



# GENDARC: The GEel Neutron Physics Data Acquisition, Analysis and Run Control program

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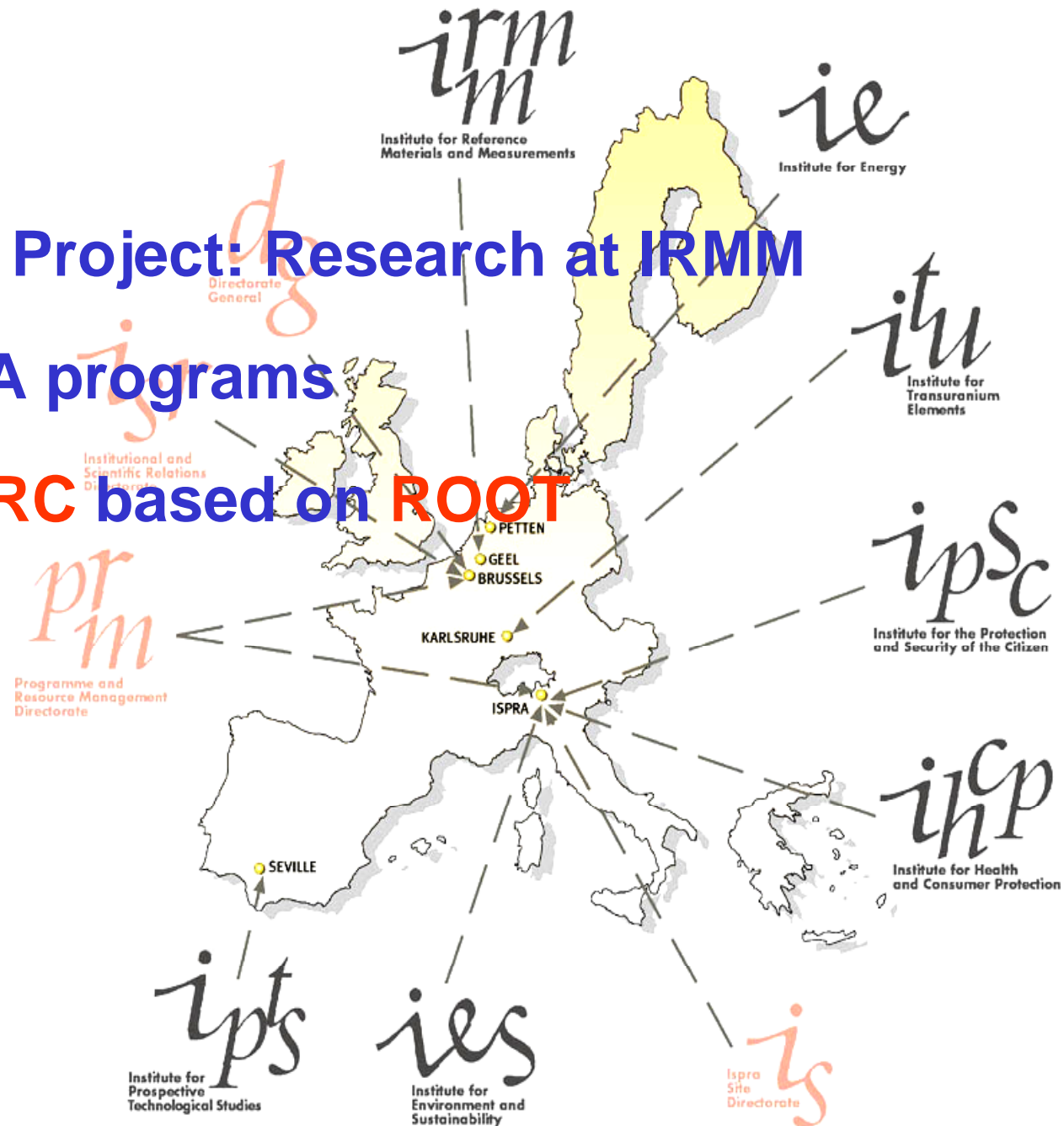
<http://www.irmm.jrc.be>  
<http://www.jrc.ec.europa.eu>





