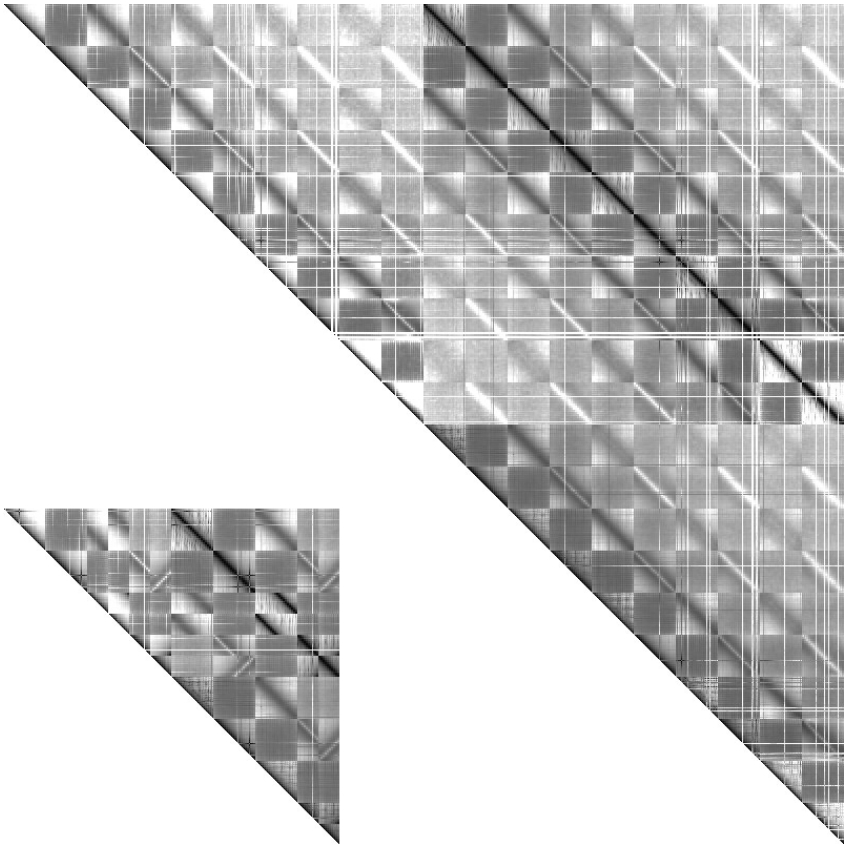
R^3B developments: Bigger detectors – greater problems?



Håkan T. Johansson, Chalmers, Göteborg

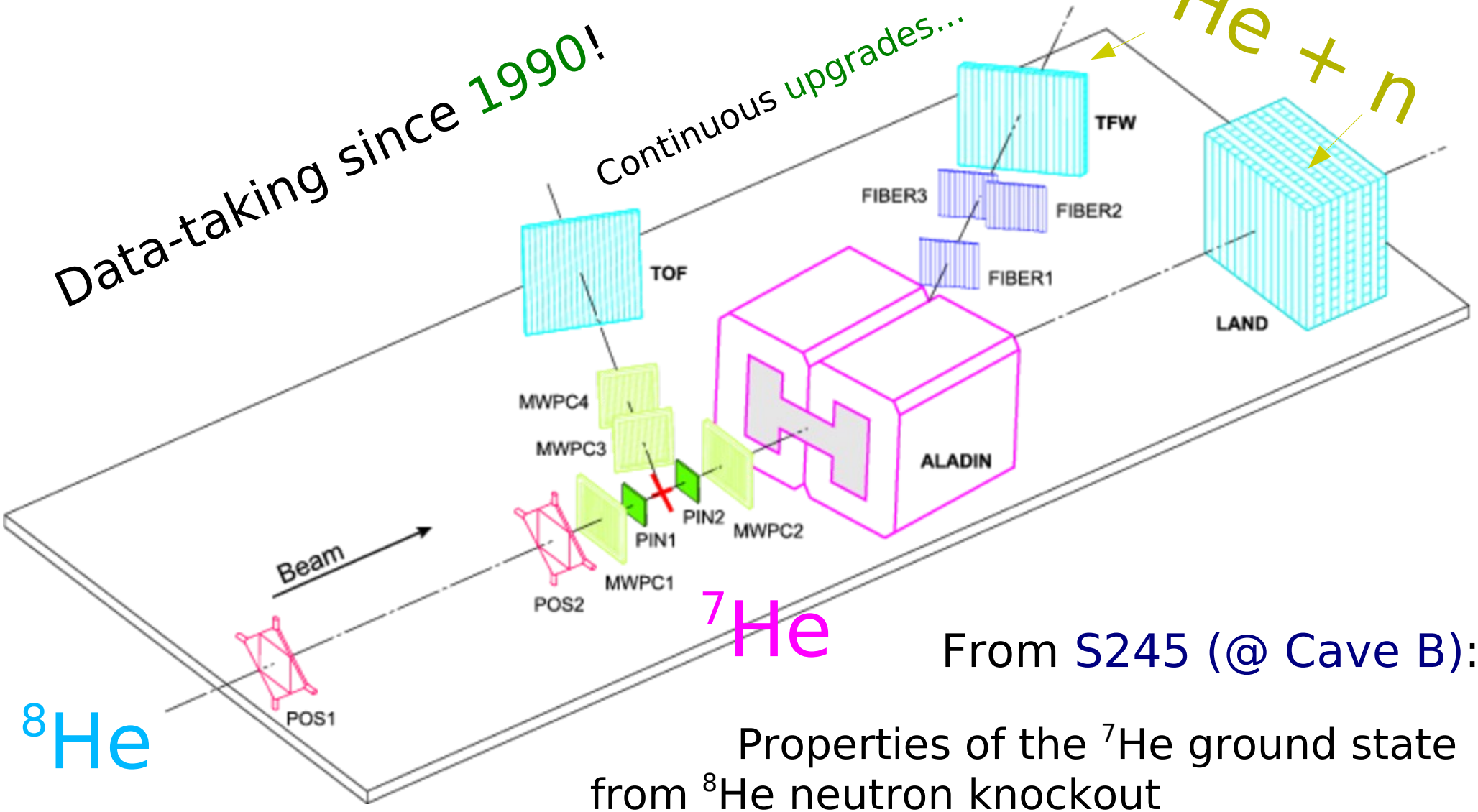
Örebro, November 2009

ALADiN-LAND setup → R^{3}B

Data-taking since 1990!

Continuous upgrades...

^{6}He + n



^{7}He

^{8}He

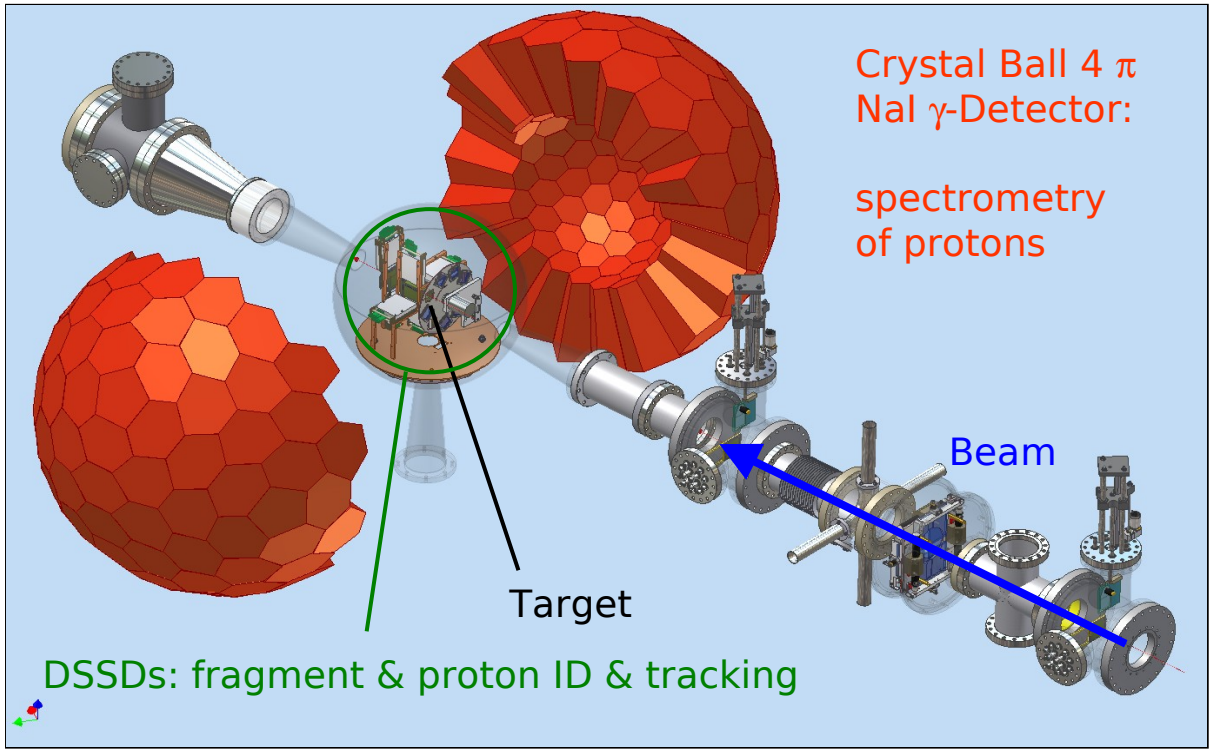
From S245 (@ Cave B):

Properties of the ^{7}He ground state from ^{8}He neutron knockout

Yu. Aksyutina, H.T. Johansson, et. al.
Physics Letters B, Vol 679 (2009) pp. 191-196

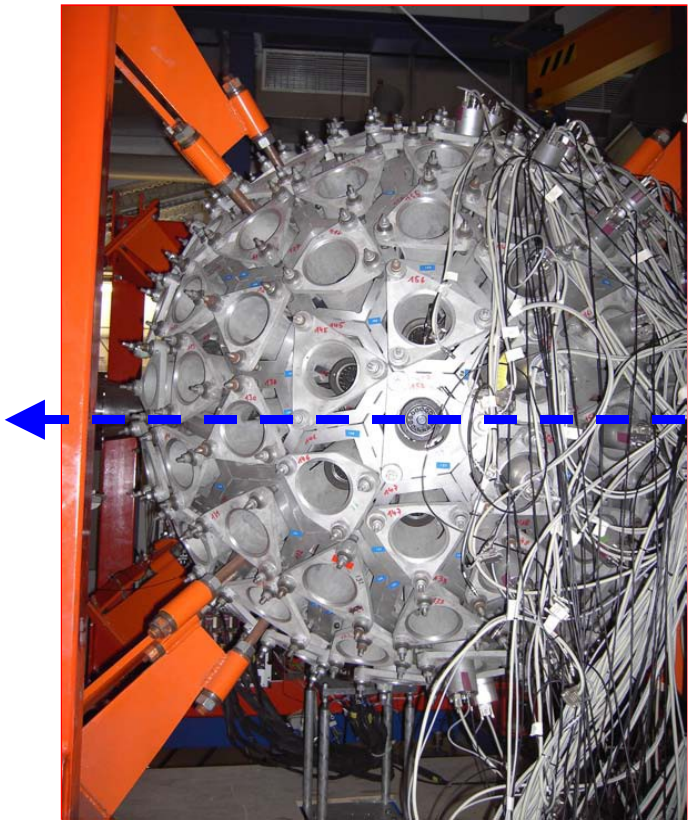
Upgrades for QFS pilot exp

LAND setup: Detectors around the target

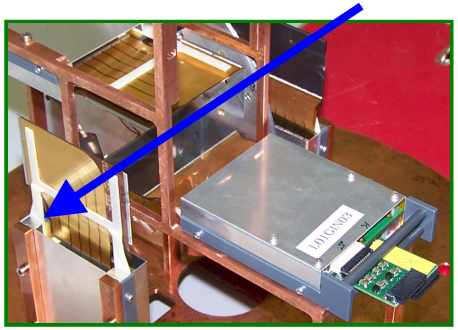


Crystal Ball for proton spectrometry

- 4π gamma detector (*1980 - ...)
- 162 NaI(Tl) crystals of 20 cm length
- New: Measure energy of recoil protons with additional readout of the forward 64 crystals (~ 1.5π) !



