Off go the …

H. Simon – GSI-Darmstadt

MENU

(i) why do we need cables

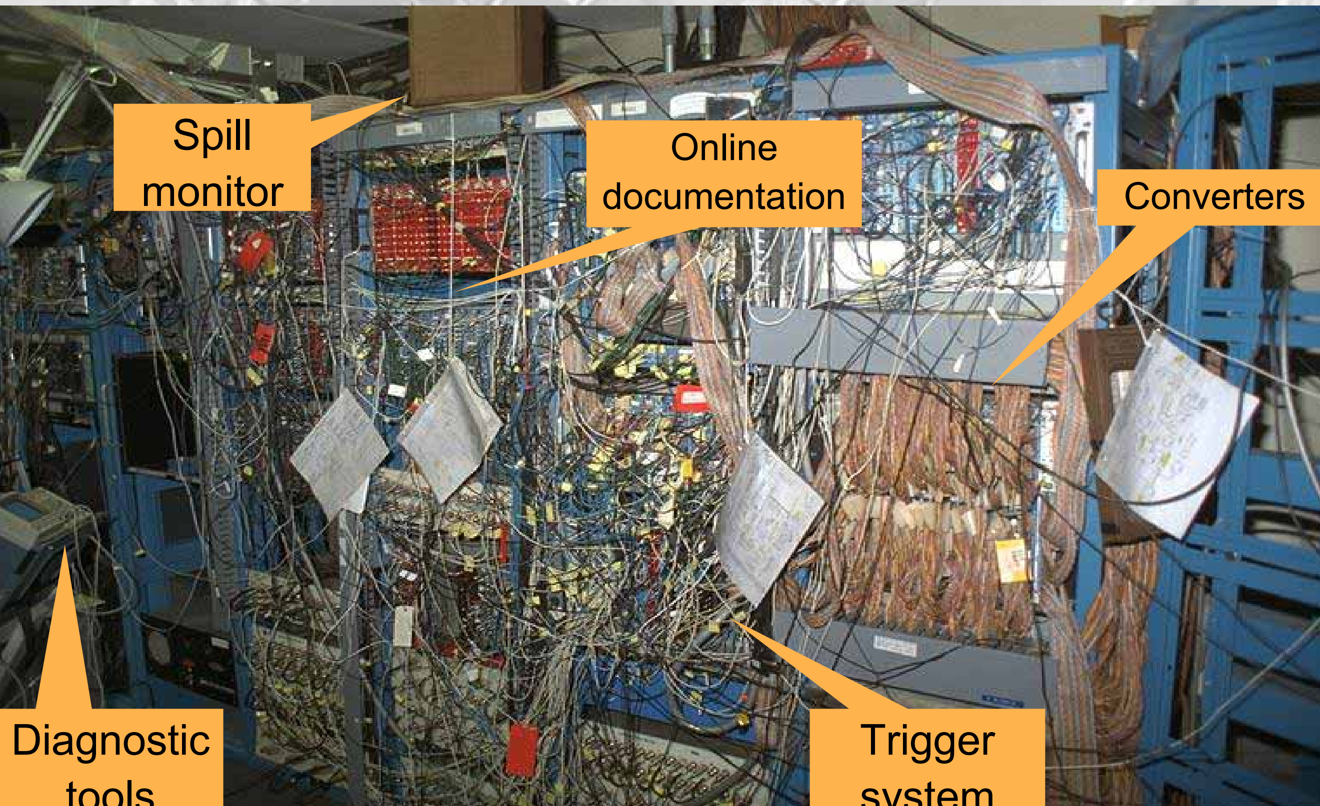
(ii) customers aka experiments

(iii) system integration using time stamps

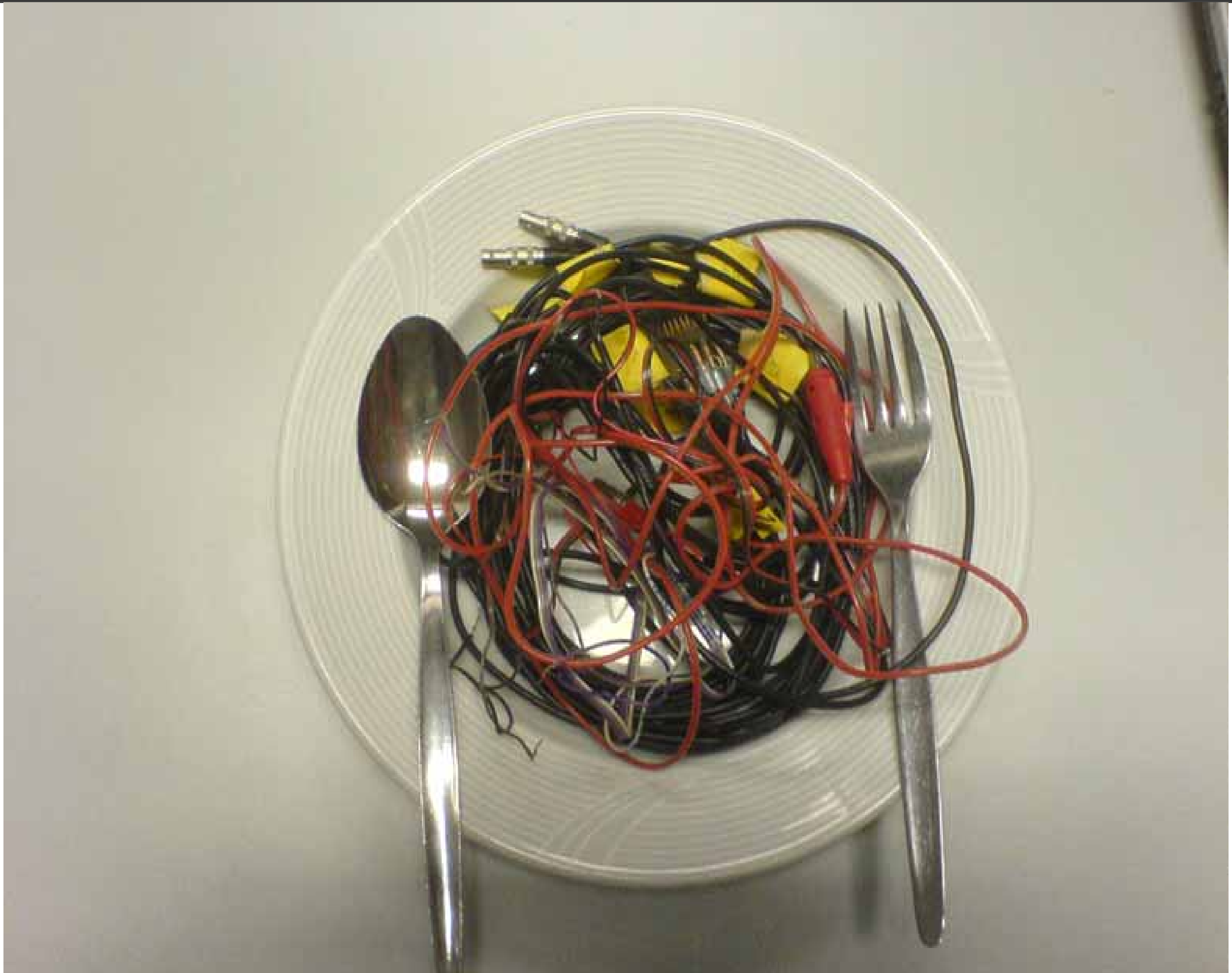
(iv) frontends

(v) summary

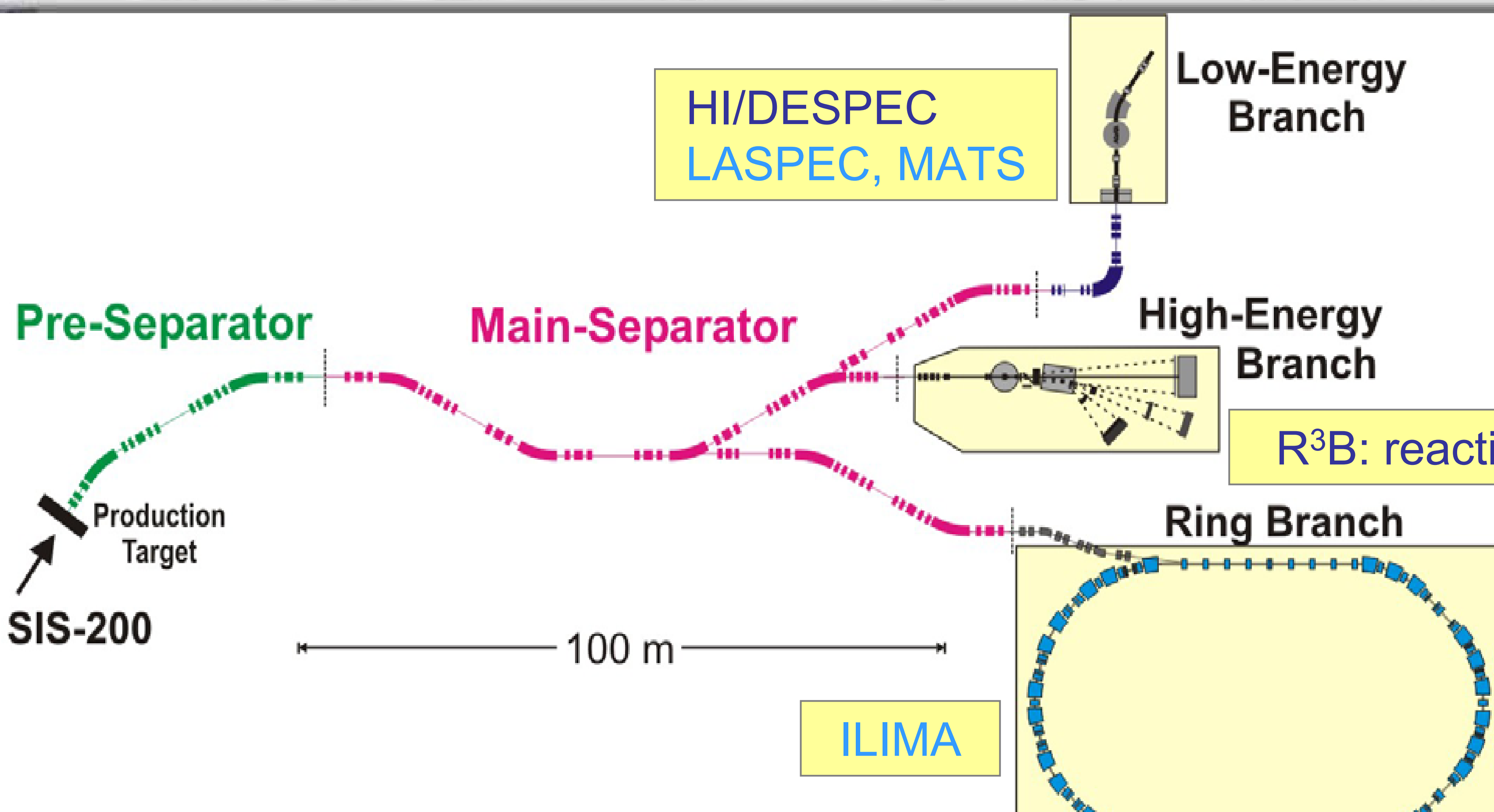
… cables !