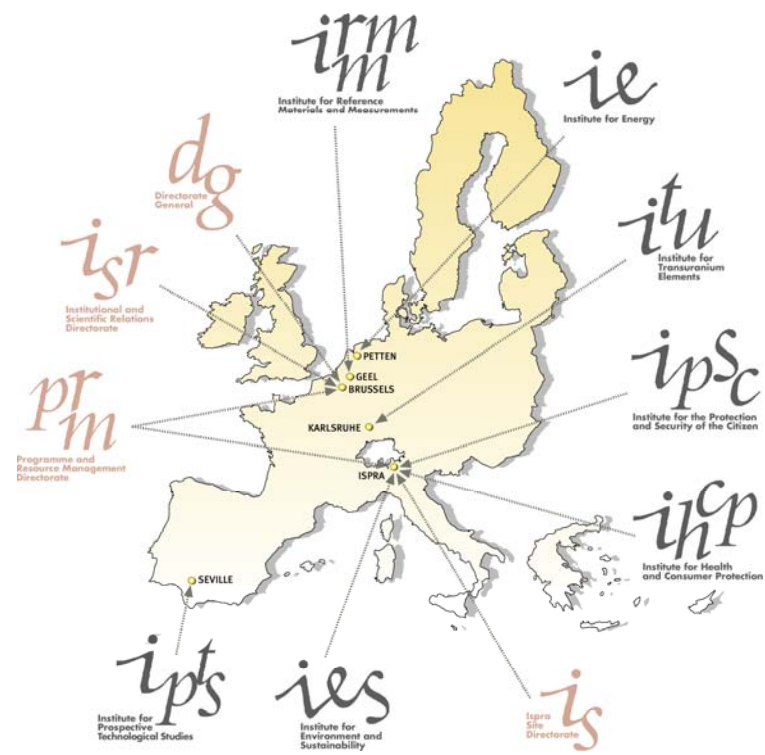
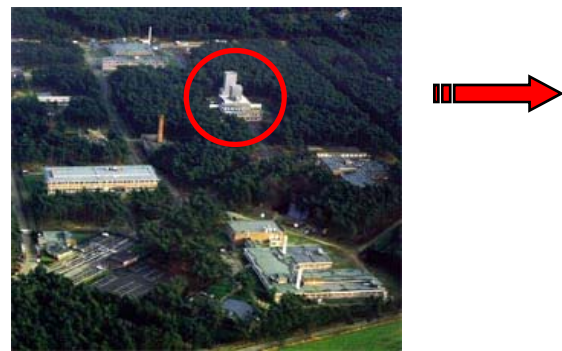
# Outline

- Background of the Project: **Research at IRMM**
- Existing DAQ / DAA programs
- Next step: **GENDARC based on ROOT**
- Outlook



# IRMM Accelerators: 7 MV Van-de-Graaff

Joint Research Centre



## High intensity quasi-mono-energetic neutrons

- 6 set-ups for neutron production
  - ${}^7\text{LiF}(p,n){}^7\text{Be}$ ,  $\text{TiT}(p,n){}^3\text{He}$ ,  $\text{D}_2(d,n){}^3\text{He}$ ,  $\text{TiT}(d,n){}^4\text{He}$
  - DC ( $I_{p,d} < 50 \mu\text{A}$ ), pulsed ion beam available
  - Ionisation chambers, NE213 neutron/gamma-ray detect,  $\text{BF}_3$  counters, HPGe detectors, Bonn sphere, PRT
- $\Phi_n < 10^9 \text{ /s/sr}$
- Neutron energy range 0.3 – 24 MeV





# IRMM Accelerators: GELINA



## GEel Linear Electron Accelerator

- **White neutron source**, electrons produce Bremsstrahlung in uranium target which by photonuclear reactions, produce neutrons
- Among the pulsed white spectrum neutron sources GELINA is the one with the **world-wide best time resolution** (Repetition frequency: 40 - 800 Hz, neutron pulse width: 2  $\mu$ s - 1 ns @ FWHM)
- **Multi-user system**, 12 different experimental stations, wide variety of detectors, and data acquisition and analysis systems
- Very long flight paths with a length between 8 and 400 m, **excellent energy resolution**
- **Long record in providing crucial high accuracy data, unique in Europe**

$$\Phi_n = 3.4 \cdot 10^{13}/s @ 800 \text{ Hz}$$

**Energy range 1 meV – 20 MeV**



“The mission of the IRMM is to promote a common European measurement system in support of EU policies”