DSSDs for proton tracking

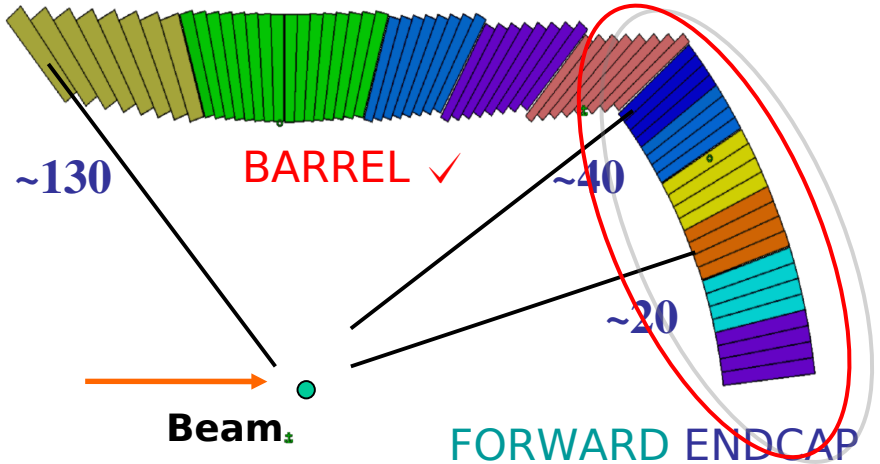


- 4 box detectors for proton tracking
- polar angle coverage ≈ 15°≤ θ ≤ 80°
- resolution: Δx ~ 100 μm; ΔE ~ 50 keV
- range: 100 keV < E < 14 MeV
- 2 in-beam detectors for tracking & ID of fragments and protons

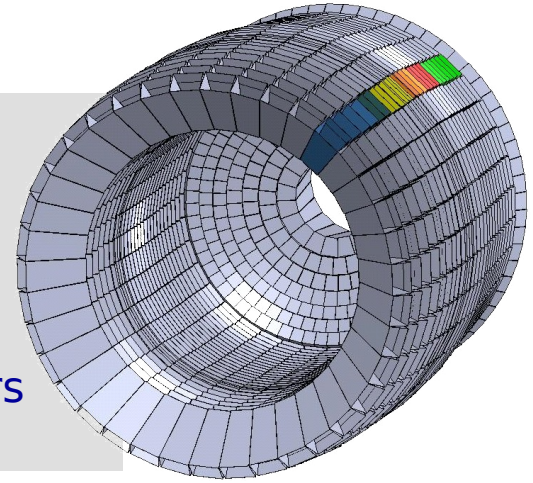
F. Wamers

CALIFA / forward end-cap challenges

General design of the detector based on kinematical considerations



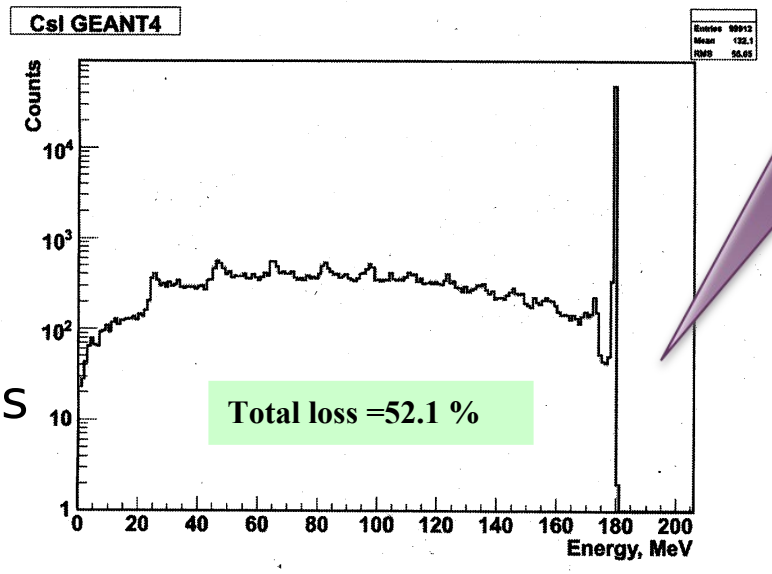
"Egg" shape
Highly segmented
Thick detection volume
Scintillation based
Performant photo-sensors



– major challenge! LaBr/LaCl Phoswich?

WG Coordinator: Dolores Cortina-Gil, Univ. Santiago de Compostela

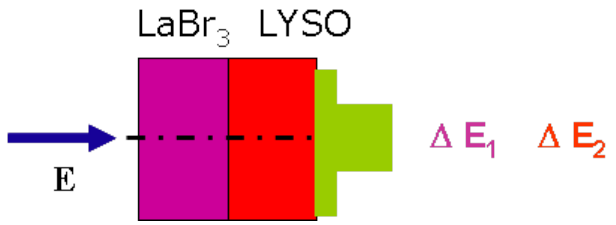
- Gamma rays Doppler shifted to high energy
  - High denisty, high resolution needed
- Crucial kinematics domain for simultaneous detection of protons
  - Reactions
- New solutions?



GEANT4 simulation (Lund Univ) for 180 MeV protons in CALIFA CsI crystal

Phoswich: p- Energy resolution

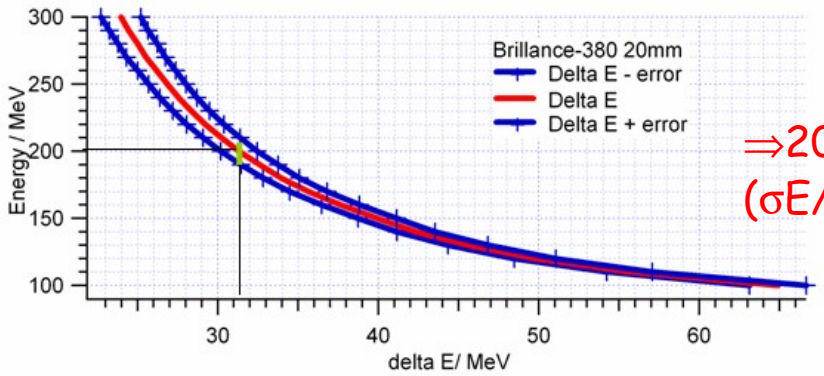
$$-\frac{dE}{dx} = Kz^2\frac{Z}{A}\frac{1}{\beta^2}\left[\frac{1}{2}\log\frac{2m_ec^2\beta^2\gamma^2T_{max}}{I^2} - \beta^2\right]$$



E → $\Delta E_1 + \sigma(\Delta E_1)$ $\Delta E_2 + \sigma(\Delta E_2)$

E = f(Δ E_1) + g(Δ E_2)

Ep= 200MeV → 20 mm LaBr → ΔE = 31 ± 1 MeV

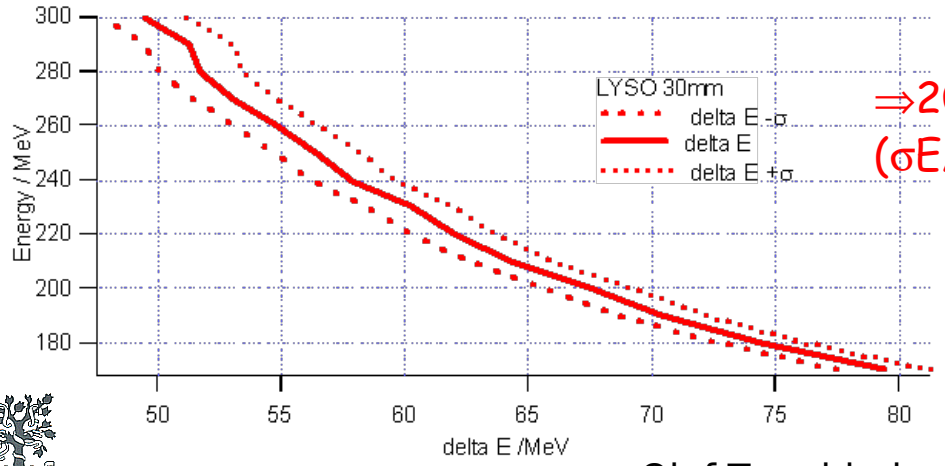


⇒200±10MeV
(σE/E=5%)

- **Protons:**

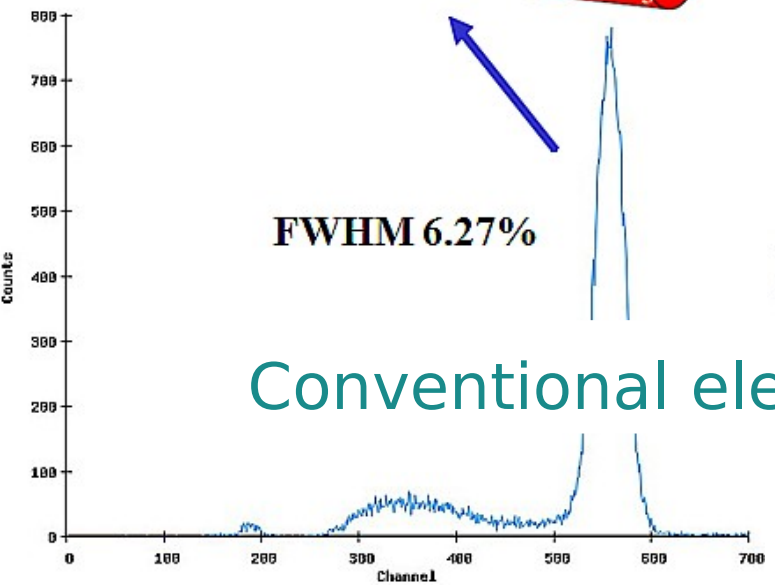
  Using two ΔE-detectors one can determine the full proton energy with a resolution of <5%.

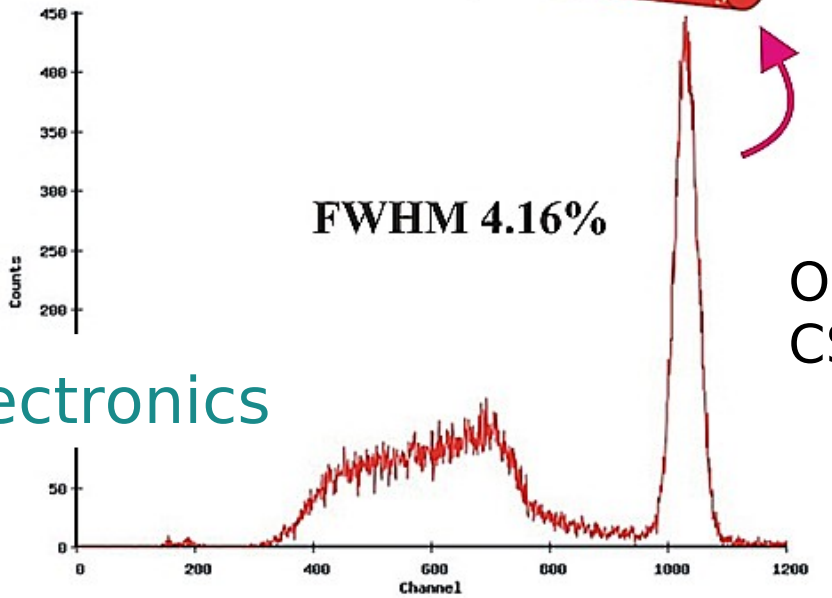
Ep= 200MeV → 30mm LYSO → ΔE = 67.5±1.8 MeV



⇒200±7MeV
(σE/E=3.5%)

