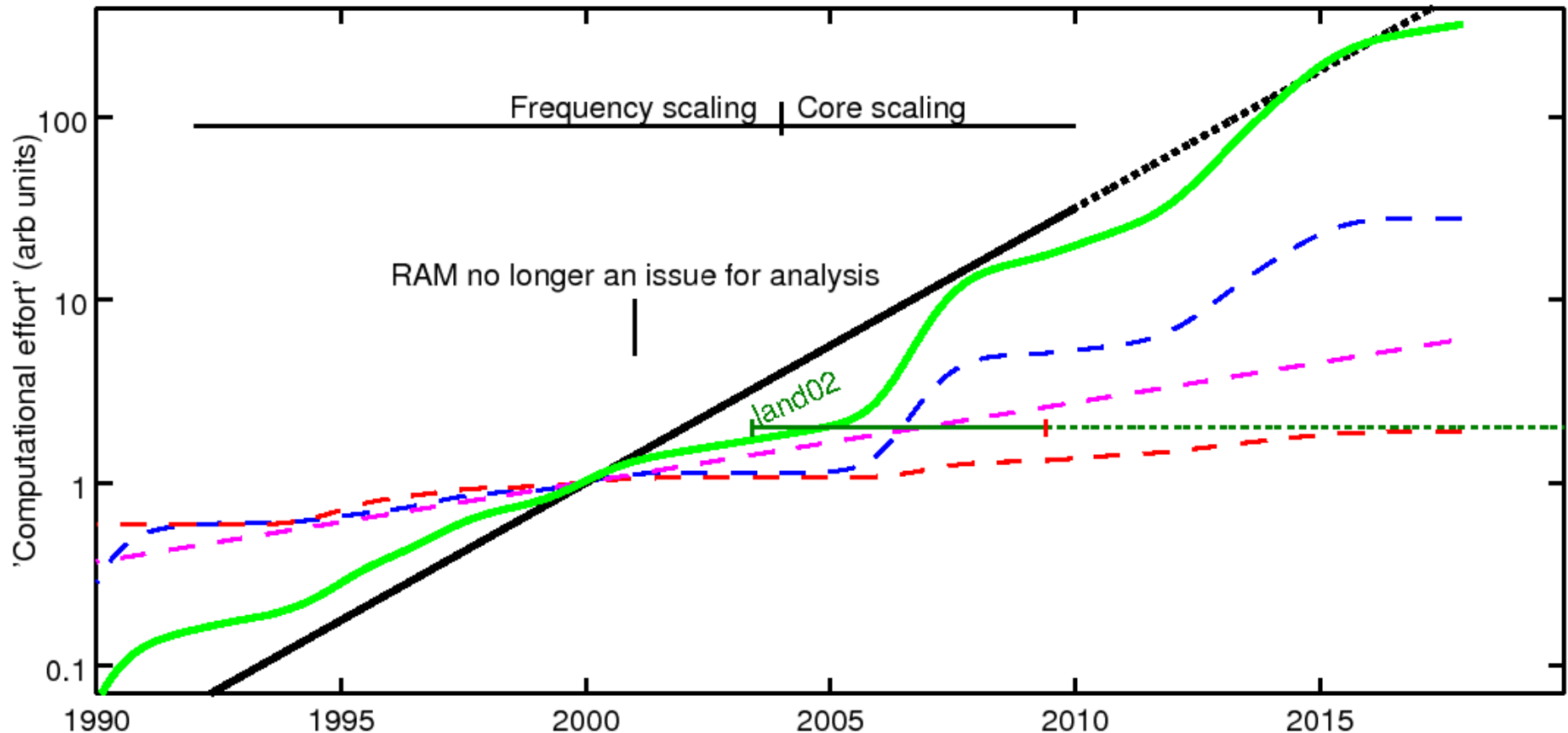
Each detector *type* requires routines for

- Calibration
- Reconstruction

History III – data rates



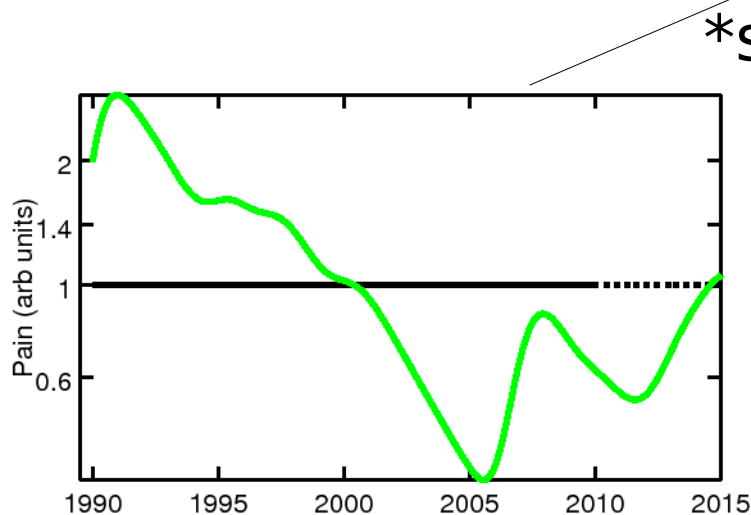
Growing with Moore's law



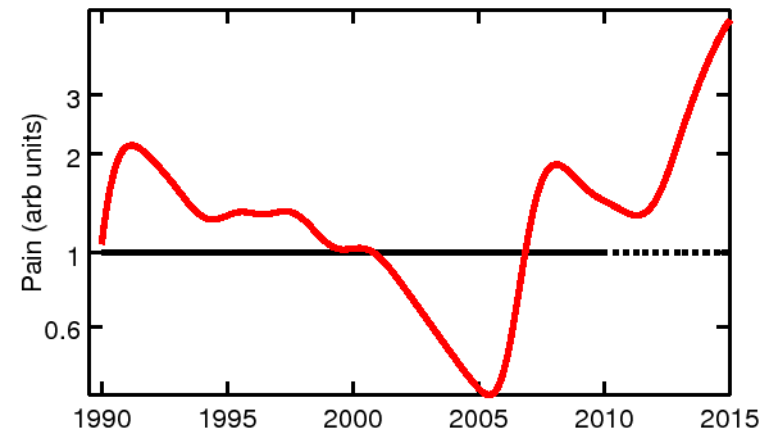
'Easy' scaling valid under assumption of efficient use of computers (i.e. adequate software)

Software is an **issue**

- Capable **calibration** methods and routines?
- Efficient reconstruction?
- Slow control params?



*sqrt(#ch)

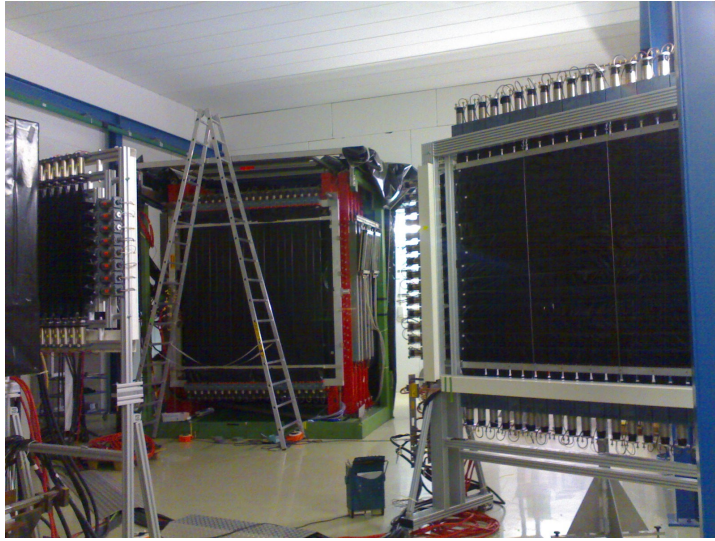


Improvements in **computer hardware** can handle the increase in **data sizes**

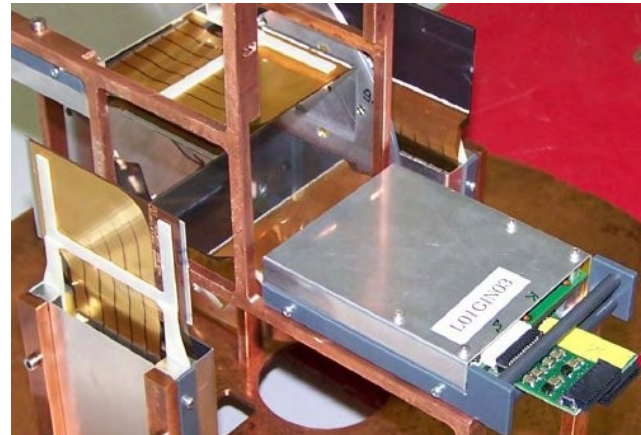
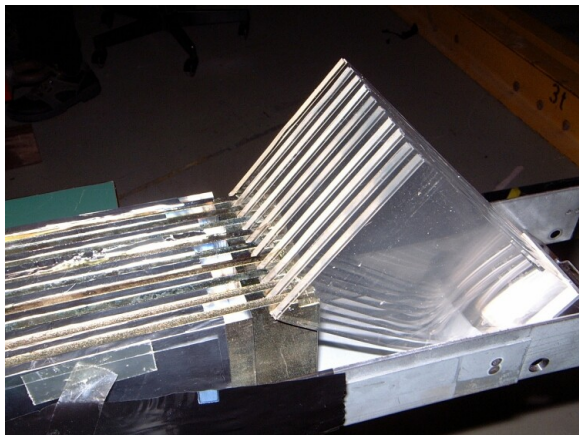
Unless the **software(s)** fulfil the requirements of the complex setup, then **no** amount of **computing hardware** will **help** to extract the *correct data*!

R³B has a curse

The ongoing analysis of LAND/R³B (test) experiments



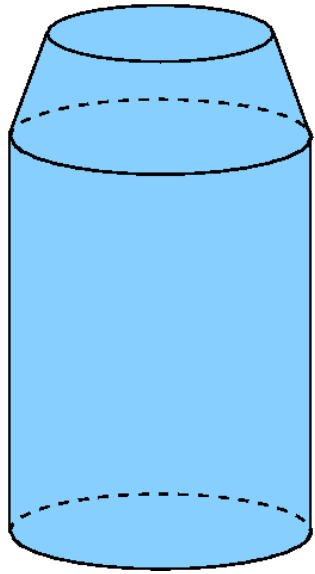
with almost **absent** focus on using **re-usable** procedures



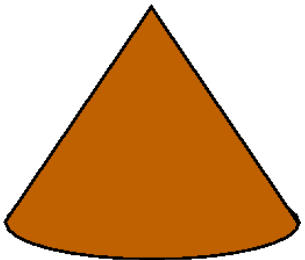
mar 2007: S223
aug 2007: S318
sept 2007: S296
aug 2008: S327

consumes development **resources** (and makes analysis take longer).

Priorities...

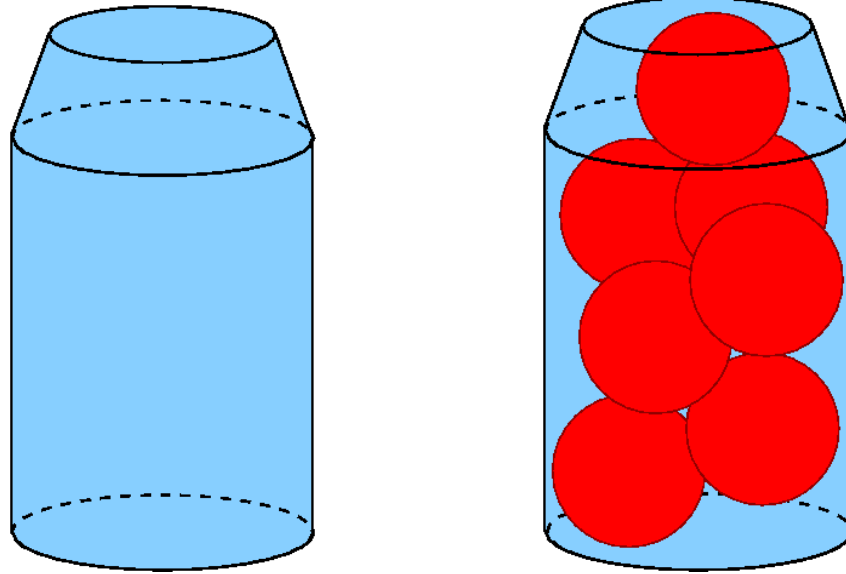


R^3B development tasks

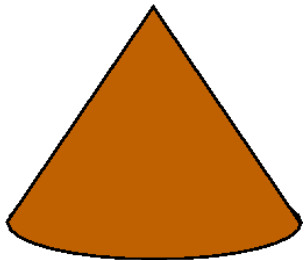


Analysing current experiments

Priorities...

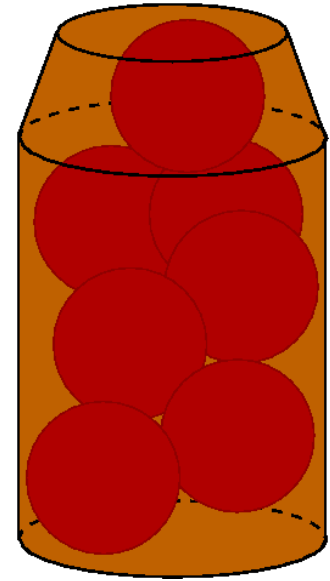
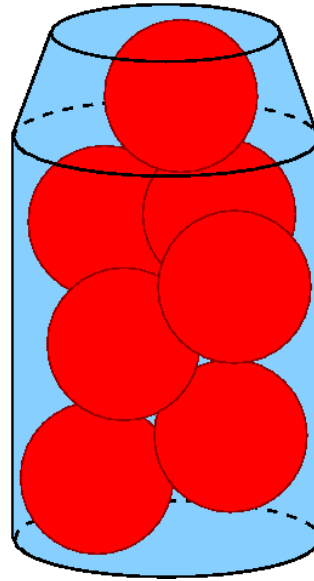
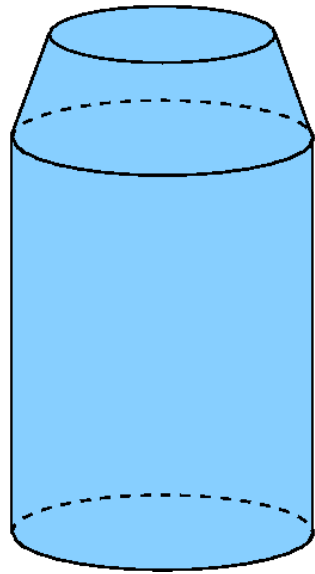


R³B development tasks

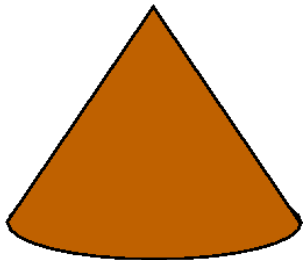


Analysing current experiments

Priorities...

