

RD51 Common Project Status Report:

The "Leopard" System

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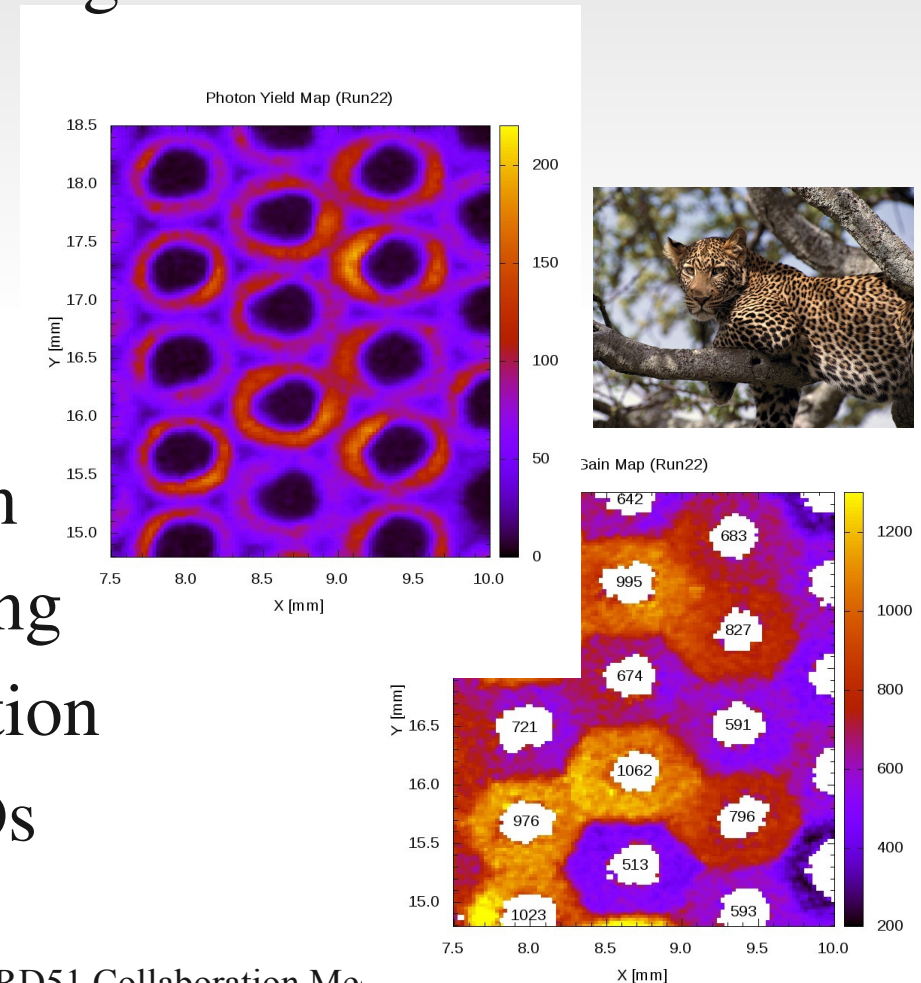


Outline

- RD51 Common Project : Leopard
(High resolution scanning)
- Positioning systems
- Optical setup
- Data Acquisition
 - Raspberry Pi
 - DAQ scheme, ADC board
 - Software + GUI
- Verification measurements
- Objective Overview

The "Leopard" Concept

- High resolution scan of TGEMs with focused UV light
- Single photo-electrons: PE yield + gain
- Critical/symmetry points
- Hole-by-hole differences
- Cherenkov detector optimization
- Simulation verification and tuning
- Quality check + info for production
- Applicability for various MPGDs



Challenges

- Optical system : 20-100 μm spot size
=> $10^4 - 10^6$ points (spectra)
- Single photo-electrons:
< 5% PE / event AND 100-1000 PE / point
=> thousands of events in each points

Necessary system requirements :

- Efficient focusing of pulsed UV light
- Actuator system (3D) : $\sim 10 \mu\text{m}$ precision, 10ms response
- Fast ADC : $\gg 10 \text{ kHz}$
- **Combined data acquisition system** (ADC and actuator)

RD51 Common Project

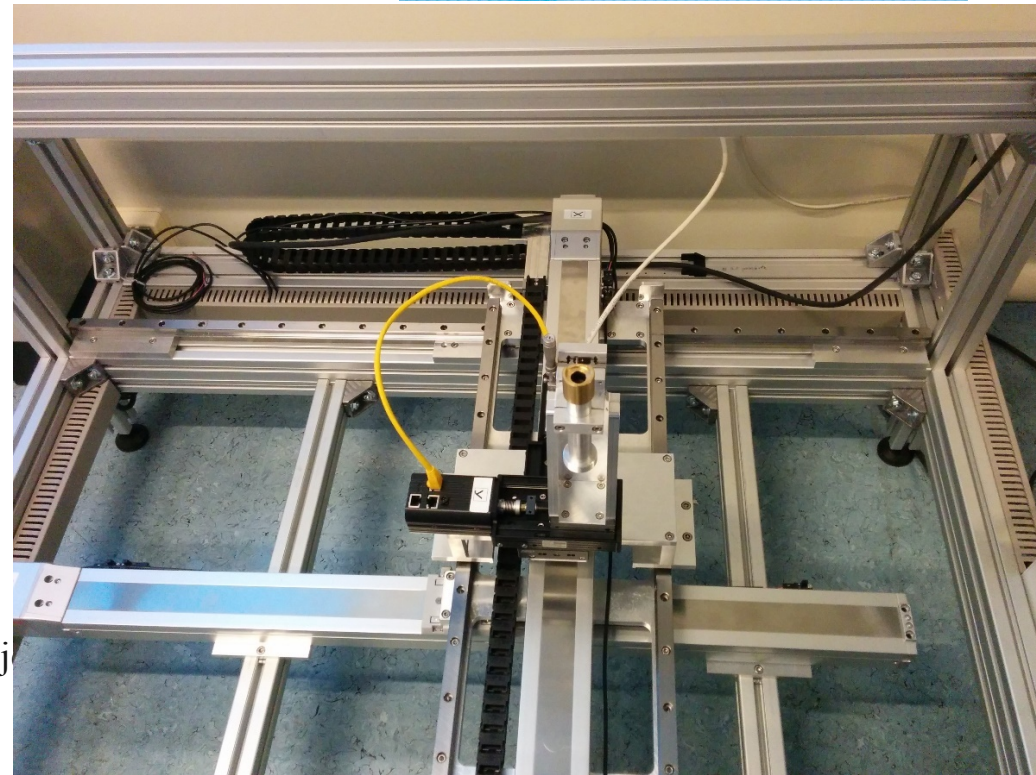
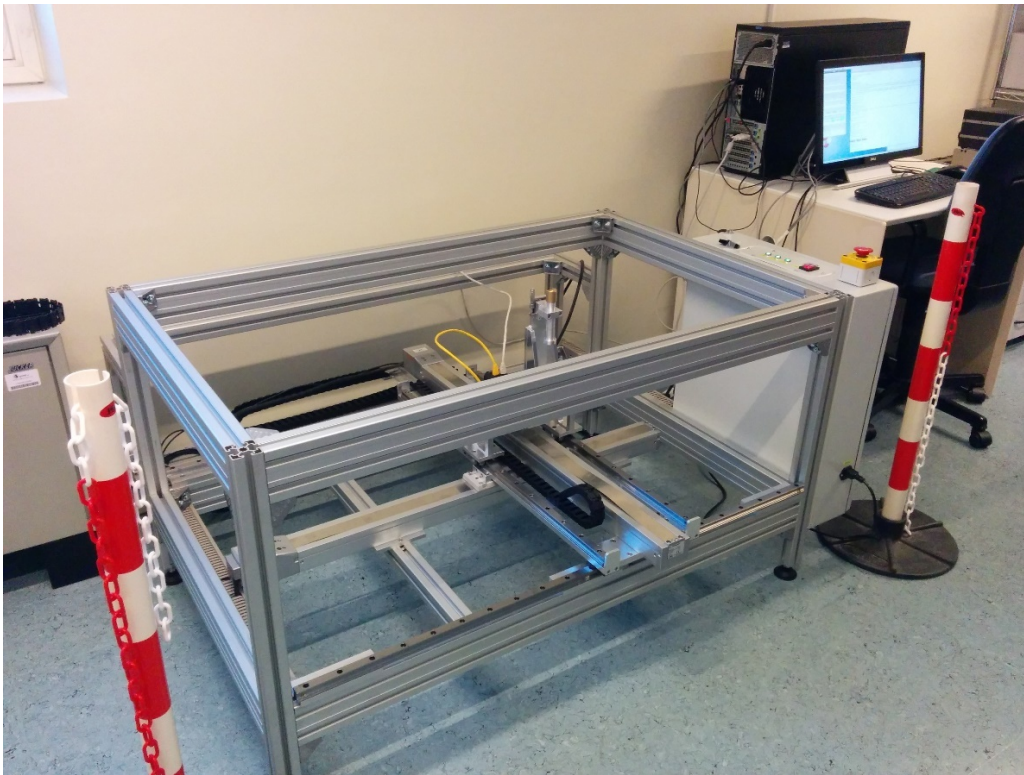
- Budapest + Trieste + Bari
- Aim : construction of usable prototypes, investigation of key components
- Two systems in Trieste and in Budapest
- Actuator system:
 - Trieste : large area
 - Budapest : moderate area
- Common optical system (Budapest)
- Data acquisition
 - Trieste : High performance DAQ
 - Budapest : Custom DAQ