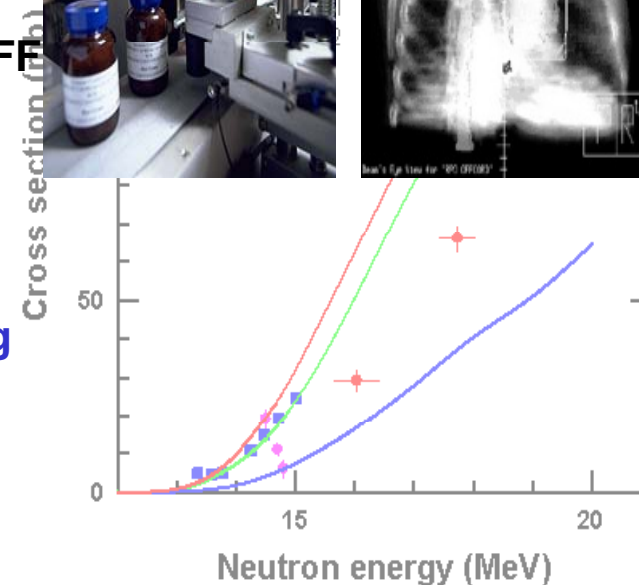
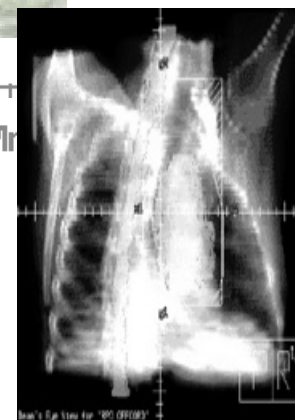
## Core competences and Applications (examples):

- **Food safety & quality** (Monitoring Chocolate, BSE,..)
- **Reference materials** productions (Biotech and Medical)
- **Reference measurements** (Chemical/Isotopic)
- **Radionuclide metrology** (Environment control of soils, water)
- **Neutron physics**

Reference data measurement for trans-national databases JEFF

Pre – normative research:

- Future energy concepts (Gen IV, Fusion)
- Improved nuclear safety, waste transmutation
- Nuclear medicine
- **Development of improved measurement techniques using Digital Signal Processing (DSP)**



# Digital Signal Processing

- Increasing computer power allows **DSP becoming the main technology** in experimental nuclear physics

### Advantages:

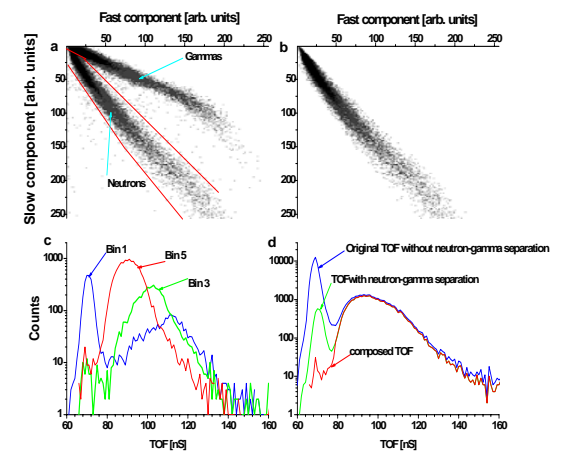
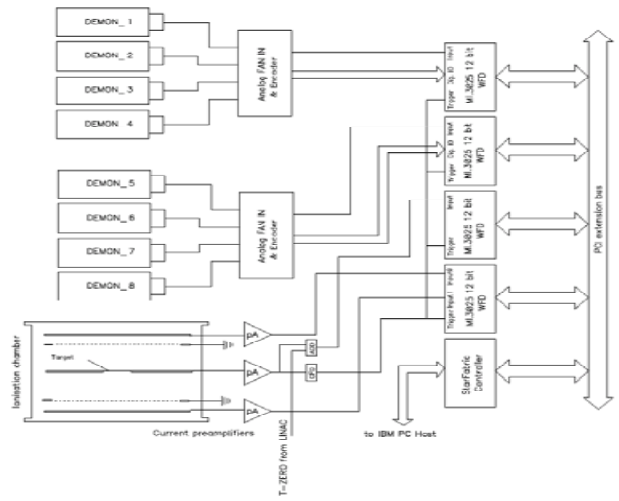
- Complete waveforms recorded **repeated data analysis is possible without repeating the experiment** (impose thresholds or coincidence time windows)
- Improved data quality**