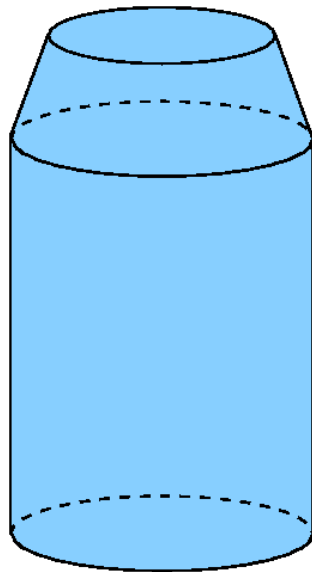
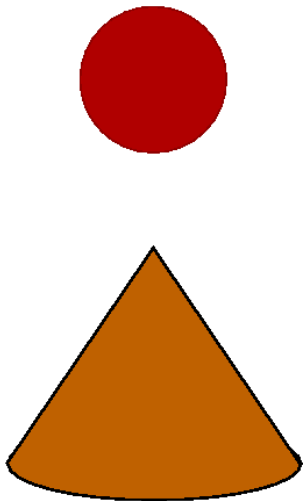
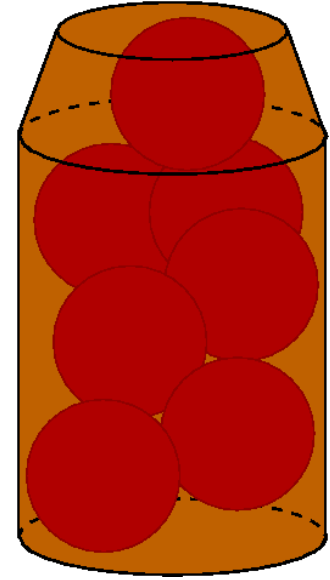
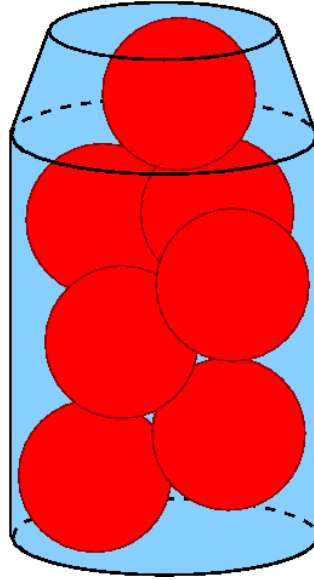
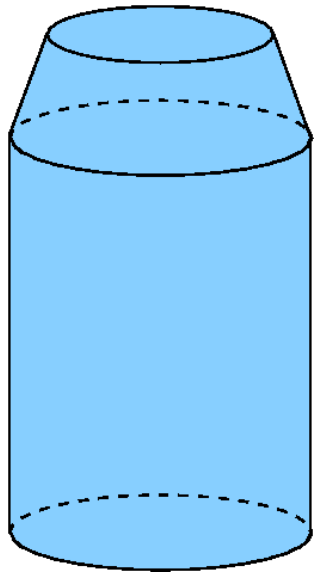


R^3B development tasks

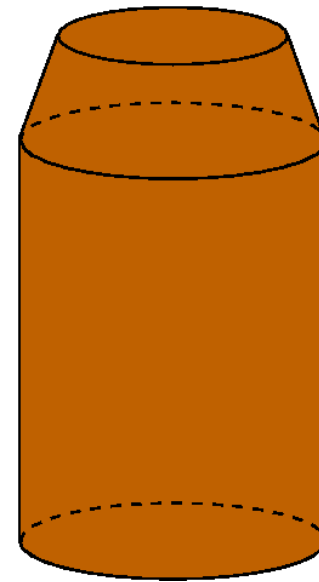
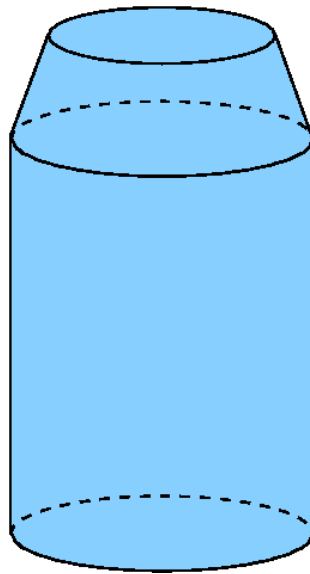
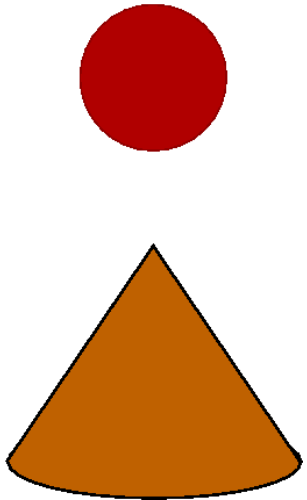
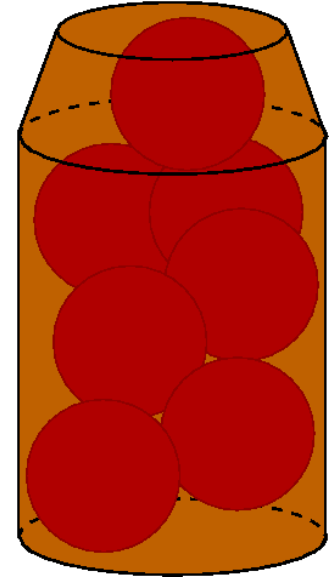
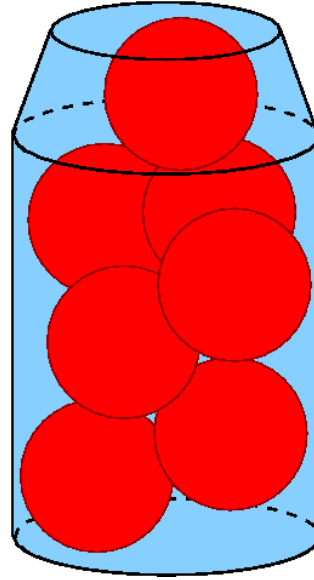
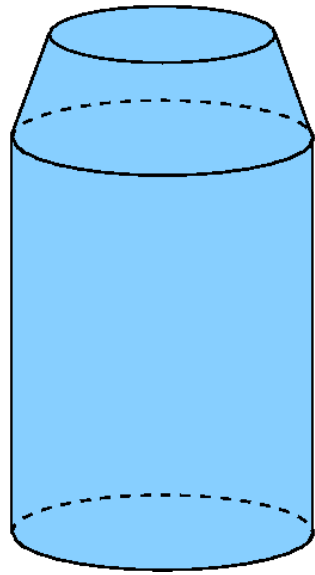


Analysing current experiments

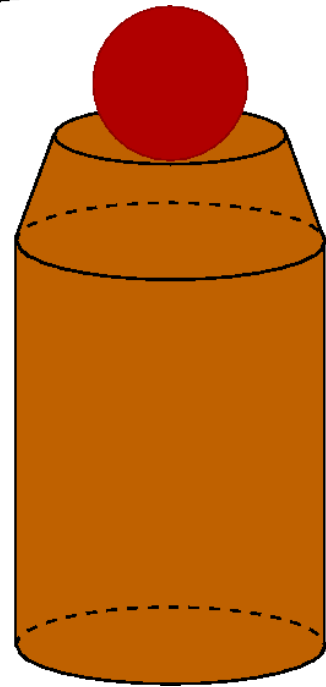
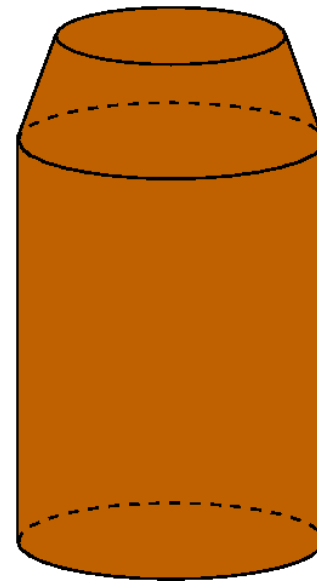
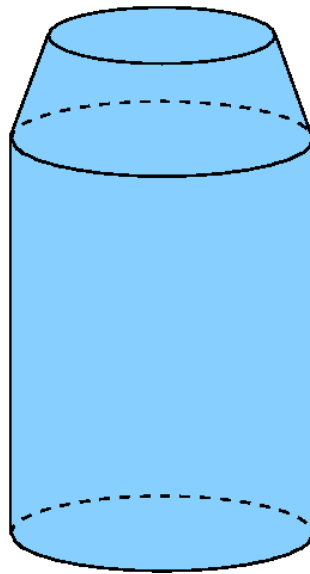
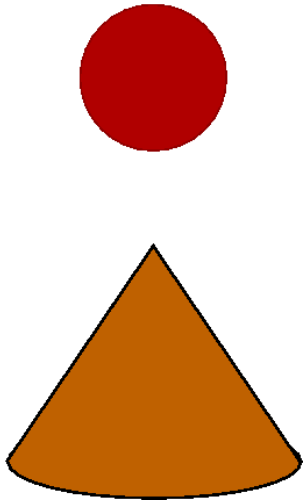
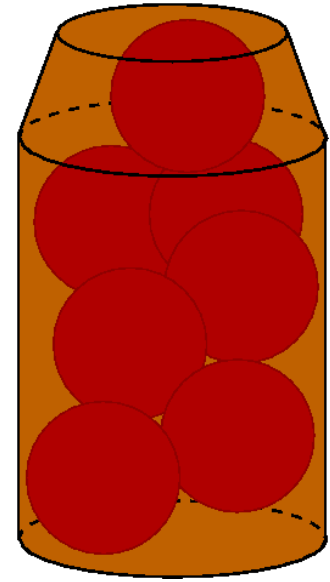
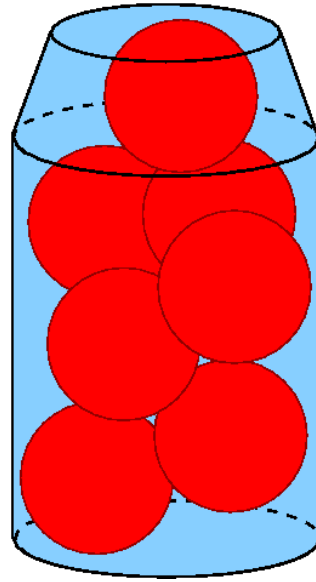
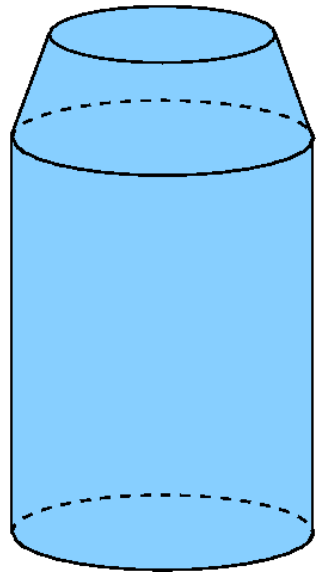
Priorities...



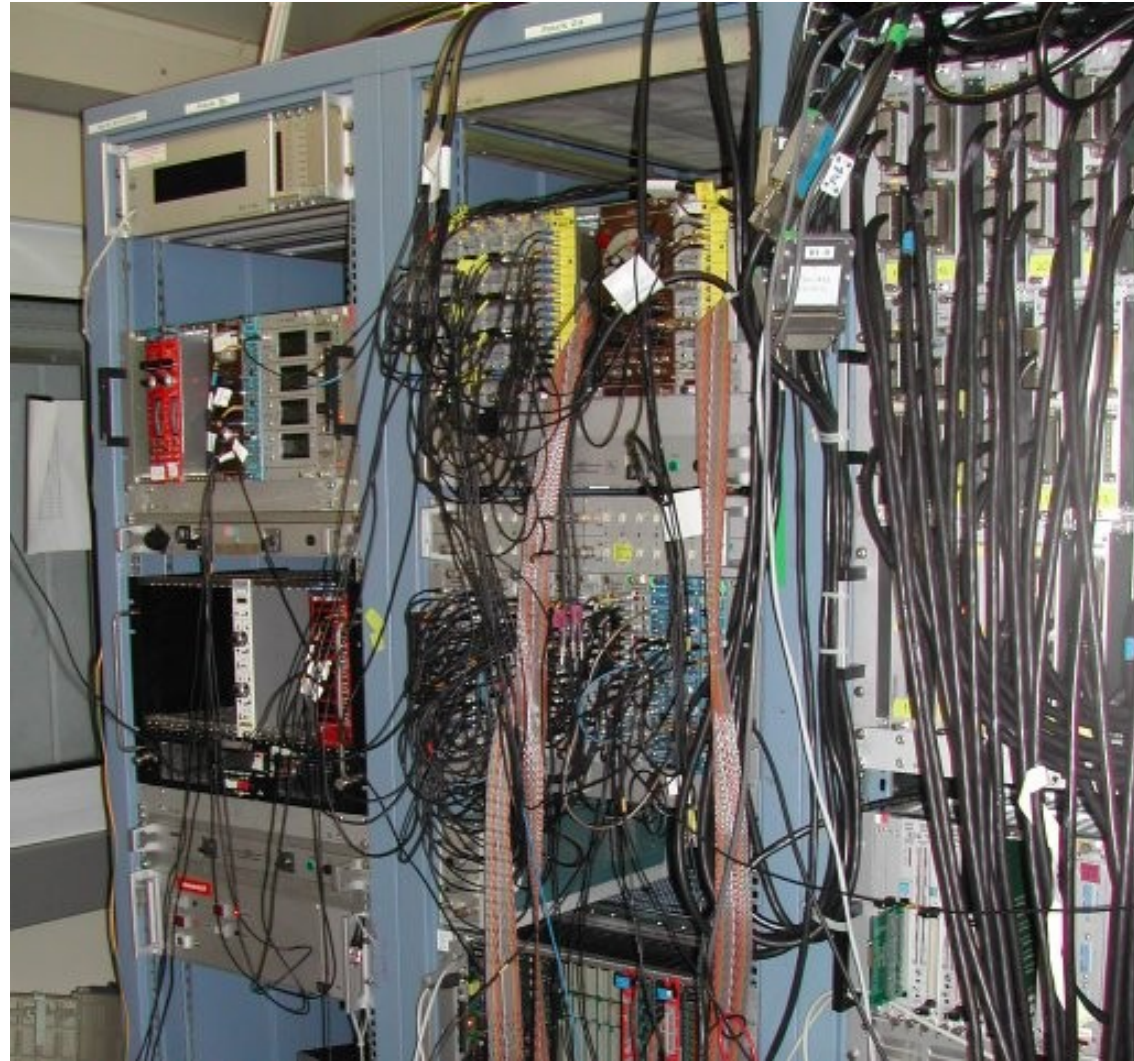
Priorities...



Priorities...



Just a few cables...