Spill monitor
Online documentation
Converters
Diagnostic tools
Trigger system

From a few 100-1000 to half a million channels



NUSTAR Experiments
(NUclear STructure Astrophysics and Reactions)



HI/DESPEC
LASPEC, MATS

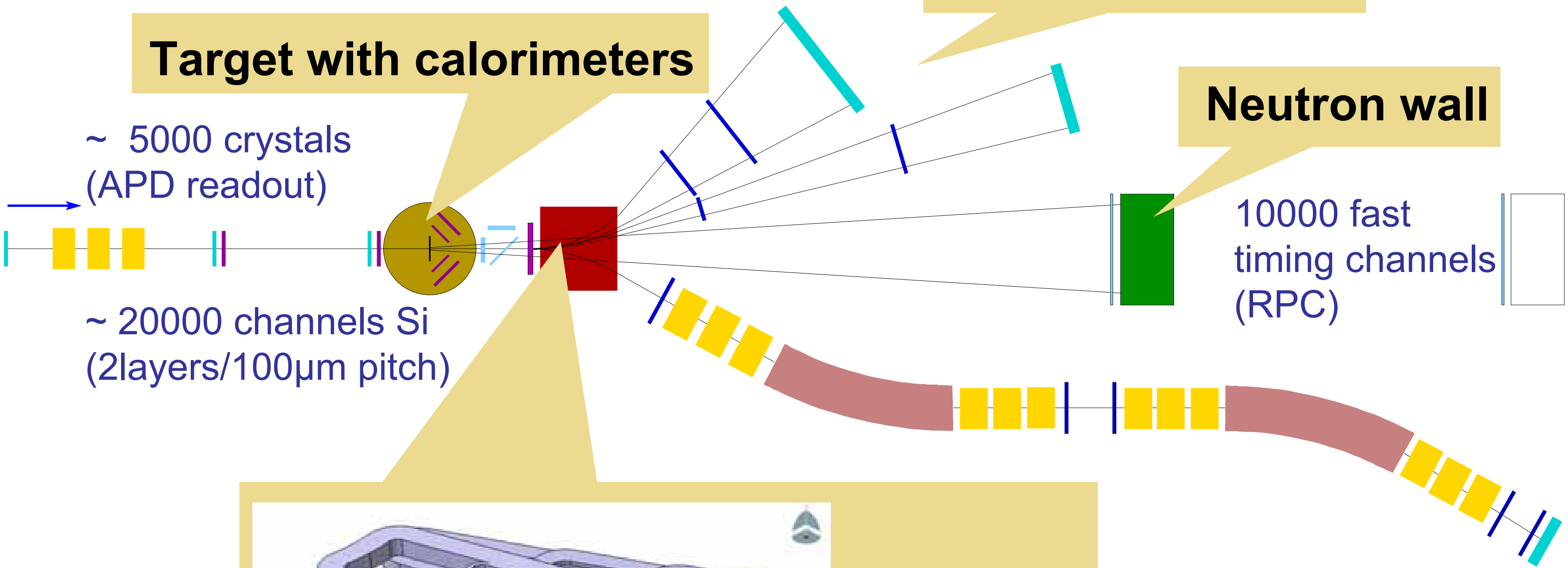
R^3B: reactions

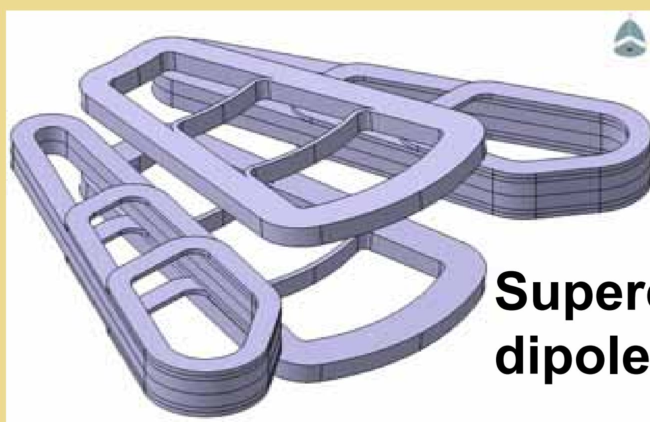
ILIMA

EXL : hadron scattering
ELISe : electron scattering
AIC : antiproton scattering

R^3B

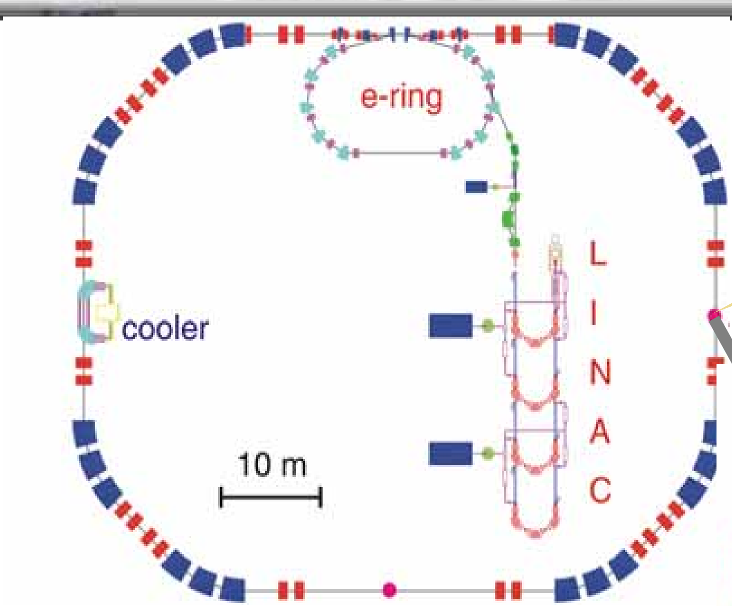
Reactions with Relativistic Radioactive Beams



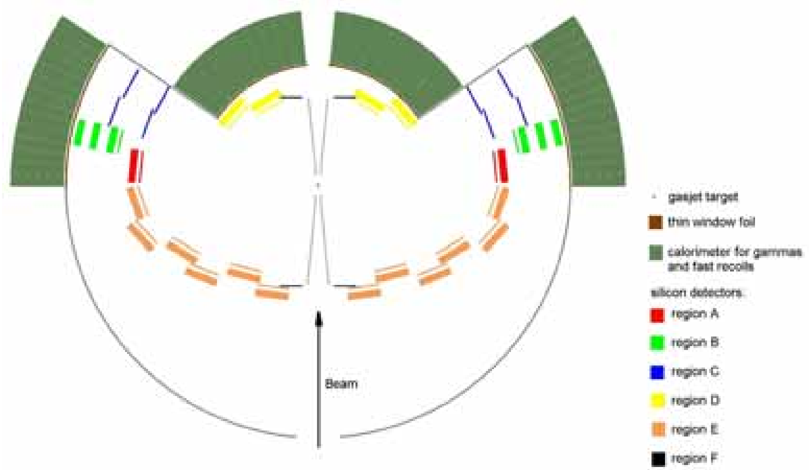


EXL

Exotic Nuclei Studied in Light-Ion Induced Reactions at NESR



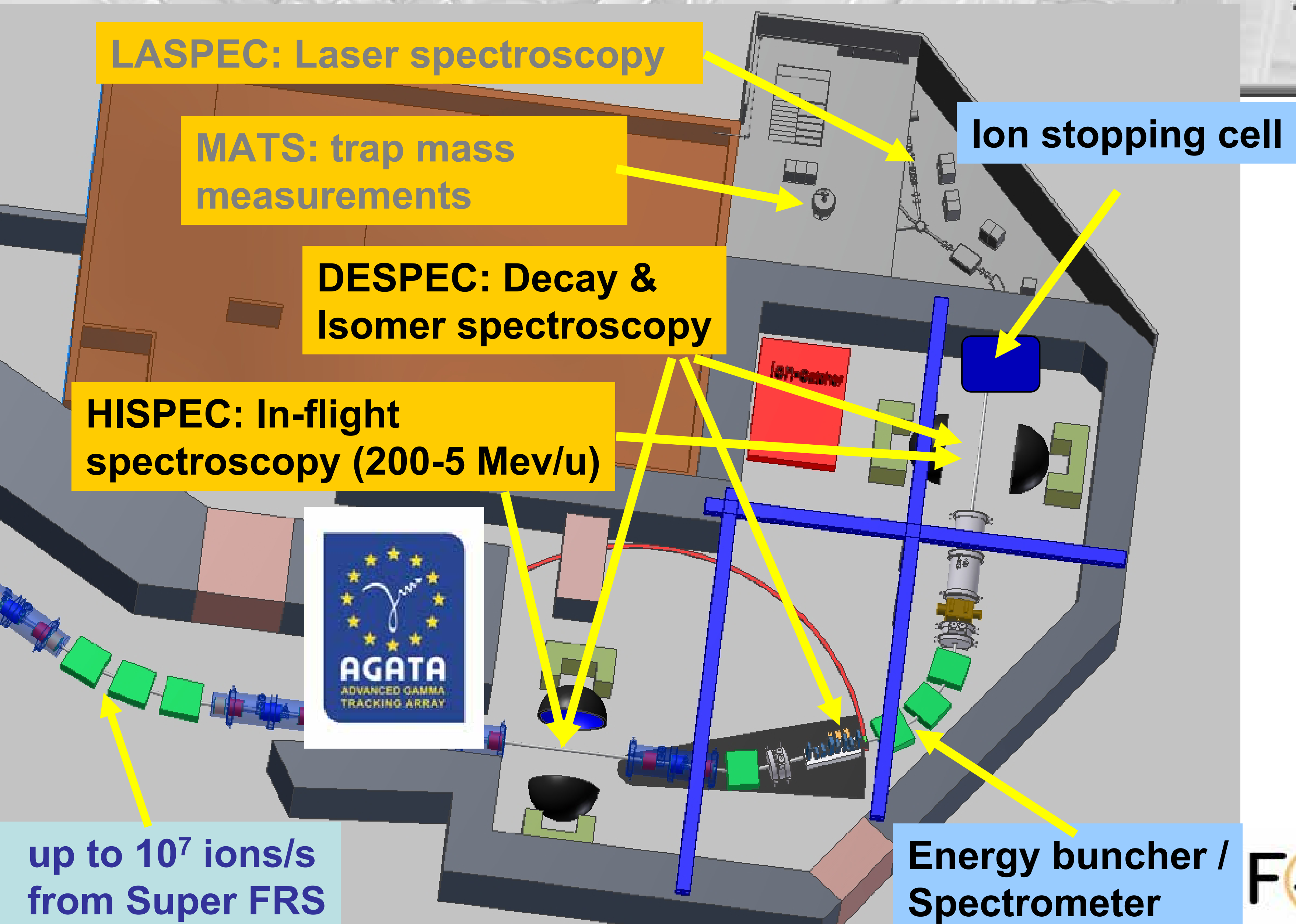
Internal target



NESR

- **Target-Recoil and Gamma Detector around internal target ca. 500 000 channels (Si strip, Si, CsI)**
- **Neutron ToF, ca. 2000 channels**

LEB: Slowed-down and Stopped beams



FAIR

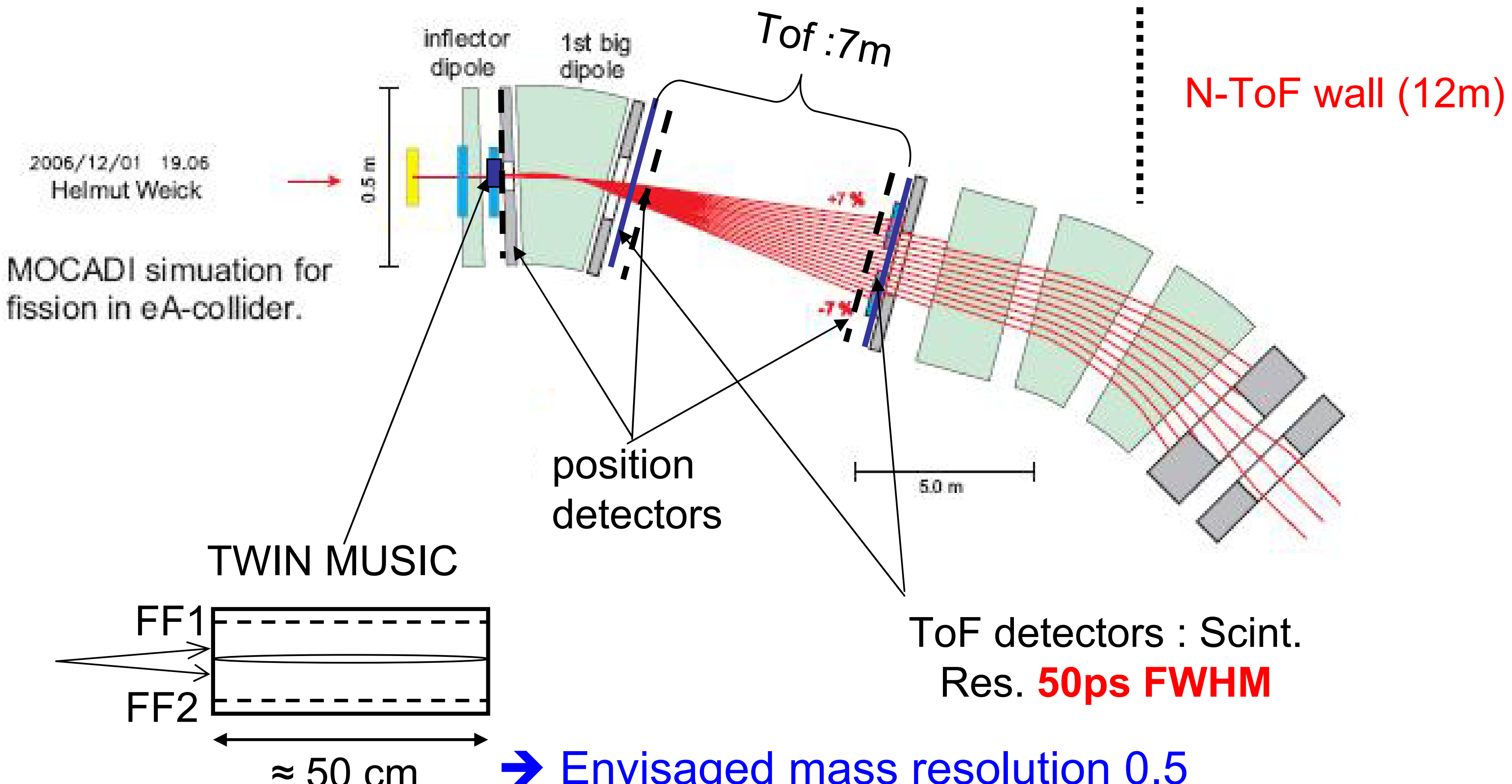
LEB Systems:

- Agata (System Integration: Clock, Trigger, DAQ)
- Lycca (Fast timing)
- AIDA (Clock Distribution, Implantation ASIC)
- Hyde (Fully Digital Electronics)
- …