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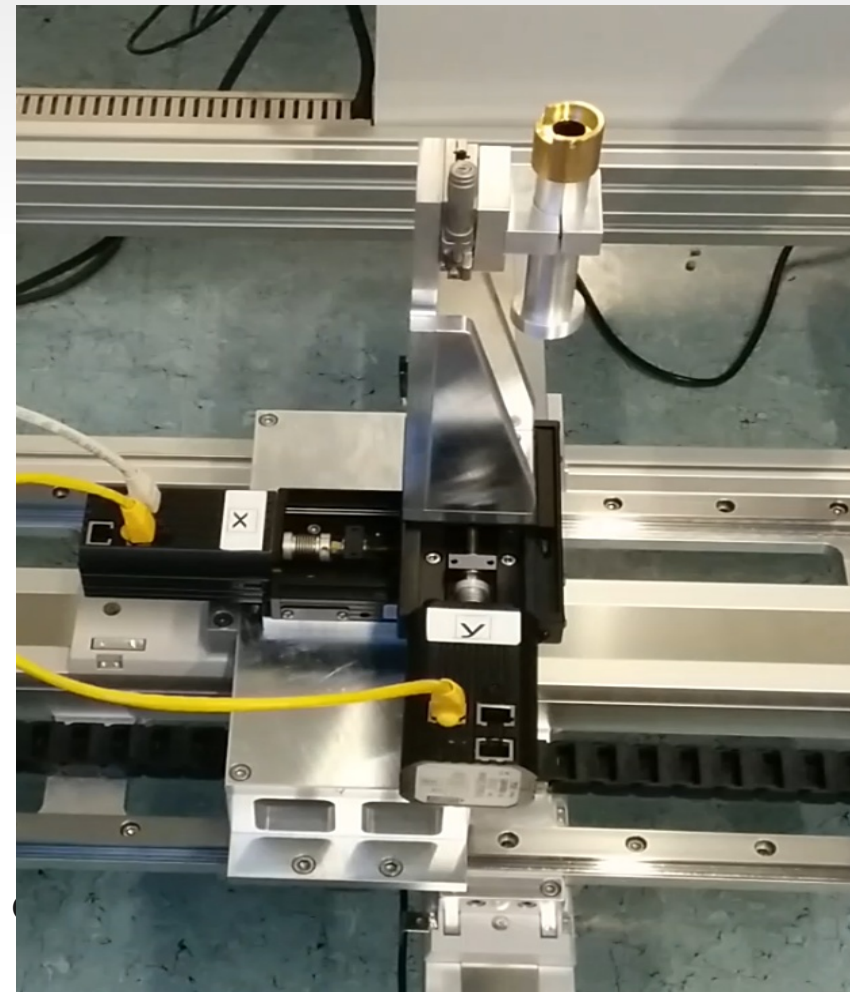
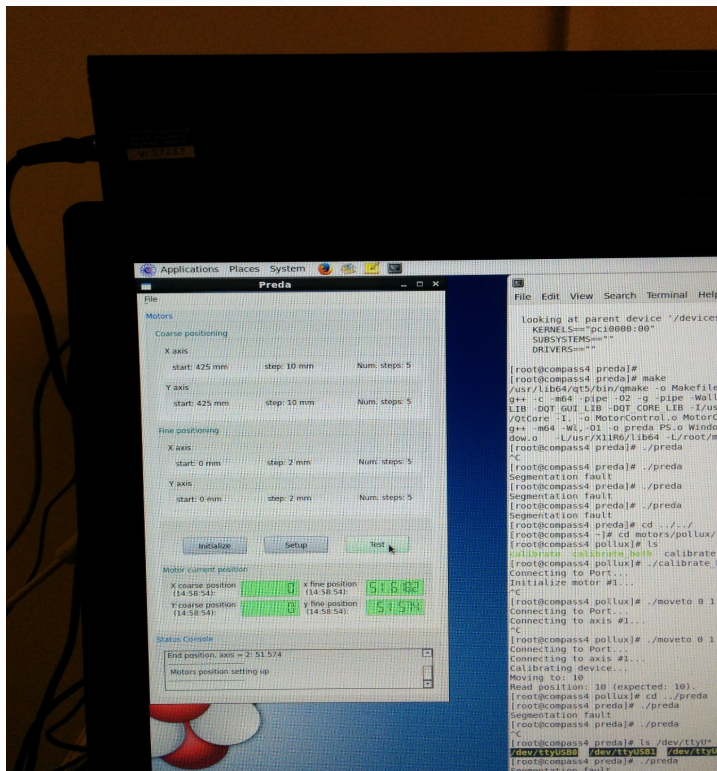
Actuator System : Trieste