Solution / workaround ----->

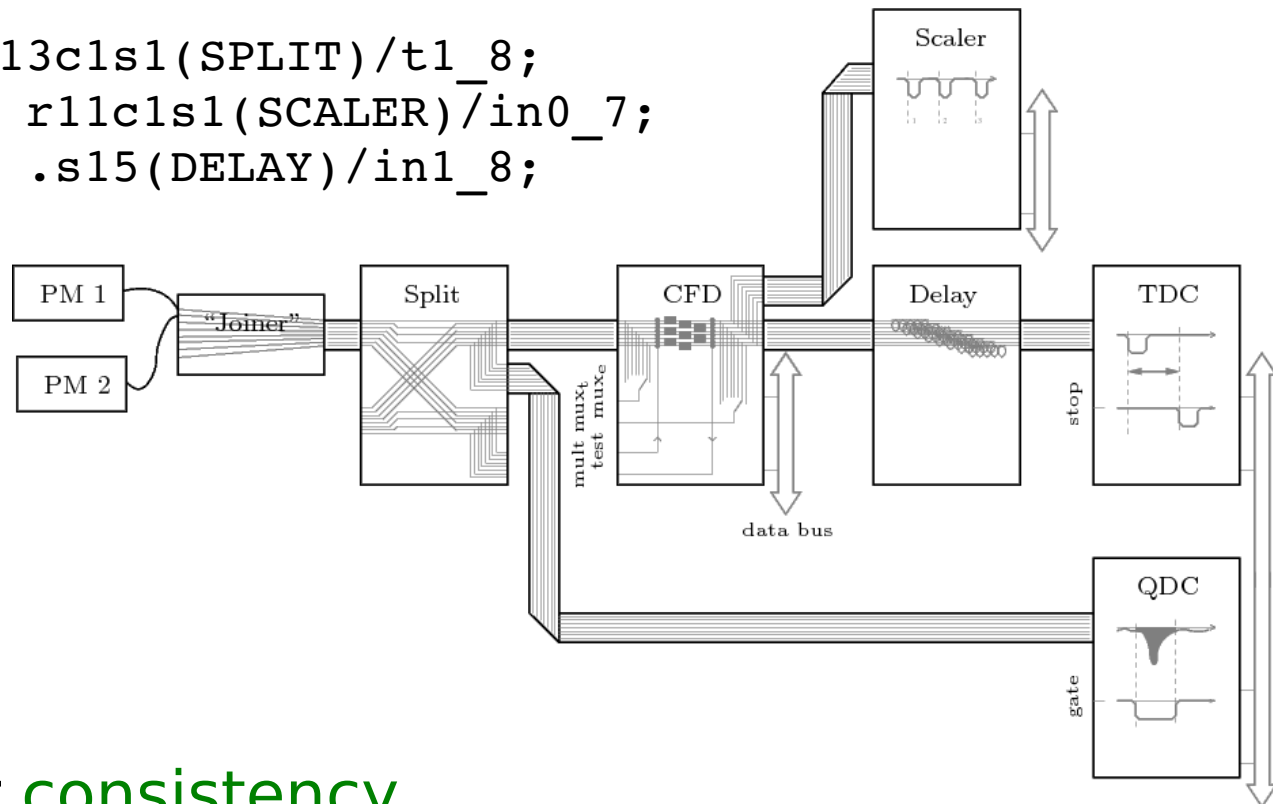
Support tool: cable documentation

```
CF8103(r12c2s1)
```

```
{  
  SERIAL("LCF6343"); // Comments
```

```
  in1_8: "N11 CFTN1" <- , r13c1s1(SPLIT)/t1_8;  
  th1_8: "1/1"         -> , r11c1s1(SCALER)/in0_7;  
  tb1_8: "CR2 SL1"    -> , .s15(DELAY)/in1_8;
```

```
  m:      .c11s3/in1;  
  test:   .s23/out1;  
  mux_tb: .s22/in1a;  
  mux_e:  .s22/in5a;  
  mux_mon: .s22/in9a;  
}
```



C-like text format.

Parsed and checked for consistency.

(Every cable documented twice – at both ends.)

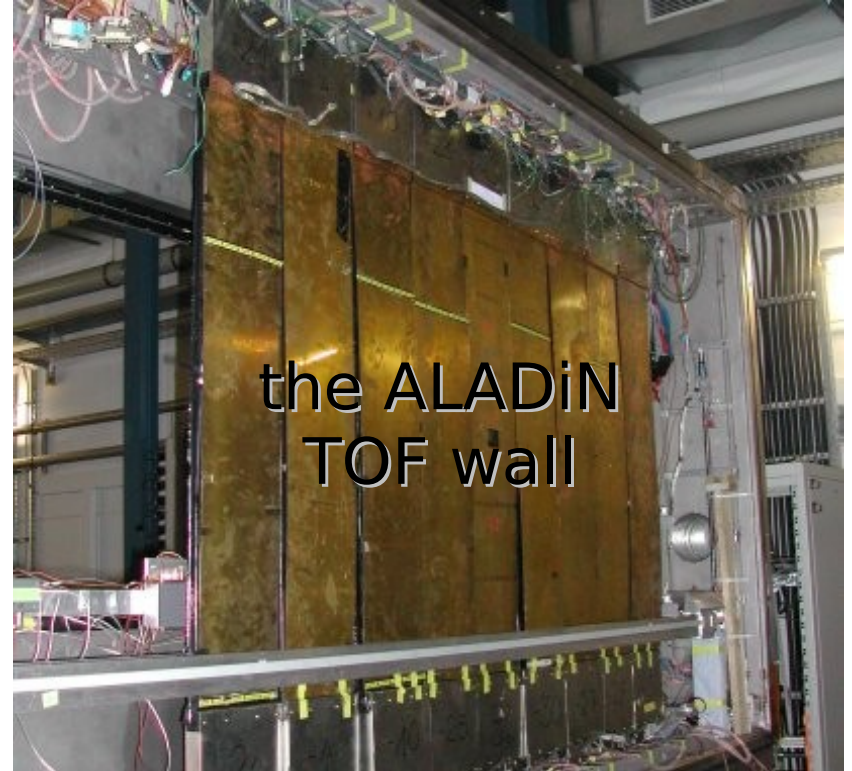
Checker generates tables for unpacking and slow-control.

S304 cable doc

Electronics chain for

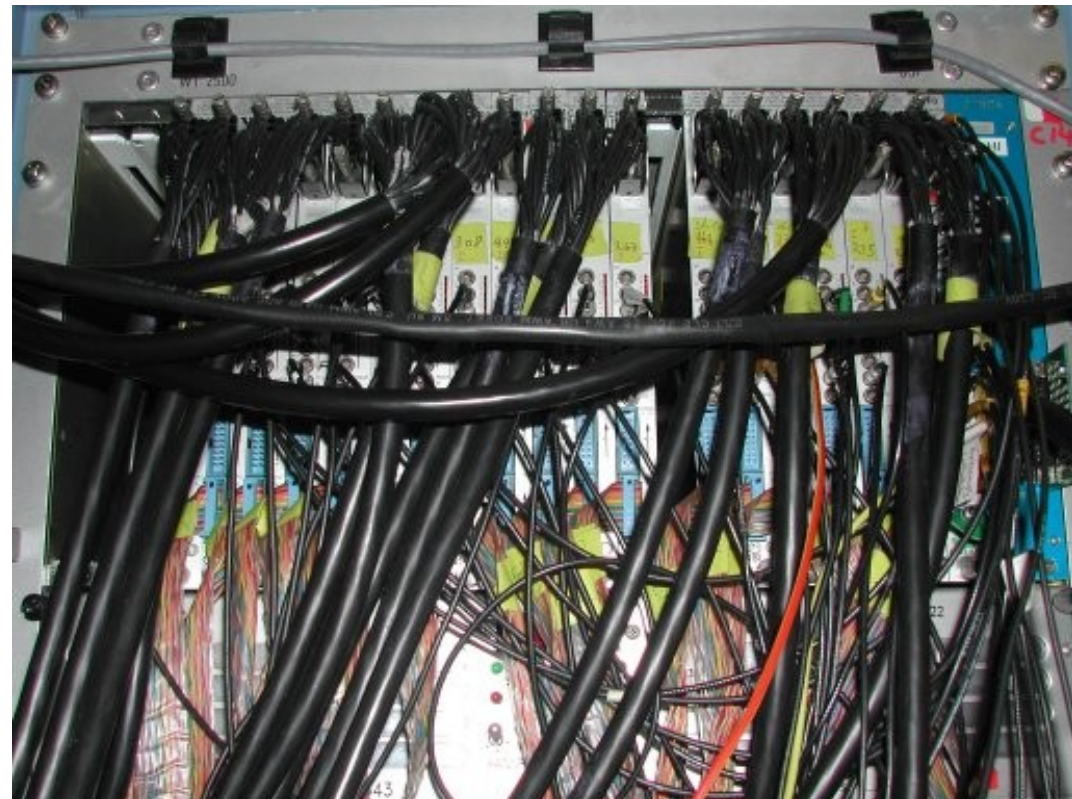


the ALADiN
TOF wall



1 PhD, < 1 week
(= a few days)

→ working unpacking
and mapping



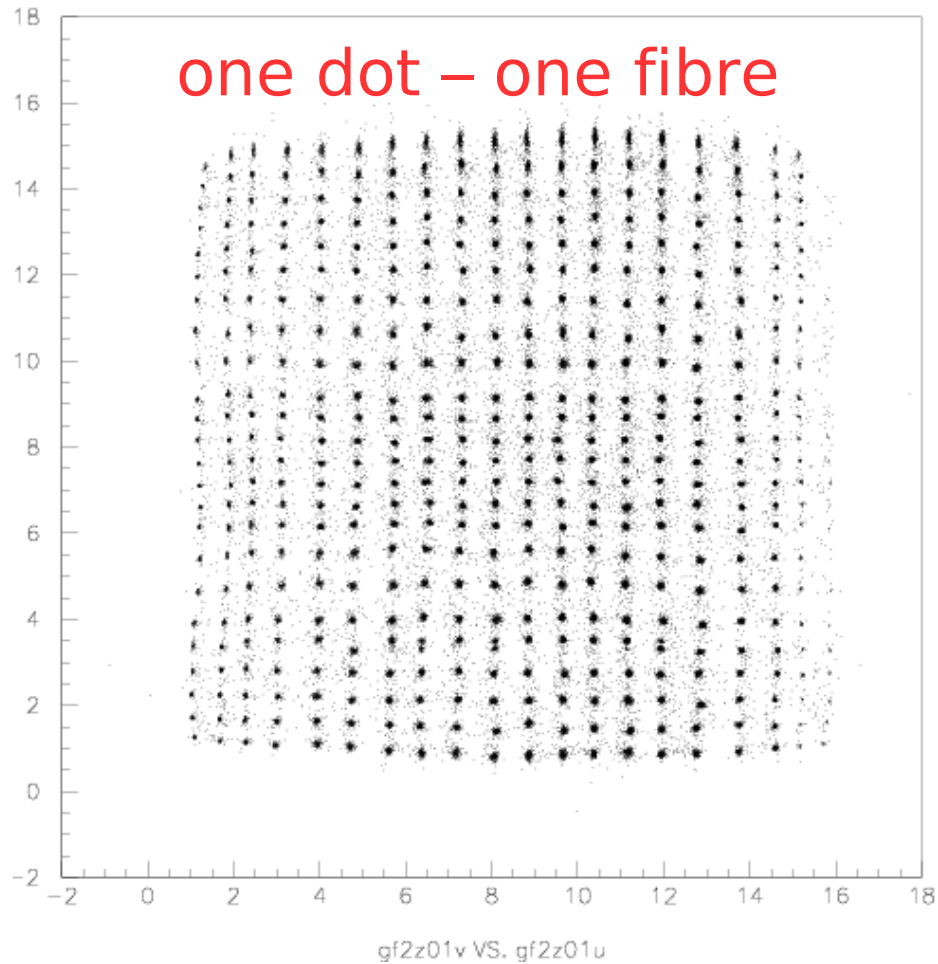
Free Running / Triggerless / software trigger – no problem

While still having events:

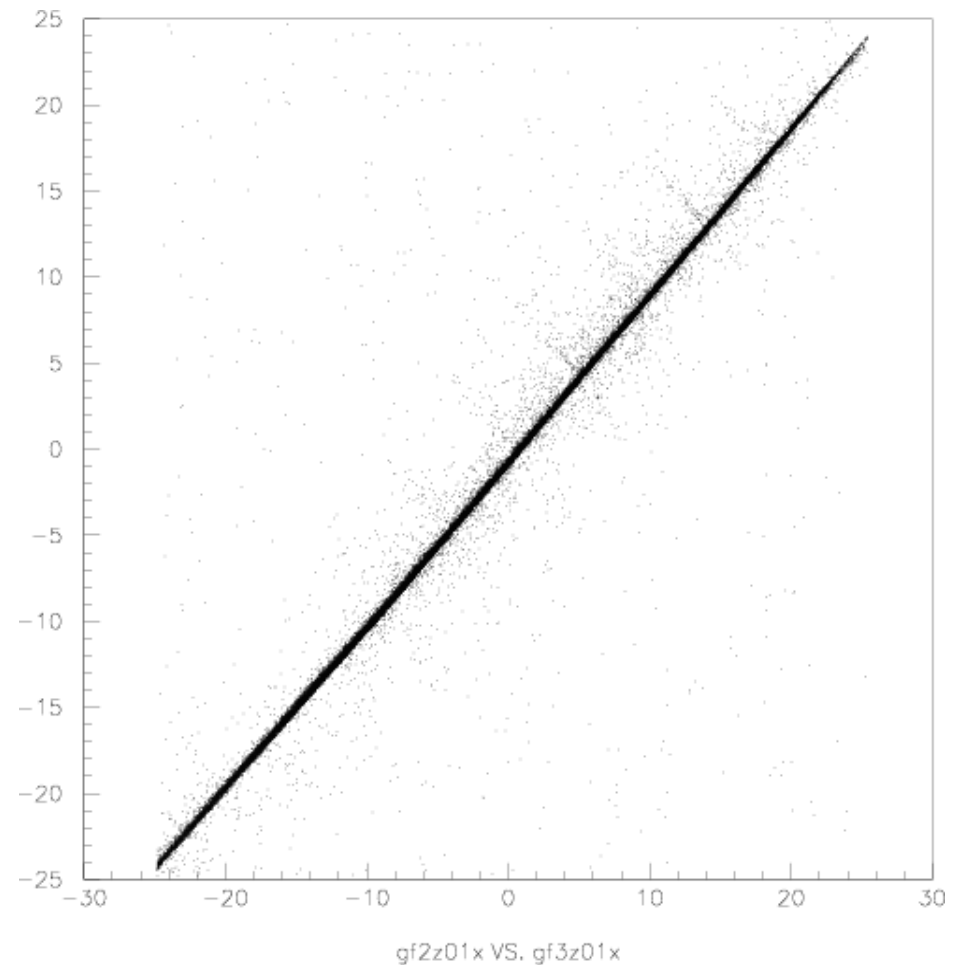
- Calibration and reconstruction logics is preserved.
- Minor modifications (not worse than other hardware replacements) of unpacking etc.