➔ FAZIA, GASPARD

In Ring Particle ID (AIC, ELISe, EXL, SPARC)

e.g. ELISe: Experimental set-up



Z1, and Z2

➔ Envisaged mass resolution 0.5

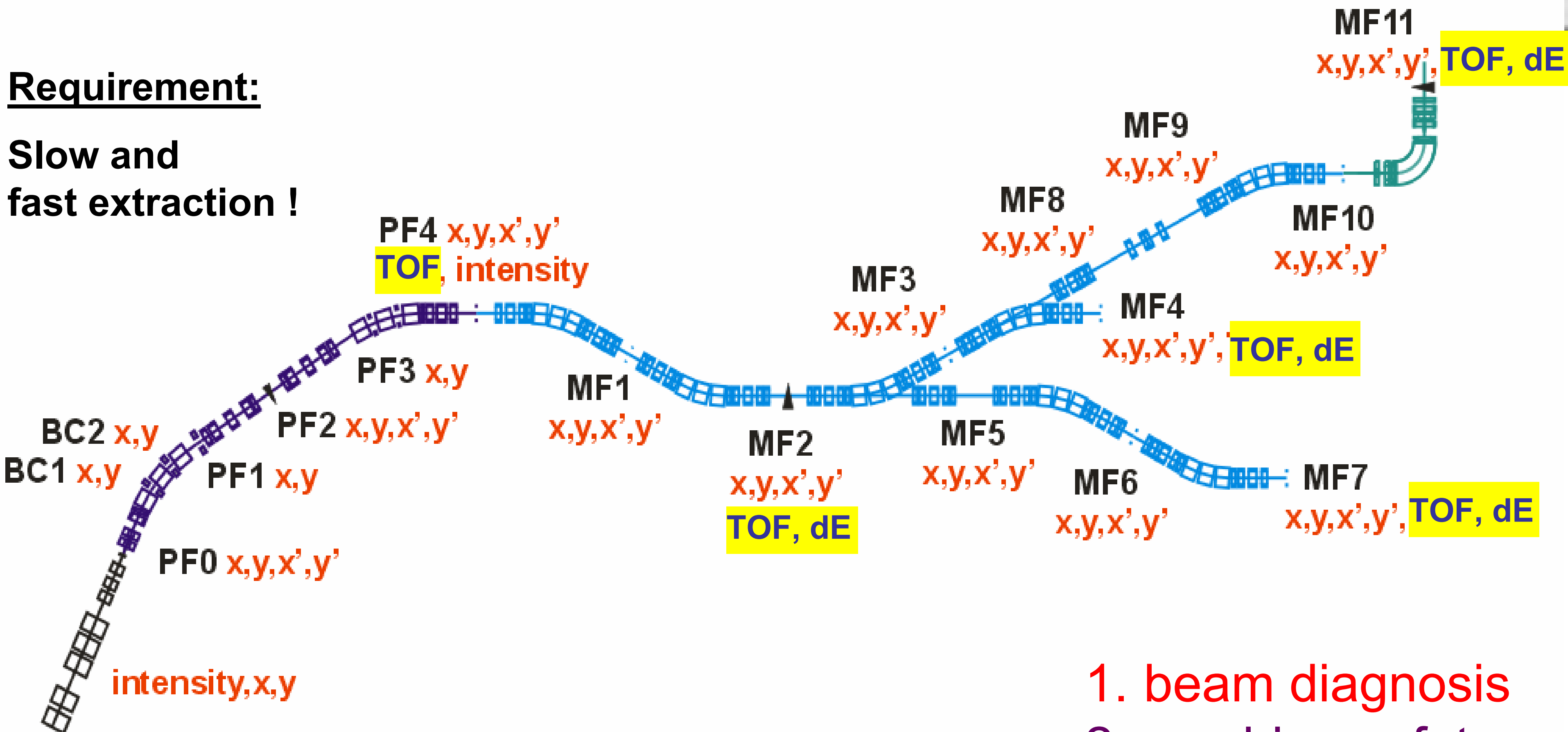
„ … sort of ideal experiment for fission studies…“

(J. Taieb et al., CEA Bruyères-le-Châtel | Saclay, CENBG Bordeaux, IPN Orsay | Lyon)

Detector Instrumentation of the SuperFRS

Requirement:

Slow and fast extraction !



1. beam diagnosis
2. machine safety
3. experiments

10^{12} /s $<10^{10}$ /s $<10^{9}$ /s $<10^{7}$ /s $<10^{5}$ /s

FAIR

$B\rho$-ΔE-TOF method: Requirements

$B\rho = A/Z \cdot \beta \cdot \gamma$ → A/Z, P

$TOF = L/\beta$ ↗ ↘

$\Delta E \sim Z^2/\beta^2$ → Z

Pos res. $\sigma \leq 1$ mm

Timing res. σ: 50 ps

ΔE resolution σ: 1-2 %

- Position: Wirechambers (single event readout)/Diamond
- ΔE: MUSIC/TEGIC
- TOF: Plastic/Diamond

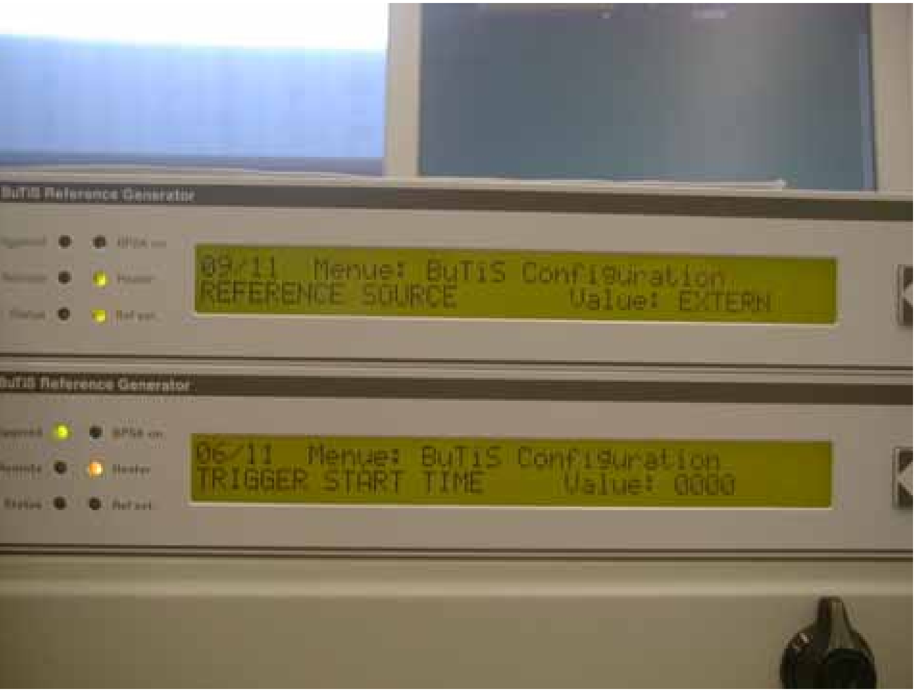
ACS/FESA

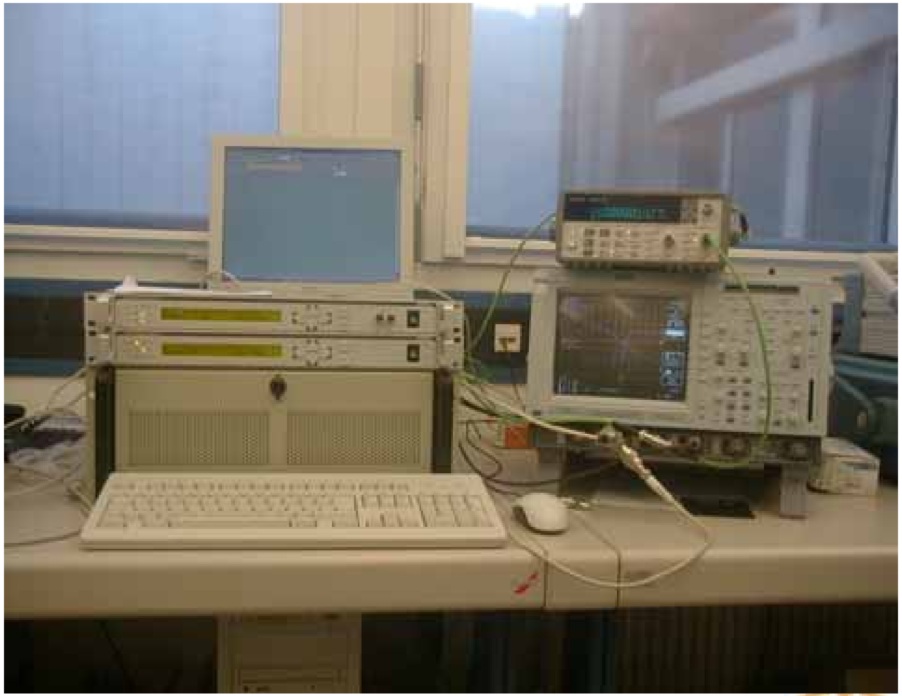
DABC(MBS)/EPICS

Large Scale → Time distribution

P.Moritz (GSI) collaboration with Works µ-wave GmbH

- Campus wide time distribution
  (1) Bunch timing accelerator (BuTiS) (2) Exp.: Time of flight between caves
- Synchronous local oscillators (100kHz, 10Mhz, and e.g. 200, 155 or 76 Mhz)
  +-100ps/km absolute uncertainty
  few ps oscillator jitter





BuTiS fibre distribution test bench

BuTiS Master

↓ 0.01, 10, e.g. 200 MHz copper

LASER +
AM modulator

↓ opt. fibre (4 * 200GHz bands)

passive splitter
distribution 1..2 km

↓

Demodulator + reflector (4th ch)

↓ 0.01, 10 MHz copper

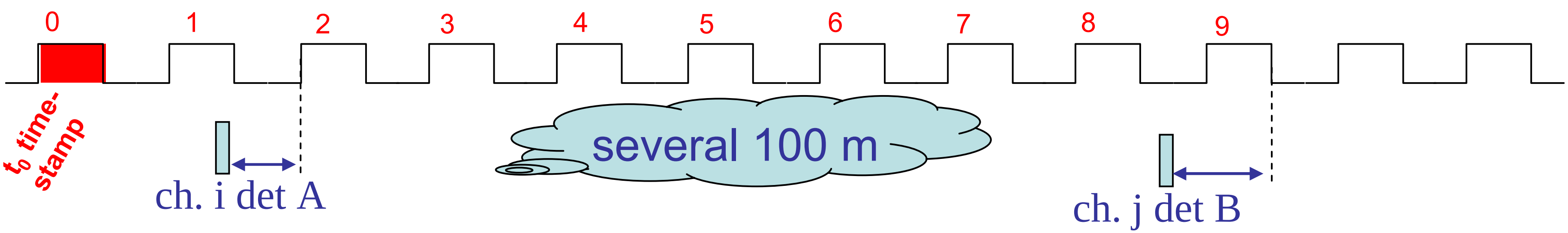
BuTiS Slave osc.

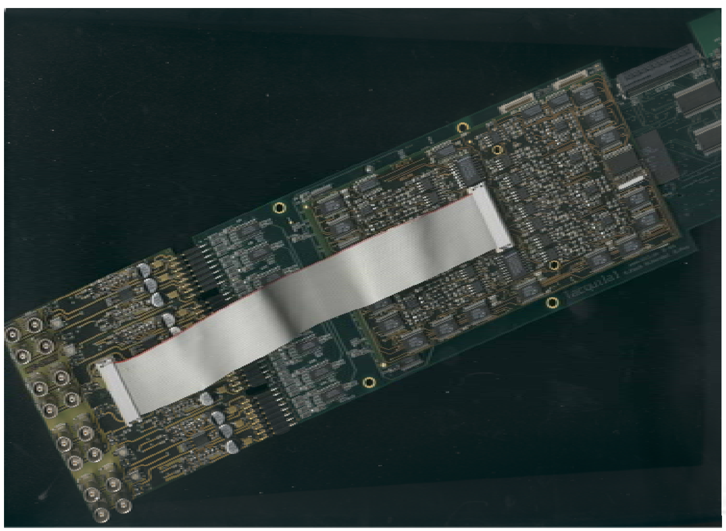
↘ 0.01, 10, e.g. 200 MHz copper → **(local TDS) ?**

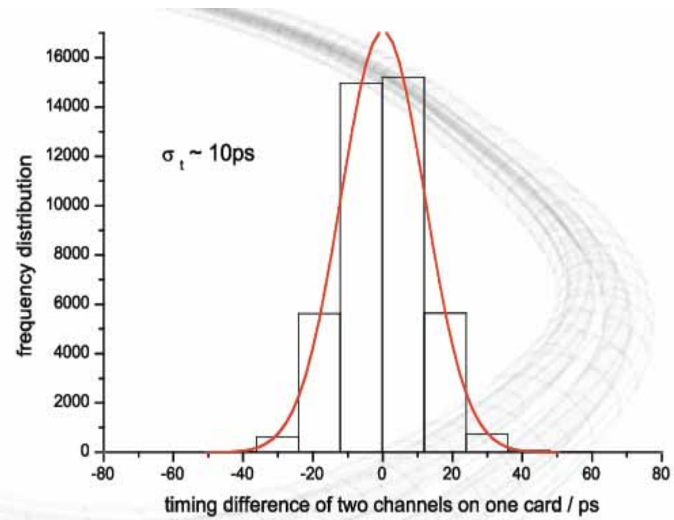
Precision timing (<50ps) vs. Campus Clock