- Two stage system: coarse + fine
- Allowing maximum surface of 700mm x 800mm



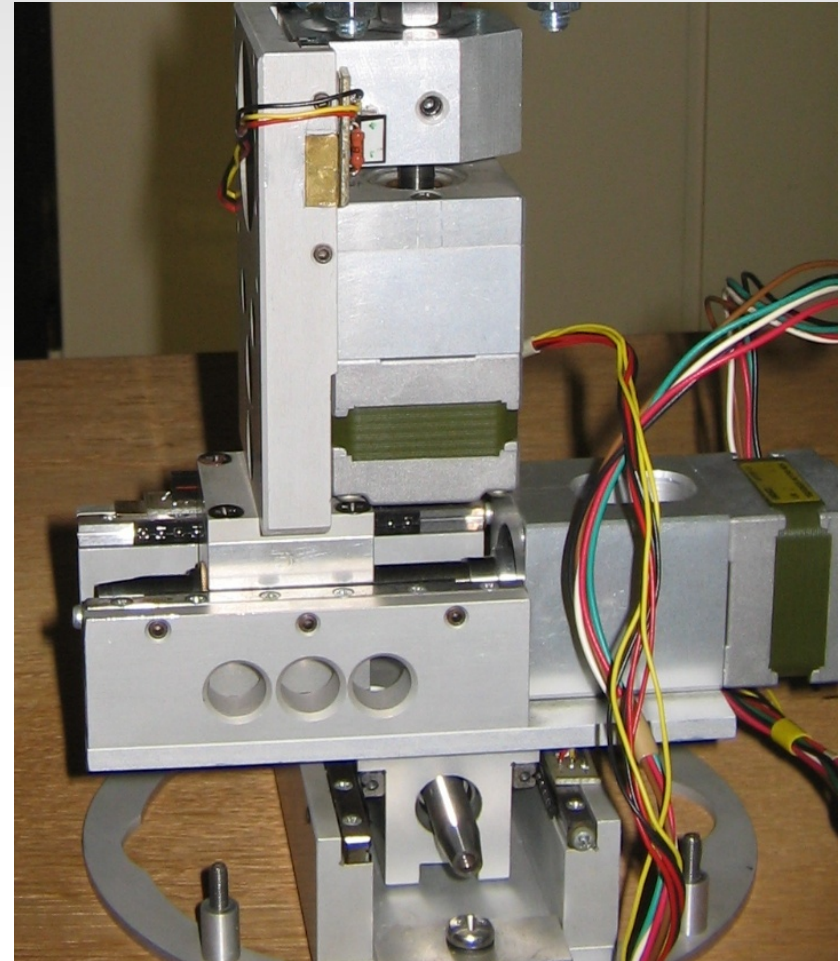
Actuator System : Trieste

- Fine system: 1 μ m precision
- Mounted onto the coarse one
- Driver: Qt based GUI



Actuator System : Budapest

- Current design :
3 axis stepping motors
Small size : $25 \times 50 \times 10 \text{ mm}^3$
with $5 \mu\text{m}$ precision
(According to project plan)
- Decision on larger size
($200 \times 200 \times 50 \text{ mm}^3$)
Construction is soon completed

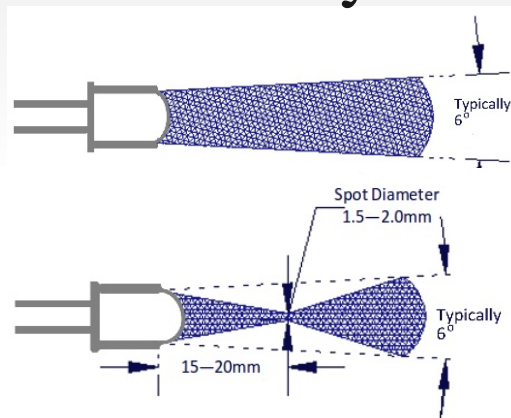


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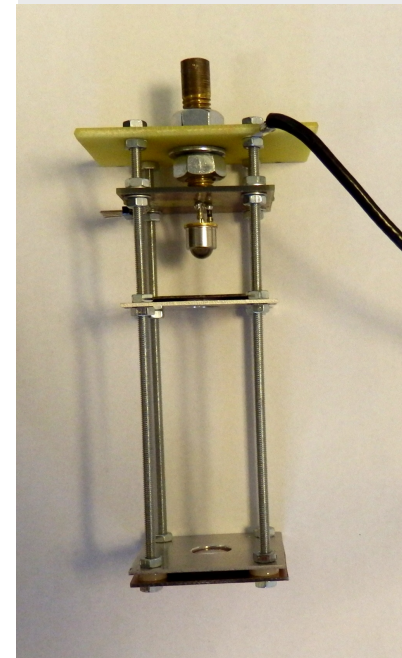
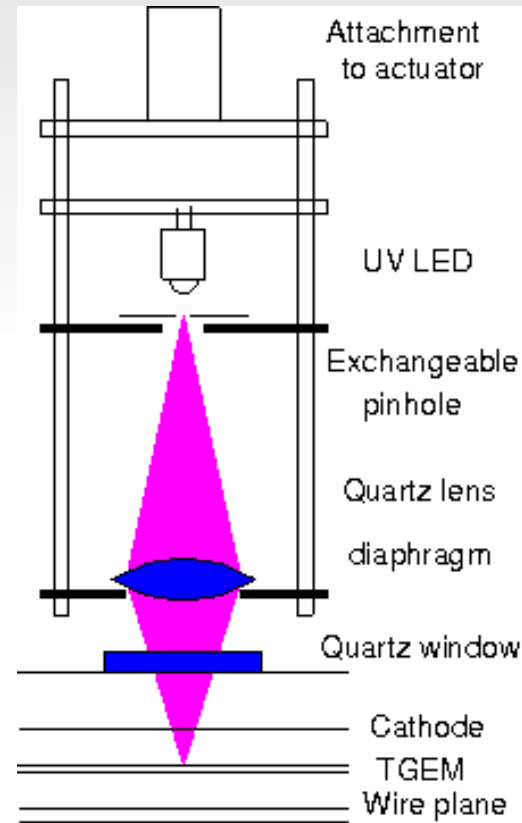
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Optical Setup

- UV LED : SETI UVTOP240
peak: 240 nm, widths: 10nm
- Ball lense cover
increased yield (x5) !



- Pinhole (spot size x 2)
150 μm - 300 μm so far
Pinhole 30 μm became usable
- Further improvements are underway



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- Future plans

Data Acquisition

- The DAQ is responsible for both moving of the optical system **and** synchronized data taking
- Actuator positioning:
faster than **ms** timescale
- Additional detector control tasks

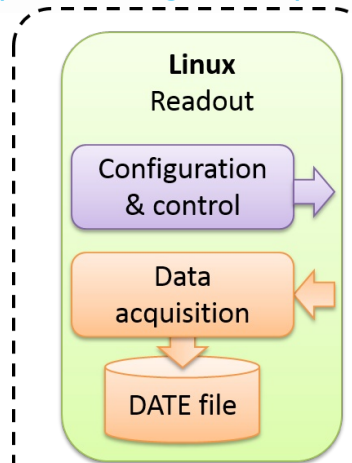
DAQ : Trieste

- Trieste-Bari development with a contribution from Freiburg University
- GANDALF based DAQ
(Generic Advanced Numerical Device for Analytic and Logic Functions)

<http://wwwhad.physik.uni-freiburg.de/gandalf/pages/applications/gandalf-portable.php>