GFI – large scintillating fibre detectors

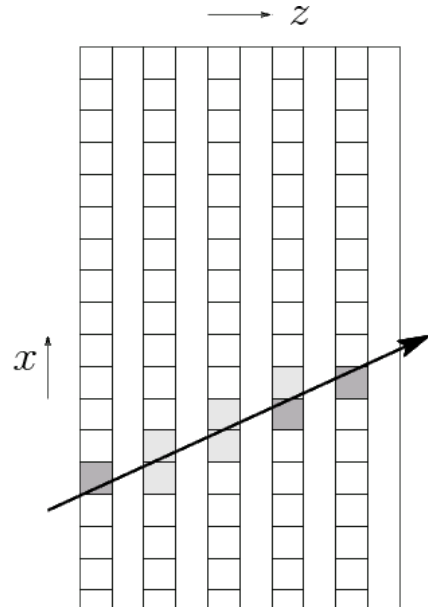
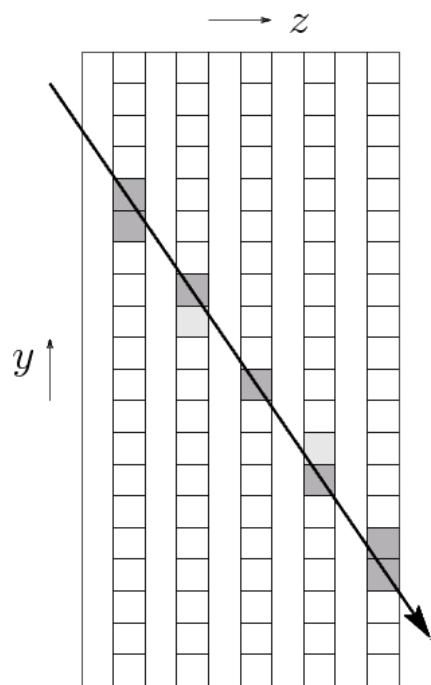


15 min beam (sweep run)
+ few hours calibration
= fully calibrated detector $\Delta x=1\text{mm}$

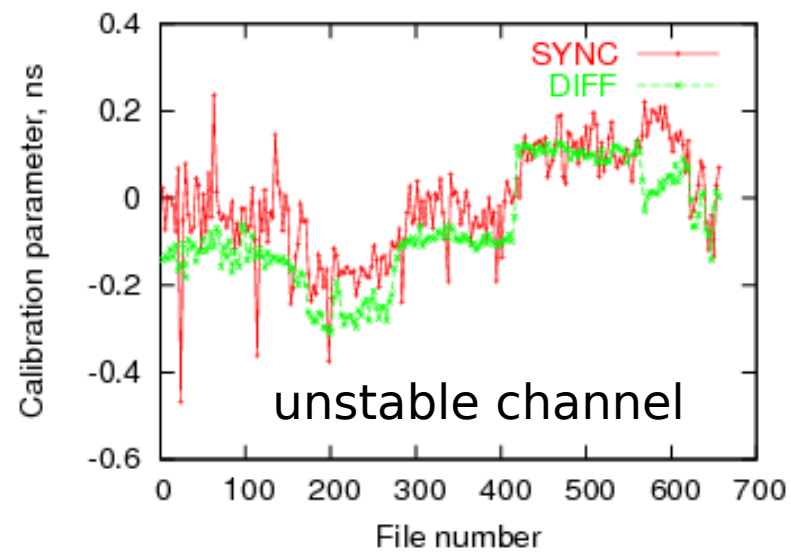
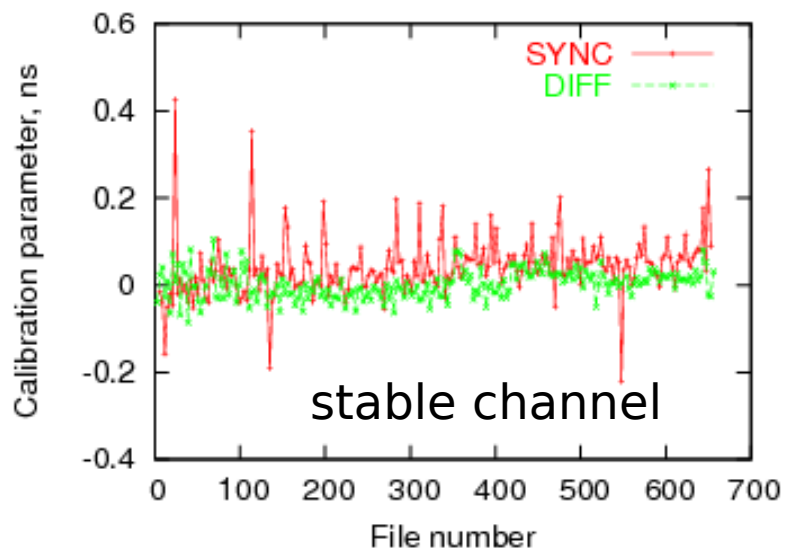
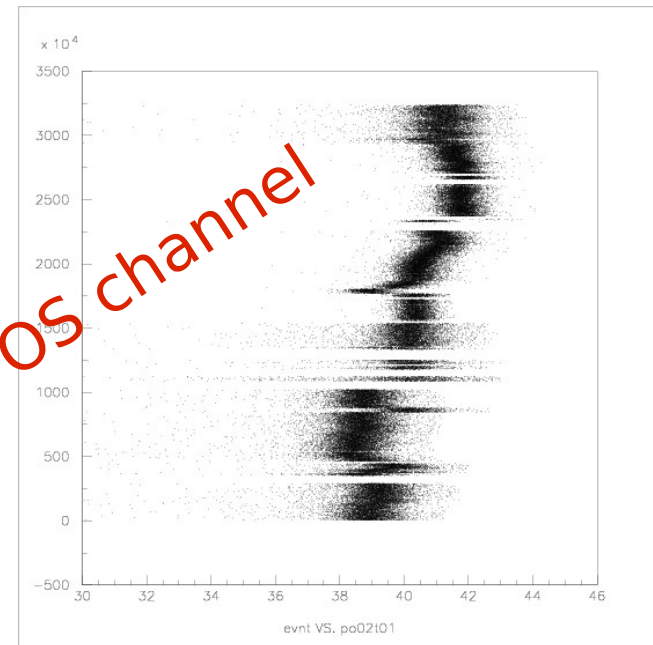


Kripamay Mahata

LAND cosmic calibration / time varying parameters



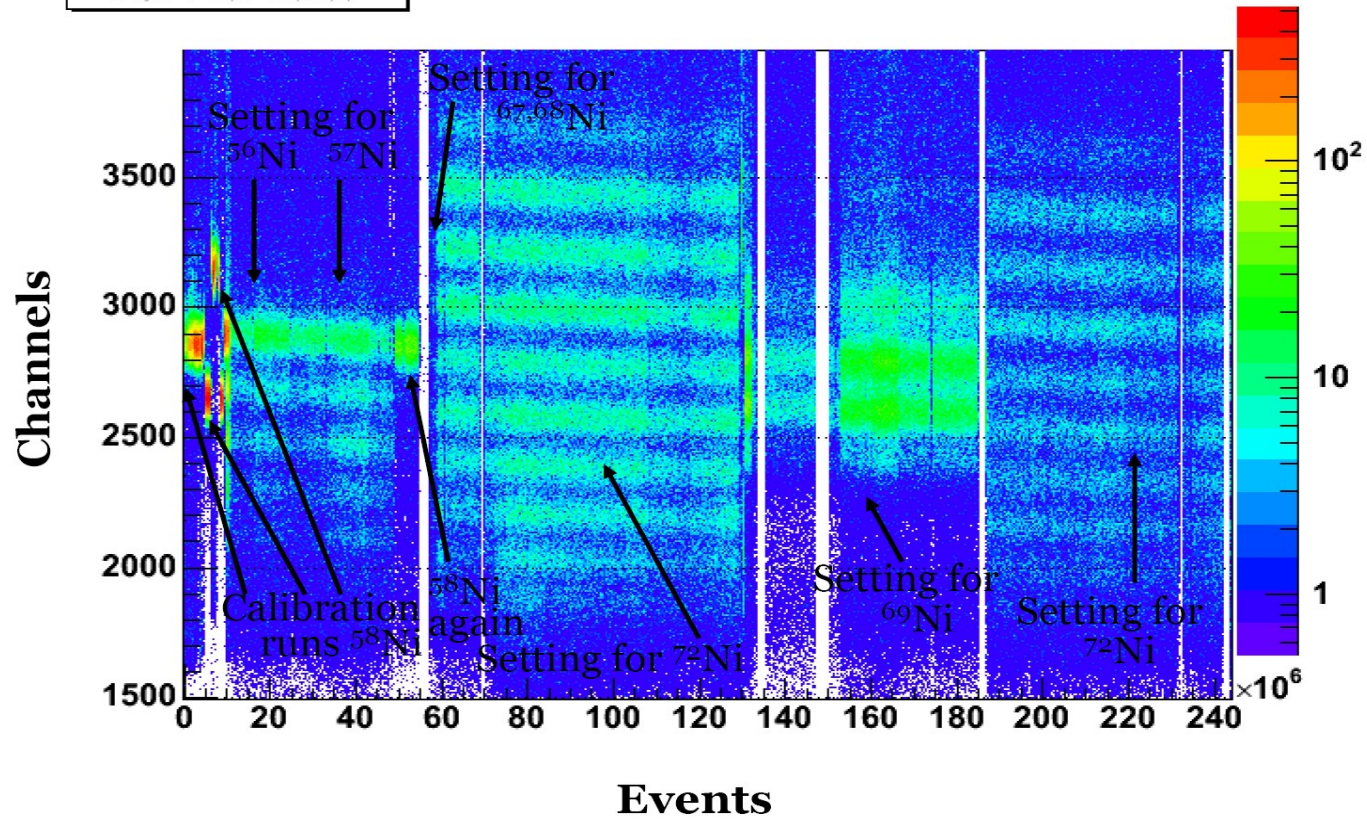
unstable POS channel



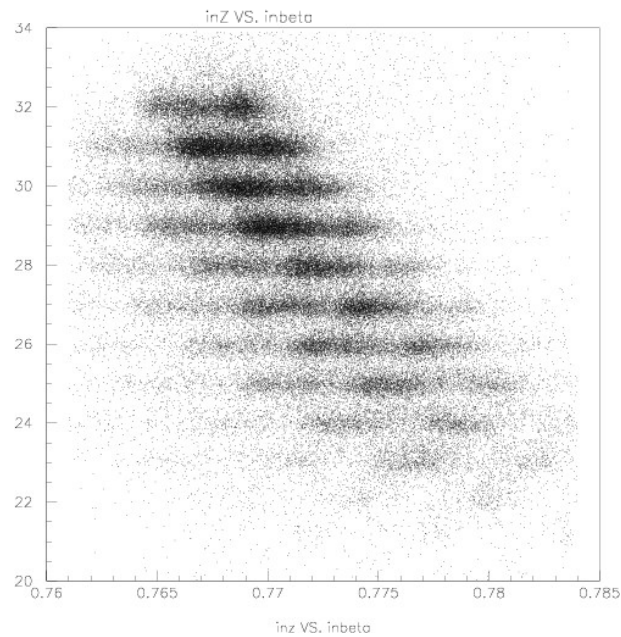
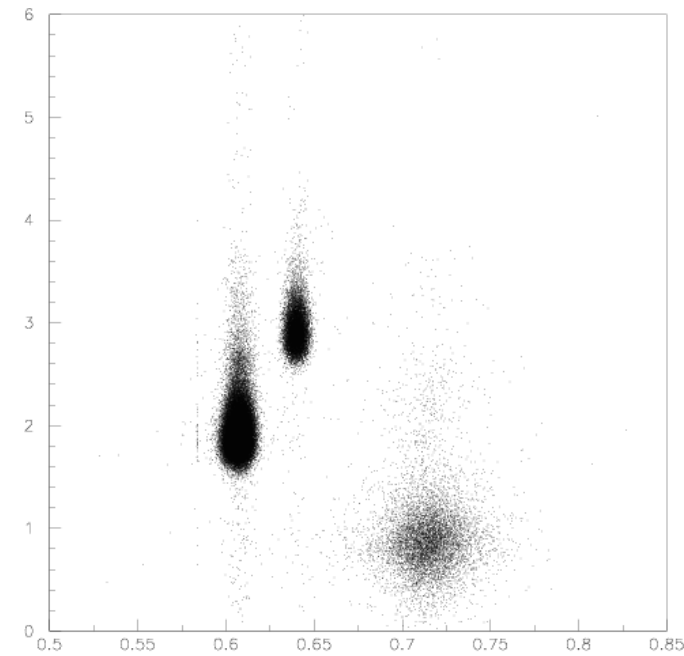
Incoming tracking

$x, x', y, y', t_0, \text{beta}, Z, (A/Z)$

PSP1 vs Entries

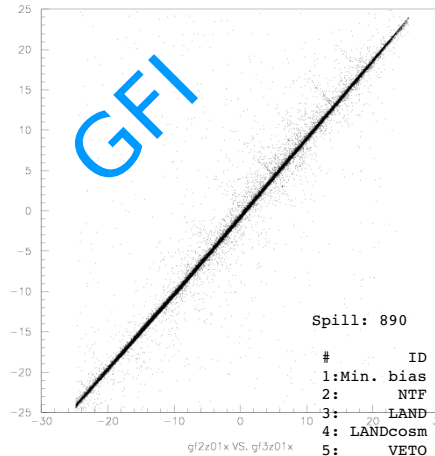
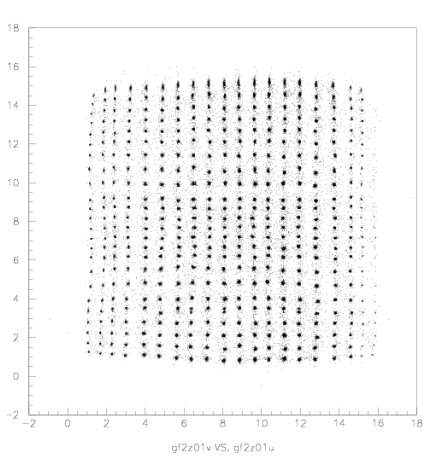


Stefanos Paschalis



Ask not what the programs can do for you,

Kripamay Mahata

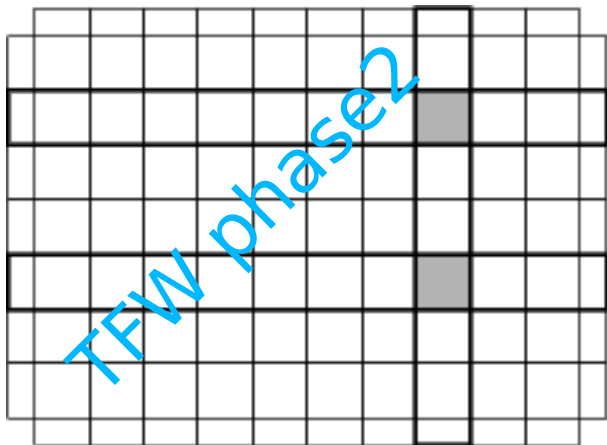
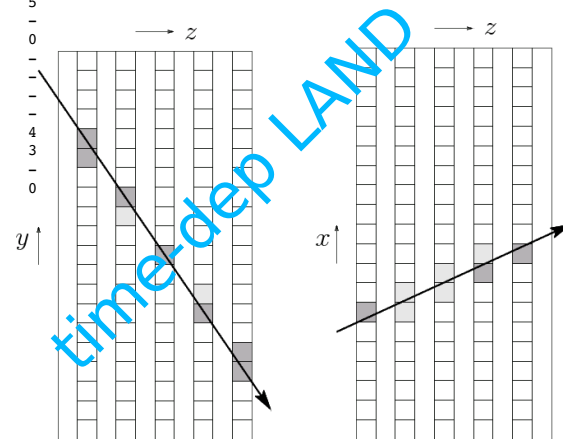
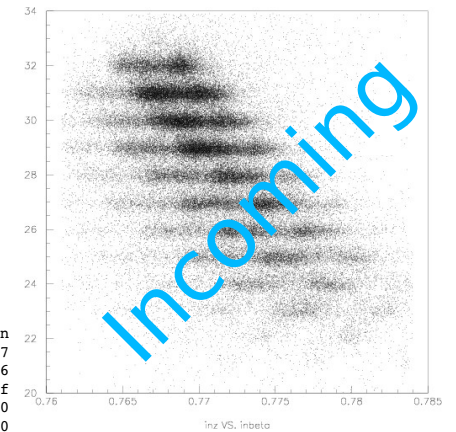