- avoid extended cabling and dead time domains

➔ free running time stamped systems SuperFRS -- Caves







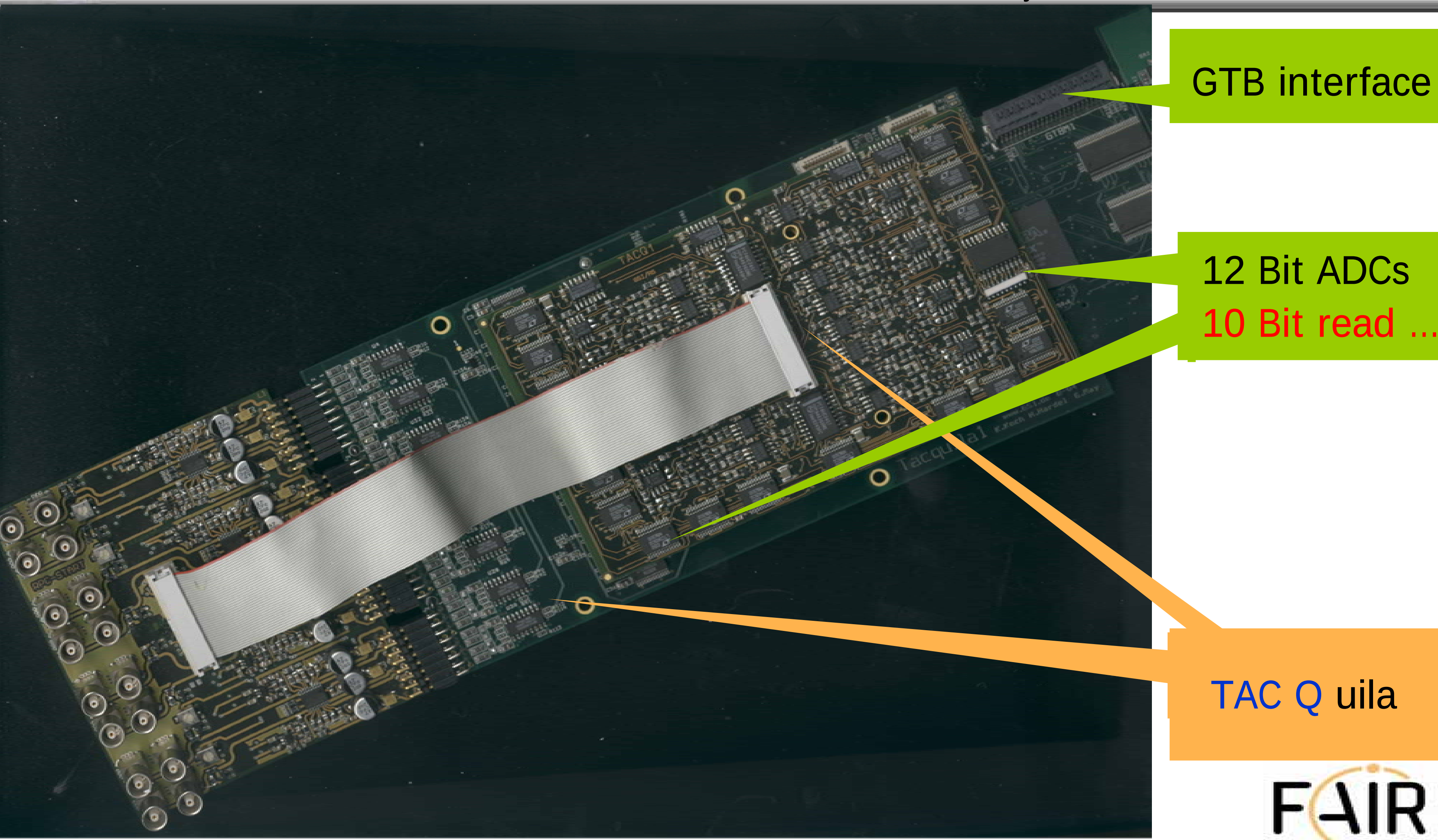
Timing FEEs:

Tacquila system (ASIC FhG/GSI)

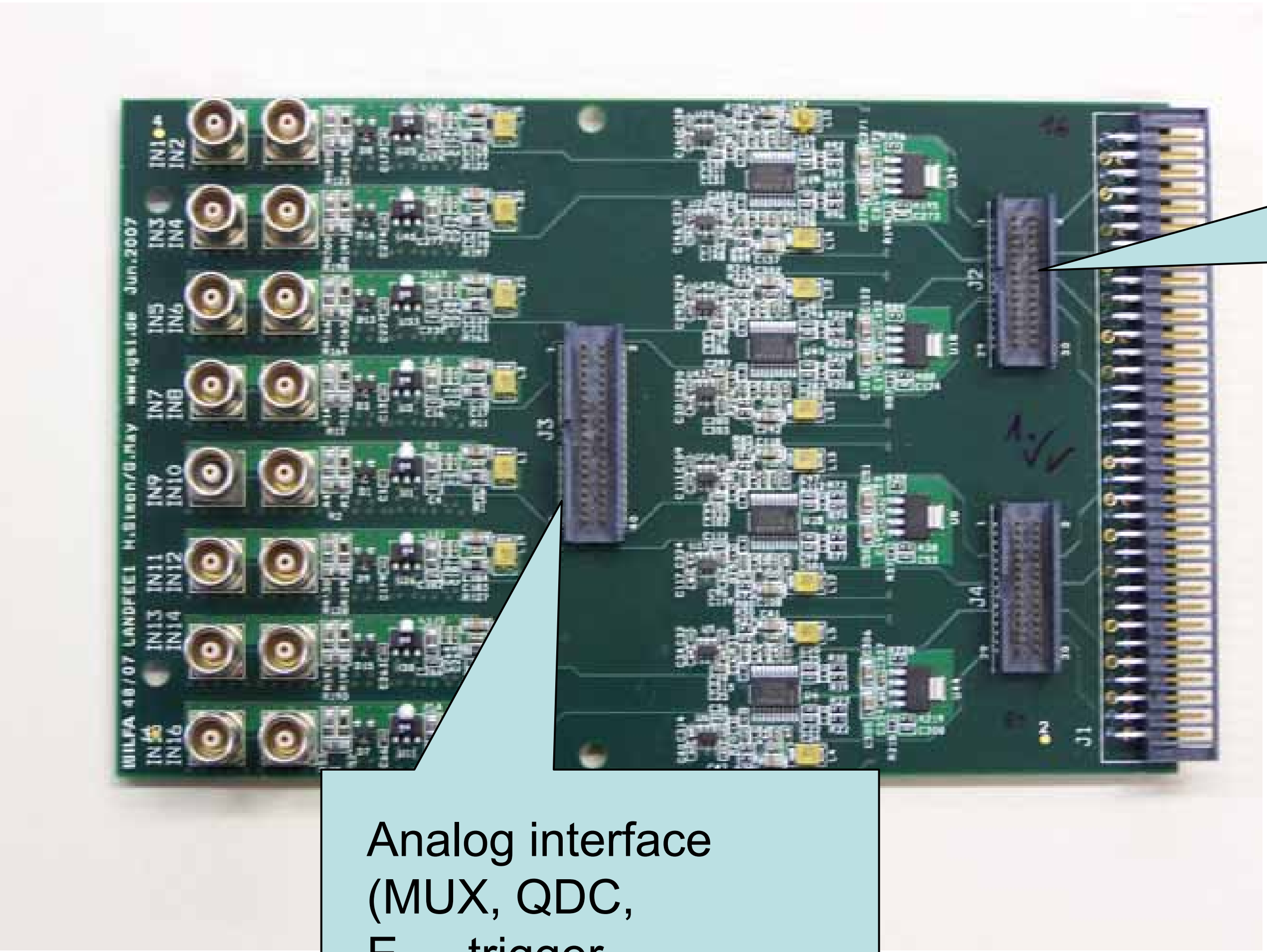
New systems (ASIC dev. GSI)

ASIC: Tacquila System

K.Koch, G. May, W.Ott, N.Kurz, J.Hoffmann



New Tacquila FEE (Q1/08) → R³B-CaveC, Lycca(RISING) includes slow control, diagnostics & triggering



Comparator levels and digital interface

Analog interface (MUX, QDC, E_{sum} trigger

- Second board PCB design
- Piggy back close to production (I²C controls, MUX, OR, analog sum and multiplicity triggers, pulser input)

Integration within MBS
→ synchronous or timestamped EB

Timestamps
(TITRIS)

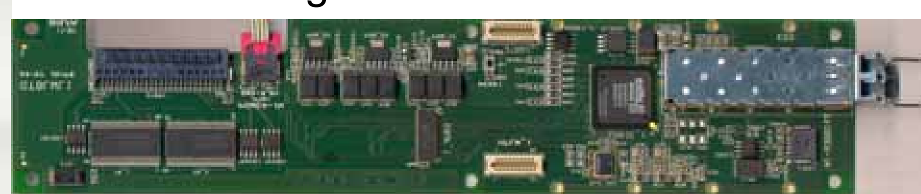
FE Trigger Distribution
(TRIDI)

Trigger Module
(TRIVA)

Logics
Scaler/Downscale
Deadtime locking
Soft triggers
(VULOM)

N. Kurz, W.Ott, J. Hoffmann

GTB & Piggy back for coupling of 'other' FEEs
FE data transfer (Cu/LWL)
and Processing



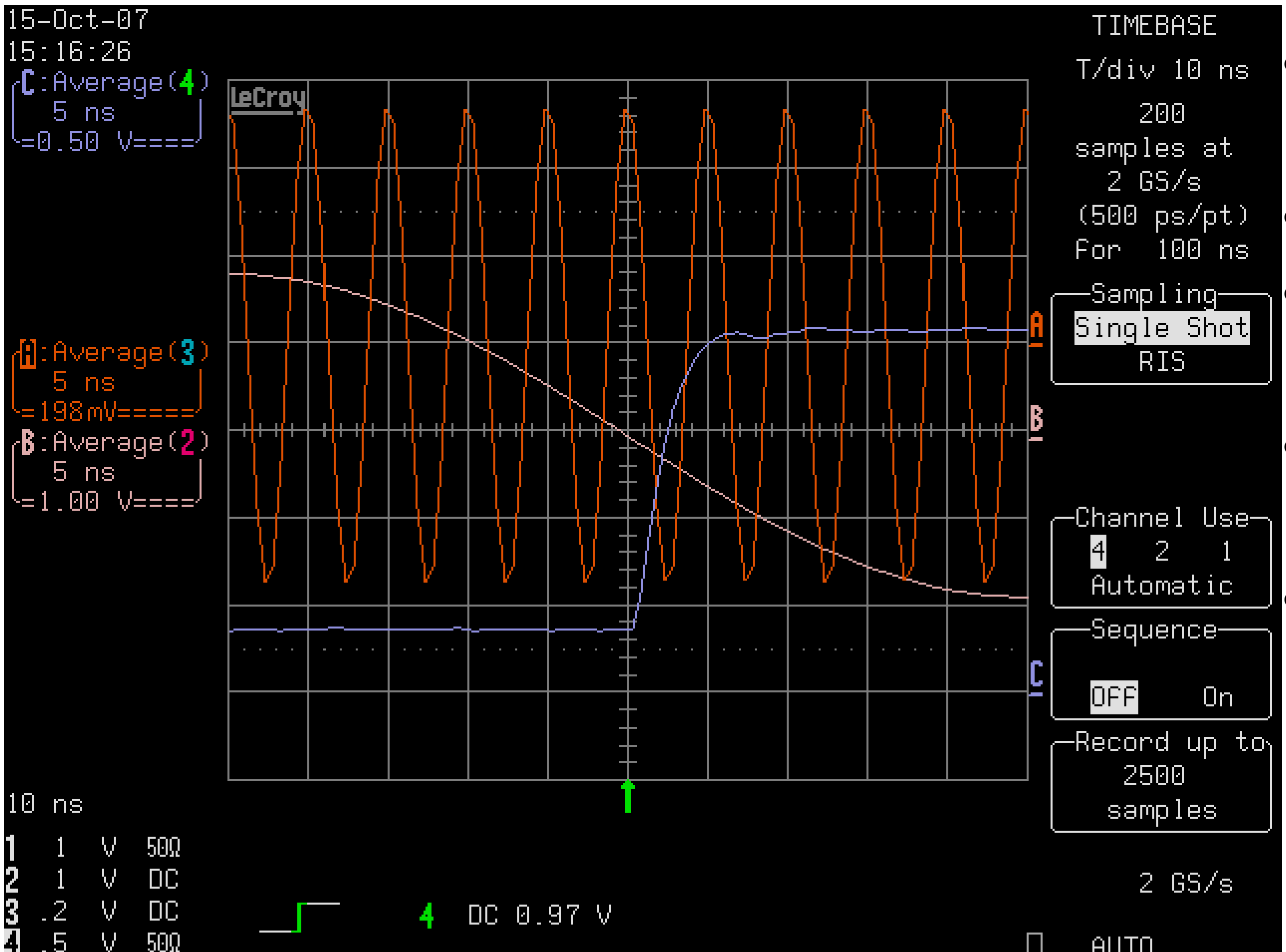
TDS Systems: One clock to rule them all …