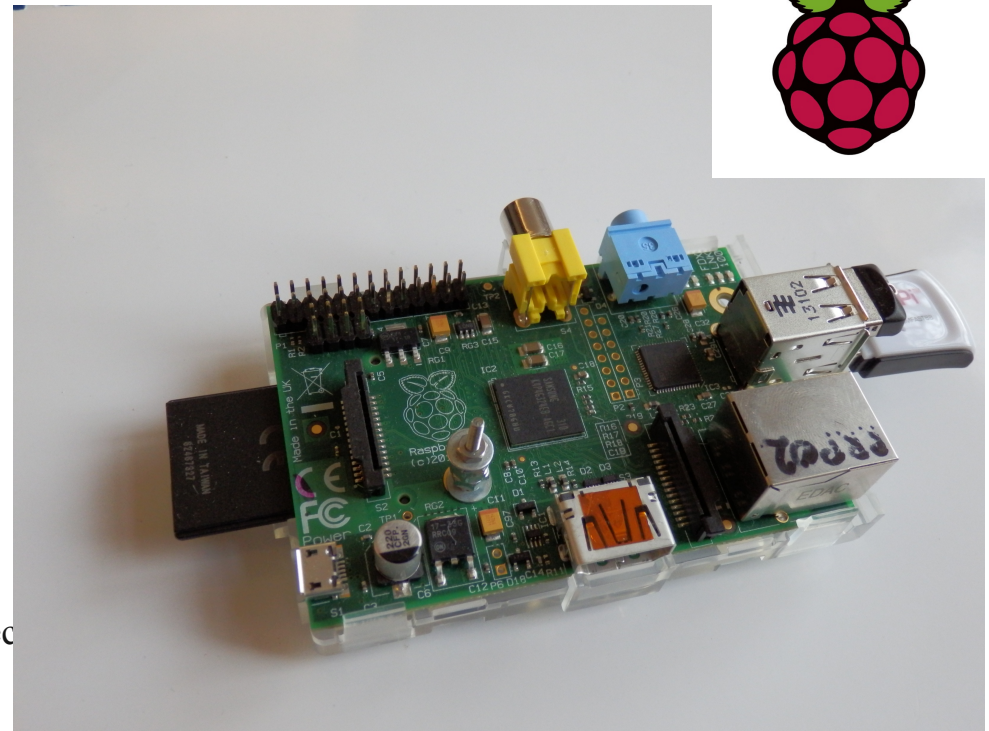
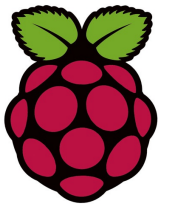
[University Freiburg]

- Qt interface + Python
- USB communication



DAQ : Budapest

- Various options for a cost efficient designs have been investigated
- Successful implementation using Raspberry Pi
- **Raspberry Pi** (is a tiny computer)
 - 700MHz ARM CPU + Broadcom 2835 chip
 - Peripherals: USB, HDMI, SD, AV, Audio
- **GPIO pins (10MHz)**
- Low power consumption
- Raspbian **Linux** :
Debian based OS
- Low cost (60EUR)

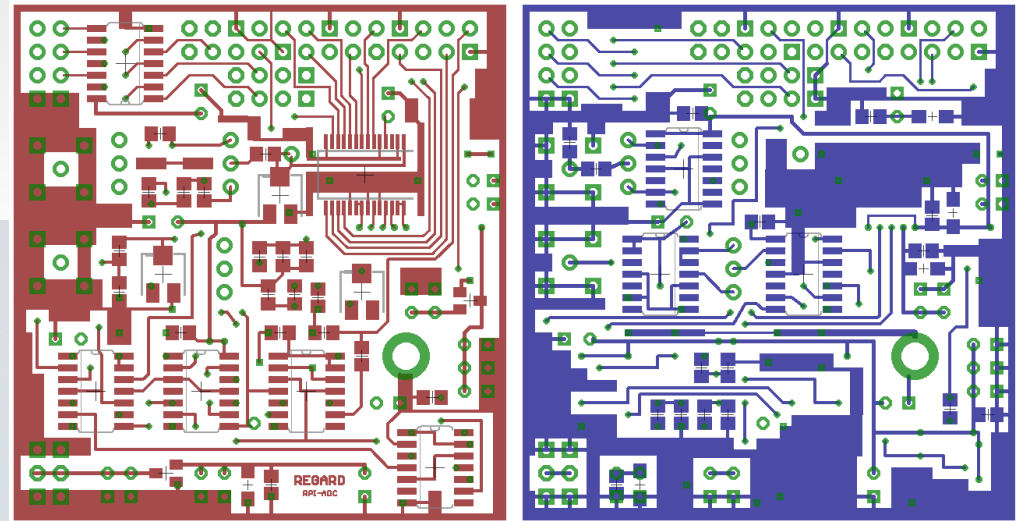
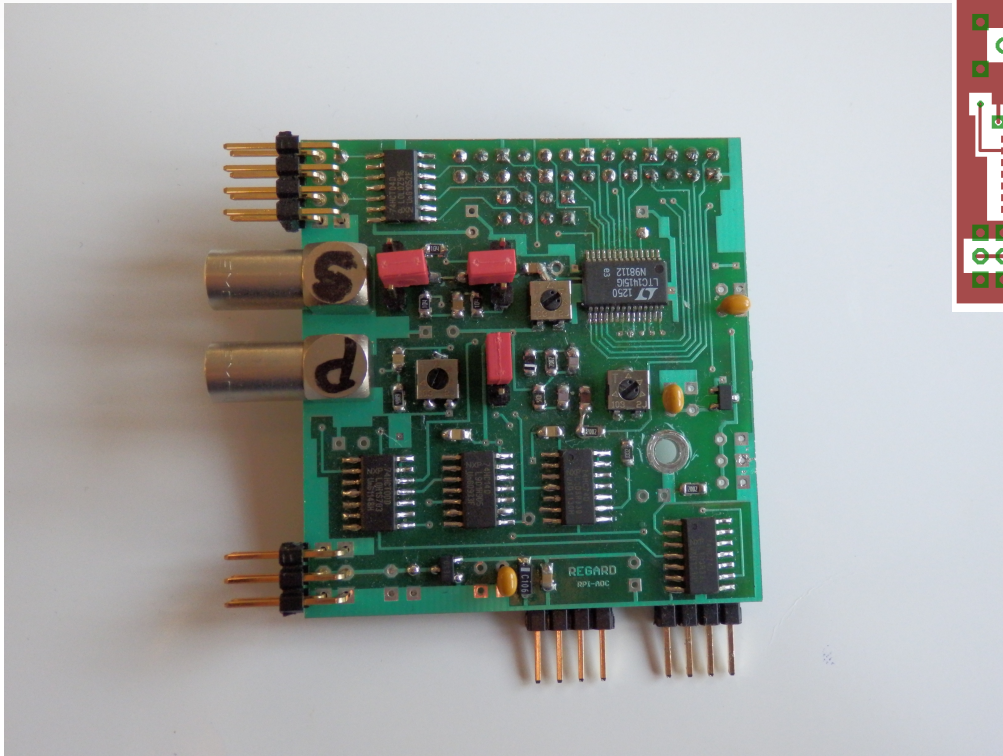