Spill: 890 TrigType: 13 Sat Aug 30 08:04:47 2008

#	ID	Raw	#	ID	B. DT	A. DT	A. Red	FC effDT	Red 2^n
1:	Min. bias	59352	# 1:	Good Beam	59350	37676	294	0% 36.5%	128.1 7
2:	NTF	58180	# 2:	GP+NTF	51527	13953	531	0% 34.1%	63.9 6
3:	LAND	5906	# 3:	GP+CB OR	42764	28195	0	- 34.1%	off
4:	LANDcosm	5906	# 4:	GB+CB Sum	808	535	535	0% 33.8%	1.0 0
5:	VETO	159	# 5:	GP+TFW	3978	2601	2601	0% 34.6%	1.0 0
6:	TFW	15854	# 6:	GB-pileup	52830	34802	188	0% 34.1%	32.0 5
7:	CB OR	360971	# 7:	PIX	0	0	0	- -	-
8:	TFW cosm	15840	# 8:	GP+LAND	877	586	86	0% 33.2%	1.0 0
9:	NTF cosm	58299	# 9:	CB muon	0	0	0	- -	-
10:	CB Sum	2660	# 10:	LANDcosm	0	0	0	- -	-
11:	FRS S8	662377	# 11:	TFW cosm	0	0	0	- -	-
12:	CB dlyOR	360815	# 12:	CB gamma	4	0	0	-100.0%	-
13:	CB dlySum	2660	# 13:	clock	1025	811	50	0% 20.6%	16.2 4
14:	PIX	2	# 14:	TCAL	1021	760	95	0% 25.6%	8.0 3
15:	!pileup	53275	# 15:	BOS	0	0	0	- -	-
16:	Spill ON	0	# 16:	EOS	1	1	1	0% 0.0%	1.0 0

Accepted physics: 4870 476.7 Hz Duration: 10215 ms
 offspill/calib: 146 1.3 Hz
 4587 cu (exp)
 4590 within 2 us: 0.01 (0.012) Within pileup reject: 0.110
 4597 within 4 us: 0.00 (0.023)
 4615 within 10 us: 0.006 (0.059)
 0 within DT: 0.000 (2.579) DT: 21.64% avg: 440 us

Stefanos Paschalis



Tudi LeBleis

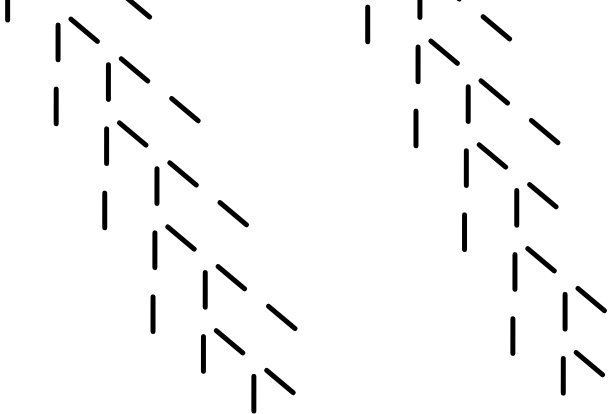
Yuliya Aksyutina

Audrey Chatillon

but what you can do for future experiments.

Tracker

Multi-hit



Multi-track

Generic
(exp't indep)

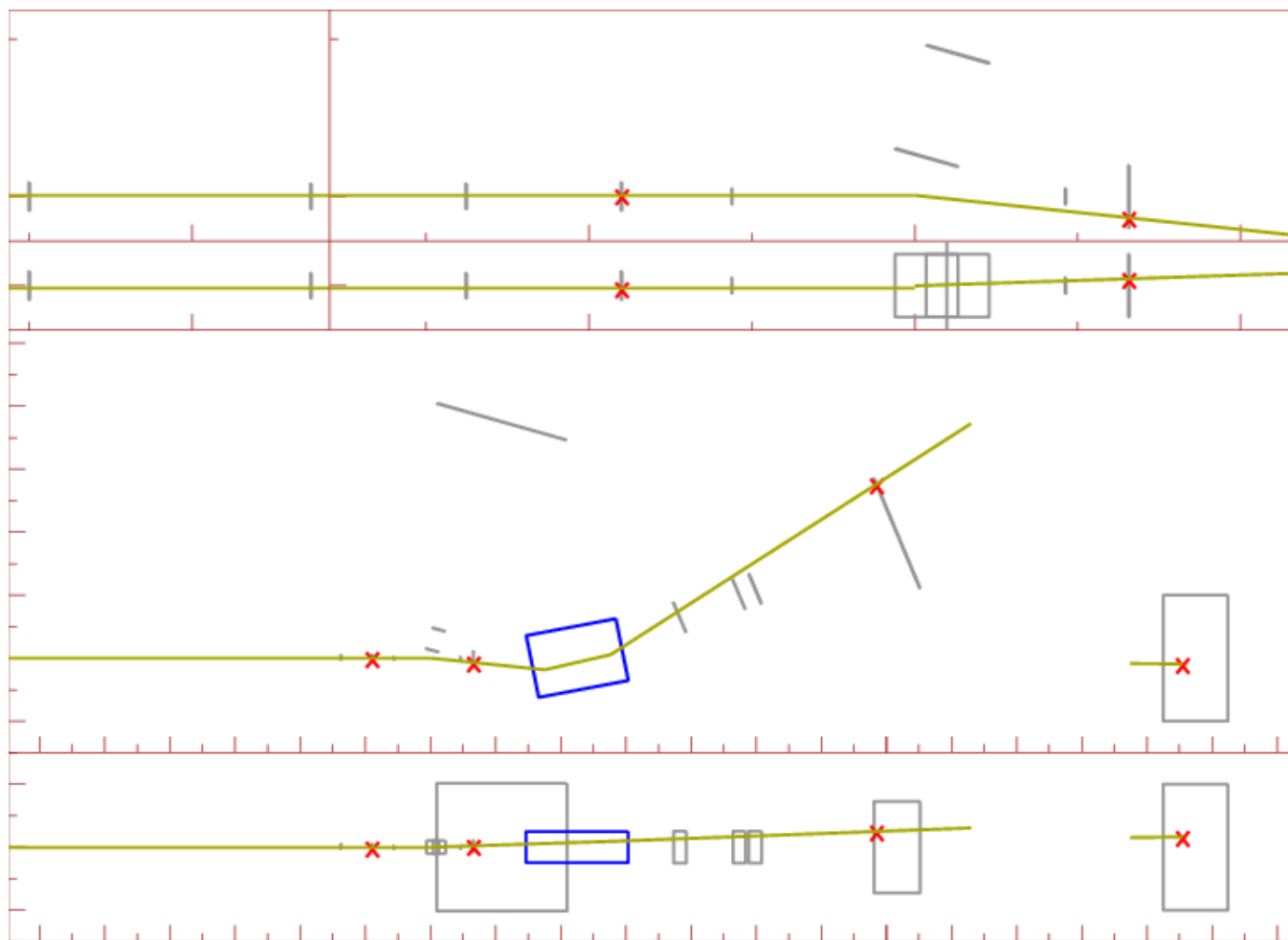
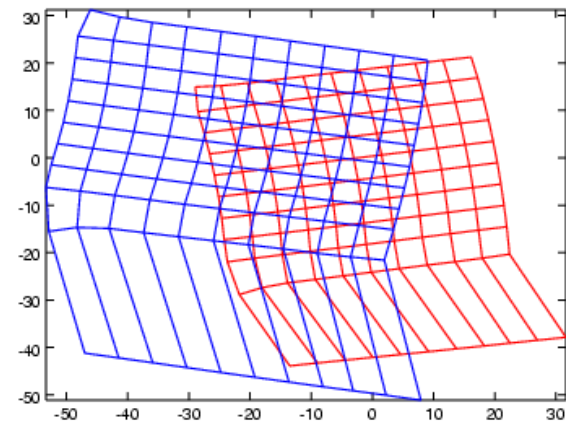
Field map

Energy loss (ATIMA)

Runge-Kutta

CPU-intensive
(interpolation)

Most likely track



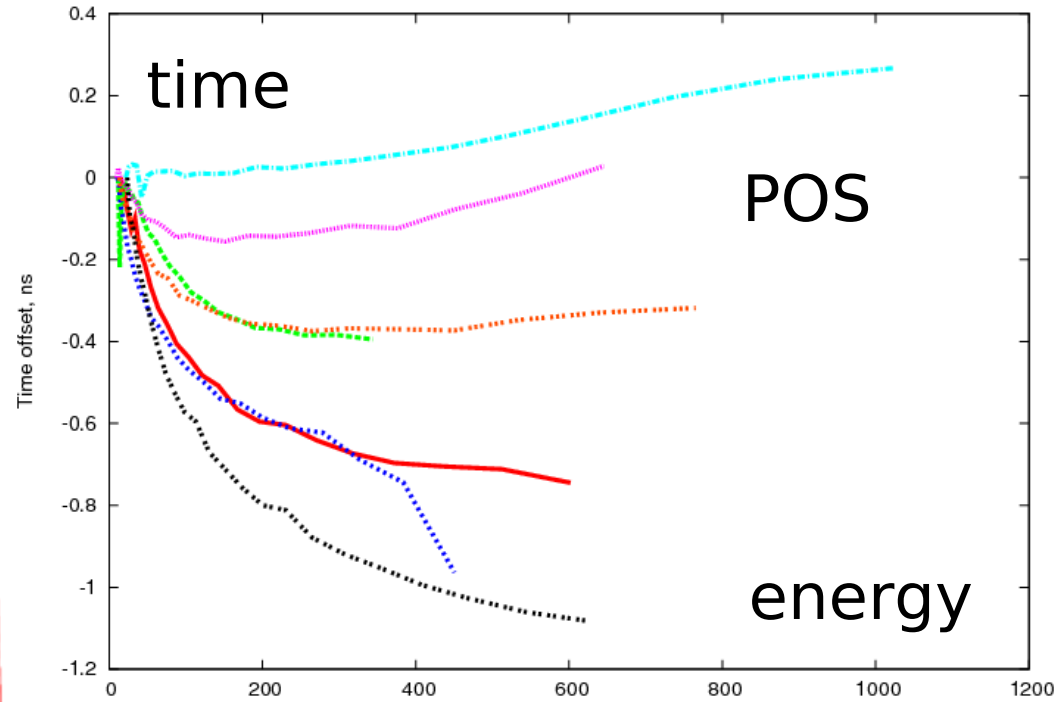
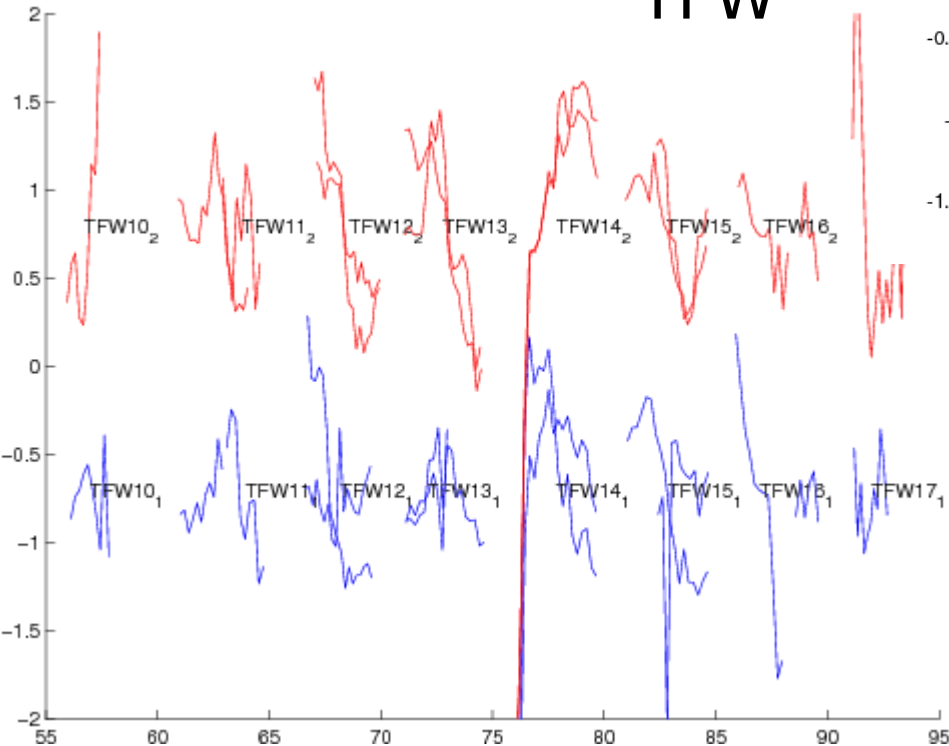
Determining walk

$$t_{\text{real}} = t_{\text{measured}} + f(e)$$

$$t_{\text{real},1} = t_{\text{real},2}$$

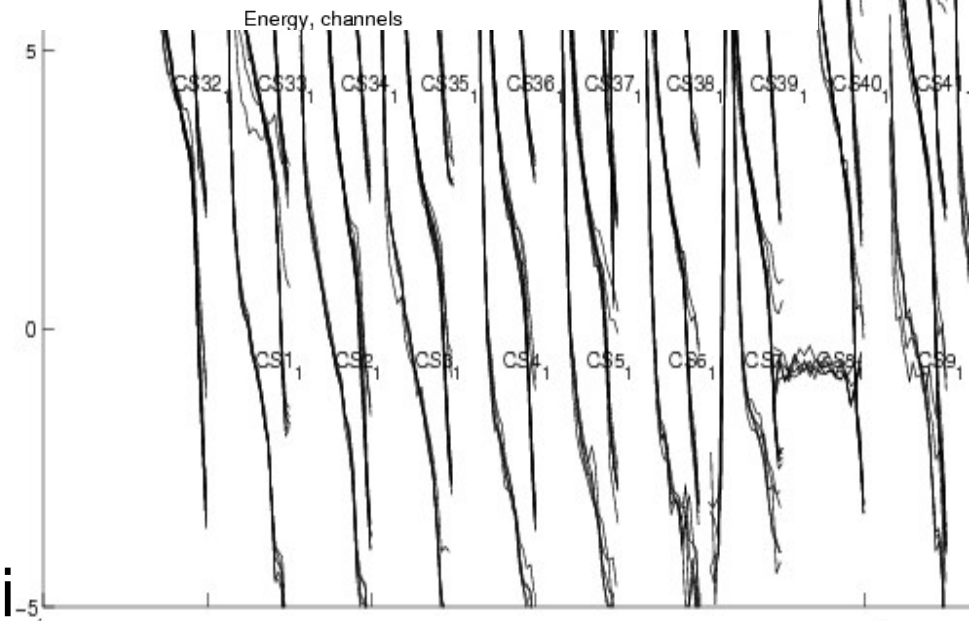
$$(t_{m,1} + f_1(e_1)) - (t_{m,2} + f_2(e_2)) = 0$$

TFW



TACquila - no CFD...