1. Coupling to existing TDS used to tag events (Centrum, Titris, Agava/GTS, …)
   ~ 5-10 ns separation/1ns precision

   Specs. are currently prepared:
   WG: J. Agramunt, M. Bellato, P. Coleman-Smith, N. Kurz, H. Schaffner, H.Simon

2. Precision time stamping
   ~5-10 ns separation/few 10 ps precision
   ➔ no payload, just phase locked to TDS

BuTiS at work (20071015)



- 10, 200 MHz sine waves (adj. phase)
- T0 pulse for sync.
- very good phase stability
- BuTiS oscillator can run standalone
- about 10k€/system

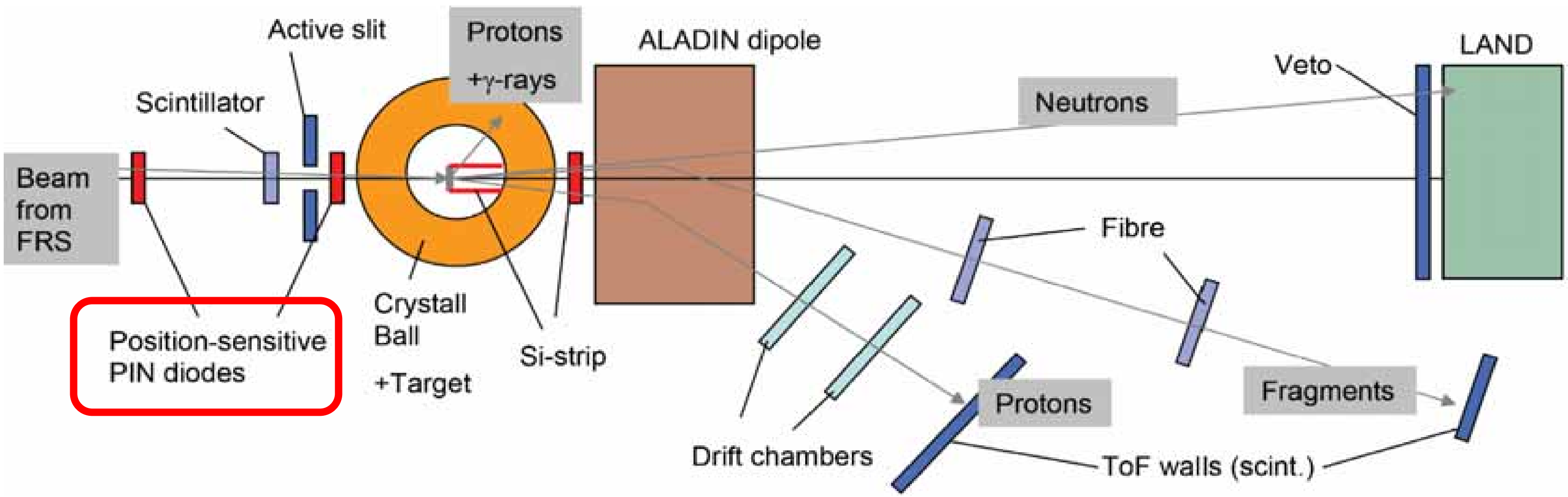
FREEDAQ: Missing building blocks

Time Distribution:

- BuTiS, anything → TDS encoder
  - intelligent triggering (few 10ps precision)
- Experiment Wide (fibre based) distribution
  - interface to various timestamp systems

- Crate Wide Distribution standard (?)
  - e.g. AIDA: 200 MHz via HDMI

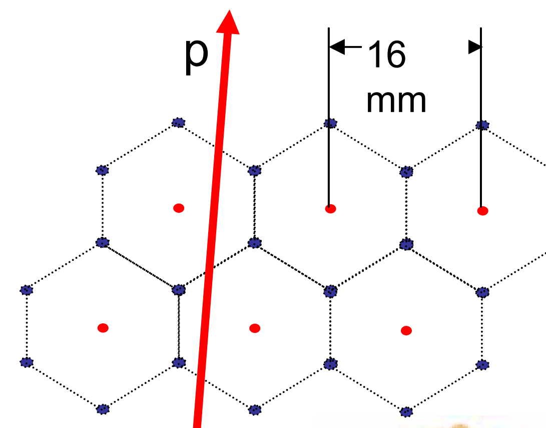
Intelligent Triggers & Controls: Test System (R^3B-CaveC) Example: PSA



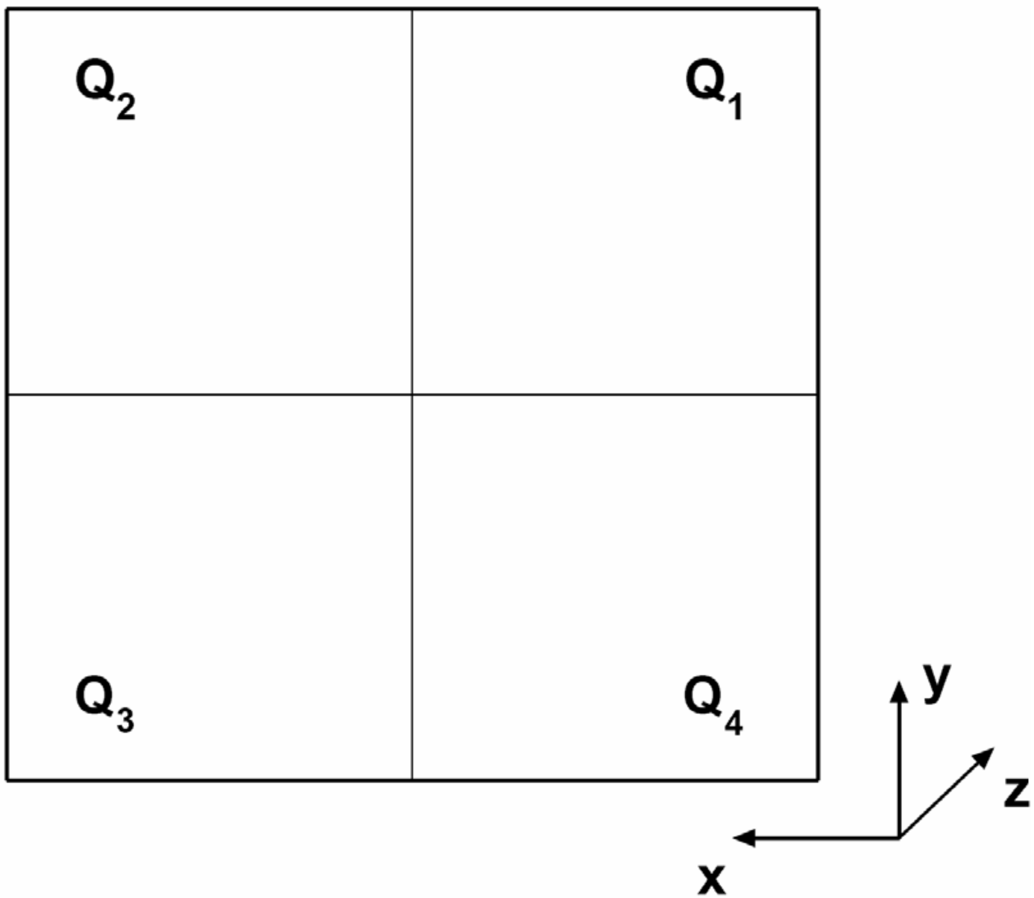
300 µm high n-type Si

4,5 x 4,5 cm²

B doped → p-side



PSP tracker



- Cathode : Sum energy
- 4 Anodes → position

$u = (Q2 + Q3) – (Q1 + Q4) / Q$

$v = (Q1 + Q2) – (Q3 + Q4) / Q$

$Q = Q1+Q2+Q3+Q4$

→ $x(u,v)$; $y(u,v)$

Idea: Use ADC coupled to Hades TRB2 of KVI: Peter Schakel / Pim Lubberdink/Victor Stoica

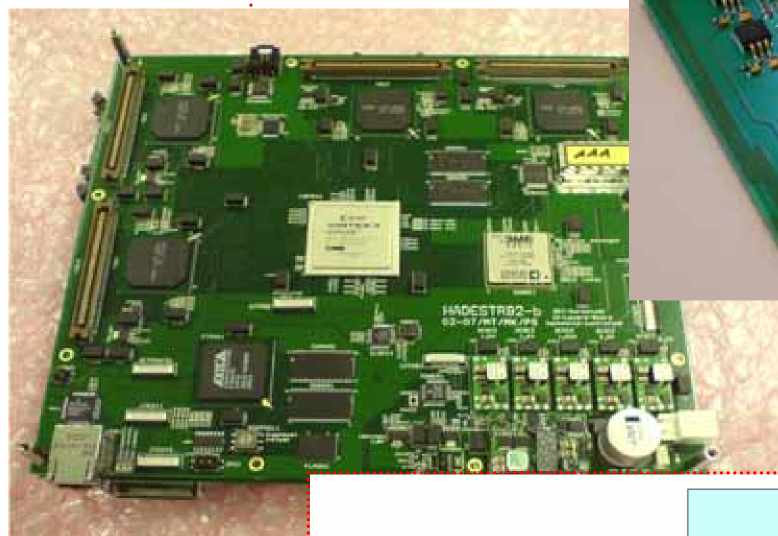
- Available hard/software environment:

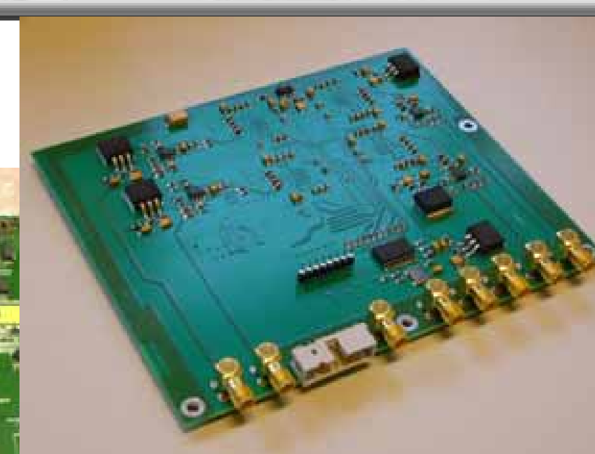
  (1) ADC Piggy back / KVI
  100MS/14Bit
  50MHZ BW

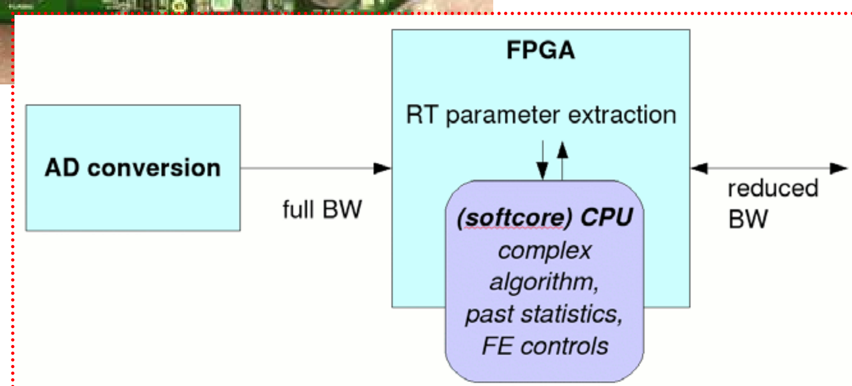
  (2) Xilinx based board
  HADES TRB2

  (3) Base line follower/
  kσ trigger
  (J. Jungmann / M. Vencelj)