DAQ logic scheme

- Trigger receiver and timing
- Signal shaping and amplification
- Parallel output ADC
- Tagging of rejected triggers
- Direct actuator control output
(can be accomodated to any moving controls)
- Realized as a single board (Leopard-Rpi board)

Leopard-Rpi board

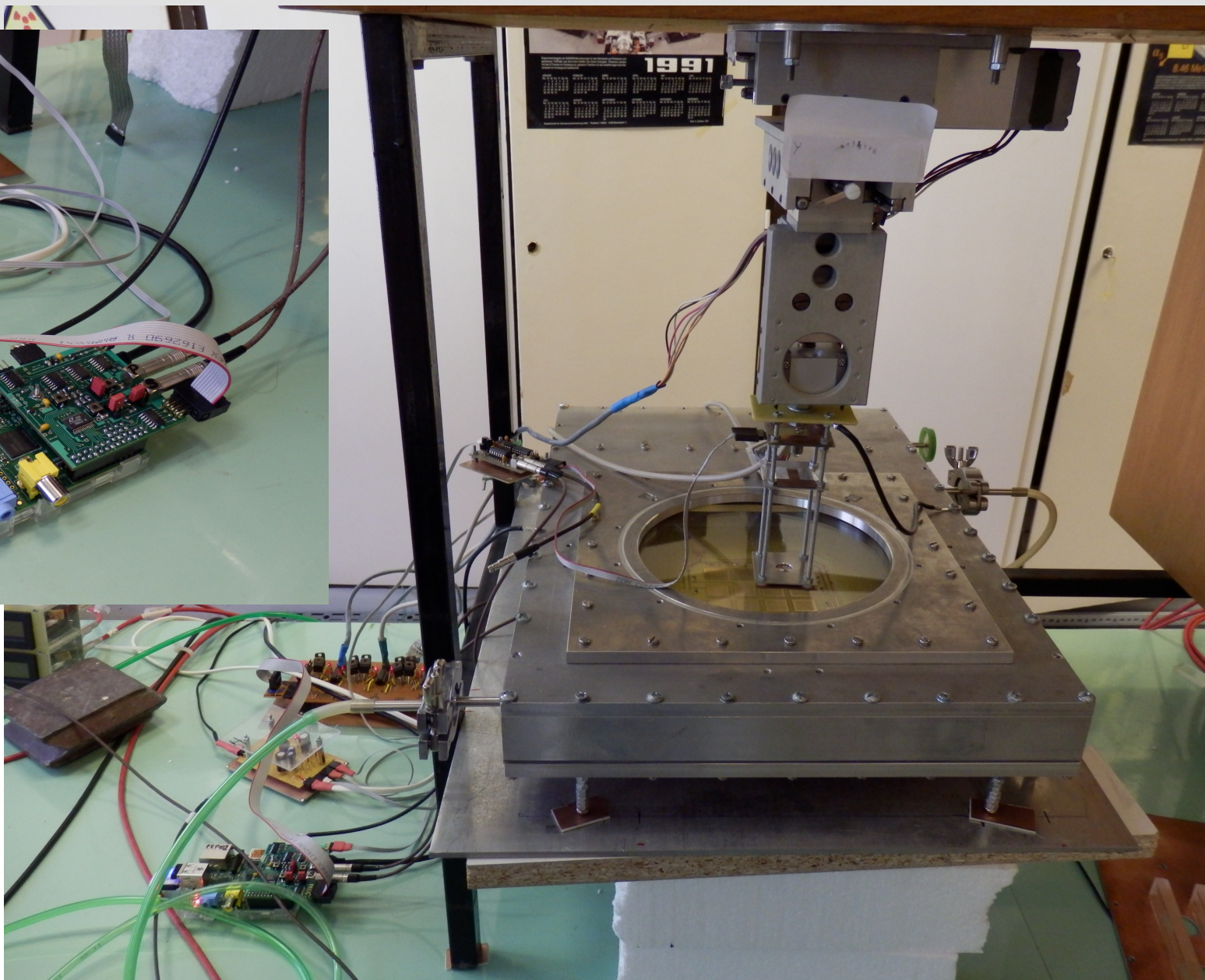
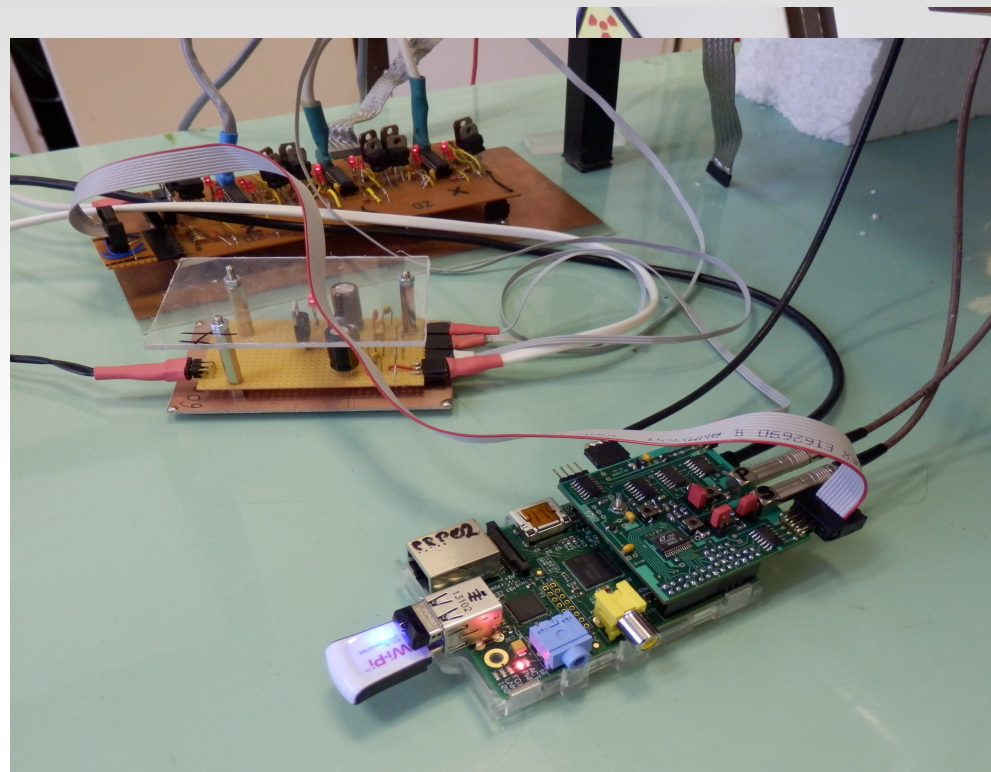
- ADC: LTC1415: single channel 1 MHz
- Fits to RPi GPIO pins



Software

- C / C++ source
- Runs on the RPi
- Command line driven (addressable by GUI)
(move / scan file / statistics / ...)
- Scan: standard programs (2D scan,..)
user defined scheme
- Implementaion of DSP for noise performance
improvement (eg. signal undershoot)
- Monitoring "maps" are updated regularly
- Histogram or Event-by-event output
- Smooth termination