CsI



Piece work / sweatshop won't work

Parameters for one channel (T+E):

- gain + offset (time)
- pedestal + gain (energy)
- walk $t_{\text{real}} = t_{\text{measured}} + f(e)$
- some detector specific parameters



Pre 2006 LAND setup: ~1500 channels, 2007/2008: 8000 ch

Assume 5 min / ch for easy, 5000 ch monotone calibration
=> 25000 min = 400 h = 50 days = **10 weeks!**

Impossible during experiment start-up (on-line)

Piece work / sweatshop won't work II

Pre 2006 LAND setup: ~1500 channels, 2007/2008: 8000 ch

Assume 5 min / ch for easy, 5000 ch monotone calibration
=> 25000 min = 400 h = **50 days** = 10 weeks!

Multiply by time varying parameters

Need **effective** and **robust** (= simple) **automatic** calibration routines

Not fully automatic (bound to **break**),
but do **99%** of the work



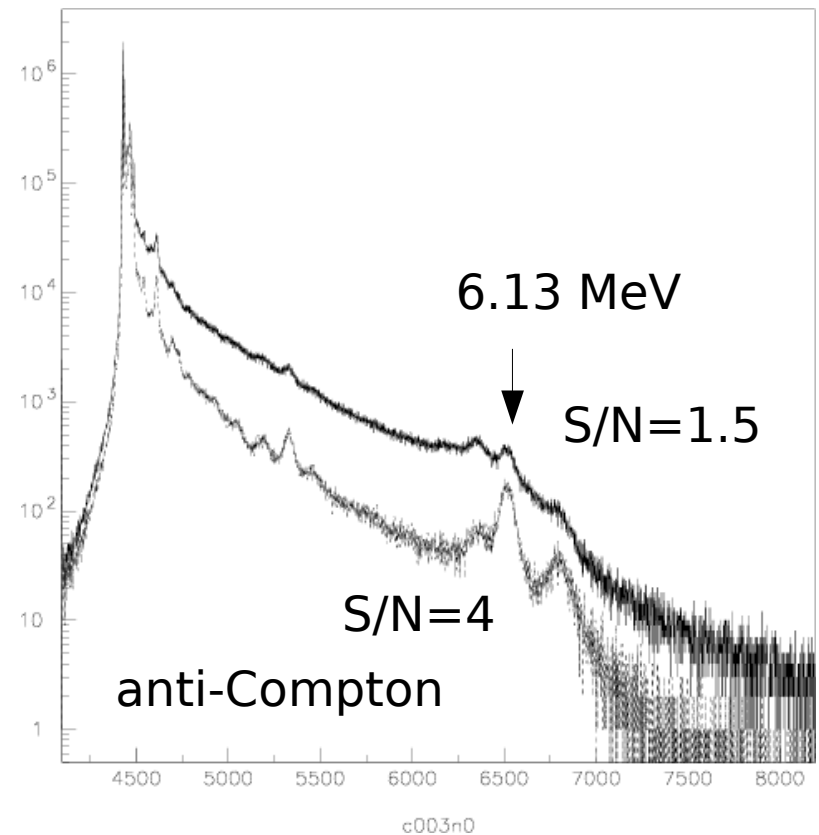
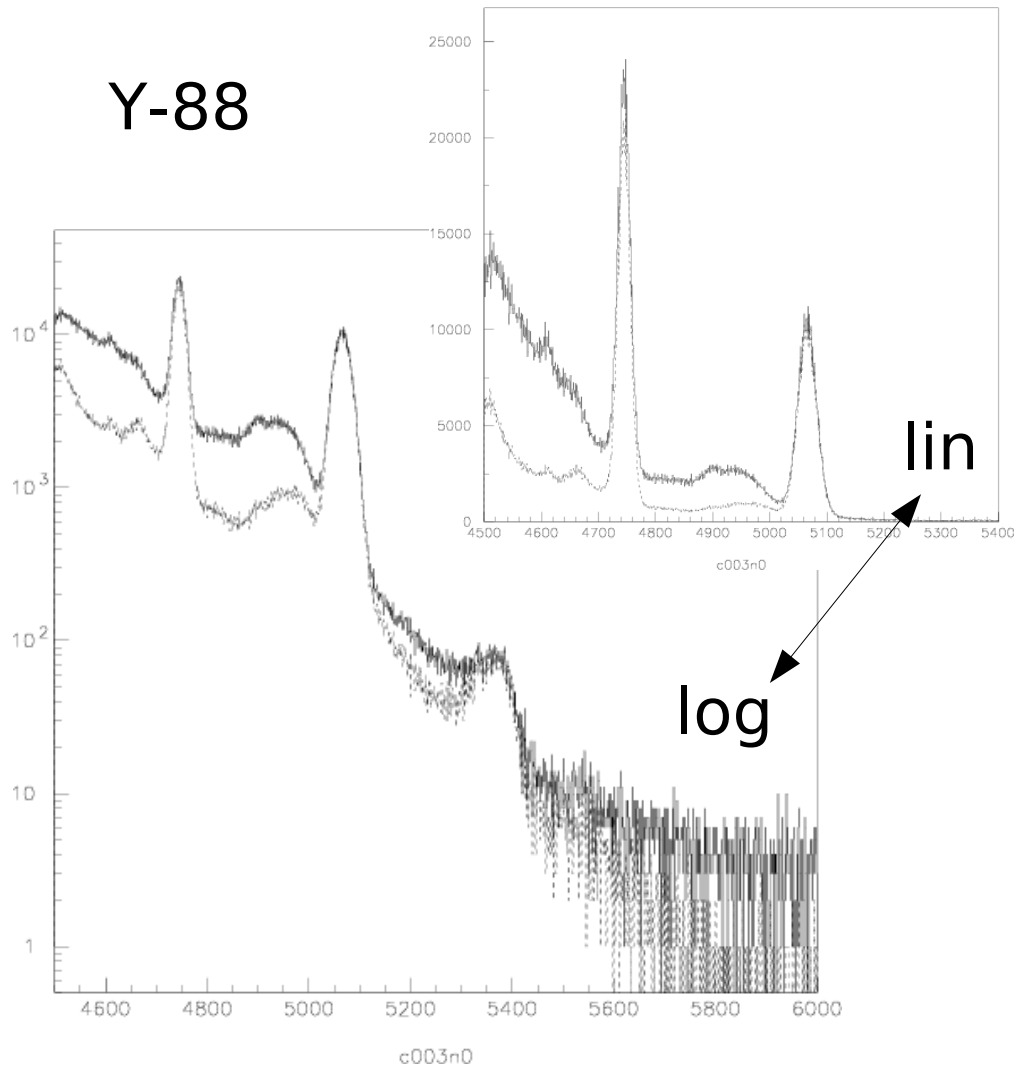
Gamma games

152 GB
raw data
 $730 \cdot 10^6$ events
(F. Wamers)

PuC source
 $^{13}\text{C}(\alpha, n)^{16}\text{O}^*$

6.13 MeV line, neutrons

Y-88



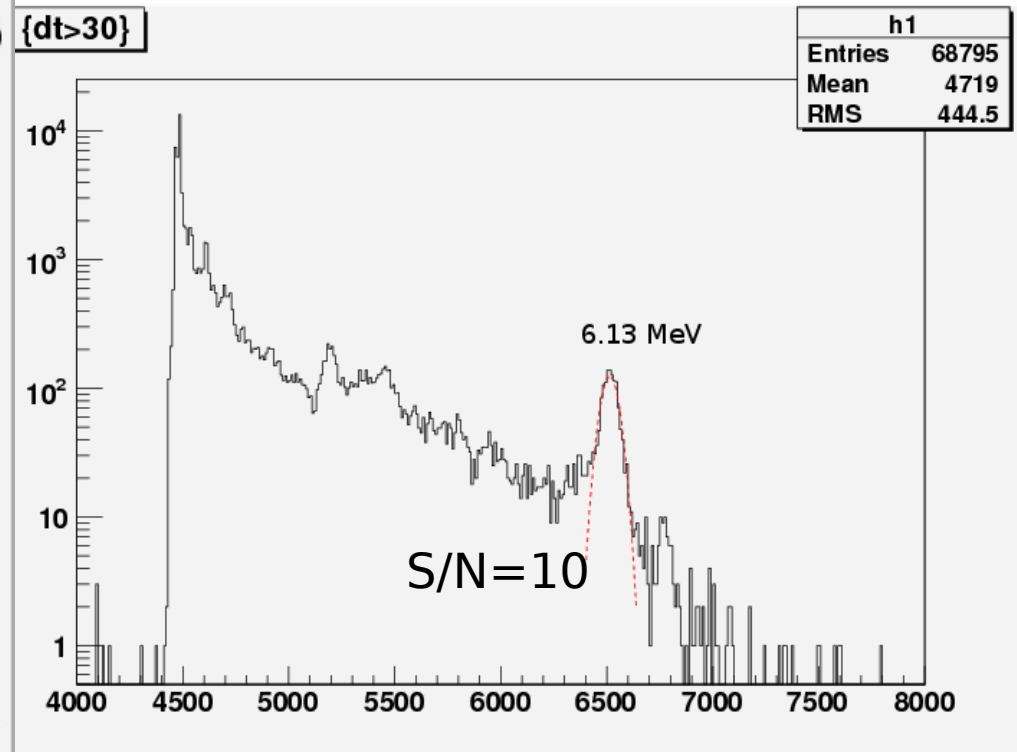
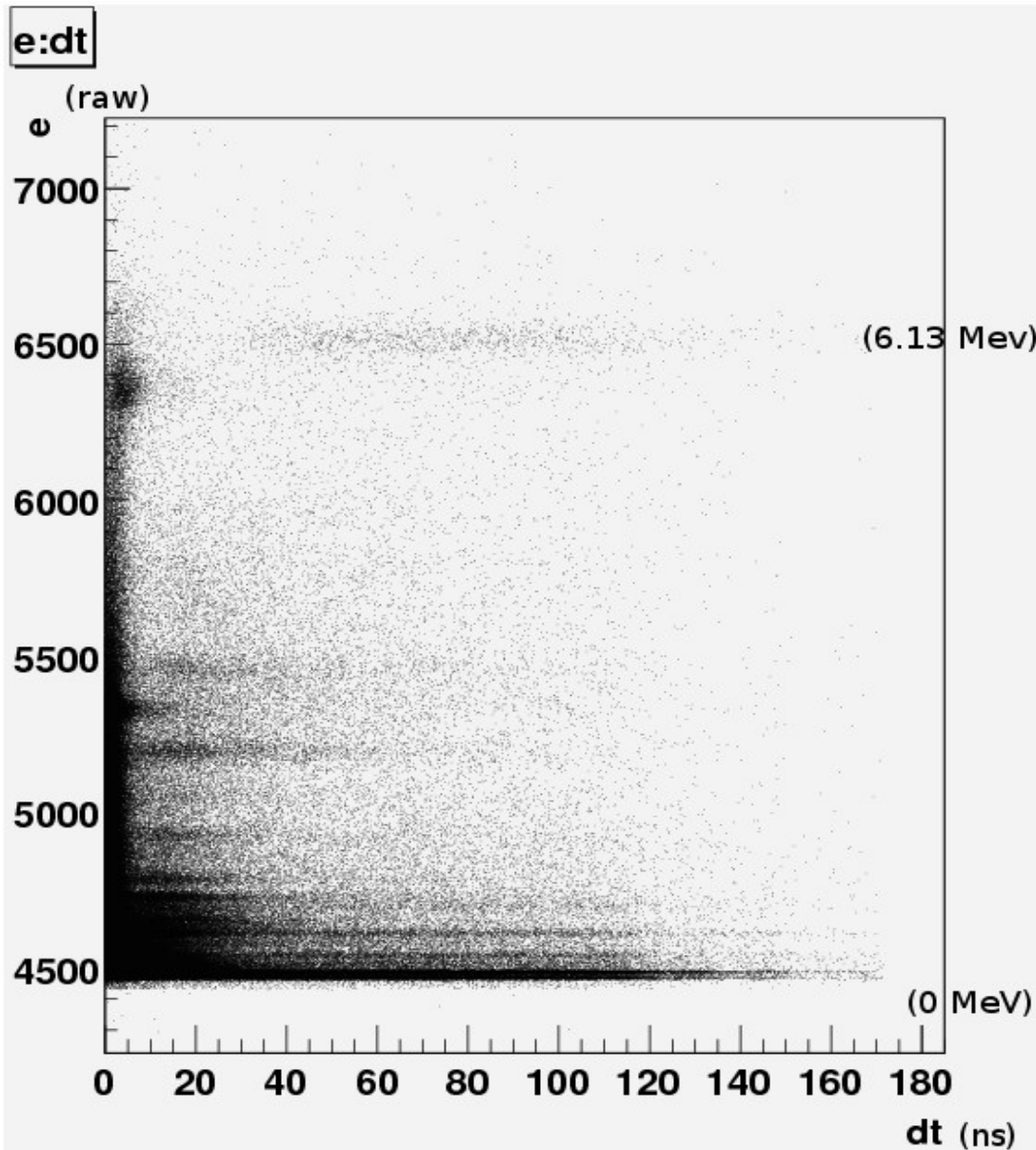
land02: 20MB/s = 70GB/h

with Olga Ershova

Gamma games

152 GB
raw data
 $730 \cdot 10^6$ events
(F. Wamers)

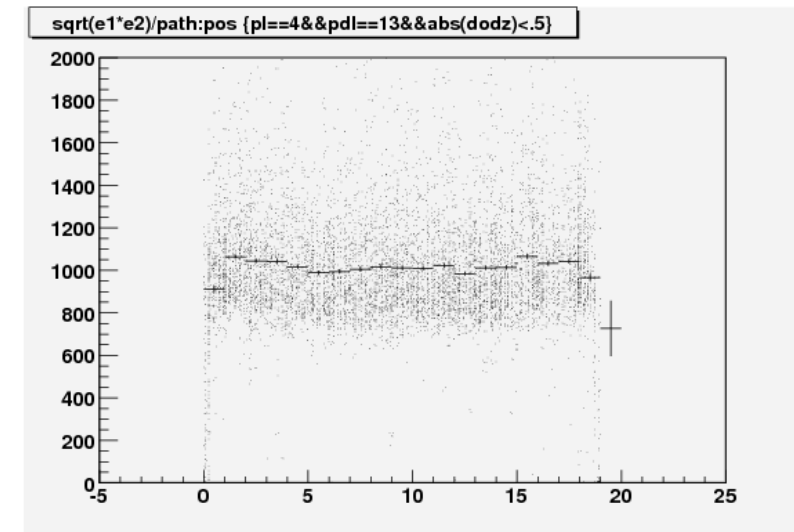
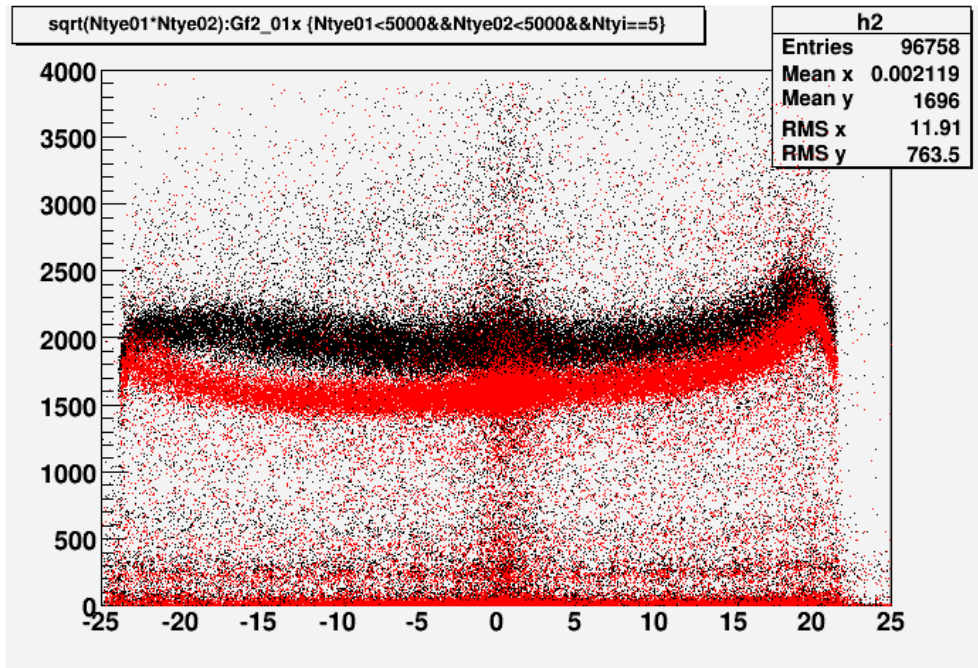
PuC source
 $^{13}\text{C}(\alpha, n)^{16}\text{O}^*$
6.13 MeV line, neutrons



