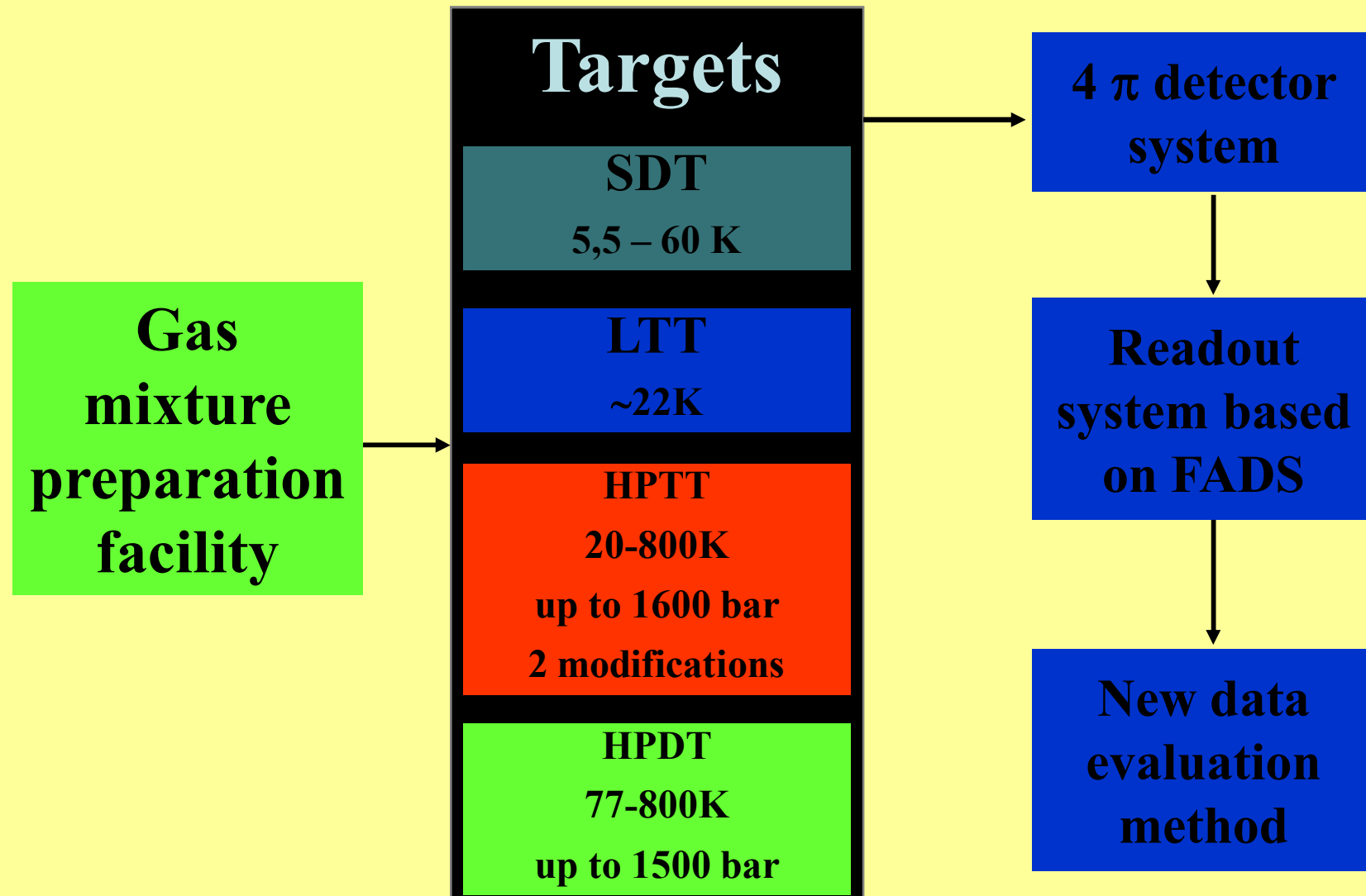# THE BASIC SOFTWARE FOR THE "TRITON" AND "ACCULINA" – THE AUTOMATED TRITIUM COMPLEXES

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TRITON facility, 1997

Targets

SDT 5,5 – 60 K	
LTT ~22K	
HPTT 20-800K up to 1600 bar 2 modifications	
HPDT 77-800K up to 1500 bar	