Presently Working Setup

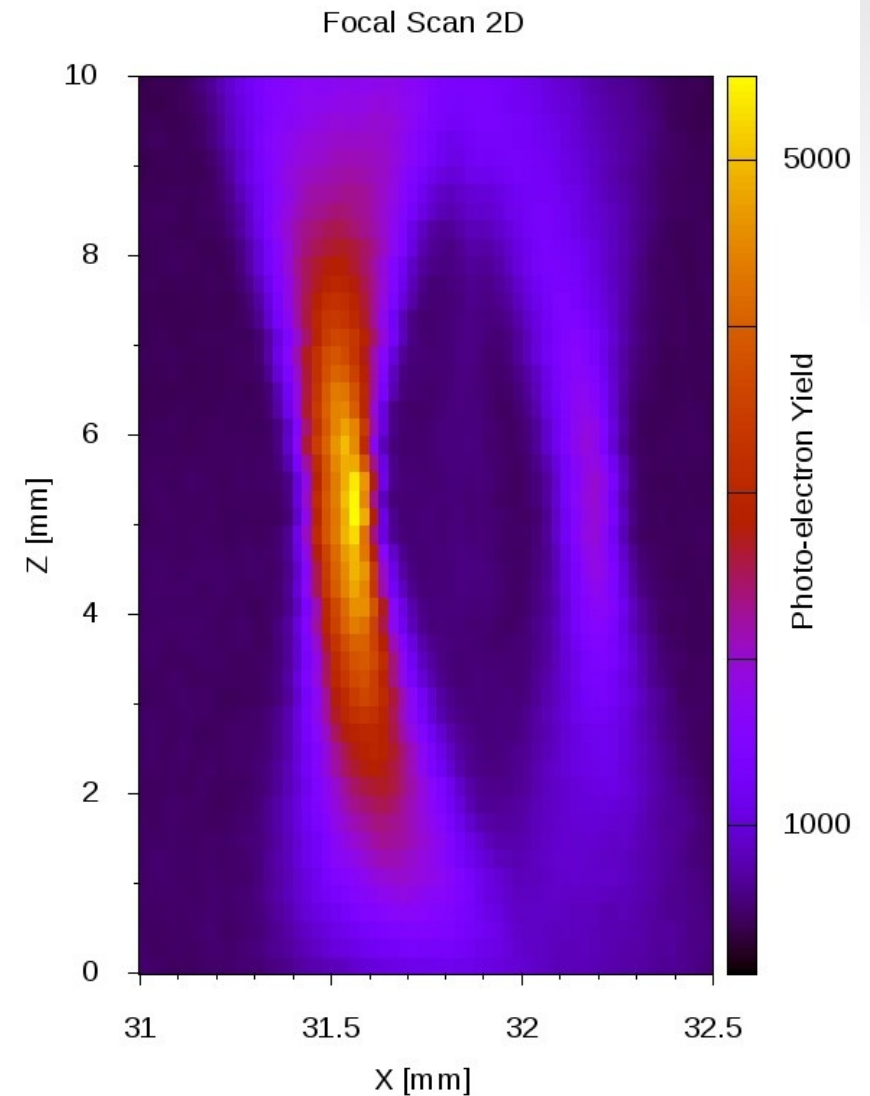
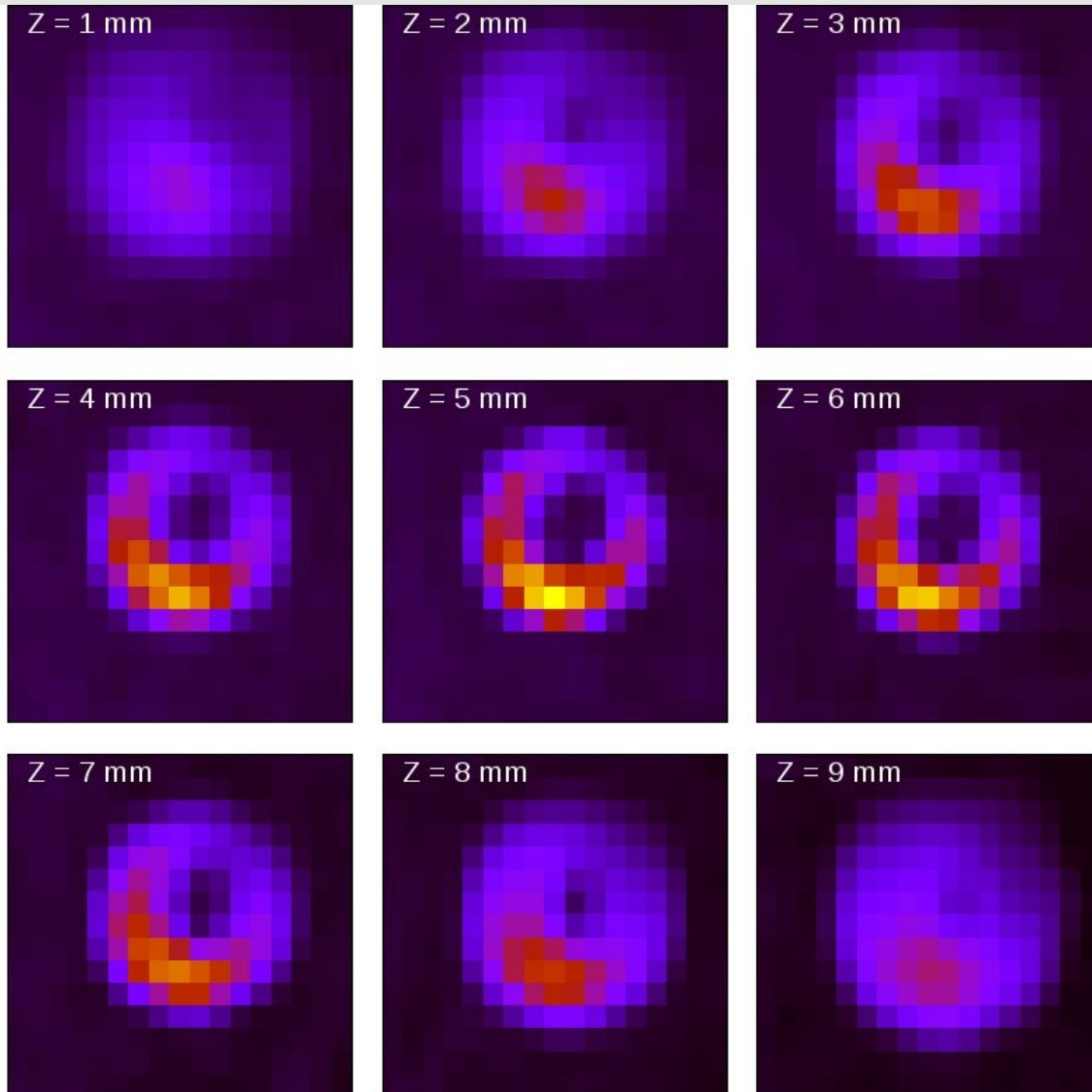