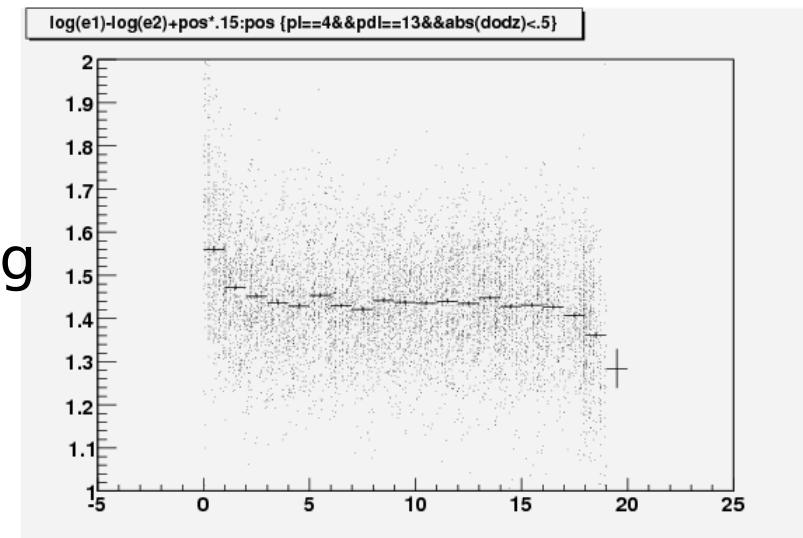
with Olga Ershova

Paddle energy anomalies (NTF)

Sweep run, middle horizontal paddles:
 $\sqrt{e1 \cdot e2}$ – should be flat



Effect (weak) also in **LAND**,
using pdl-perpend. muons



- **Pedestals** varied, cannot cure effect
- Already at **TCAL** level → **no** land02 calib bug
- → **Genuine effect – model** not working (simple exponential attenuation)
- Reconstruction cure 'obvious'
- **Calibration** challenging! - Millepede II ??

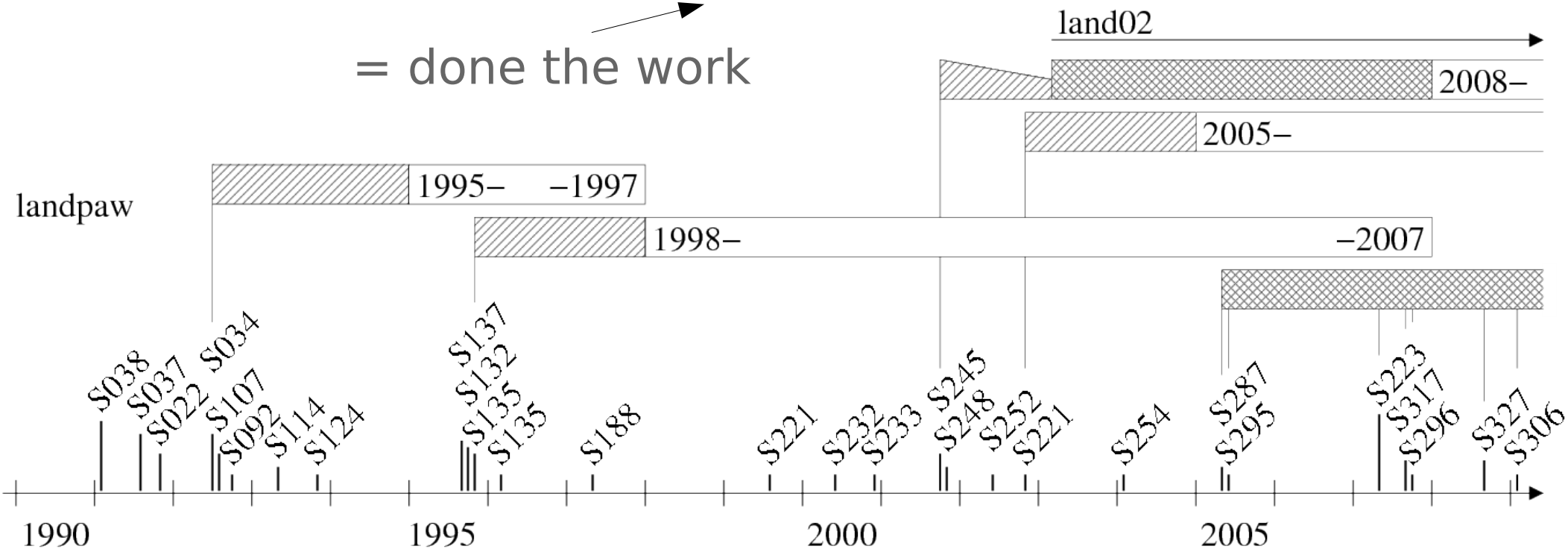
with Olga Lepyoshkina

History IV: TTP (time to publication)

Getting longer. **Is a problem.** Critical!

S245 and S287 have paid a price for the existence of land02.

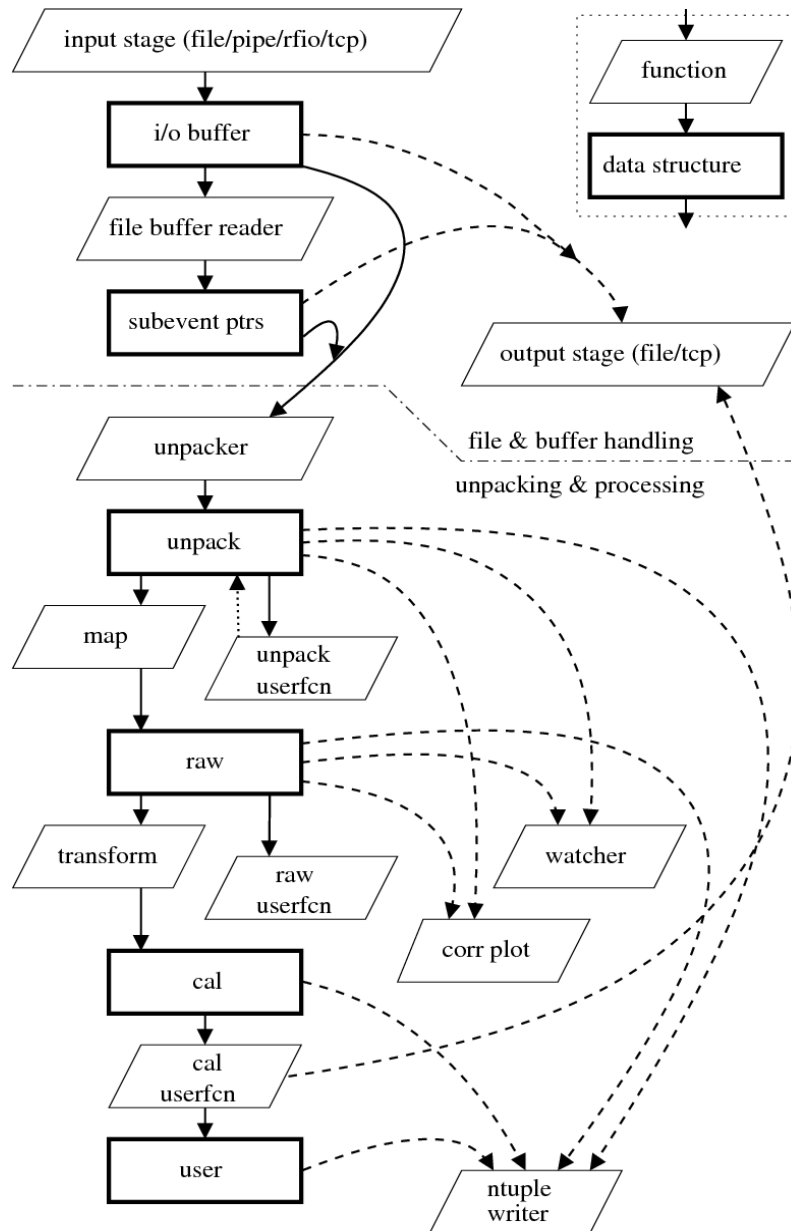
= done the work



Just trying to 'squeeze' current experiments out is no a solution:

- Not likely to work anyhow (too complex).
- Kills the future -> D.O.A. **R³B.**

UCESB – unpack & check every single bit



'Quick-n-dirty' generic unpacking and data 'quality' monitor

Unpack code generation from C structure-like **specification**:

```
SUPER_TDC(slot)
{
    UINT32 value;
}
SUBEVENT(ONE_CRATE)
{
    tdc1 = SUPER_TDC(slot=5);
    tdc2 = SUPER_TDC(slot=6);
}
EVENT
{
    crate1 = ONE_CRATE(type=5);
}
```

<http://fy.chalmers.se/~f96hajo/ucesb/>

Watcher – the DAQscope

Thu Sep 27 10:49:39 2001

Physics: 536
 Offspill: 175
 Tcal: 21
 Other: 30

Event: 8663685

```

POS1_1T 2..2 .4.1...2.11887562112...2.....825 1
POS1_2T 2..2 33.2...11.2249746431..2...2.....8.5 1
POS1_3T 2..2 3.2...2..11.27974642.12...2..2.....8.5 1
POS1_4T 2..2 32...2...2..2797563..2...2...2...2.....8.5 1
POS2_1T 2..2 3...121.21.693..1...2...2...2...2...2...8.5 1
POS2_2T 2..2 2...2...21259..2...1...2...2...2...2...825 1
POS2_3T 2..2 1..2...2..1397.2...2...1...2...2...2...835 1
POS2_4T 2..2 1..1..21.149812...2...2...1...2...2...835 1
POS1_1E 2..2 A74432.1.....++1 1
POS1_2E 7855 974.....++1 1
POS1_3E 3413 A64311.....++1 1
POS1_4E 8855 9652.....++1 1
POS2_1E 8855 96432.....++1 1
POS2_2E 7855 9764343232.1.....++1 1
POS2_3E 7855 976442212.....++1 1
POS2_4E 4523 A7542311.....++1 1
PIN1_1E 21.2 8578666541.....5.....1....++ 1
PIN2_1E 3..2 9548655541.1.....15..1.....2....++ 1
N1_1_1T 4225 2.2.2.2.1.213.2112...1221.....++ 1
N1_1_2T 42.5 ..11112.112.1.11312.2.2..22.11.....++ 1
N1_2_1T 4225 2.2.22.1.2.222.2.21..222.....++ 1
N1_2_2T 42.5 ..112.2.2.2.1.11212.2.2.121112.....++ 1
N1_1_1E 2... 46.52.1....2..1.....++  a
N1_1_2E 31.. 3.3522.5..1.1.....++ 1
N1_2_1E 3... 32354.25...1.....++ 1
N1_2_2E 1... 4355..121..1..1.....++ 1
  
```

Each line is a histogram for one raw channel

Values are \log_2 of bin content

Stored zeros and overflow

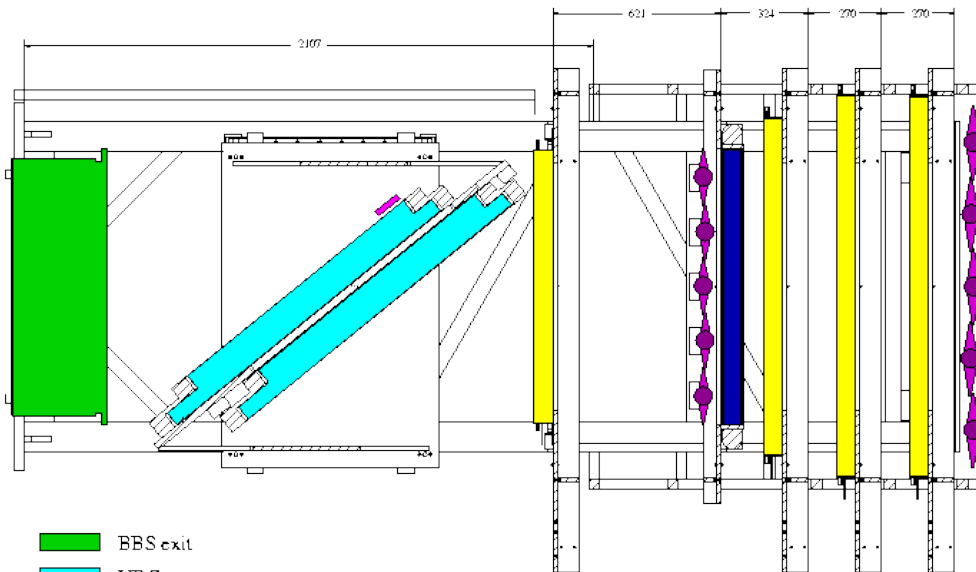
Colour by most contributing trigger type