Gas mixture preparation facility

4 π detector system

Readout system based on FADS

New data evaluation method

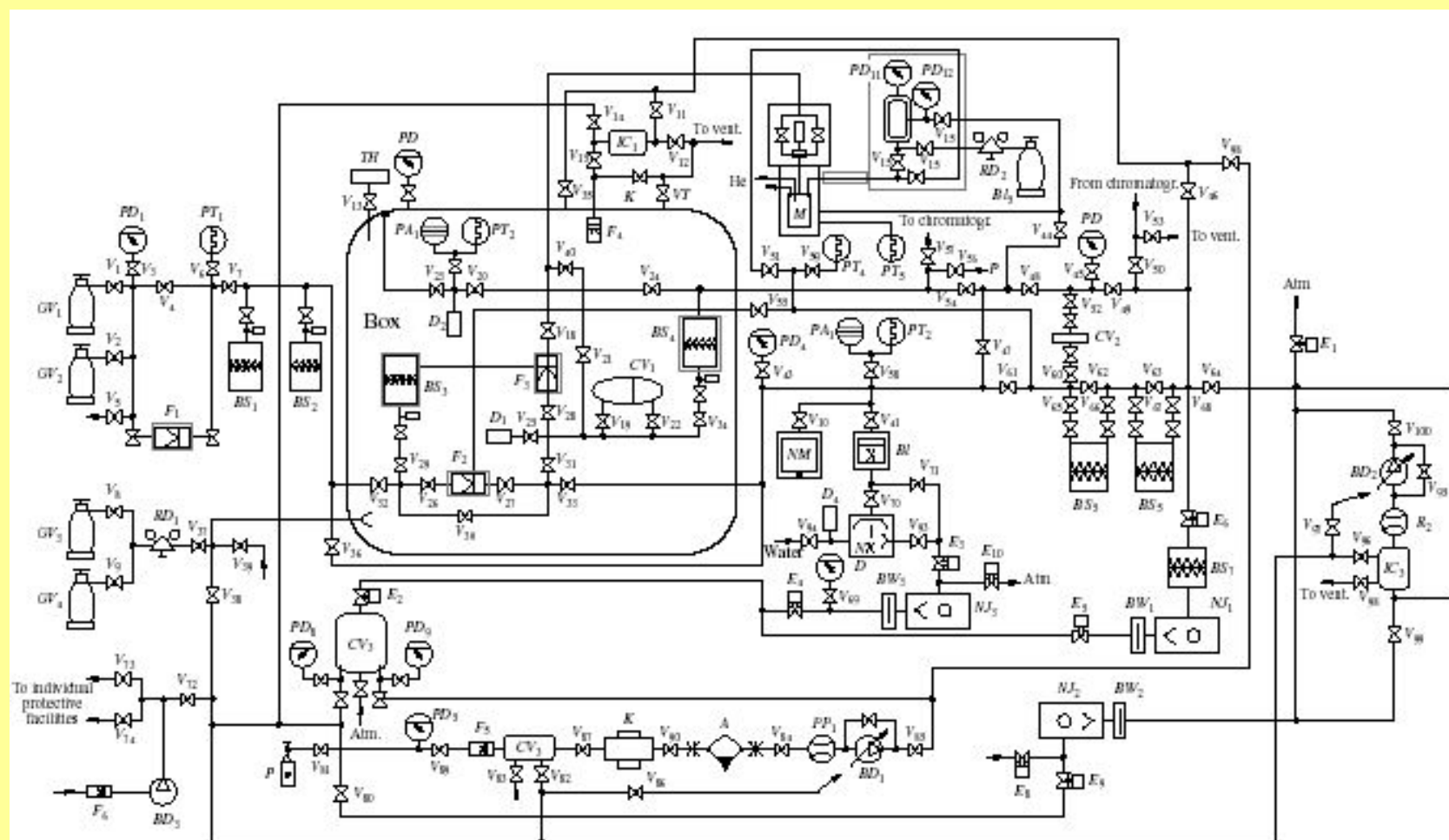# The complex for prepares the gas mixture and targets of the TRITON facility


Fig. 1. Schematic of the gas pipelines of the Triton-facility complex for preparing gaseous mixtures [15]: (BS_1, BS_2) protium and deuterium generators; (BS_3) tritium generator; (BS_4) mixture generator; (BS_5, BS_6) uranium traps; (BS_7) adsorption trap; (PA) ПИМ-2 ionization transducer; (PT) thermocouple transducer; (CV_1, CV_2) vessels; (CV_3) receiver; (CV_4) hydrogen vessel; (D_1, D_2) "Сапфир-22-Ex-M" pressure gauge; (M) high-pressure tritium target; (TH) draft and pressure meter; (IC) ionization chamber; (NM) ion pump; (ND) diffusion pump; (NJ) roughing pump; (R) rotameter; (P) sampler; (K) converter; (A) adsorber; (BD) air blower; (BW) oil-catch filter; (F_1–F_3) diffusion filters; (GV) gas vessels; (F_4–F_6) aerosol filters; (V) valves; (E) electromagnetic valves; (PD) pointer manometers and vacuumeters; (SV) safety valve; (RD) gas reducers; and (VT) ventilation valve.