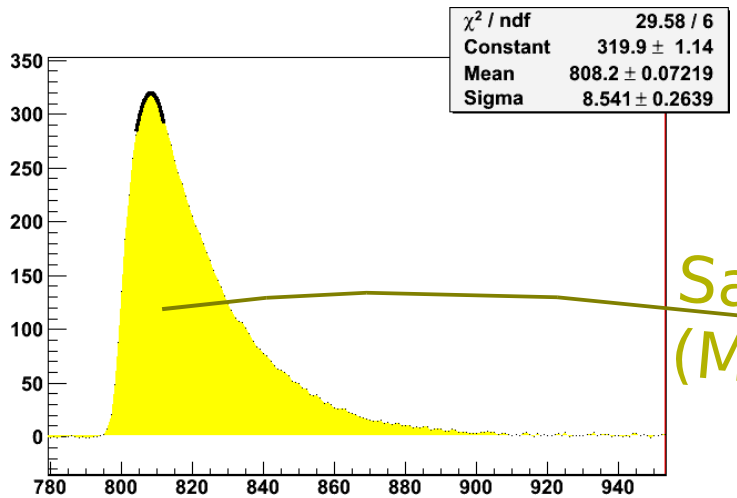
γ in $LaBr_3$/$LaCl_3$ phoswich



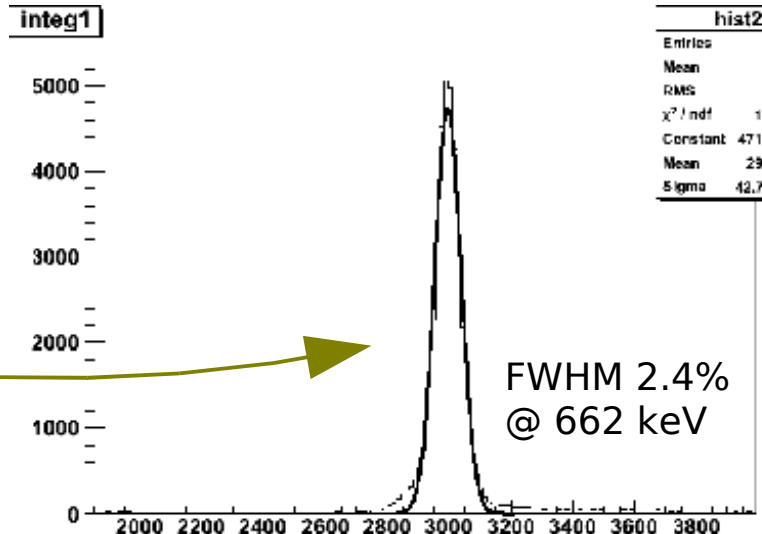


Conventional electronics

Olof Tengblad,
CSIC, Madrid



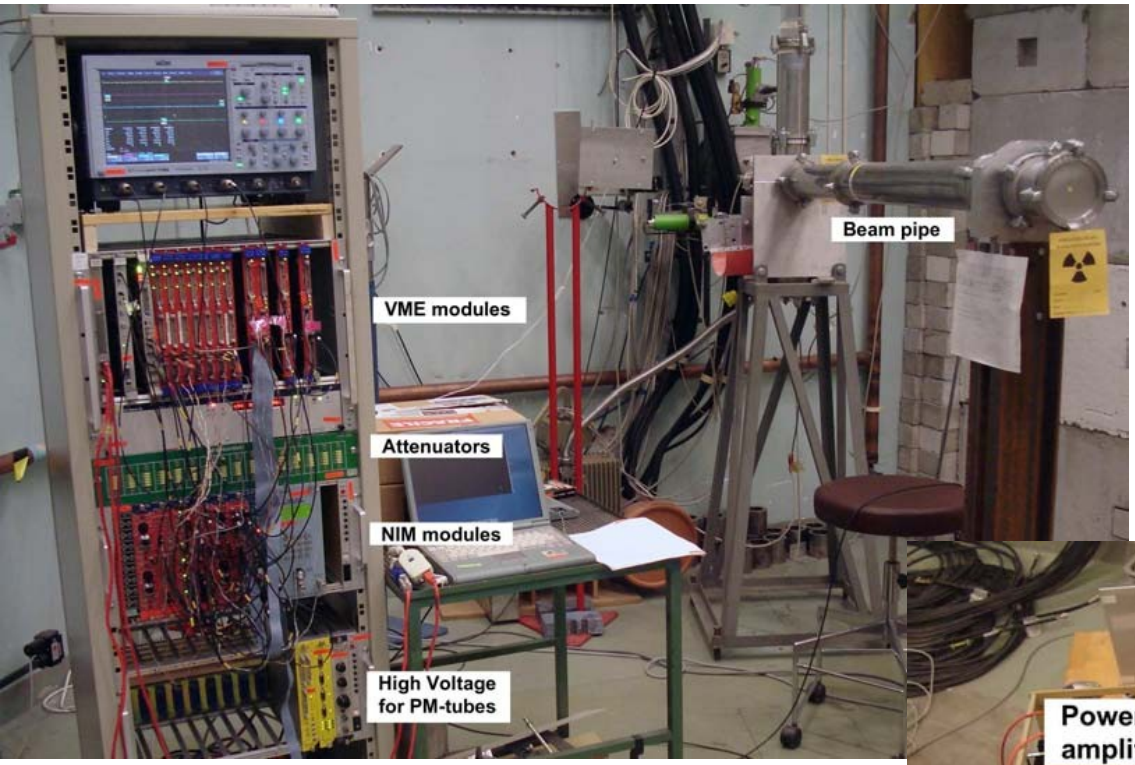
Sampled signals
(MATACQ32)



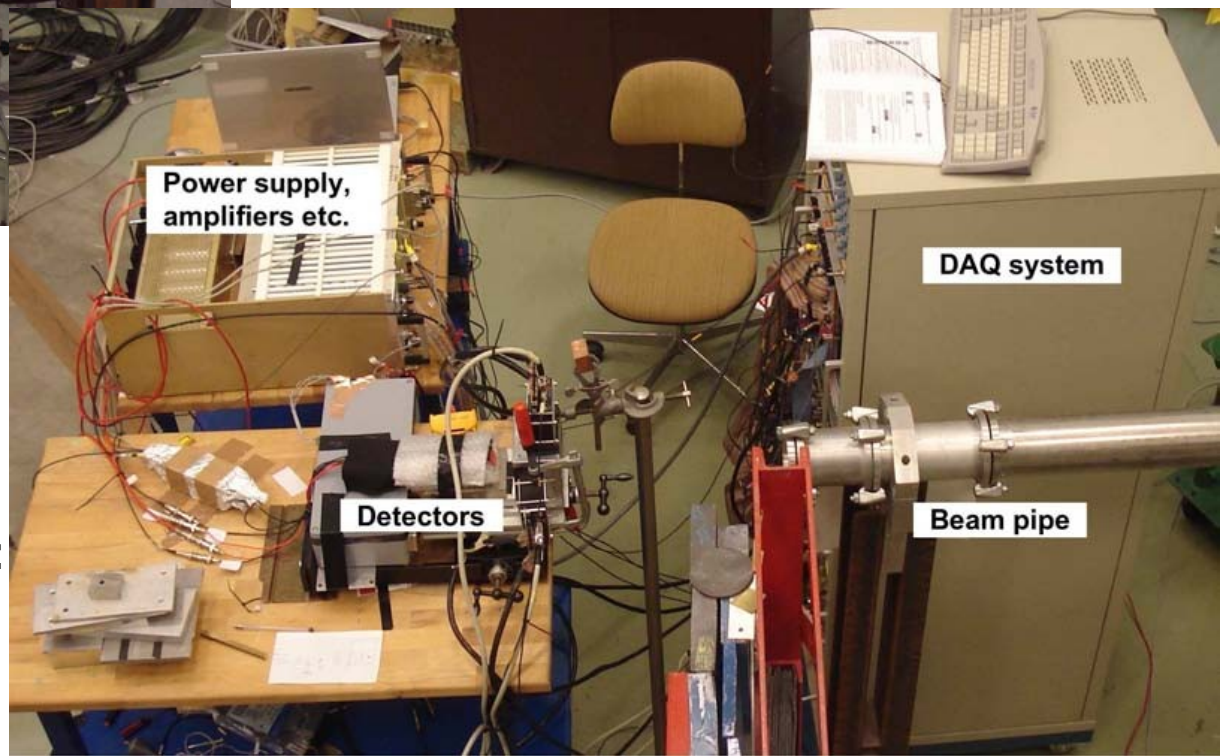
FWHM 2.4%
@ 662 keV

Test with protons at TSL in Uppsala

(March 2009)



Also see the next presentation by D.D. DiJulio

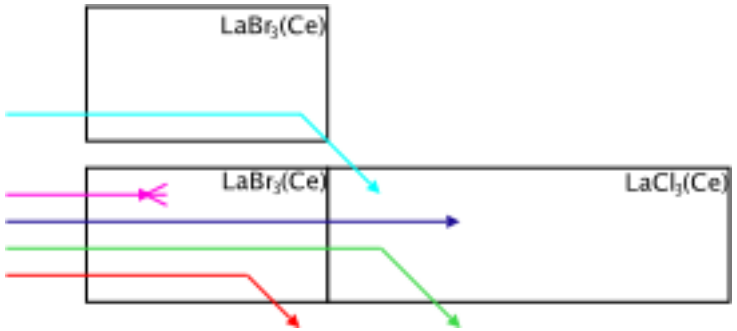


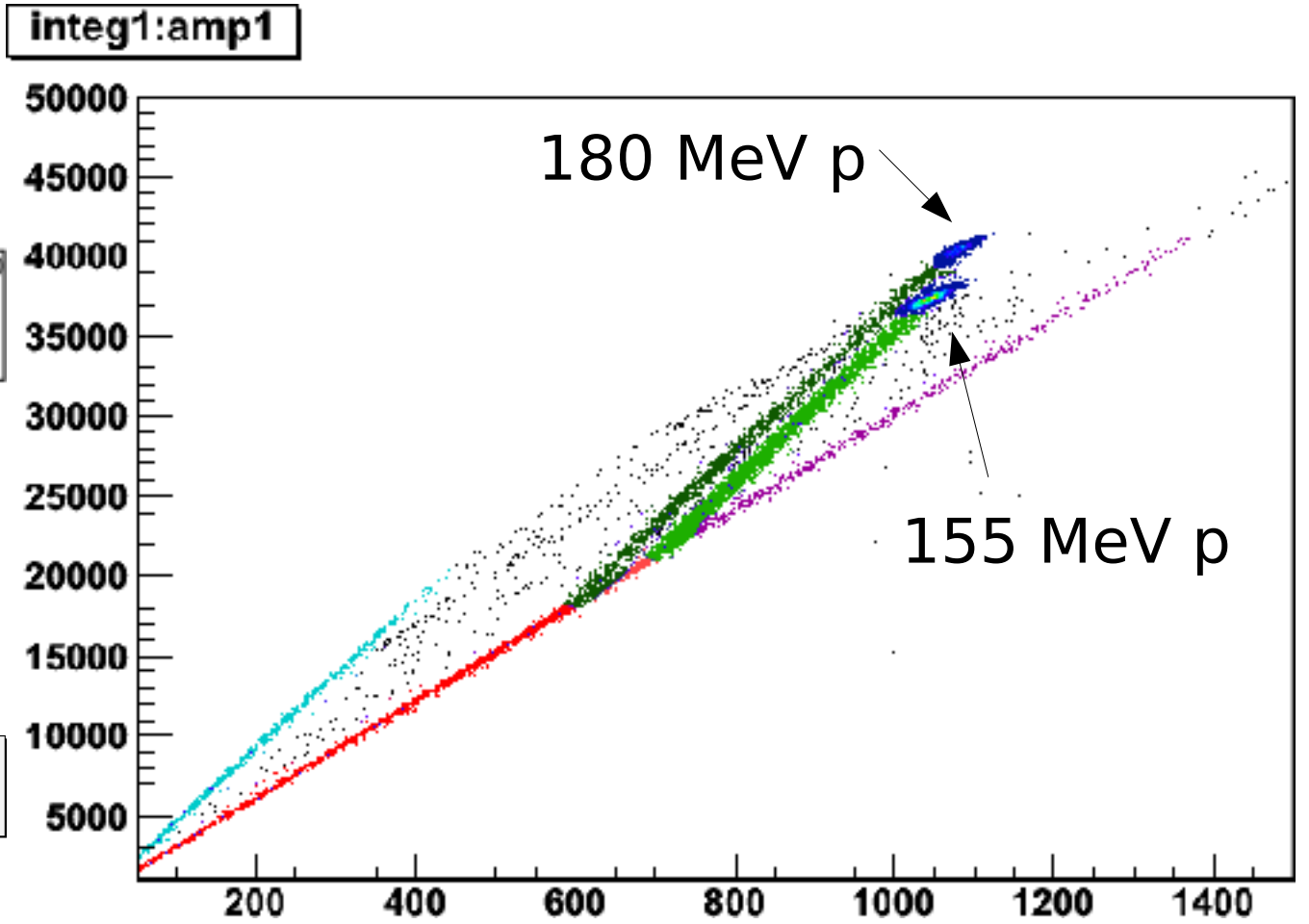
Pictures from the
DAQ-team's report:

J.M.R. Bergström, E.M. Blomberg,
E.A. Gallneby, J.E. Hagdahl,
M.O. Nordström, and H.P.A. Wittler:

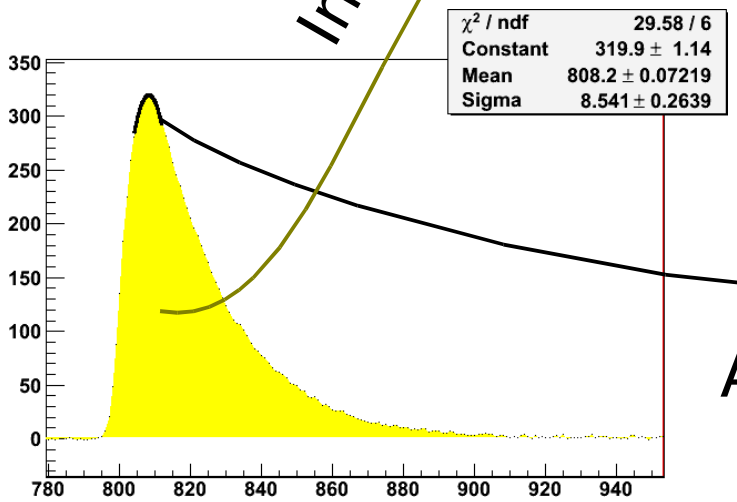
Proton beam test of CALIFA
detector prototypes

They do it with Pulses





Integral



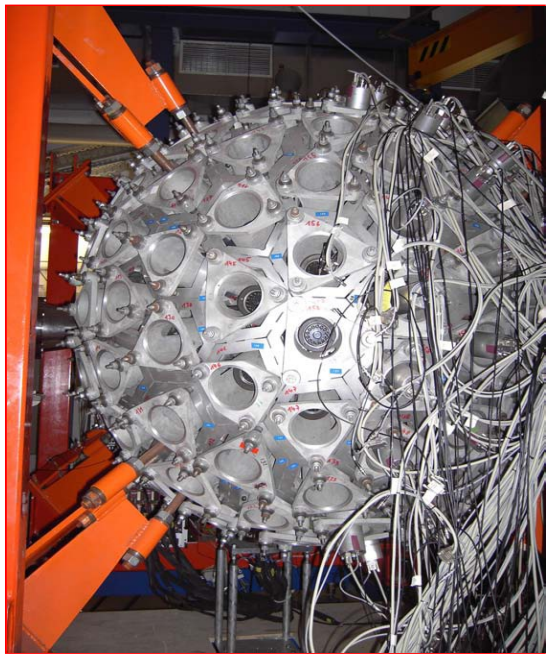
Amplitude

"DAQ-team" & T. Nilsson

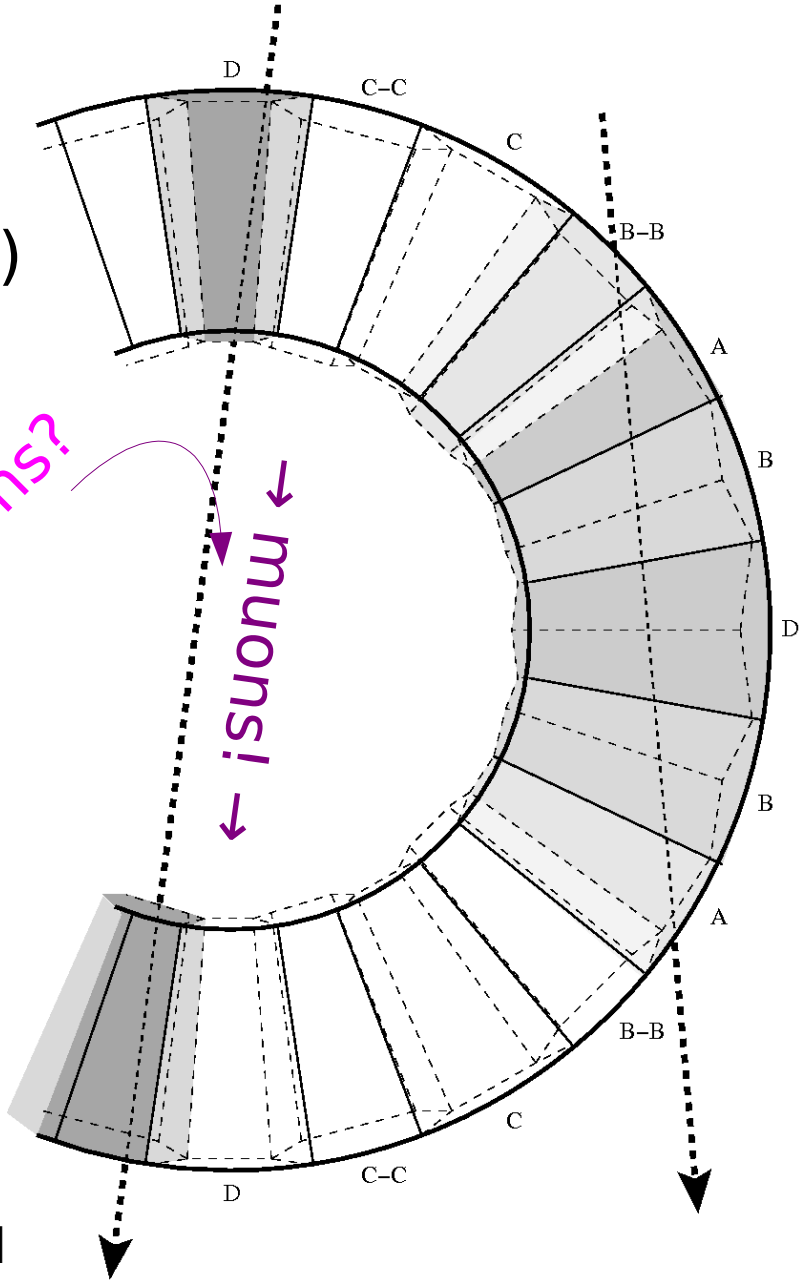
The γ are not enough - XB Calibration @ 90 MeV

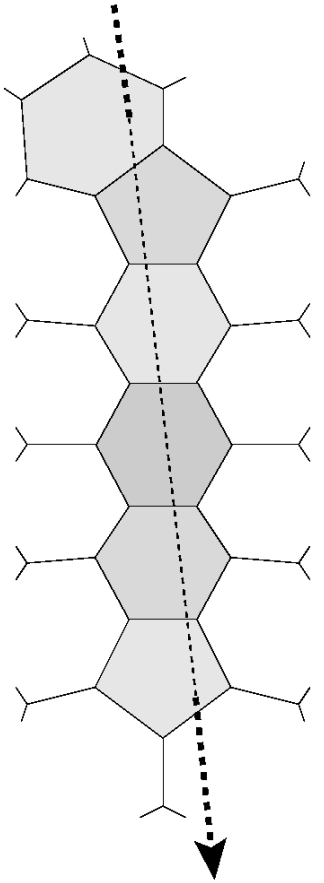
Gamma sources:
up to ~3 MeV
(to 6 MeV with n-dirty e.g. PuC)

20 cm NaI crystals can
stop 275 MeV protons



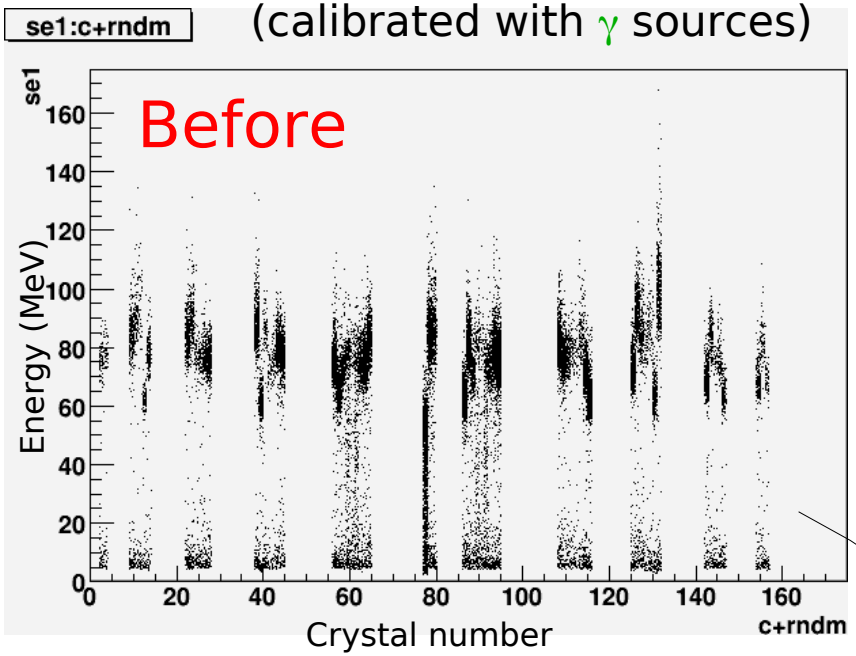
Darmstadt-Heidelberg Crystal Ball

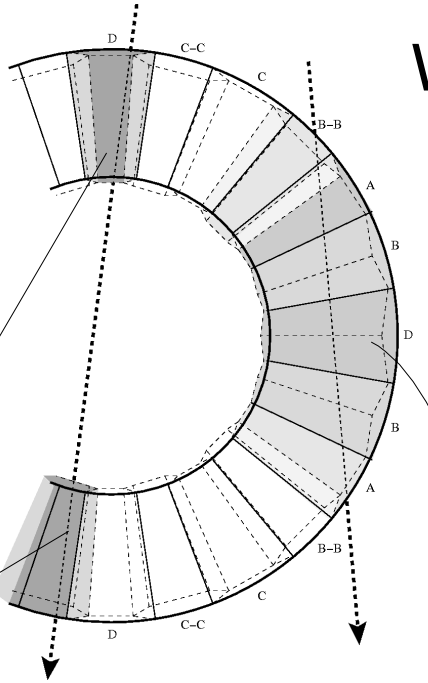




XB Proton branch calibration

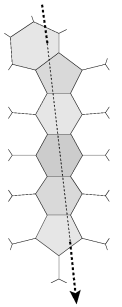
(calibrated with γ sources)

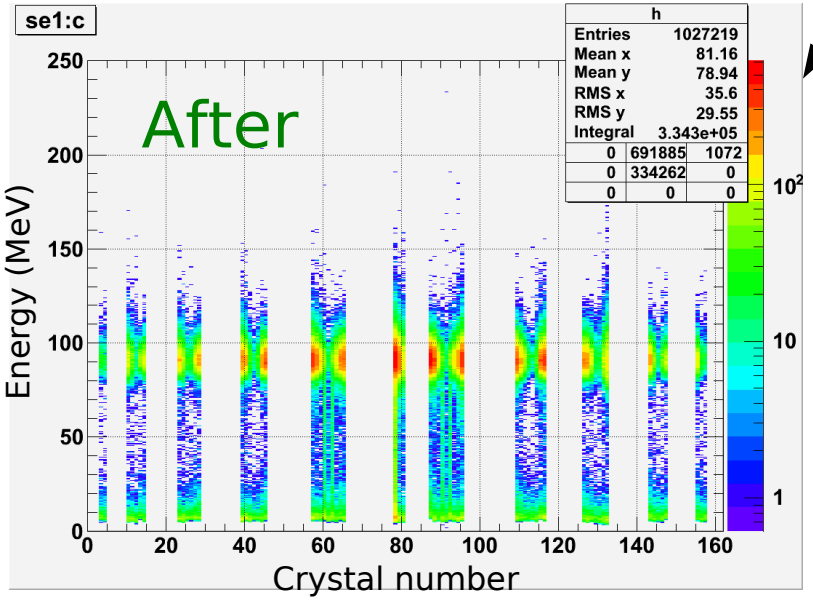


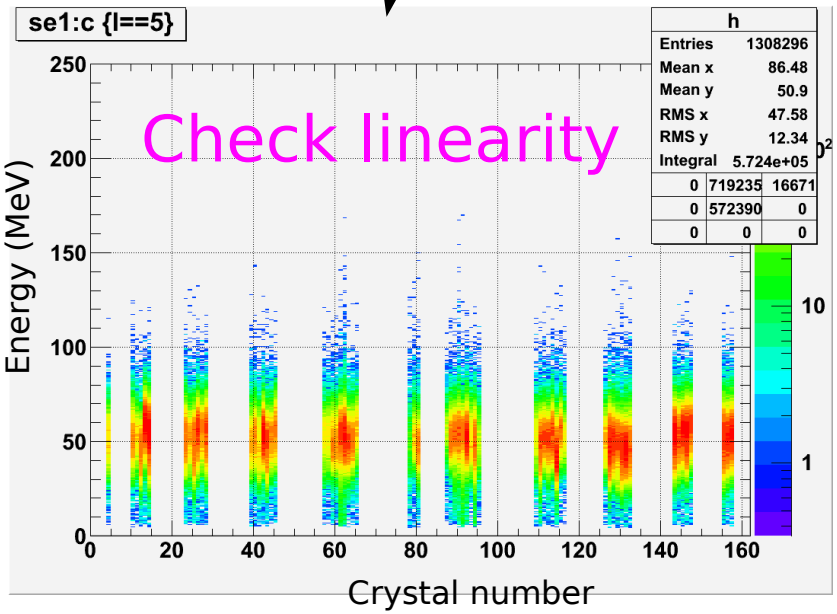


With F. Wamers

Search for
muon needles
in offspill crystal
haystack events







More data – more trouble?