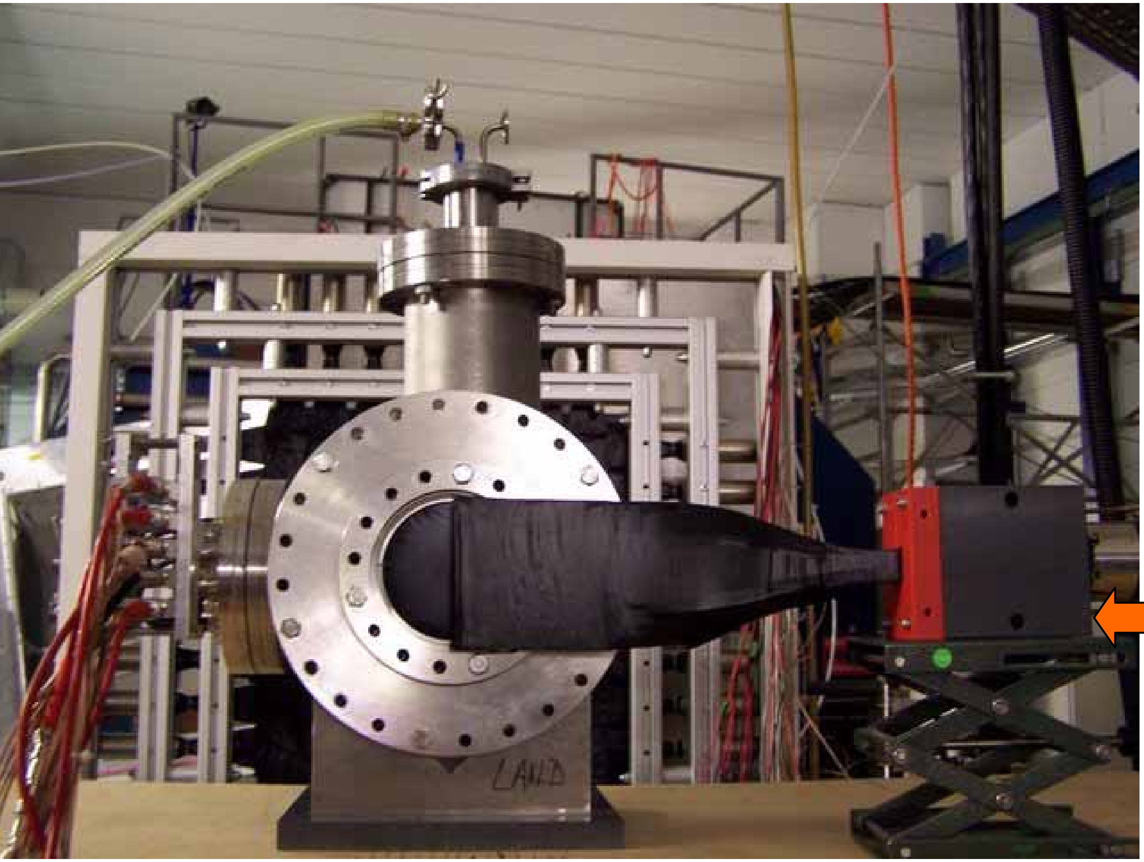
  Labview based readout system

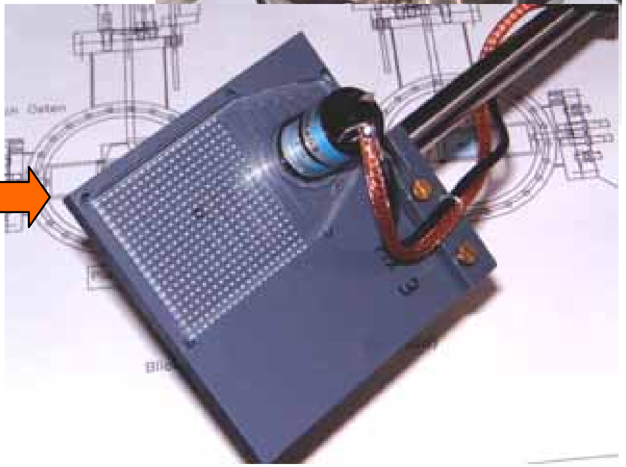




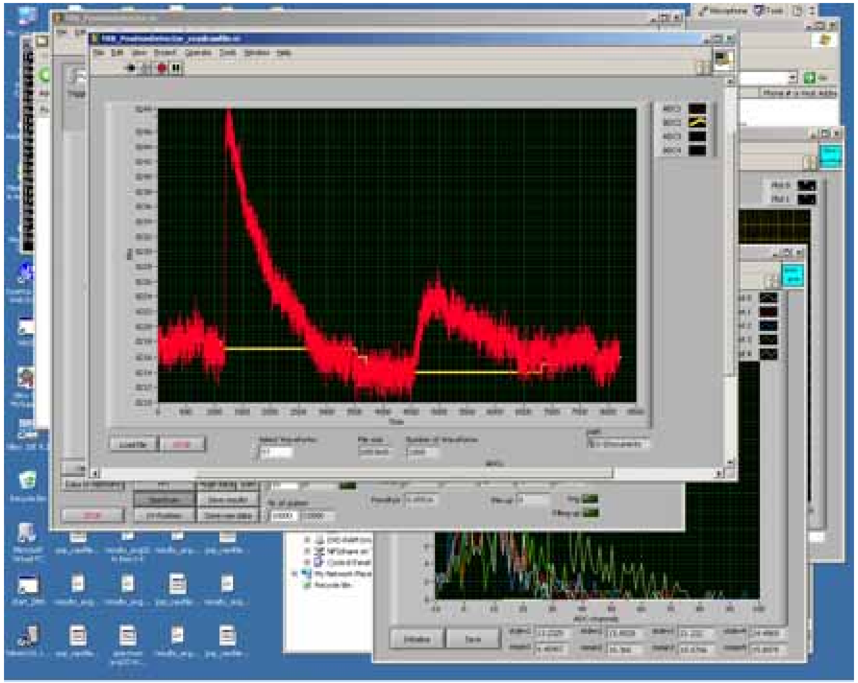
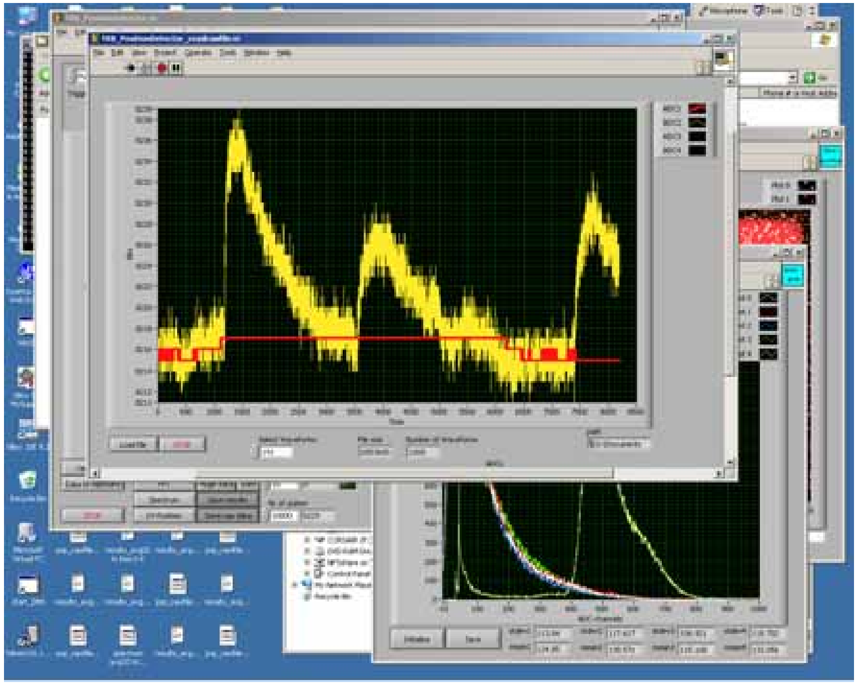


Test experiment S327 (16.-18.4.2008)
^{12}C: 550-700 MeV/u ; 2-50 kEv/s





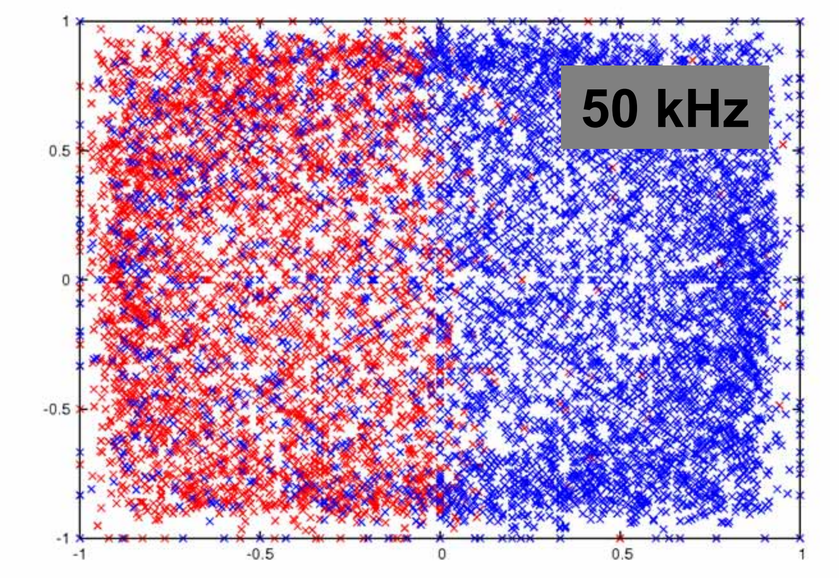
Results: Trigger/Baseline

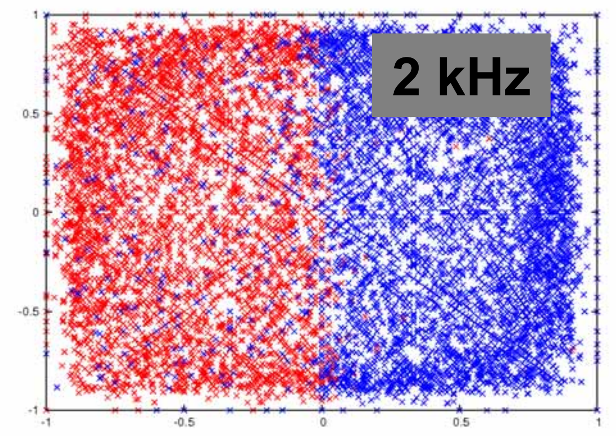


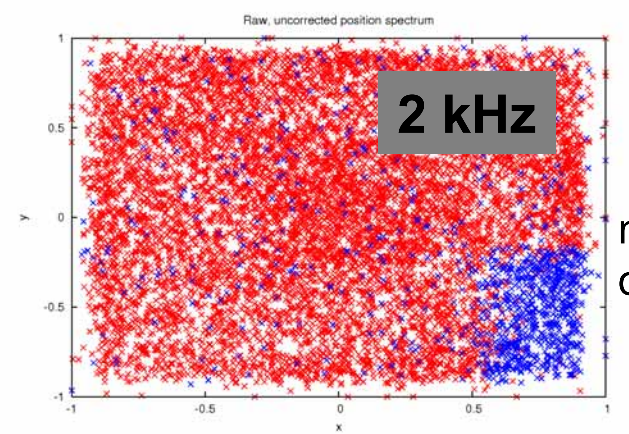
Baseline follower works !
(Bimodal Kalman Filter)

Treatment of double hits !

Results: Position







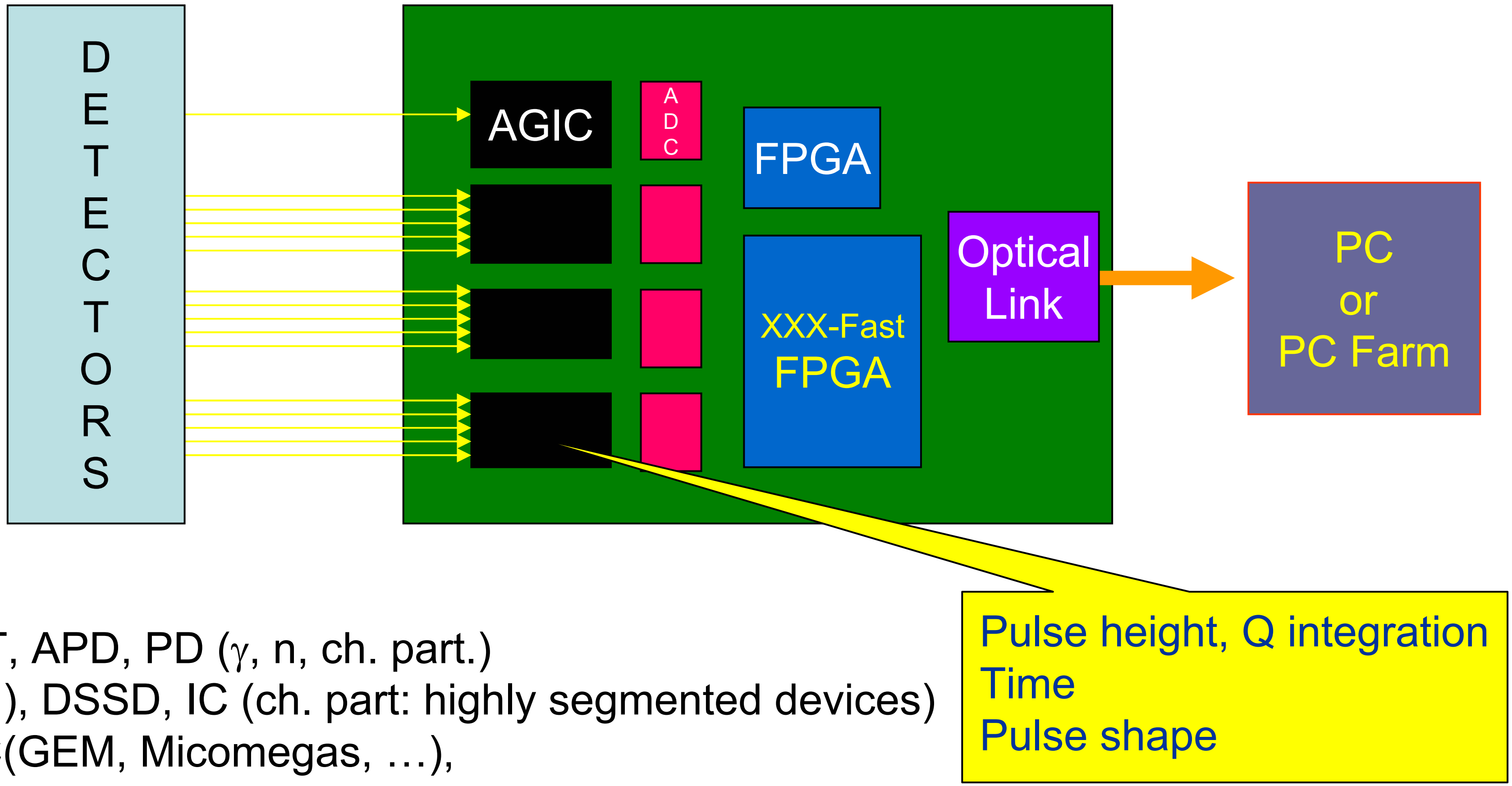
minimal distortions

Online reconstruction of positions:

i. @ full rate (i.e. 50+ kHz, theoretical limit: ADC speed !)
ii. no correction yet