Structure of the measurement-and-control system
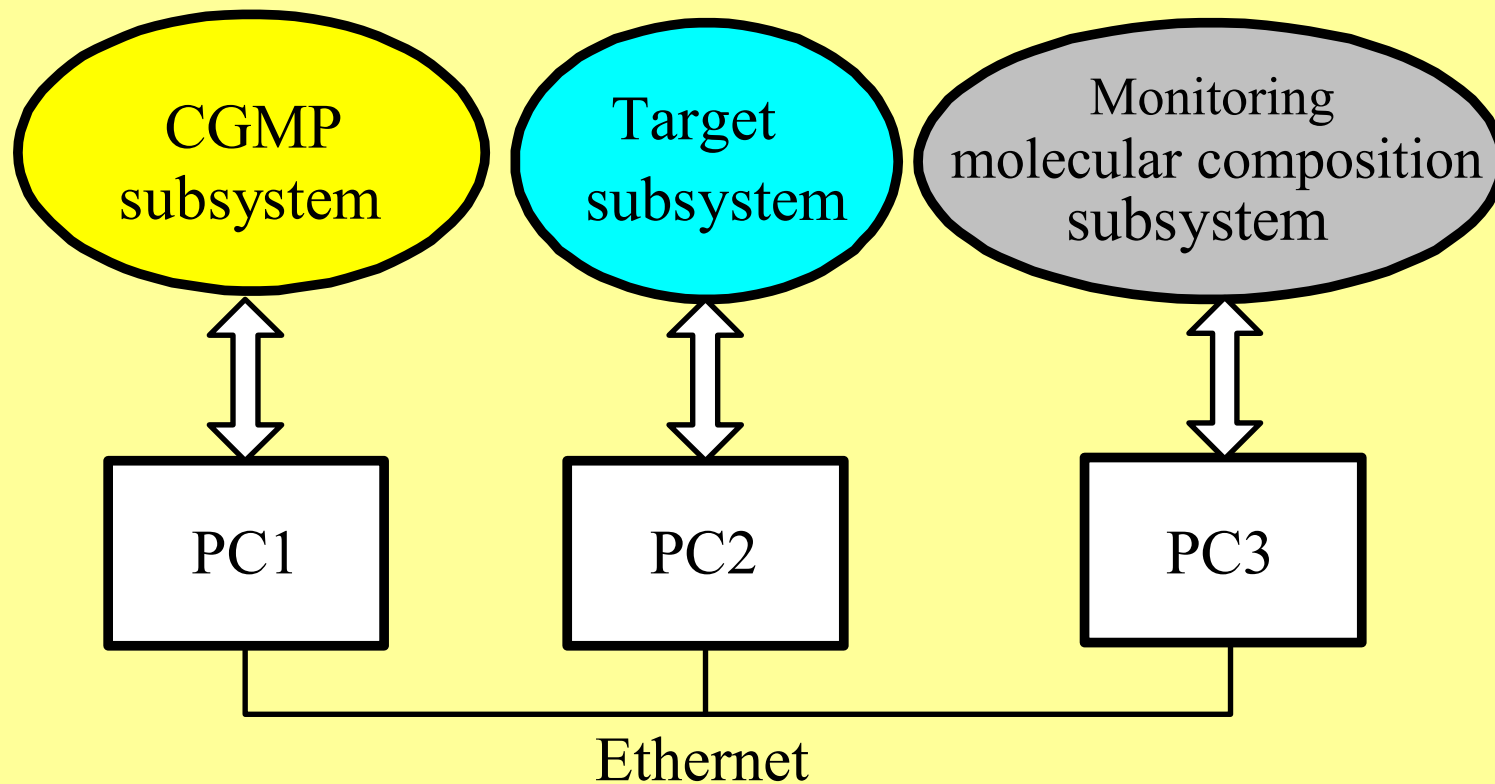
FLNR JINR: ACCULINA facility, 2000