More (new) detectors

More channels:

Better intensity:

Higher event-rates ?

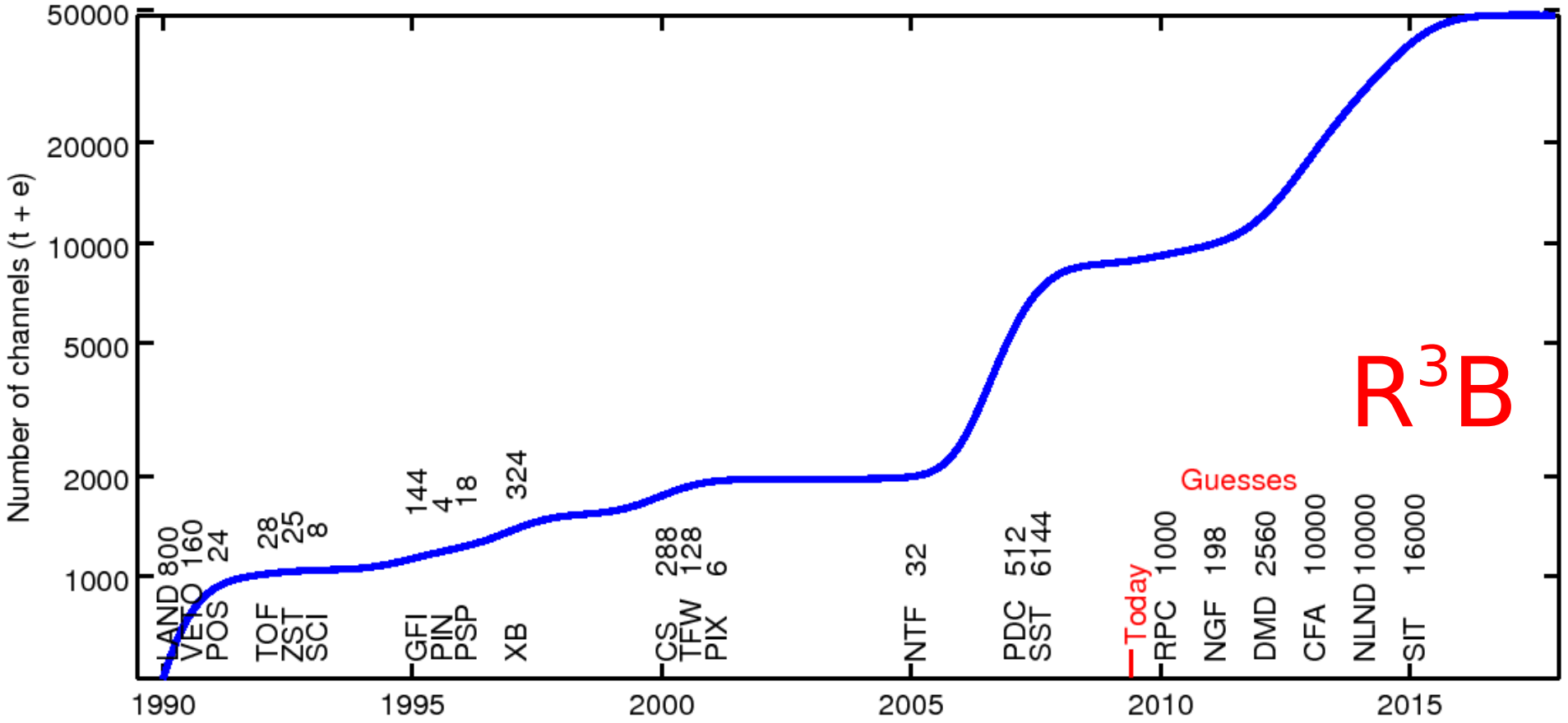
DAQ will evolve:

Higher data-rates

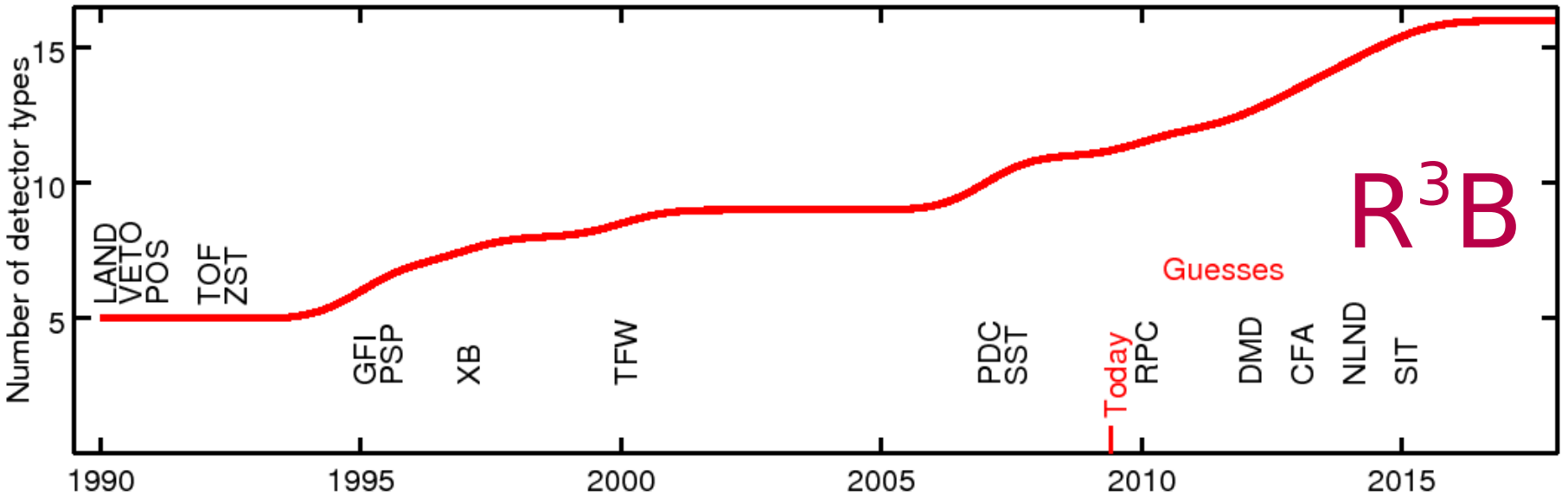
```
Spill: 890      TrigType: 13       Sat Aug 30 08:04:47 2008

 #         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

ALADiN-LAND History I – channel counts



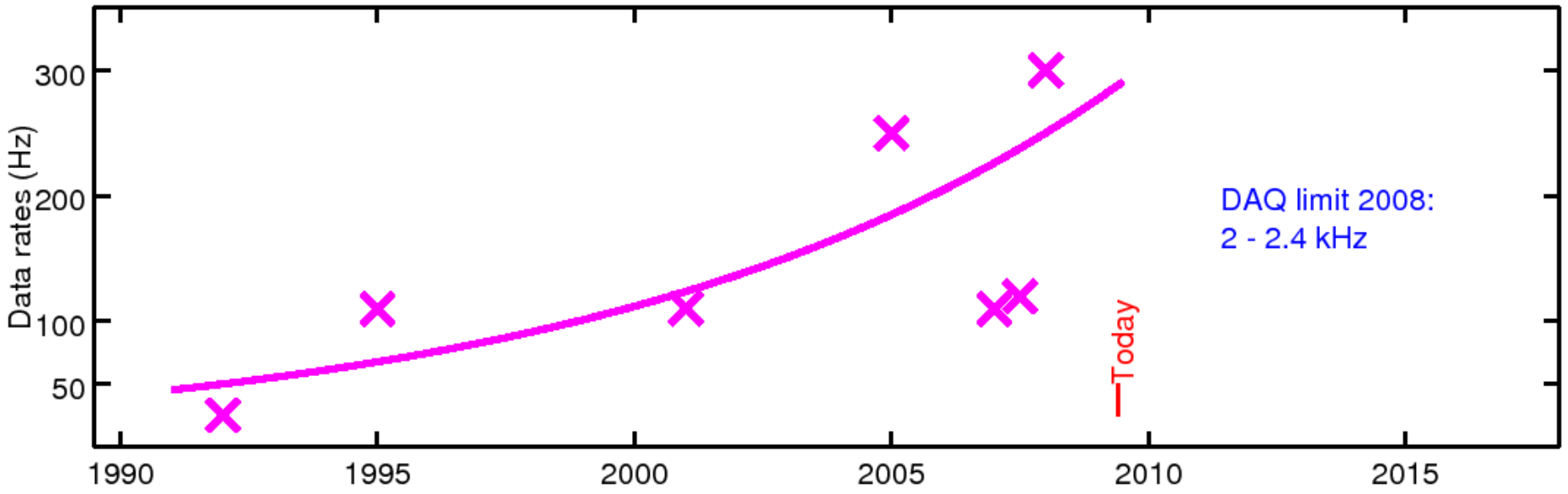
ALADiN-LAND History II – detector types



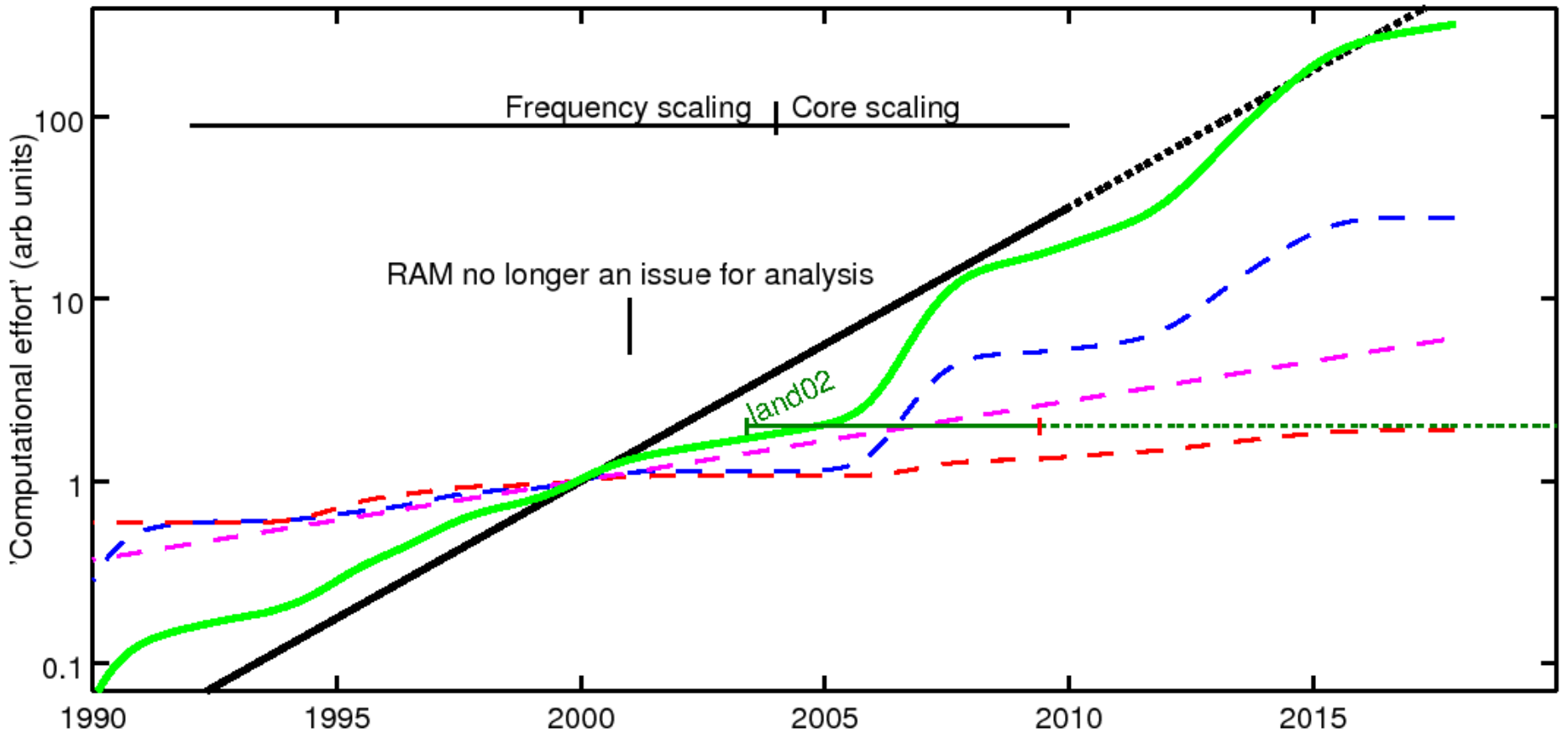
Each detector *type* requires routines for

- Calibration
- Reconstruction

ALADiN-LAND History III – data rates



Growing with Moore's law

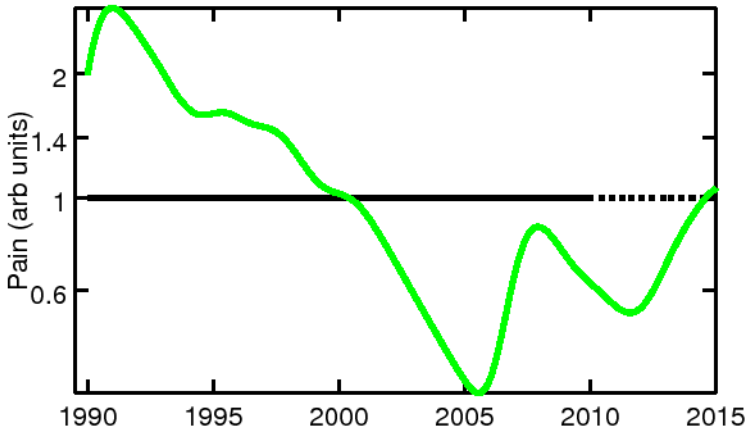


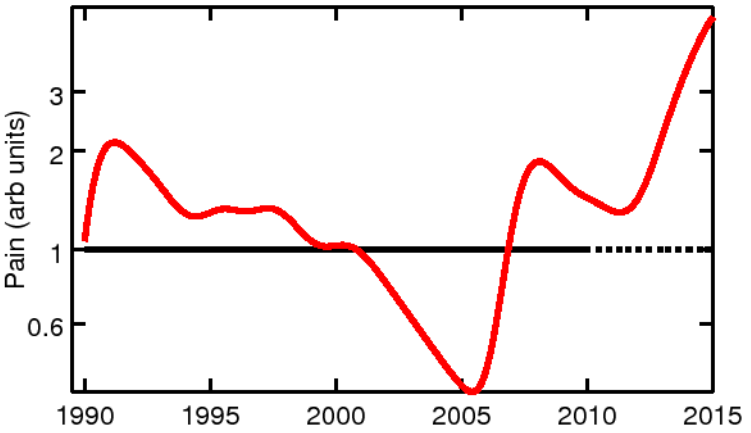
'Easy' scaling valid under assumption of efficient use of computers (i.e. adequate software)

Software is an **issue**

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

*sqrt(#ch)

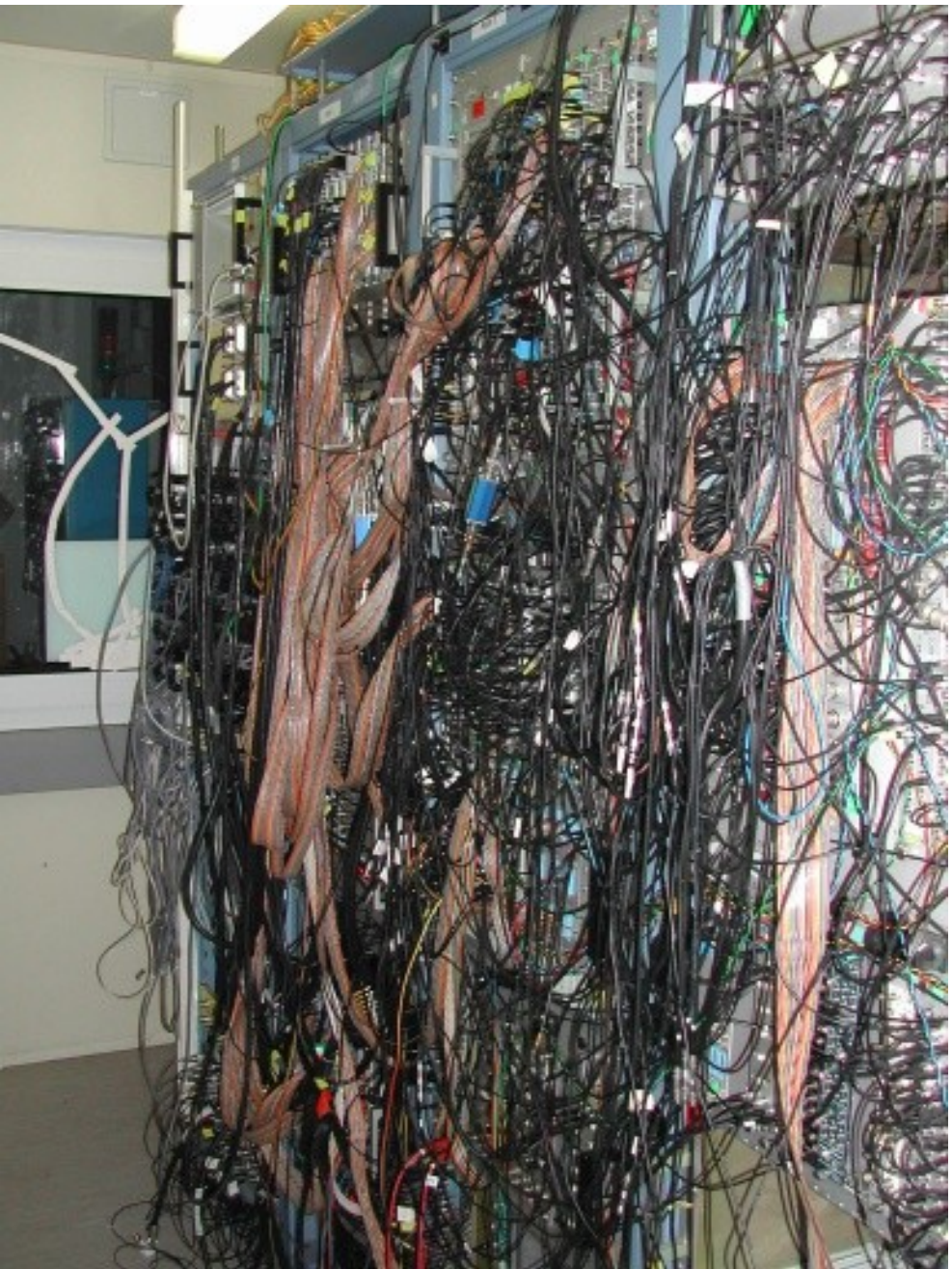


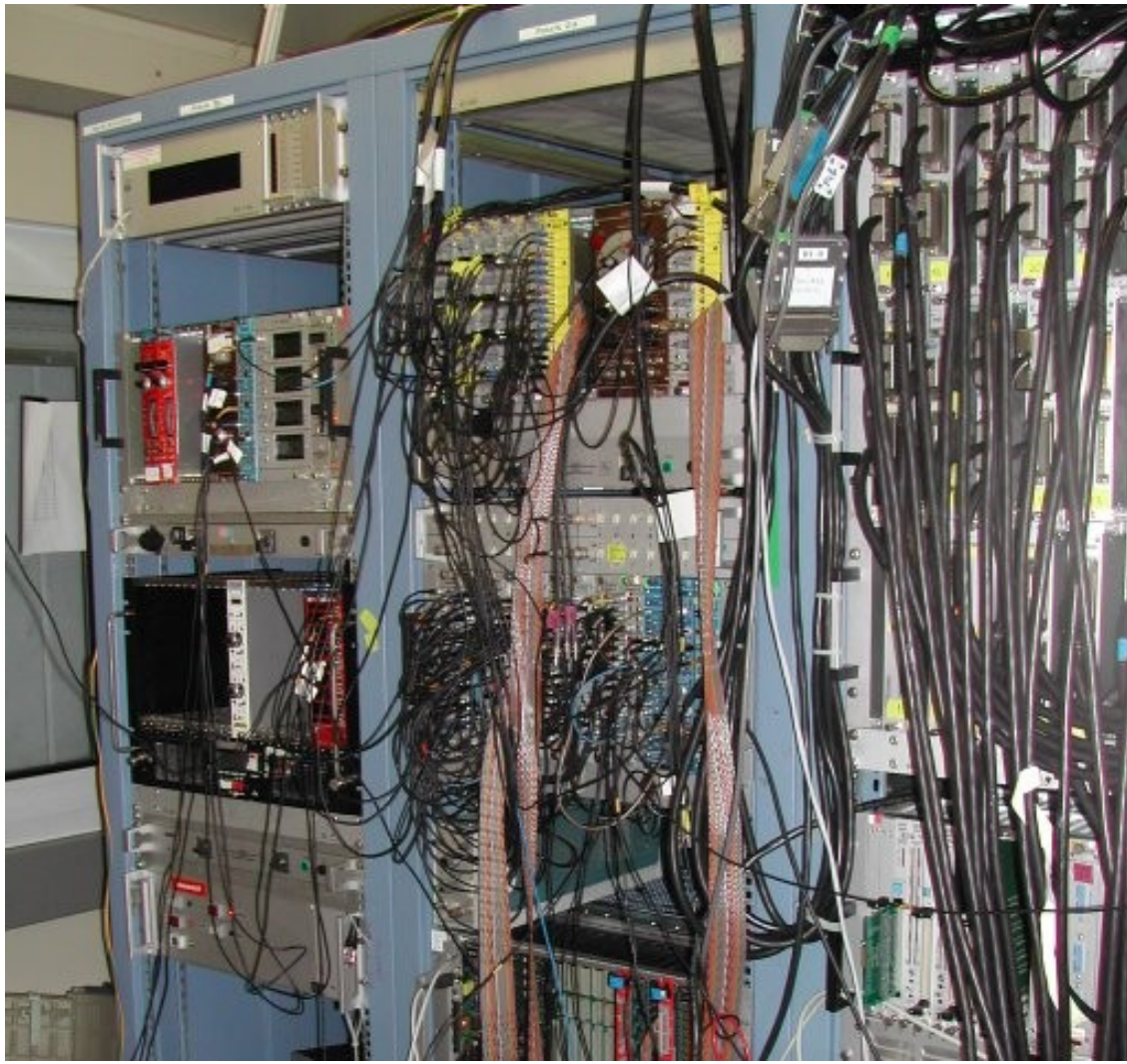


Improvements in computer hardware can handle the increase in data sizes

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

Just a few cables...

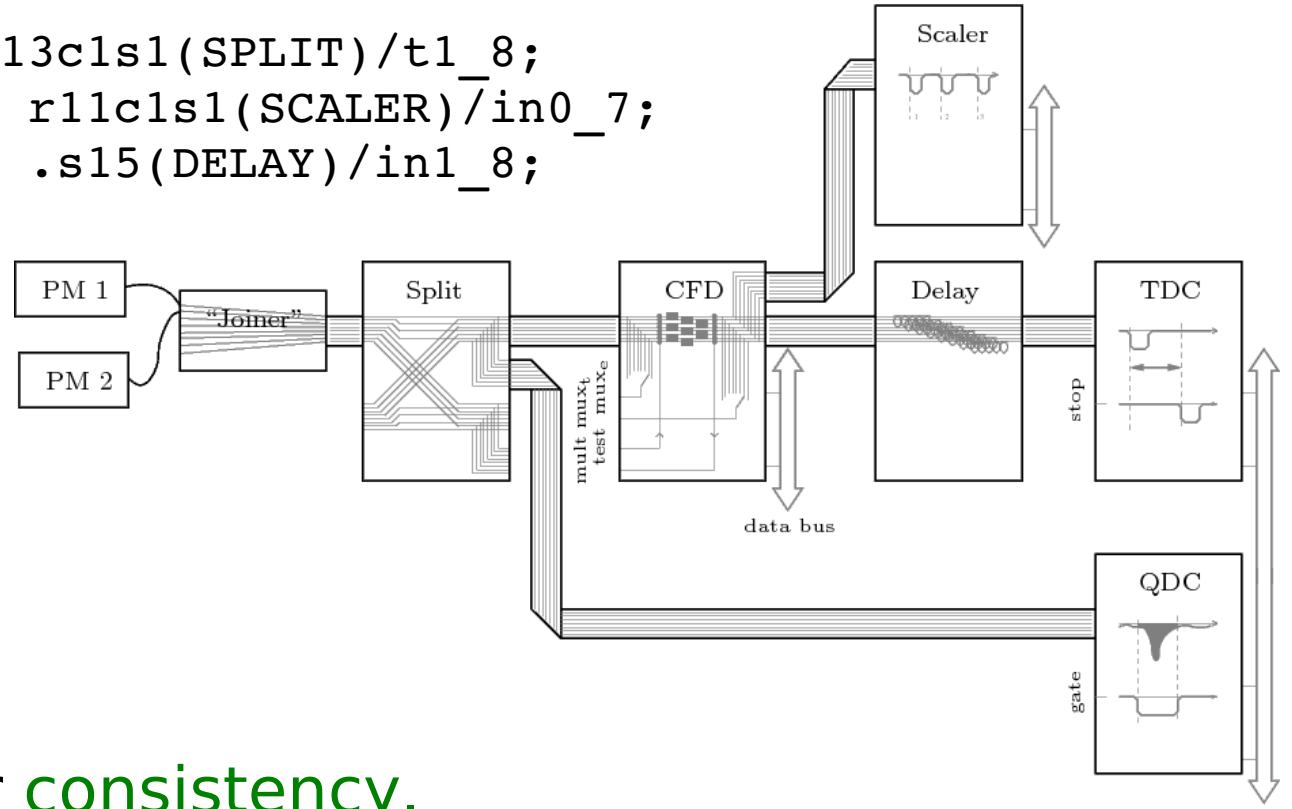




Solution / workaround ---------->

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;
}
```