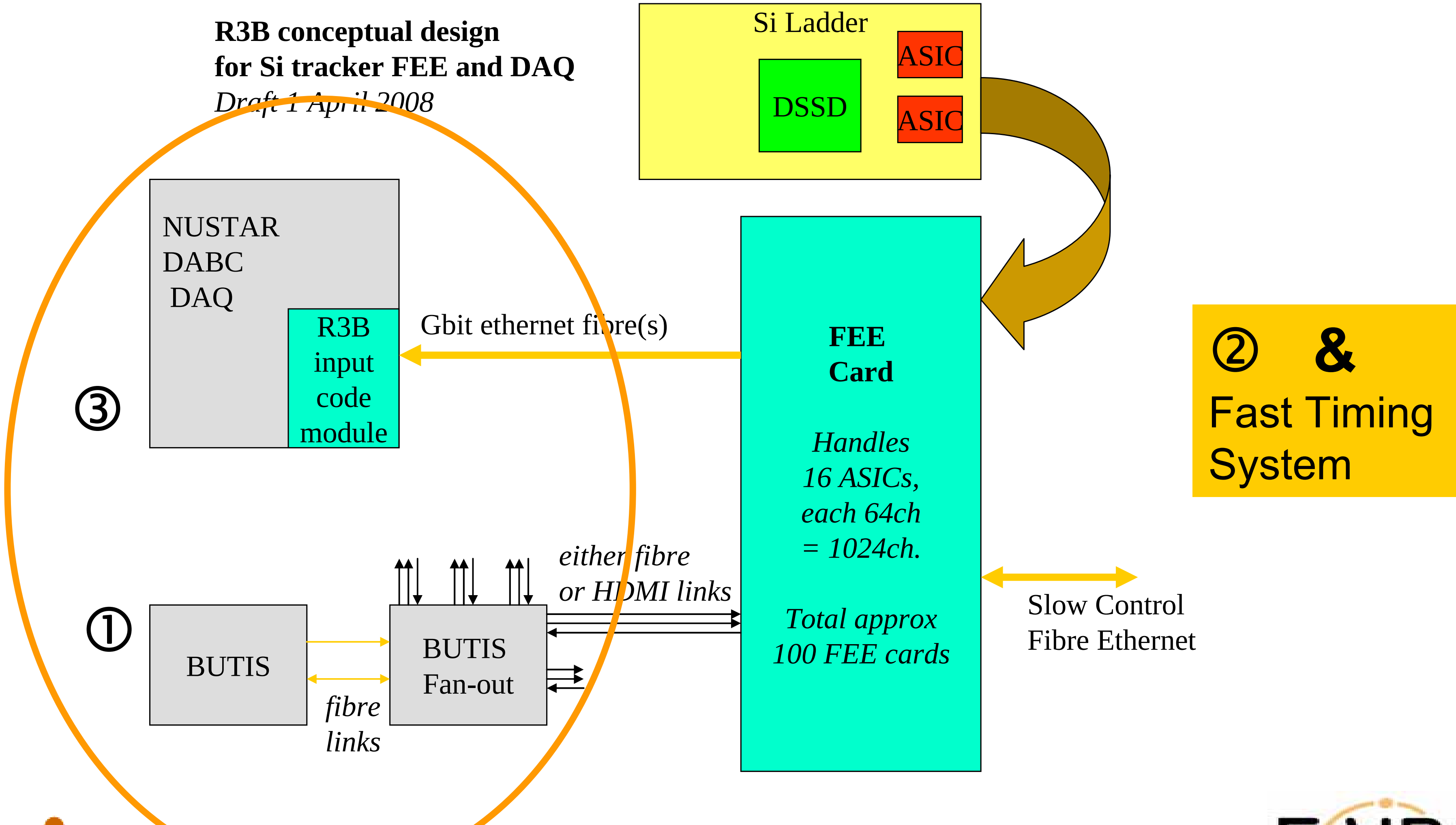
→ development of a “slow process”

… so what do we really want (c.f. FREEDAQ)



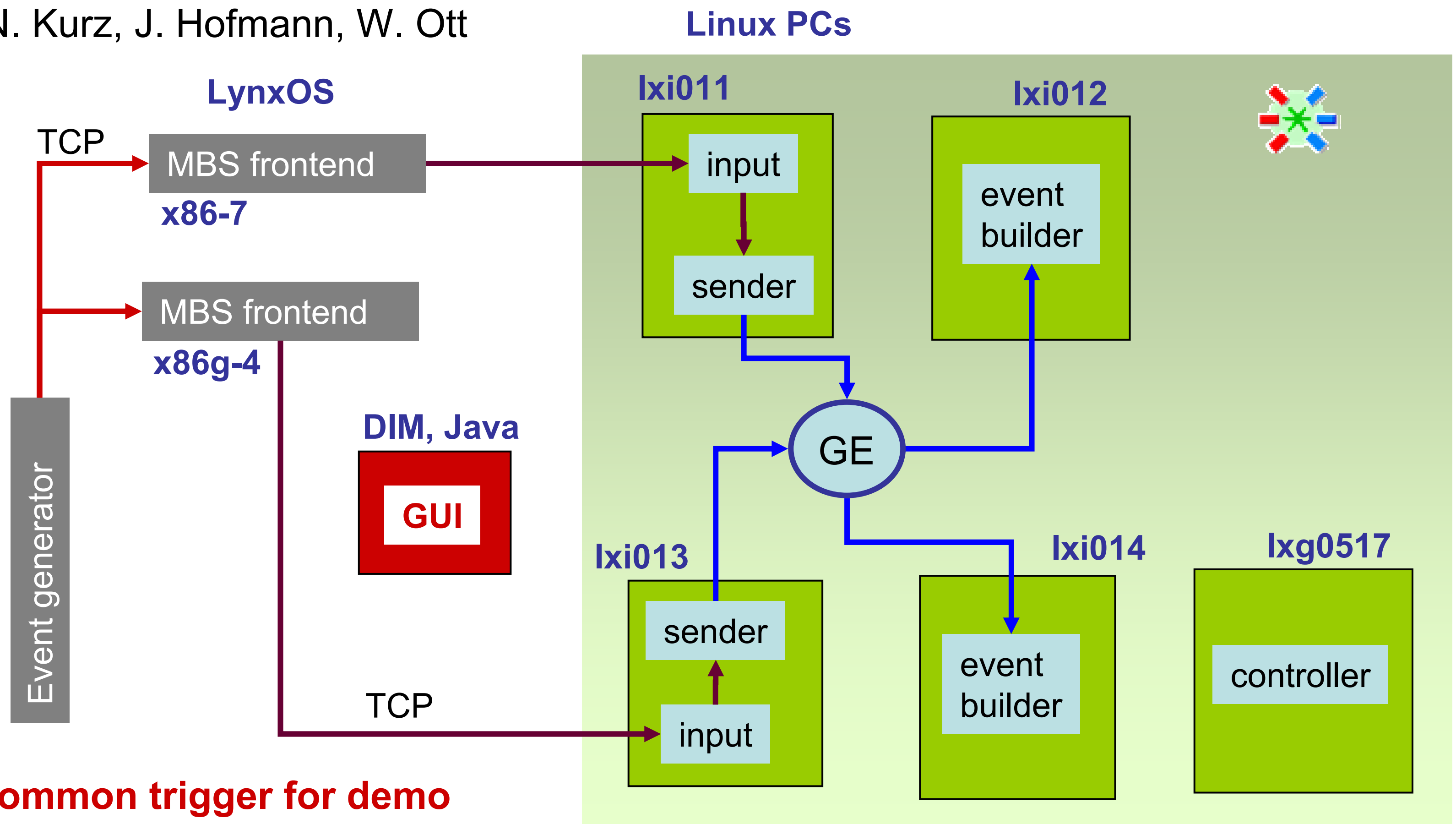
PMT, APD, PD (γ, n, ch. part.)
Si(Li), DSSD, IC (ch. part: highly segmented devices)
TPC(GEM, Micomegas, …),

R³B SI: Highly segmented systems lans concept for large channel counts …



Asynchronous Collection via DABC: e.g. Network event building for MBS

N. Kurz, J. Hofmann, W. Ott



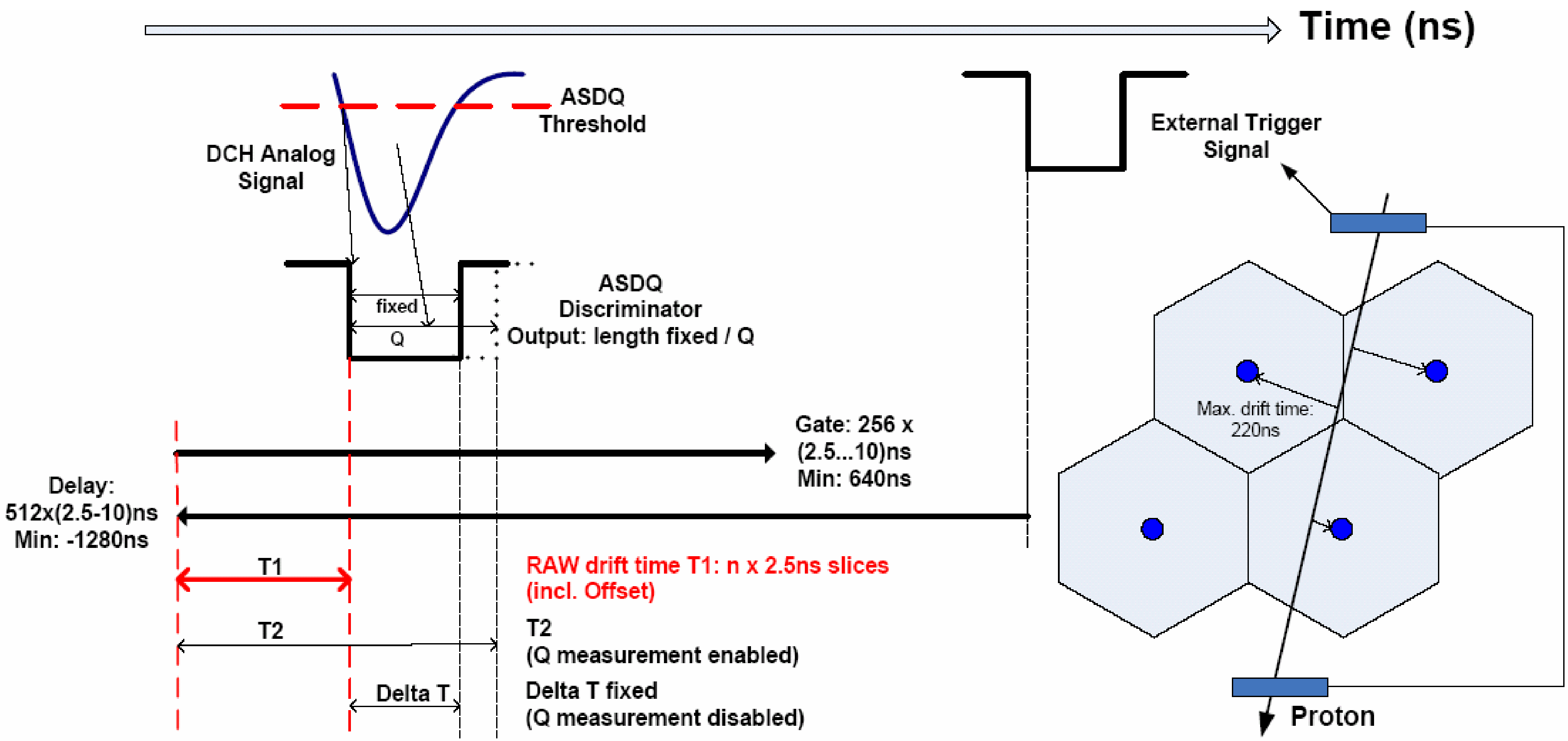
No common trigger for demo

GE: Gigabit Ethernet

H. Essel, J. Adamczewski, S. Linev

➢ DABC structure

Multichannel FEES: Timing diagramme ASDQ chip + FPGA (R³B-CaveC p-DCH)



non collaborating !

R³B-CaveC Proton recoil/Ion detection in vacuum
AMS/SIDEREM

non collaborating !