- Standard PCI format
- Fastest 12 bit A/D converter board
- Up to 200 MS/s on one channel
- Up to 100 MS/s on two channels
- Up to 60 MS/s on four channels
- Simultaneously sampling on all channels
- 6 input ranges:  $\pm 200$  mV up to  $\pm 10$  V
- Up to 256 MSample memory
- FIFO mode for slower samplerates
- Window and pulsewidth trigger
- Input offset up to  $\pm 100\%$
- Synchronization possible



But, with WFDs **size of data grows rapidly**

→ Modern DAQ / DAA tools: **ROOT**

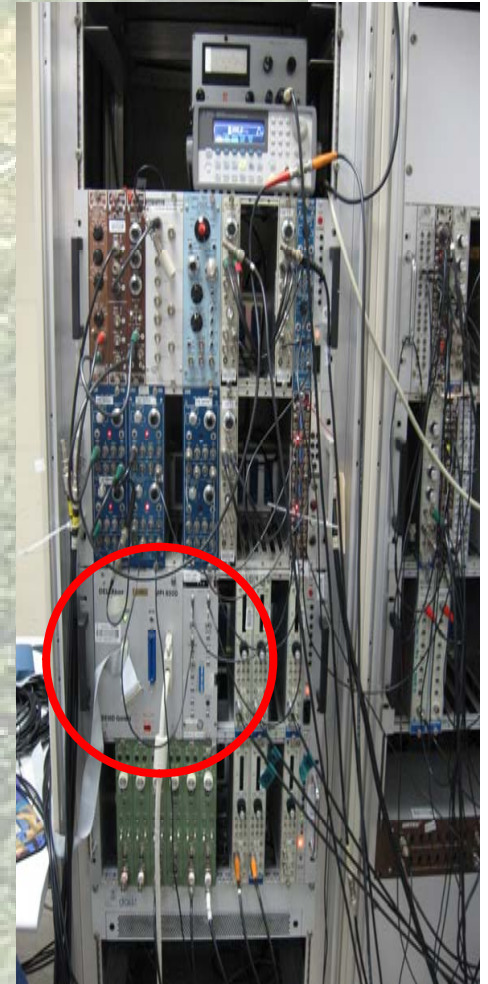




# Existing DAQ/DAA Software: LISA

- Several DAQ / DAA programs in use by IRMM NP Unit, the most complete is **LISA [1]** based on **commercial analysis program PV-WAVE** from Visual Numerics Inc. (*PAW*- like syntax)
- **Utilised in several experiments** for the acquisition and analysis of nuclear data
- **Data input** from different type of ADCs or Multiplexers connected to **MPI 8100 Multi-Parameter-Acquisition-Interface** from Send GmbH via a parallel SCSI data bus and a RS232 control interface **or similar Data Logger**

[1] **LISA- a powerful program package for Listmode and Spectral data Analysis.** *A.Oberstedt, F.-J. Hambsch, Nucl. Instr. Meth., A340 (1994) 379-383*