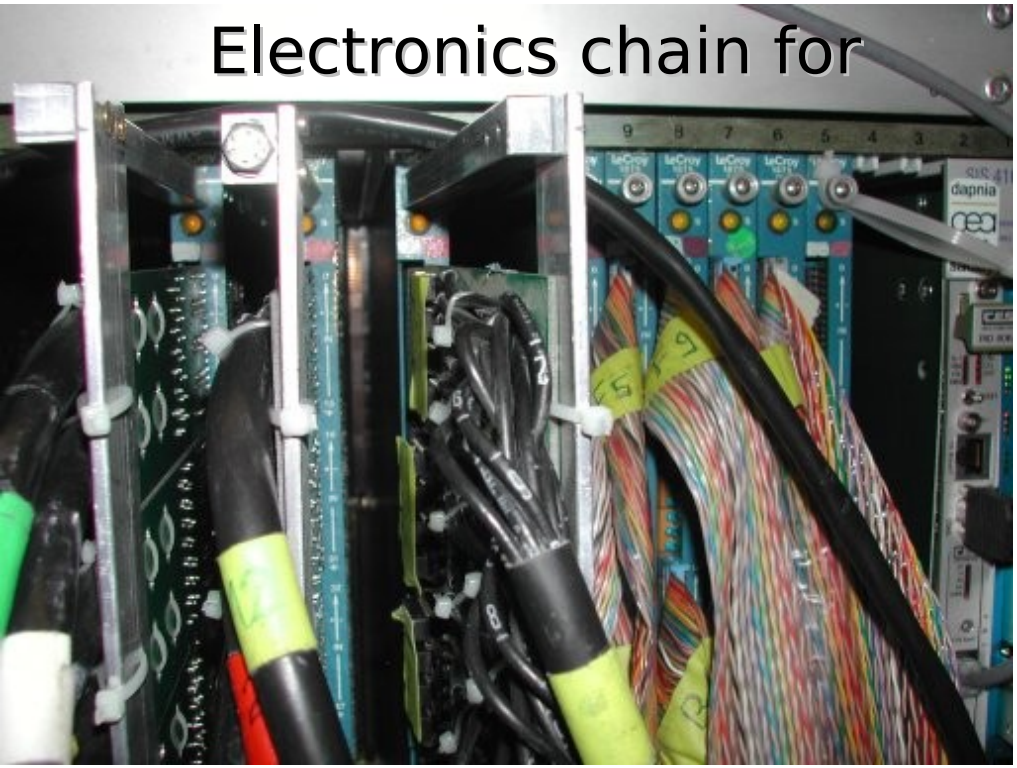


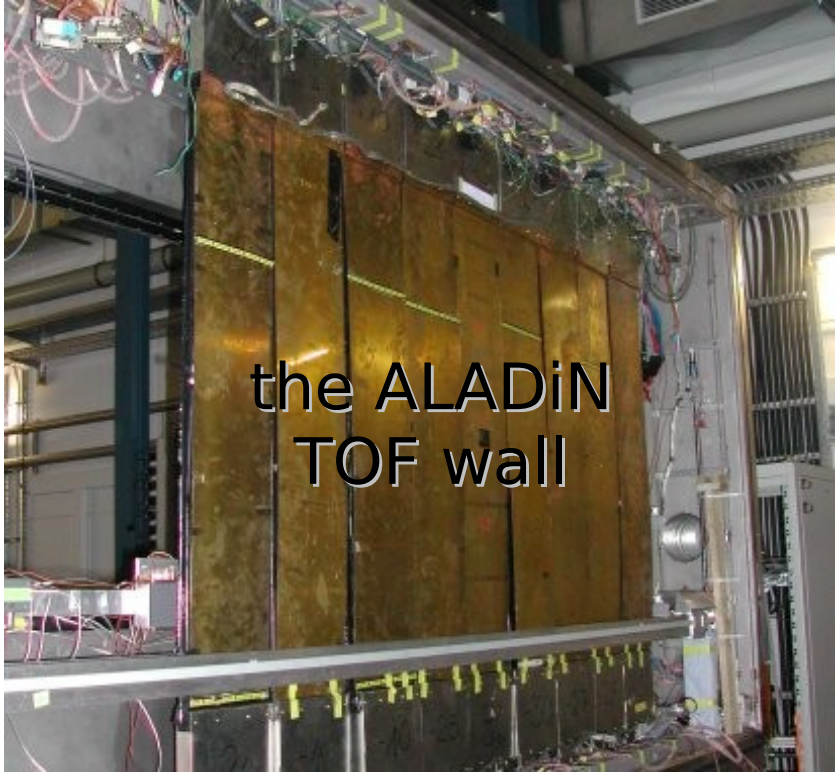
C-like text format.

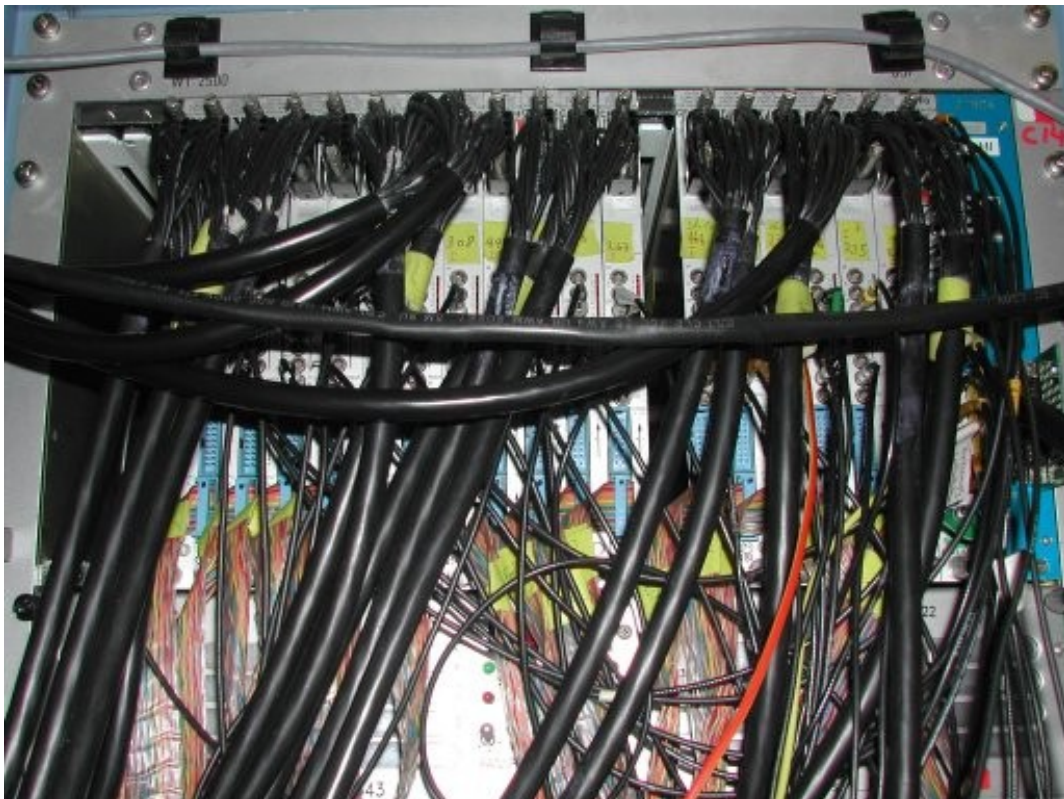
Parsed and checked for consistency.
(Every cable documented twice – at both ends.)

Checker generates tables for unpacking and slow-control.

S304 cable doc





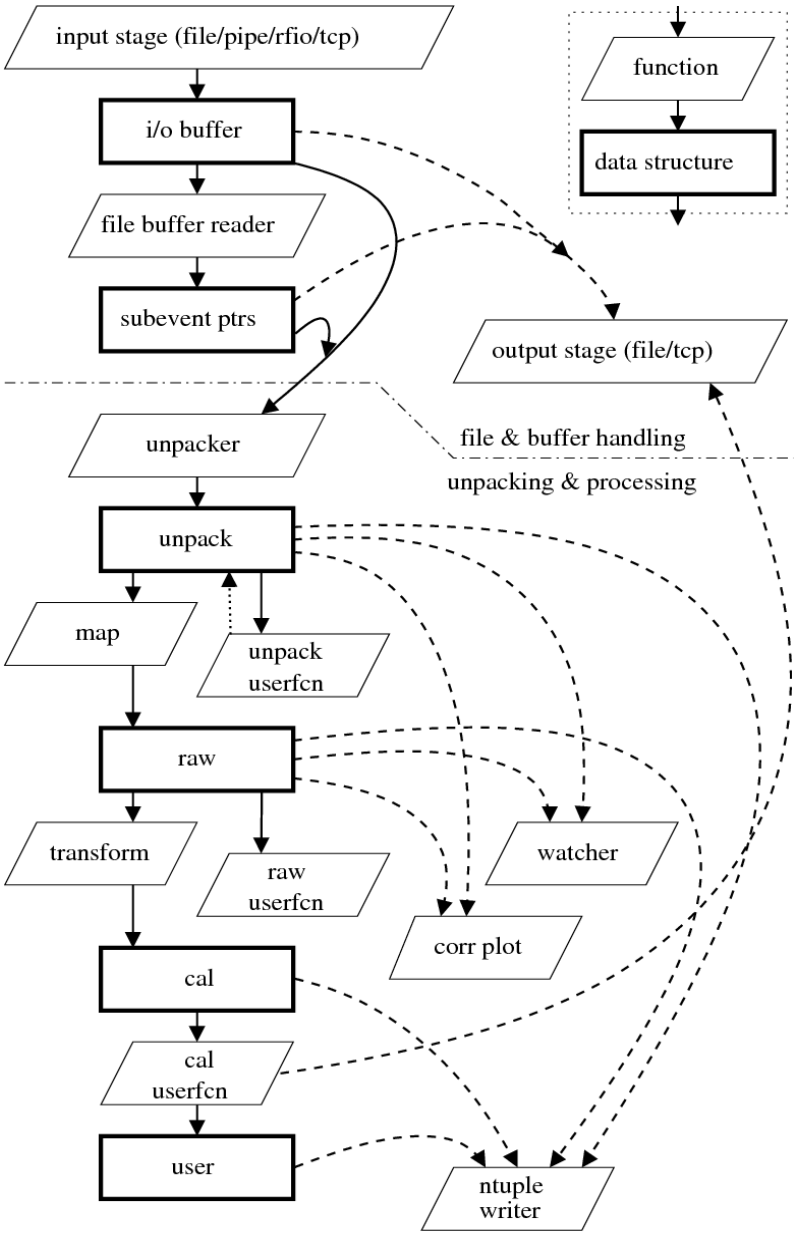


1 PhD, < 1 week

(= a few days)