Gas tritium target ($2 \cdot 10^{20}$ cm^{-2})

to DEMON

n

n

t

Triton telescope

t

p

Proton detector
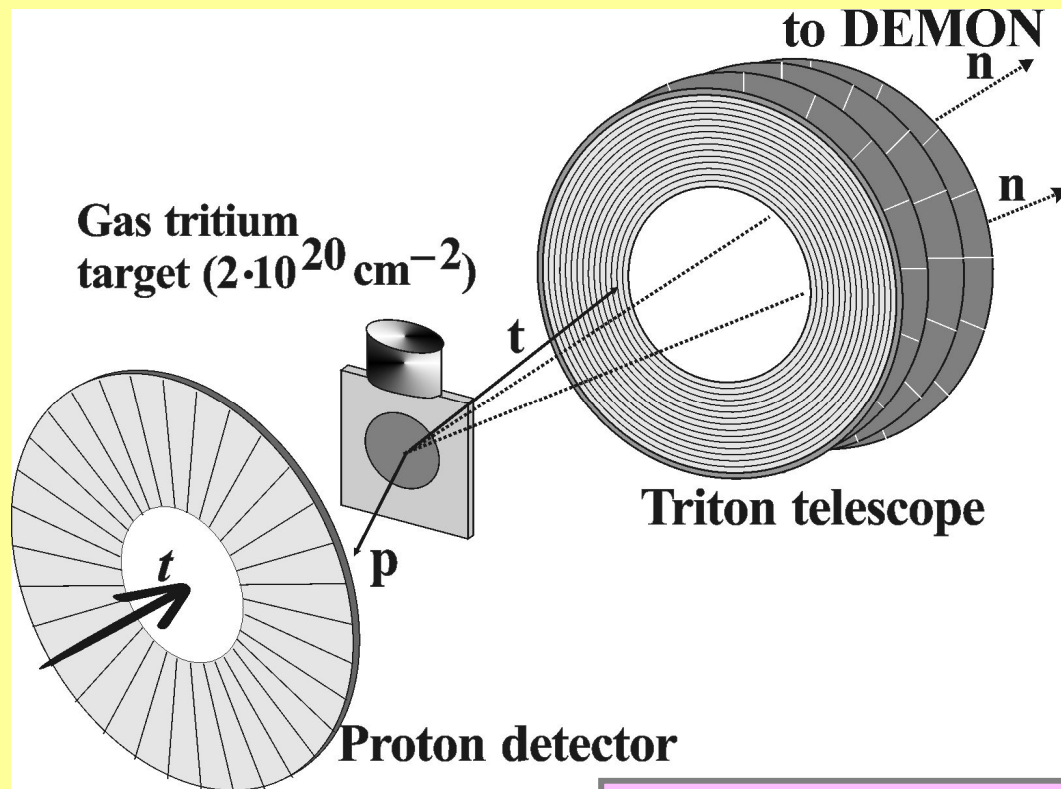
GANIL, Caen, France
Strasbourg, IPN
Brussels University
RIKEN, Japan

RFNC-VNIIEF:
❑ **Liquid tritium target**
❑**Gas feeding system for U-400M cyclotron ion source**

FLNR JINR:
❑ **U-400M cyclotron**
❑**ACCULINNA separator**
❑ **scattering chamber**
❑ **detectors**

Equipment for study of neutron-rich nuclei

- Cyclotron U400-M ion source feeding by the hydrogen isotopes

- Filling of the tritium target by the hydrogen isotopes and ^{3}He, ^{4}He

- Evacuation and utilization tritium from the target

- Control of working temperature with the accuracy $\pm0,1K$

- Monitoring of the radiation environment

- Automatic monitoring and control of the working parameters
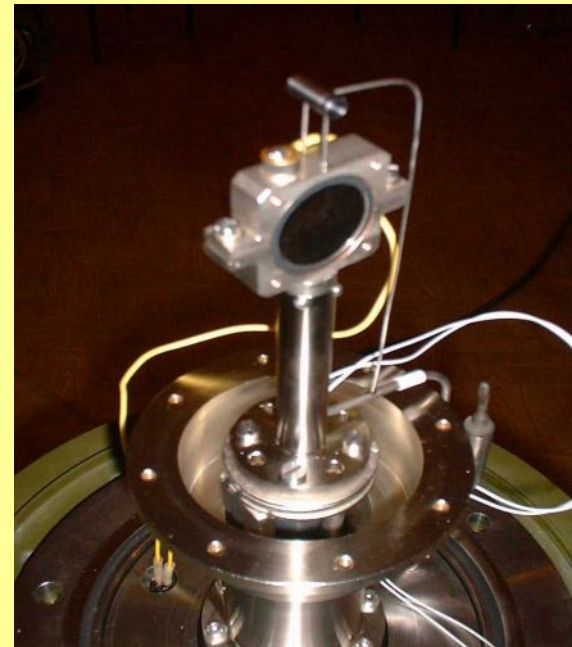
TRITON and ACCULINA facilities included:

- the gaseus and tagret complexes with automated data acquisition and control systems

- the software for the automated data acquisition and control systems (was made using the programming package developed by the authors)

Motivation for development own programming package

• for operation with tritium need very reliable equipment and software.

• the industrial SCADA-systems (supervisory control and data acquisition) have the "closed" code.

In the case own program we have the total control under the program evolution, available original code and the experience in tritium activity – all these made the software reliable, and its behavior predictable.
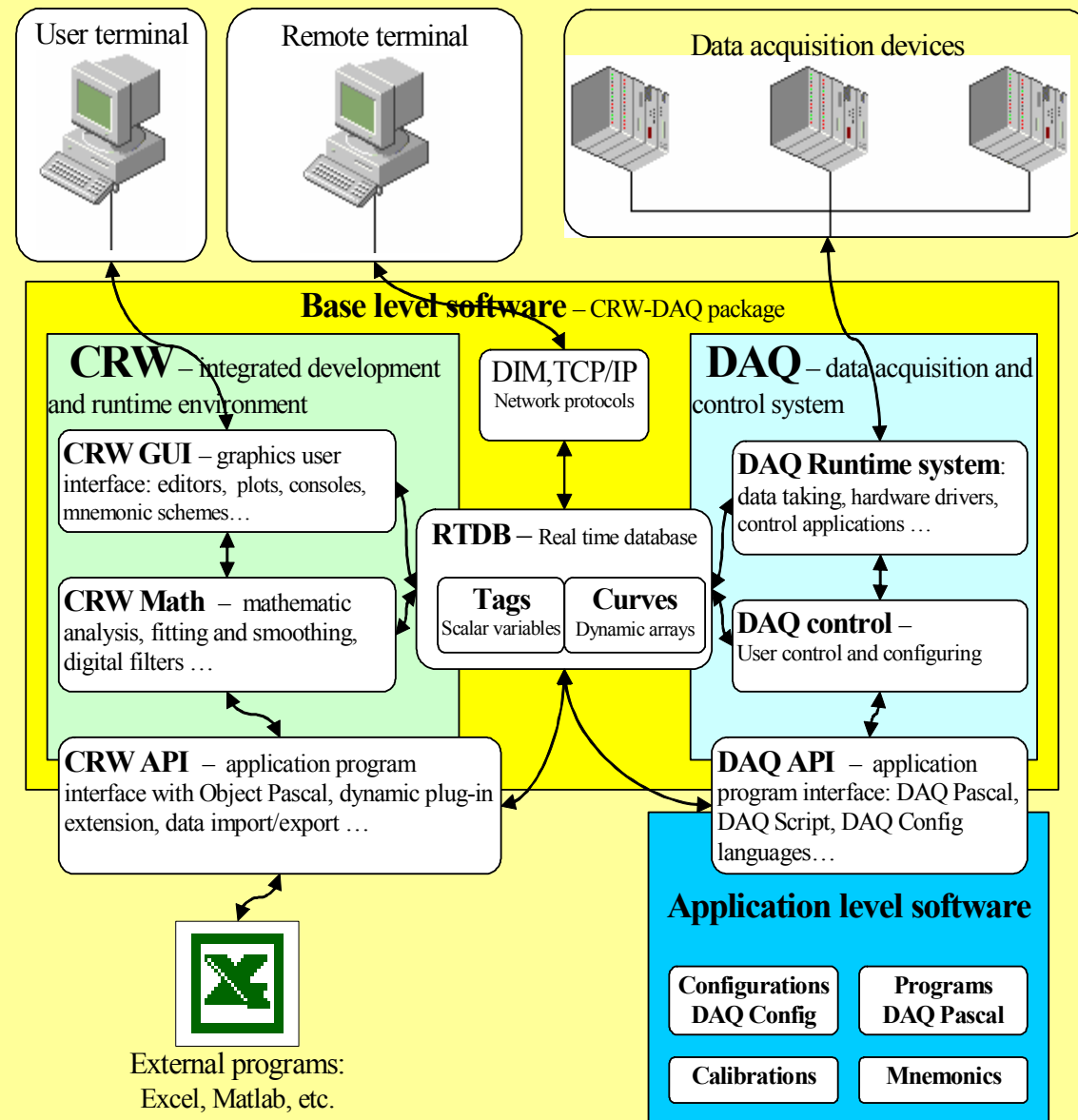
Programming package CRW-DAQ

- Our programming package is mini-SCADA system called CRW-DAQ .