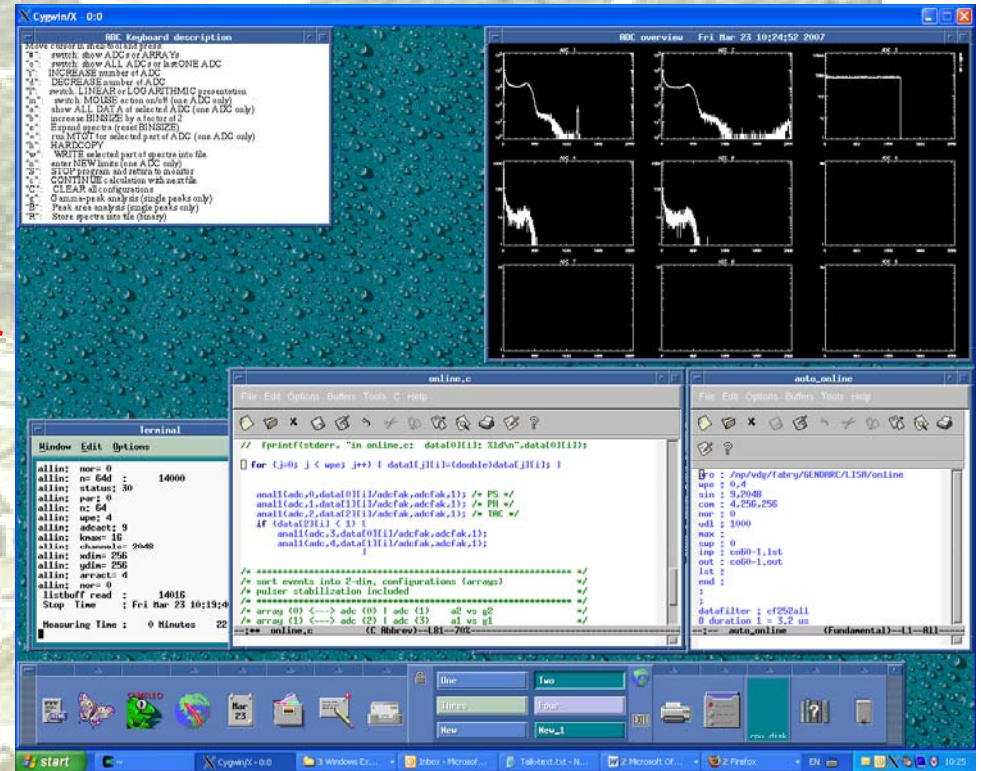


# Existing DAQ/DAA Software: LISA

- **PV-WAVE CL language + User- built C-processors**, (separate process) output piped into the main program for data display
- **Data manipulated only within C- processor** (with own syntax)
- **Controls DAQ program (FORTH)**
- **Running on Sun Solaris 8/ 9 UNIX**

PRO:

- **Huge amount of existing source code** data acquisition analysis has been developed in the last decade, used in publications
- **Data analysis source code IS BEING developed** presently
- **SIMPLE & EFFECTIVE:** User writes only C-processor, fast to learn



CONTRA:

- **Modern GUI is missing**
- **Expensive licences:** Extension difficult
- **Older data analysis tools**







# The Next Step: GENDARC with ROOT

Modernisation: Replace PV-WAVE program and to develop GENDARC based on ROOT (CERN)

Development has started

## GENDARC basic features:

- **Compiled program, up to 10 times faster performance** than an interpreted code
- Program **uses free GNU- 3.3.2 compiler**, from within ROOT itself via ACLiC, the Automatic compiler of libraries for CINT (the C++ - interpreter)
- Running on major platforms Solaris **UNIX, Linux** and **Windows** via Cygwin
- **Open-source** nature of our development, combined with that of ROOT, allows usage of free copies of it on every PC or Workstation, without the need to obtain expensive software licences, **saving financial resources** that can be used elsewhere