Spill synchronized

Correlation plots – EuroSuperNova (ESN) @KVI MWPC maps

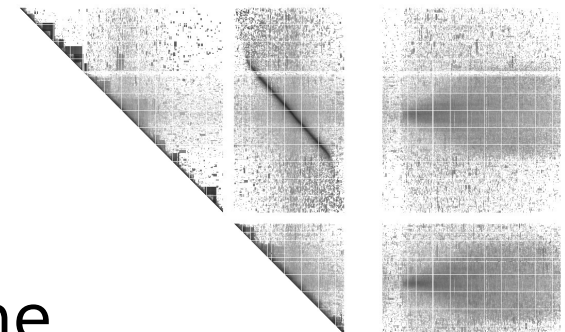
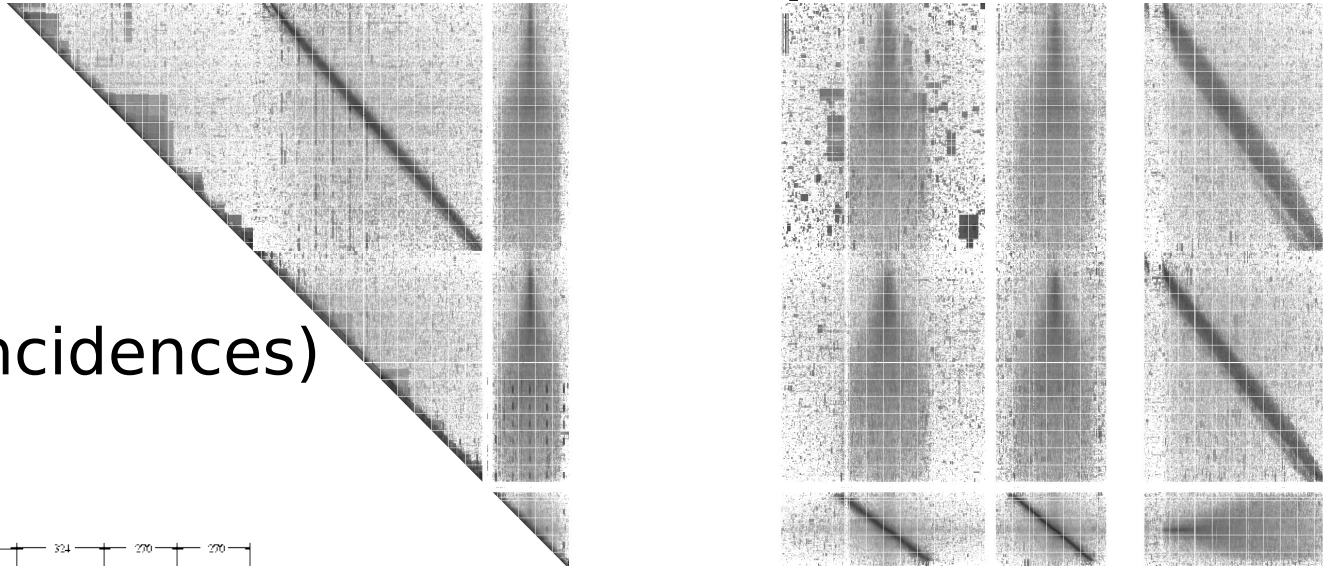
Every row/column =
1 channel

Intensity = $\log_2(\# \text{coincidences})$



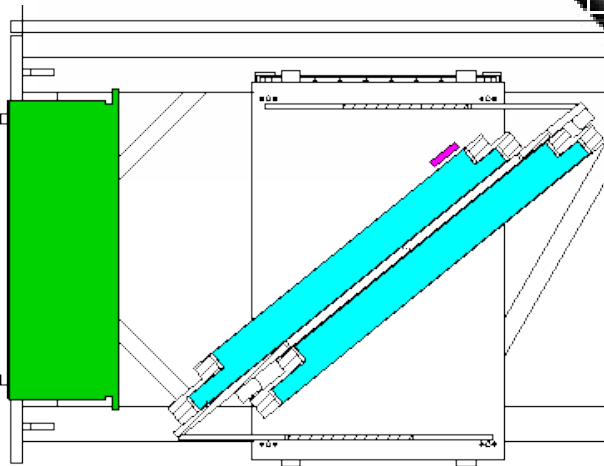
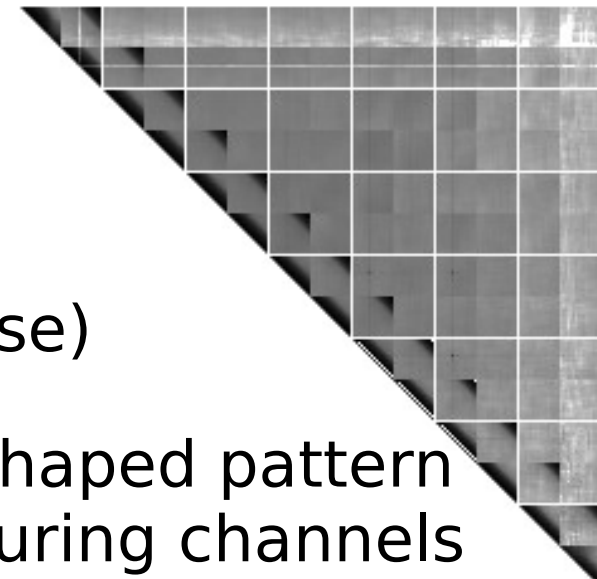
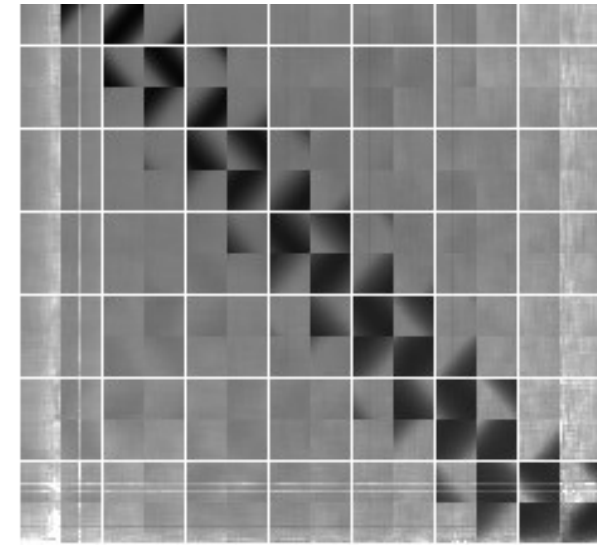
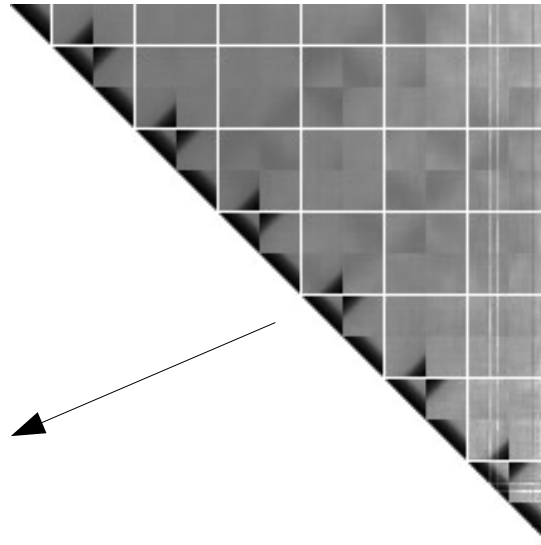
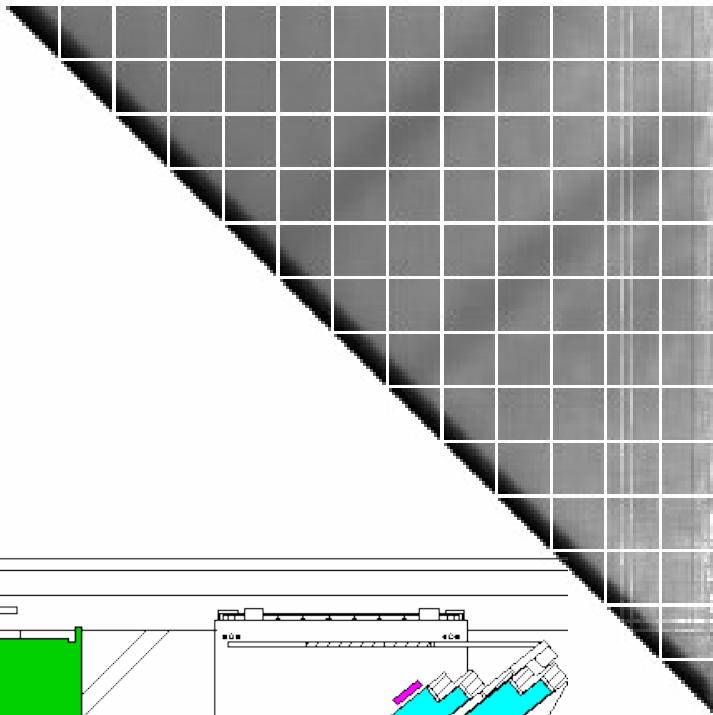
- BBS exit
- VDCs
- MWPCs D1-D4
- Scintillators S1 & S2
- Analyzer C

<http://www.kvi.nl/~snovadoc/>



Plot shows the
~2500 active channels
of 32k possible

Correlation plots – ESN VDC maps



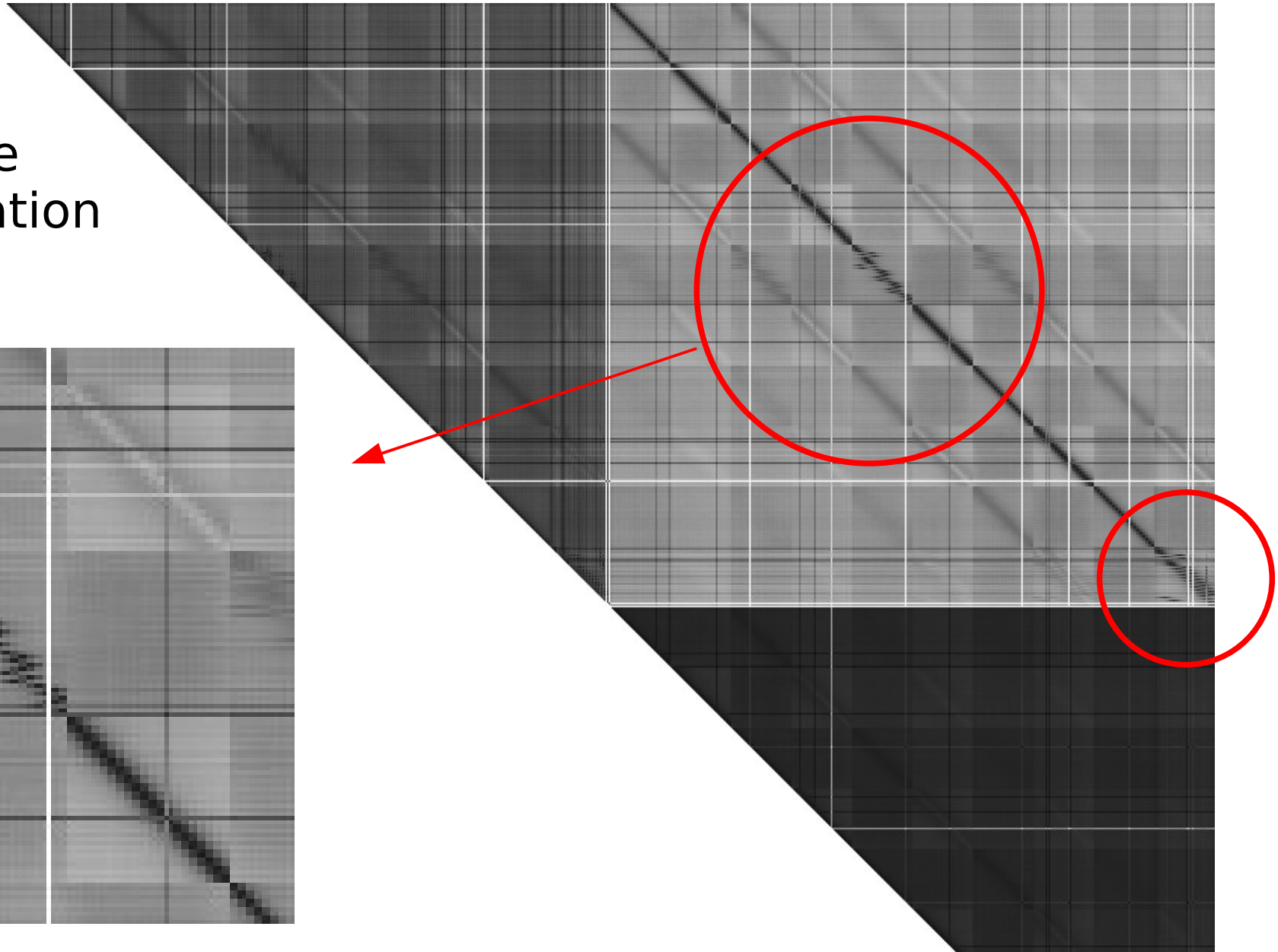
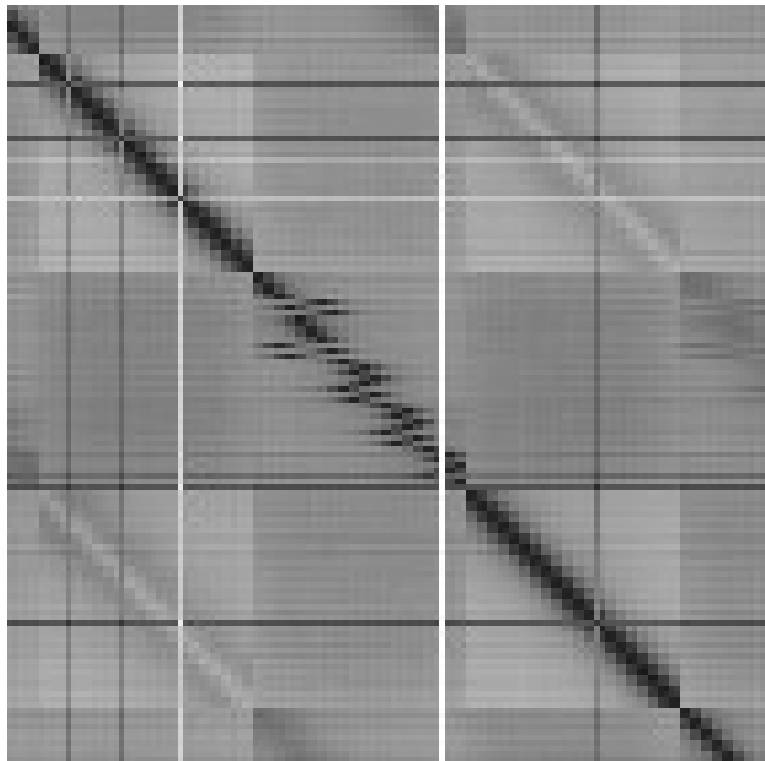
■ BBS exit
■ VDCs

Every second 16-fold
cable inverted (on purpose)

Every ion track gives V-shaped pattern
(in time) in ~ 10 neighbouring channels

Quickly finding LAND cable mismap

8-fold cable documentation problem



Finale!

I have nothing to offer but requirements for discipline, commitment and hard work.

And a great deal of **FUN!**

Thank you!

It is not even the beginning of the end.

"Now this is not the end."

but it is, perhaps, the end of the beginning."