2014. February

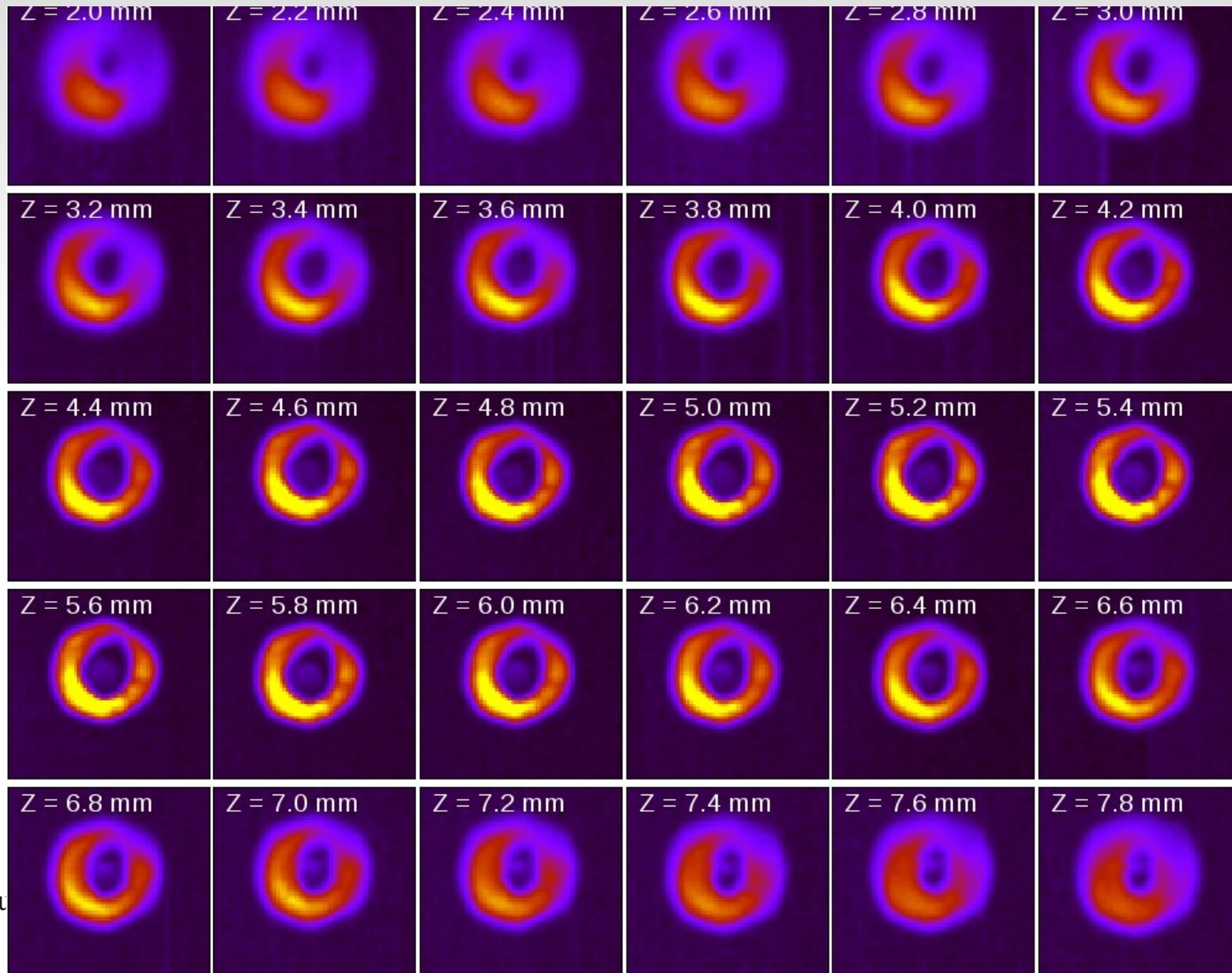
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Verification / Focal Scans

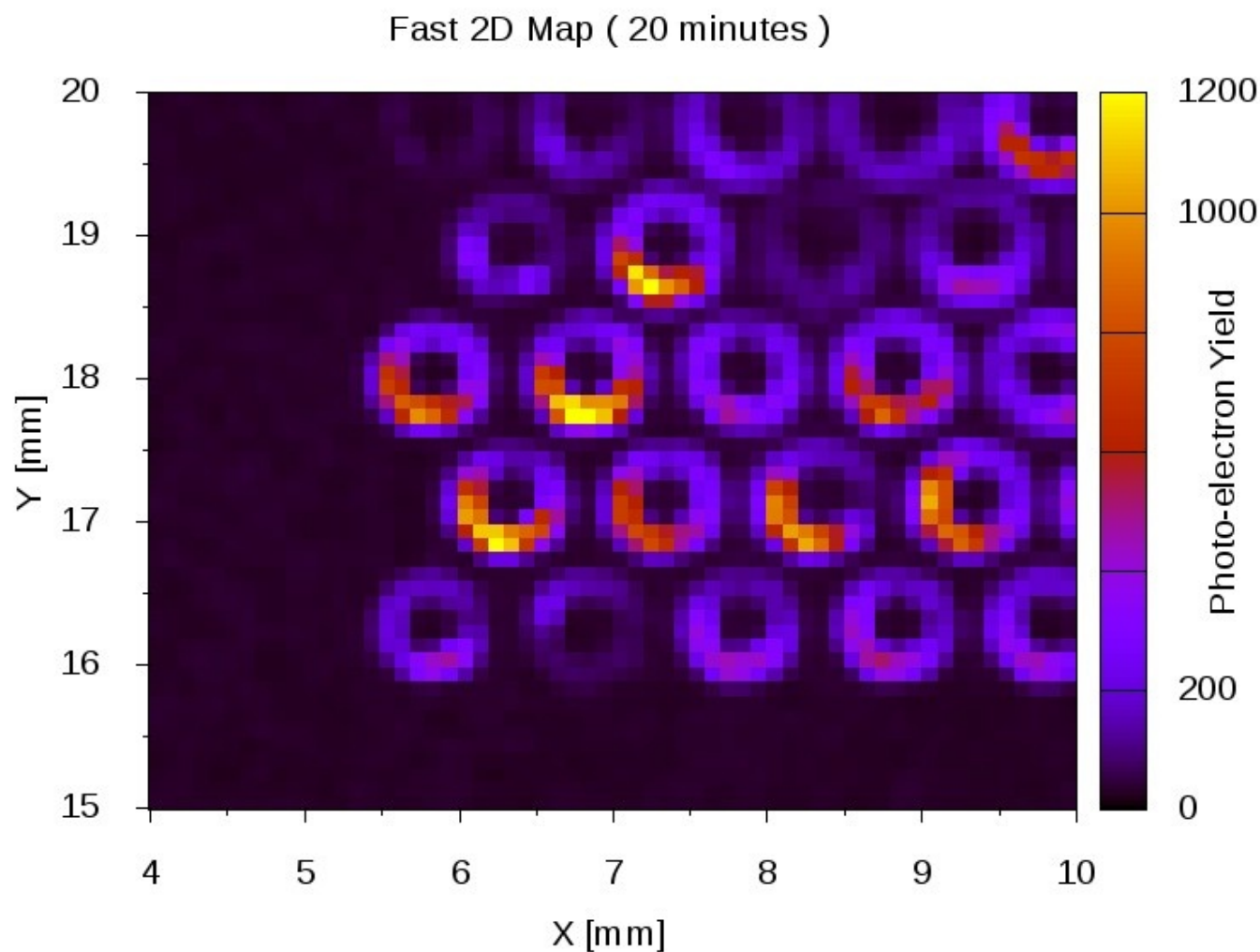


Verification / Focal Scans



Speed : 20 min run

- DAQ rate : 120 kHz achieved
with 99.5 % events accepted



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Project Objective Overview

Key project objectives were reached, or demonstrated to be reachable soon, complying with the estimated budget. Final version of improved prototypes are under construction

During the process of R&D improvement of performance parameters have been targeted, and therefore further developments are underway.