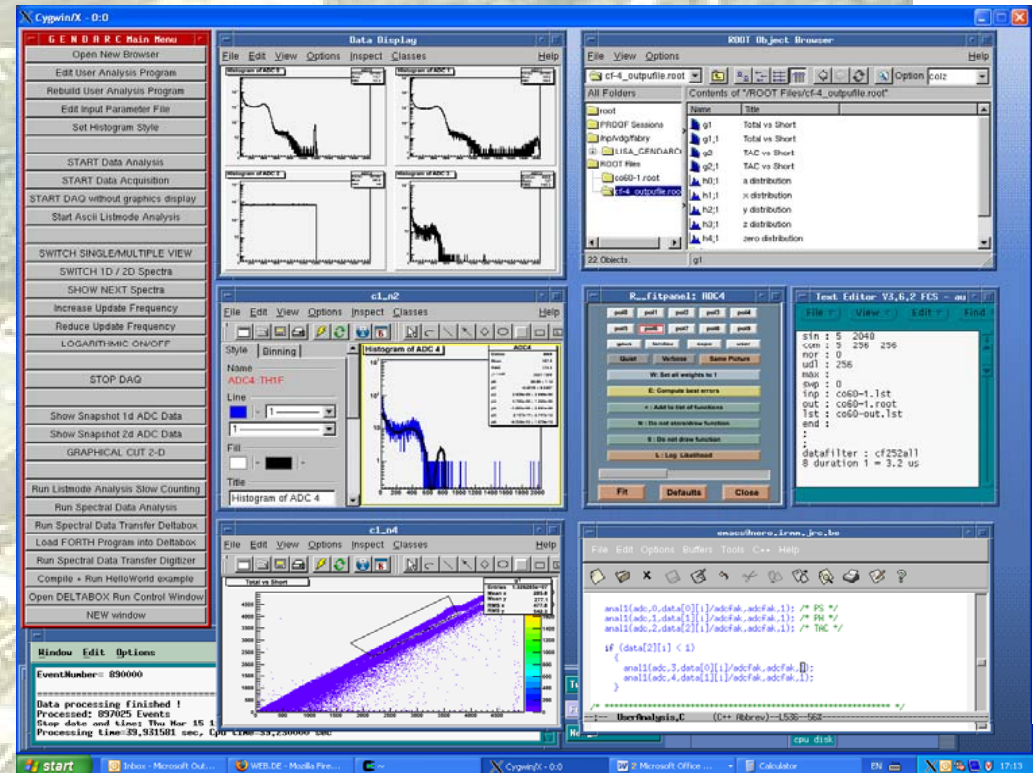
# GENDARC Attributes

In addition to LISA- features,

**GENDARC uses numerous ROOT-features** via GUI including:

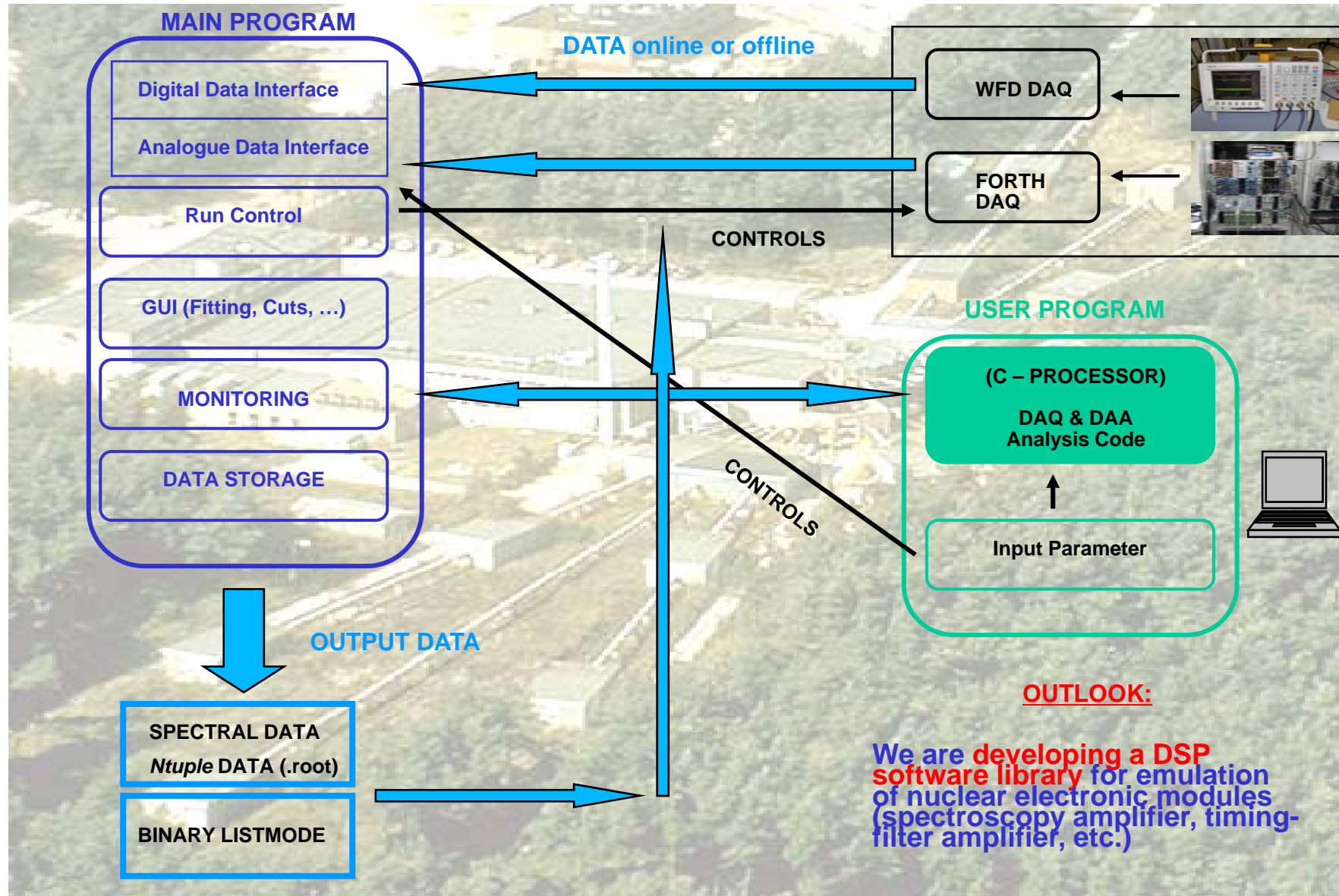
- Use of *Ntuples* → *n-dimensional analytical cuts* possible
- Tools for fitting of spectra
- Graphical cuts
- GUI, changing Histogram – Style, etc.
- Special CPU time for the processing of GUI-events is allocated