→ working unpacking
and mapping

UCESB – unpack & check every single bit



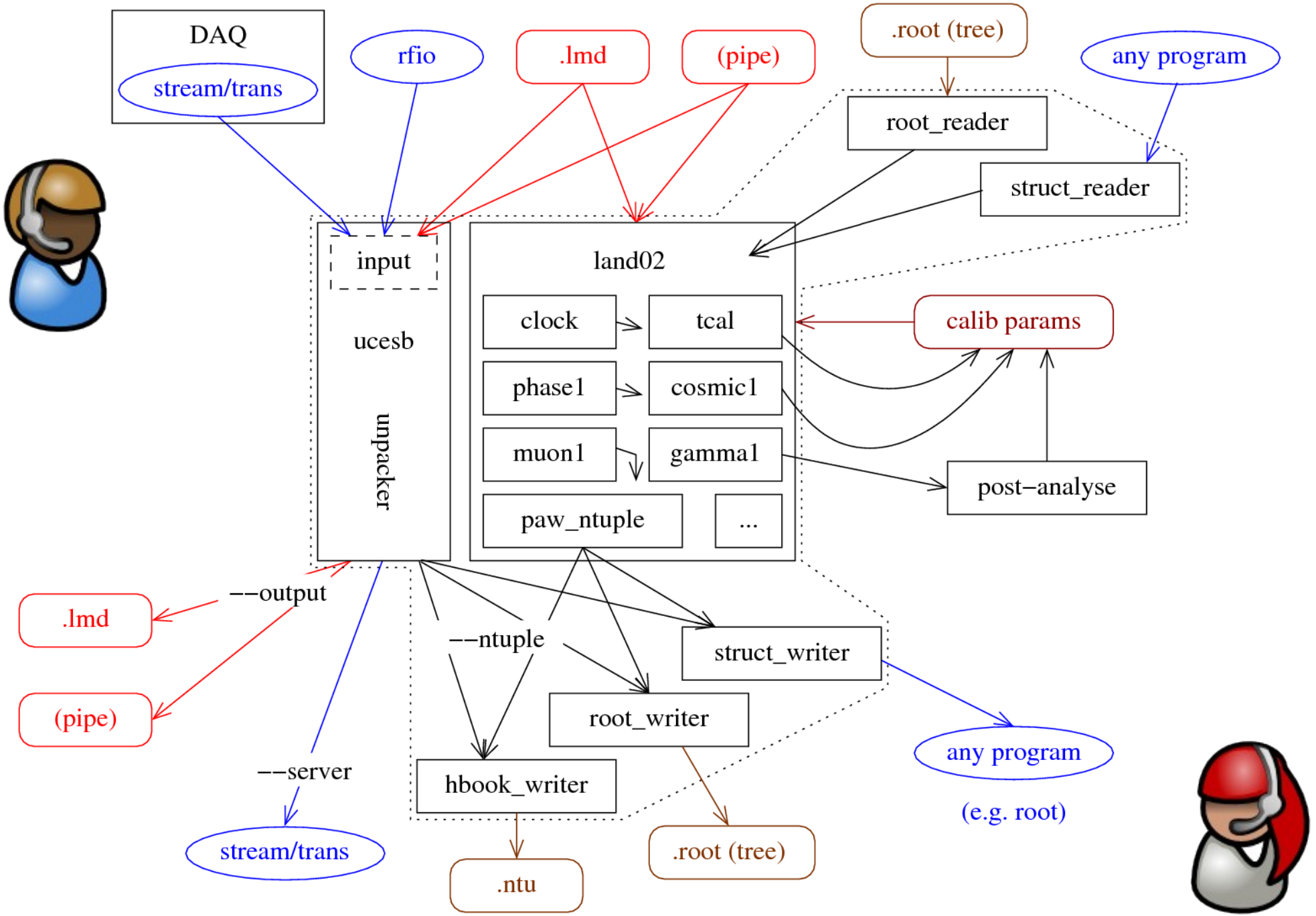
'Quick-n-dirty' generic unpacking and data 'quality' monitor

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/

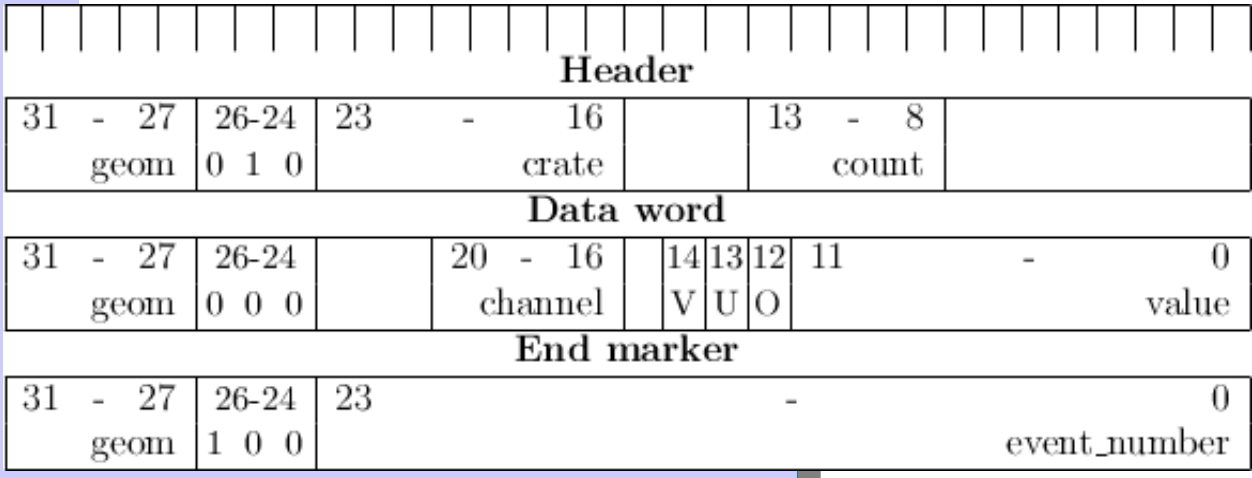
ucesb/(land02) interaction



Module .spec structure

```
VME_CAEN_V775(geom,crate)
{
  MEMBER(DATA12_OVERFLOW data[32] ZERO_SUPPRESS);

  UINT32 header NOENCODE {
      8_13:  count;
      16_23: crate = MATCH(crate);
      24_26: 0b010;
      27_31: geom = MATCH(geom);
  }
  list(0<=index<header.count) {
      UINT32 ch_data NOENCODE {
          0_11:  value;

          12:    overflow;
          13:    underflow;
          14:    valid;

          16_20: channel;

          24_26: 0b000;
          27_31: geom = CHECK(geom);

          ENCODE(data[channel],(value=value,overflow=overflow));
      }
  }
  UINT32 eob {
      0_23:  event_number;
      24_26: 0b100;
      27_31: geom = CHECK(geom);
  }
}
```

CAEN V775 (TDC) data format:



File formats

Common code for low-level I/O-buffers

Several file packaging readers (buffers etc):

LMD – .lmd – list mode data (GSI standard)

PAX – KVI data (ESN unpacking)

EBYEDATA – (Daresbury) MIDAS

HLD – Hades files

(more - easily possible... suggestions? (i.e. have any interesting files?))

Event handling (including unpacking) is common code

Piece work / sweatshop won't work

Parameters for one channel (T+E):

- gain + offset (time)
- pedestal + gain (energy)
- walk $t_{real} = t_{measured} + f(e)$
- 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

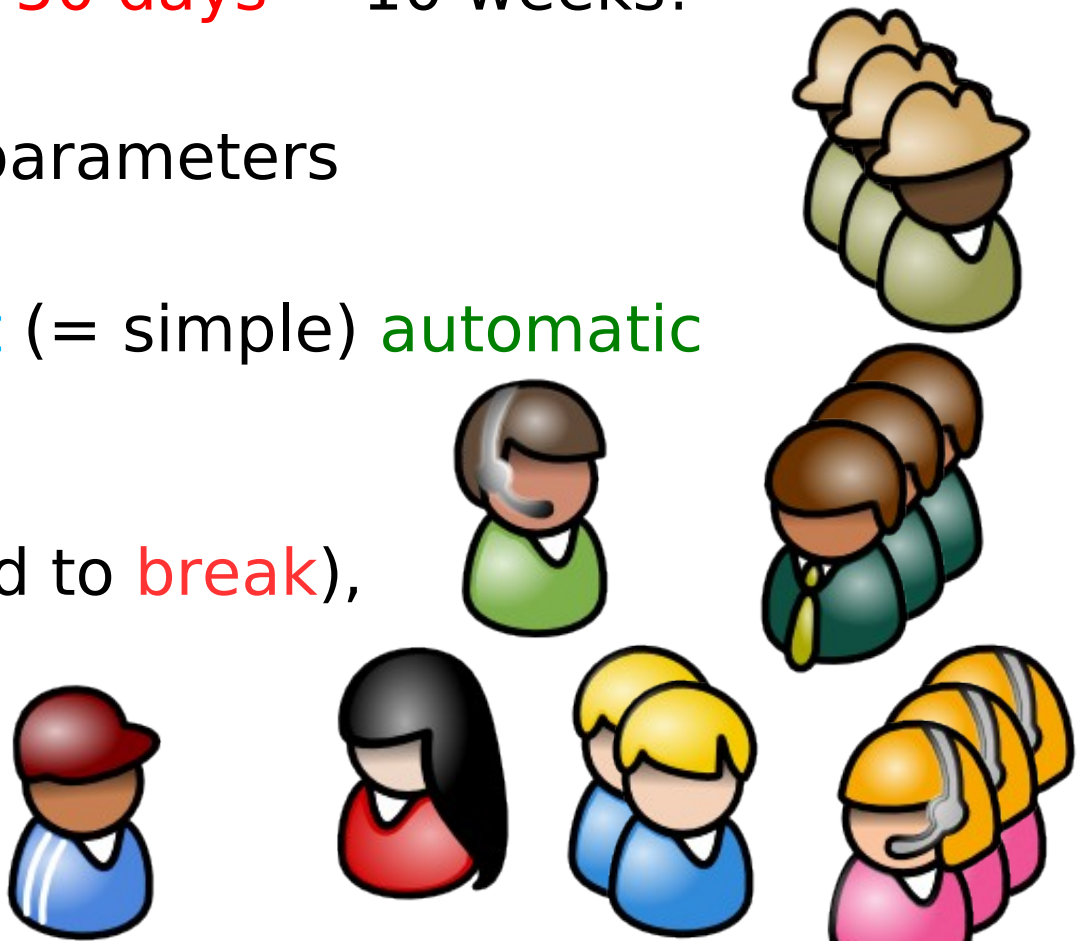
Pre 2006 LAND setup: ~1500 channels, 2007/2008: 8000 ch

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



Finale!

Thank you!

A great deal of FUN!

It is not even the beginning of the end.

"Now this is not the end. but it is, perhaps, the end of the beginning."