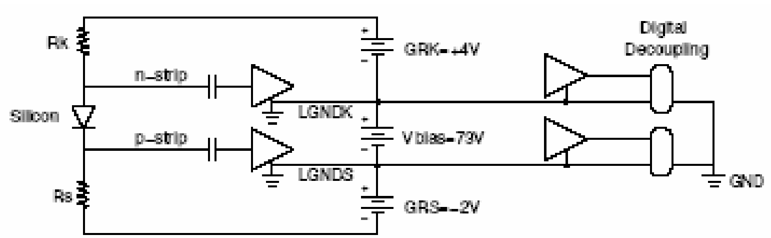
Front of the SSD (thickness 300µm)

41 × 72 mm², strip pitch 100µm
Dynamic range – 100 keV - 14 MeV
Resolution 50keV for 5.5MeV alphas

FEE
AMS(-02) readout:
e.g. NIM A 439 (2000) 53

6+10 read out 2*5(320) + 6(384)
VA_hdr.AMS64 resp. 9a chips
IDEAS/Norway →FEE: < 3W / detector

→SIDEREM (GSI/EE)
→NO self trigger/ calib. pulser !



GSI

APV Frontend - M. Böhmer, TUM

non collaborating !

- APV25-S1 RAL
  → CMS (Si, …)

(128 channel analogue pipeline
192 columns analogue storage.
50 ns shaped pulses
100mV / 25,000 electrons
40MHz sample
Useful data marked
test pulser, pos/neg, …)

- I²C control
- Clck, Trg
- Low power consumption

- Readout to MBS (ADC/FPGA/DSP)

Token Ring Scheme (NXYTER)

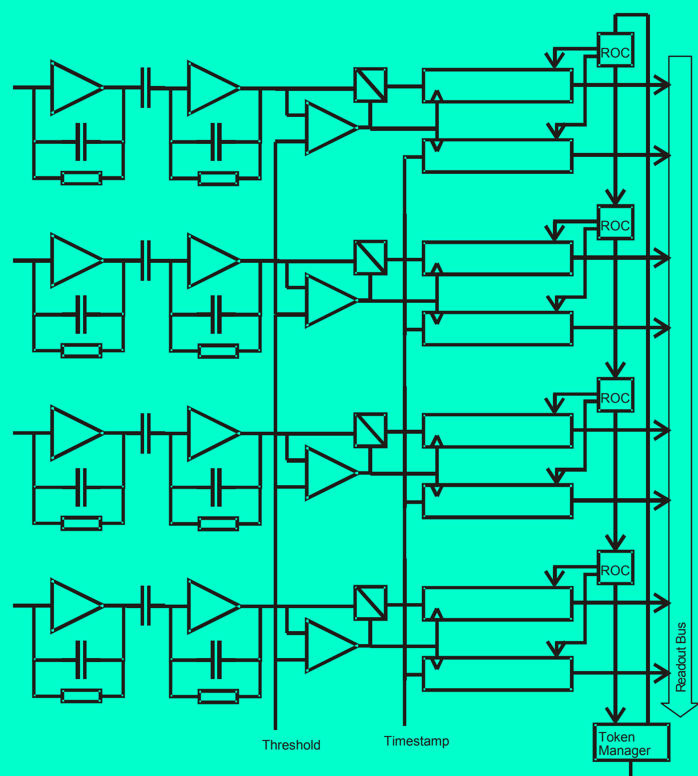
➔ “deadtime free”

collaborating !

Ch. Schmidt (GSI)

ASIC Labor Heidelberg

Sparse & derandomized readout



- Periodic readout at 20MHz
- Token asynchronously passes from channel to channel in search of data
- Within one readout cycle token could pass through all channels
- If token encounters occupied channels, data readout is initiated.
- After readout the token passes to the next channel.

→20 MHz/128 Ch ≈ 160 kHz

ENOB 10.4

Ulrich Trunk
Physikalisches Institut der Universität Heidelberg

Variety of applications: Test with single wire readout foreseen !

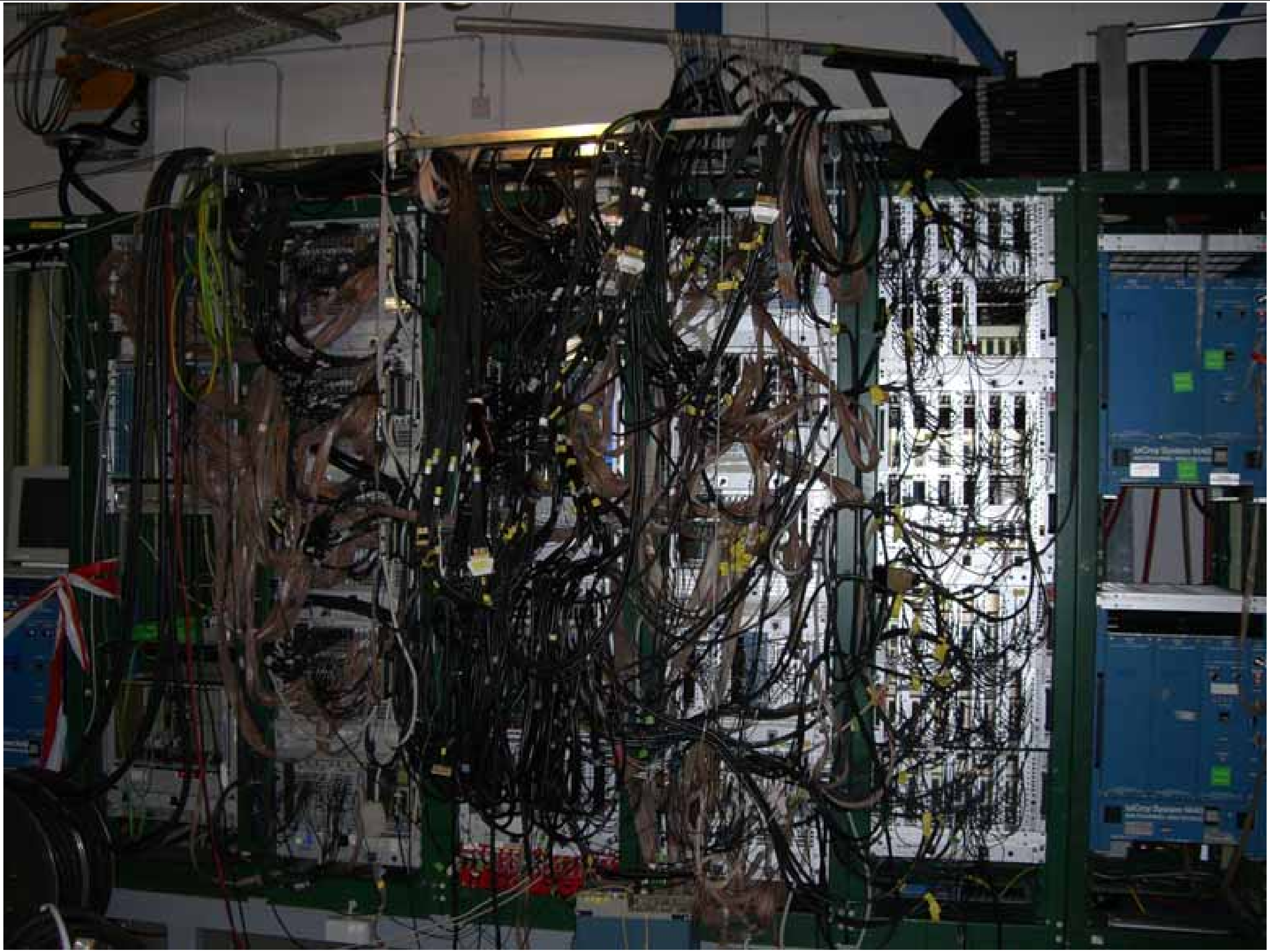
FAIR

Summary

- System design studies
- FEs either integrated into existing (DAQ/controls) infrastructure
- … or handled software wise (DABC)
- Missing (FREEDAQ) Items
  - timestamp distribution and protocol
  - adequate multi-channel FEs with high dynamic range

FIN

LAND electronics ~600 ch   7 → 1 + ε crates !

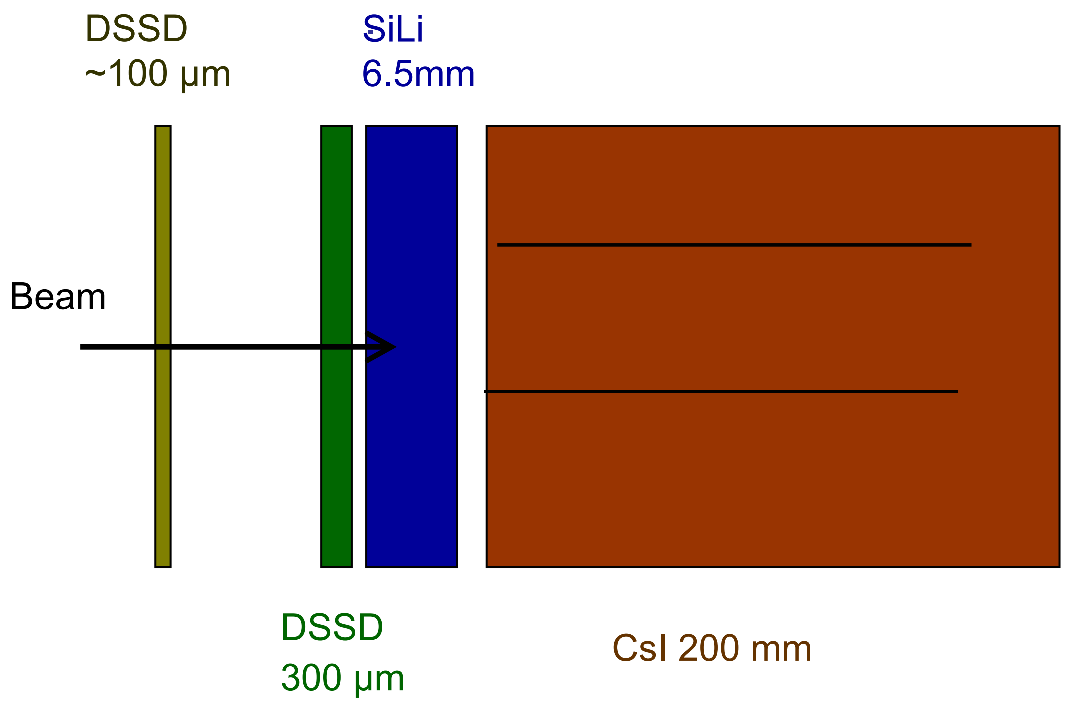


= 30 Tacquila cards with LAND FEE + 2 VME helper modules + 1 VME CPU
+ 10 VME QDCs
+ 3 HV bins

FAIR

Common Demonstrator Layout

R³B, EXL, others (?)



- modular
- vacuum compatible
- readout ?

(self triggerable,
test/calib. facilities,
high dyn. range,
time stamps …)

First DSSD – e.g. 2.1 x 2.1 cm^2, 0.3/1.25 mm pitch (PTI, EXL) or 0.1/0.1 mm pitch R³B

Second DSSD – e.g 5.2 x 6.7 cm^2, 0.1/0.2 mm pitch (Micron, EXL) or 0.1/0.1 mm pitch R³B

Si(Li) or Si – e.g. 9 x 5 cm^2, 4 x 2 pads ---- EXL

CsI – e.g. volume 3 x 3 cm^2 x 20 cm

Purpose of the R³B/EXL Demonstrators – Topics to be Investigated and Questions to be Solved

- Detection of MIP`s with thin DSSD`s
- Tracking with high resolution
- Performance of CsI in combination with Si detectors
- Energy and position resolution for protons, alphas for various energies
- Performance of DSSD`s with larger pitch size (from 0.3-1.5 mm)
- Very low threshold detection
- PSA
- Combination of DSSD`s with Si(Li)`s
- Vacuum compatibility
- Heat production
- Feedthroughs
- Noise Analysis
- Evaluation of realistic background conditions
- Definition of demands for the final ASIC design

Possible Design of the Demonstrators

- frames and readout boards:

  should be common for EXL- and R³B demonstrators

  should be made from ceramics

  potential producers are PTI, Mesytech, Uppsala, India

  the design of MUST could be a basis

  responsible for design and construction: O. Kiselev, H. Simon

- readout:

  number of readout channels: around 1000, frontend in (high) vacuum

  (for EXL: bakeable to at least 150 ºC see CHICSI setup)

  trigger: external trigger → self triggerable

  dynamic range: 150 keV – 5 MeV (in Si(Li) up to 100 MeV)

  data rate: 1-10 kHz

  options: Jülich, Daresbury, AMS, GSI nXYTER

  responsible for readout: R. Lemmon, O. Tengblad, P. Golubev

Detector Scheme for Super-FRS target area

available/possible systems

Fast extraction		Slow extraction
	Intensity	
Resonance Transformer		Cryogenic Current Comparator (SQUID)
Diamond (single crystal, current readout)		SEETRAM
		Diamond (poly crystal & particle)
	Position	
Pickups		
	Profile	
Beam induced fluorescence(BIF)		BIF
Rest Gas Monitor (RGM)		RGM
Current Grids		Current Grids/Wire chambers
	Monitoring	
Camera on target (IR)		Camera on target (IR)

full intensity | reduced intensity (< about 1 nA)