The development of the program is taking place within our experiments





# GENDARC Structure





# GENDARC / LISA Interface

## PROBLEMS:

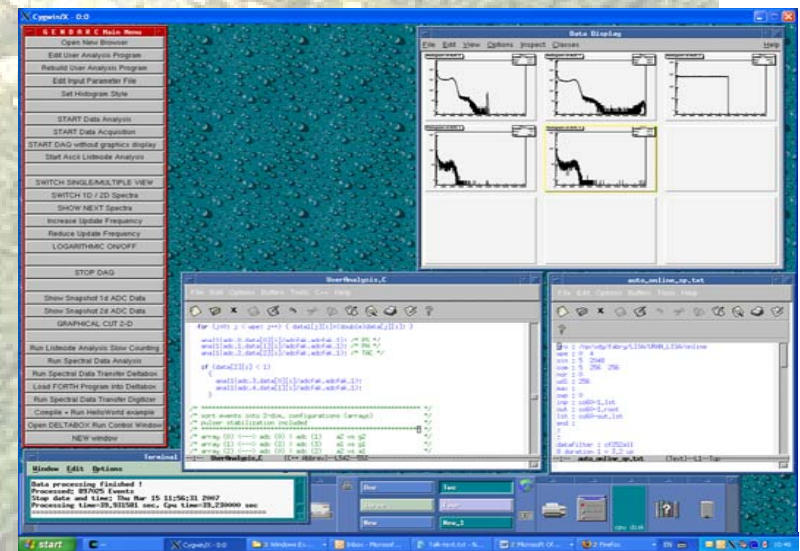
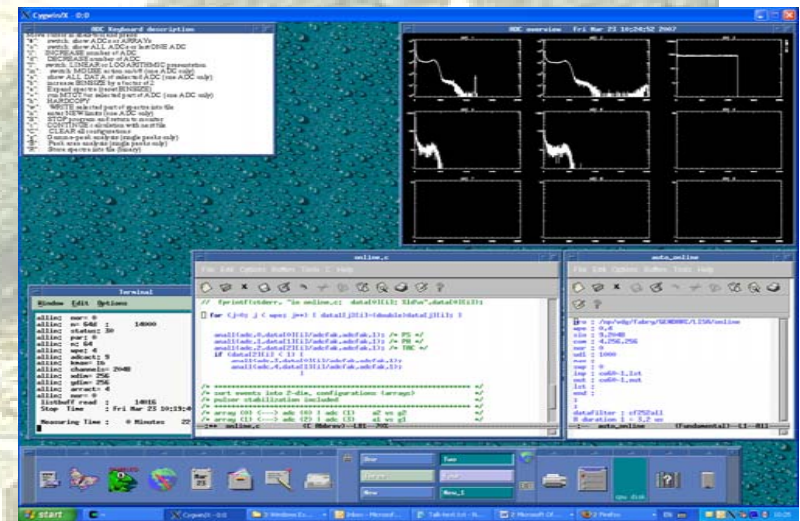
- ROOT is powerful, but for new users **not too easy to learn**
- **Great amount of tested source code exists in LISA** developed over the last decade

## SOLUTION:

**GENDARC/ LISA -software interface, which allows using all existing programming code from LISA**



- All LISA C- processors to be run within GENDARC
- New users can analyse data quickly
- **Saves programming effort, time and also cost**





# Summary

**GENDARC based on ROOT** development has begun

- **DAQ and DAA framework** for data from analogue and digital nuclear electronics modules
- **Online monitoring, Run Control, State-of-the-art analysis** tools from ROOT
- **Supersedes existing DAQ / DAA program** based on expensive commercial software
- **New software interface** enables to **re-use all existing data analysis programming code** developed over the last decade **saving effort, time and cost**

**NEXT STEP: Implementation of DSP software library**

**MANY THANKS FOR THE SUPPORT FROM ROOT TEAM AND COMMUNITY !!**

**I HOPE THE ROOT PROJECT WILL CONTINUE TO GO FORWARD !!**

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