Common Fund support has largely encouraged concentrated R&D efforts and collaboration between participating institutes.

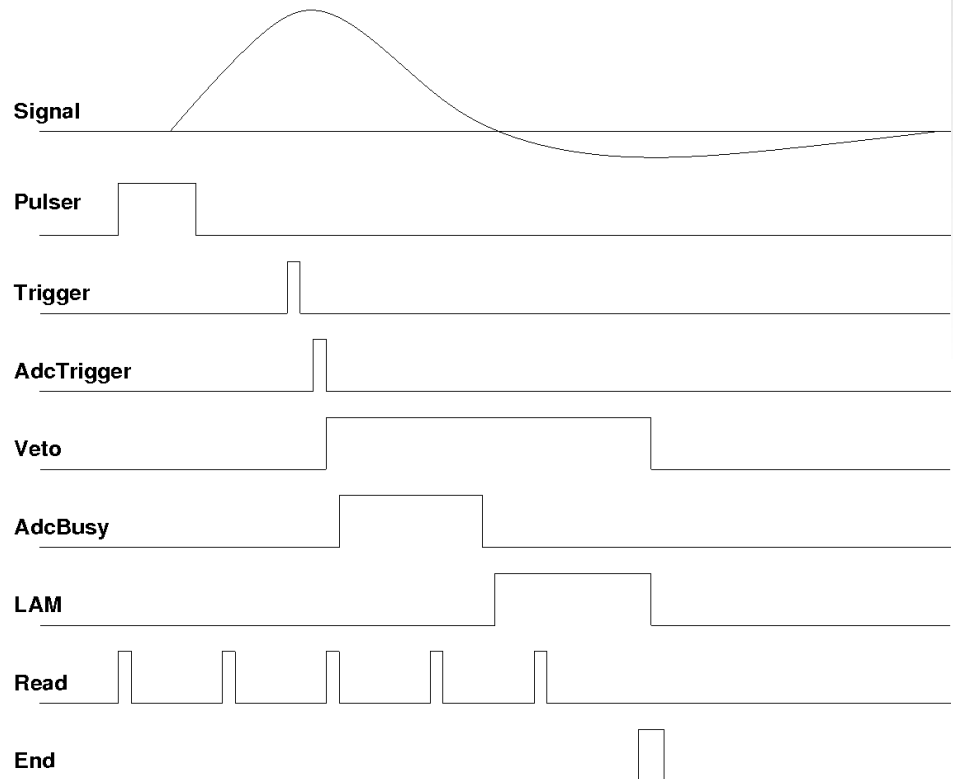
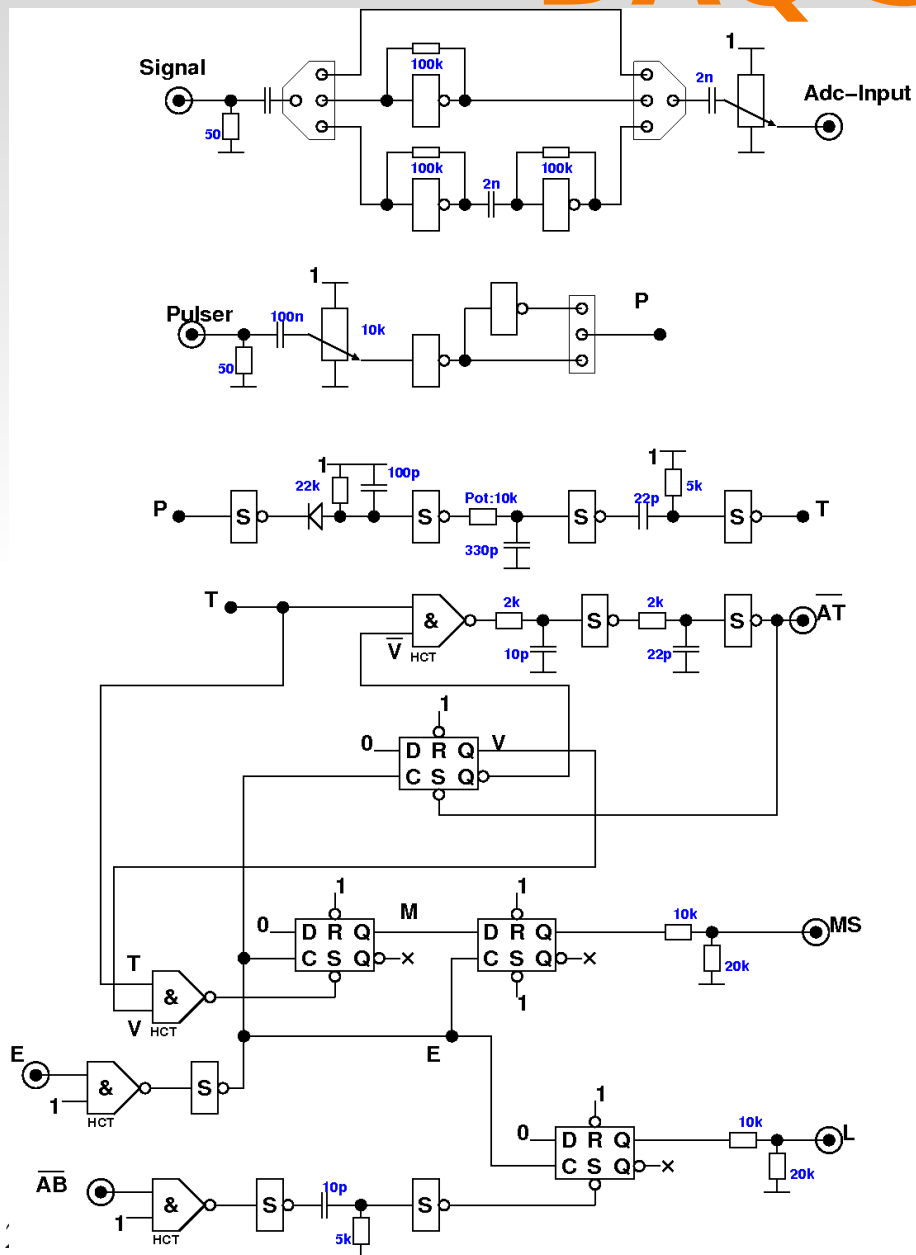
Application Plans

- Direct demonstration of Leopard scanning on standard GEMs
- TGEM R&D:
 - Different hole configurations, various gases
 - Common (Budapest+Trieste) measurement session (two weeks in February)
 - TGEM+MM configuration investigation (see talk by S.Levorato)
 - Comparison of visual, UV, and Fe-55 scans



Backup slides

DAQ Scheme



Gain calibration of the MWPC section

- Single TGEM exploration
- Underlying structure (post amplification MWPC stage) is measurable via shining **through the holes**