- CRW-DAQ is abbreviation of "CuRve in Windows for Data AcQuisition".

- That is graphically-oriented software for   design data acquisition and control systems and analyse experimental data.

CRW-DAQ

- The first version of the package named CRW16 designed in 1996 and operated in 16-bit protected mode under DOS/DPMI or Windows-95/98 that corresponded to the level of computers and programs of that time.

- Since 2002 the 32-bit version (CRW32) of the CRW-DAQ package has been being developed for Windows-NT/2000/XP. The source code of the package is written in Object Pascal.

- **Site www.crw-daq.ru**

Structure of CRW-DAQ package

User terminal

Remote terminal

Data acquisition devices

Base level software – CRW-DAQ package

CRW – integrated development and runtime environment

CRW GUI – graphics user interface: editors, plots, consoles, mnemonic schemes…

CRW Math – mathematic analysis, fitting and smoothing, digital filters …

CRW API – application program interface with Object Pascal, dynamic plug-in extension, data import/export …

DIM,TCP/IP
Network protocols

RTDB – Real time database

Tags
Scalar variables

Curves
Dynamic arrays

DAQ – data acquisition and control system

DAQ Runtime system: data taking, hardware drivers, control applications …

DAQ control – User control and configuring

DAQ API – application program interface: DAQ Pascal, DAQ Script, DAQ Config languages…

Application level software

Configurations DAQ Config

Programs DAQ Pascal

Calibrations

Mnemonics

External programs:
Excel, Matlab, etc.

The base level software

CRW - integrated graphic environment for development and execution

- CRW GUI – graphic user interface (editors, plots, mnemonic shemes
- CRW Math – mathematics analysis
- CRW API – application program interface with Object Pascal, dynamic plug-in extention, data import/export

RTDB - real time data base (tags and curves)

Network protocols – DIM, TCP/IP

DAQ - data acquisition and control systems

- DAQ RunTime system - hardware drivers, control applications
- DAQ control system - user control and configuring
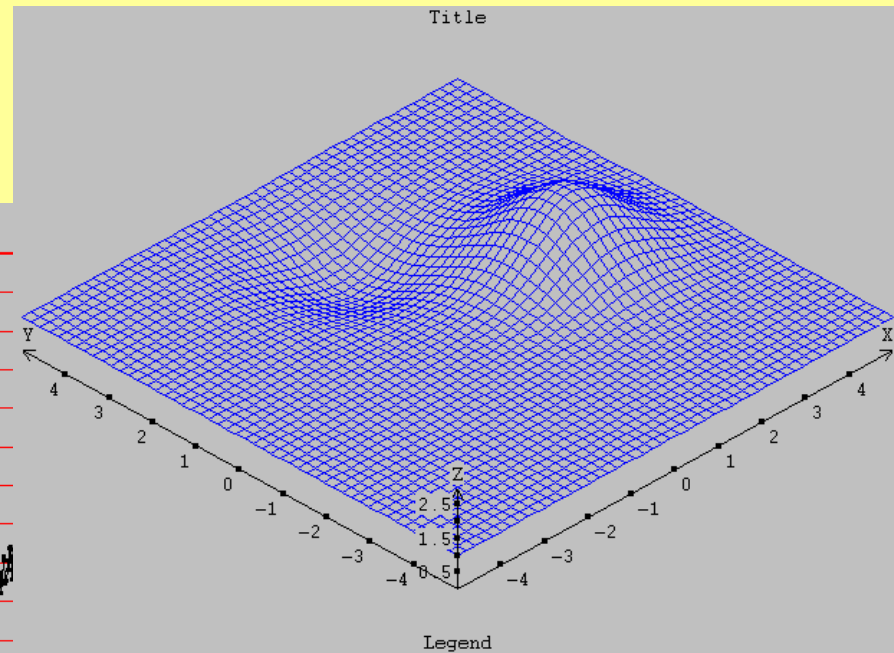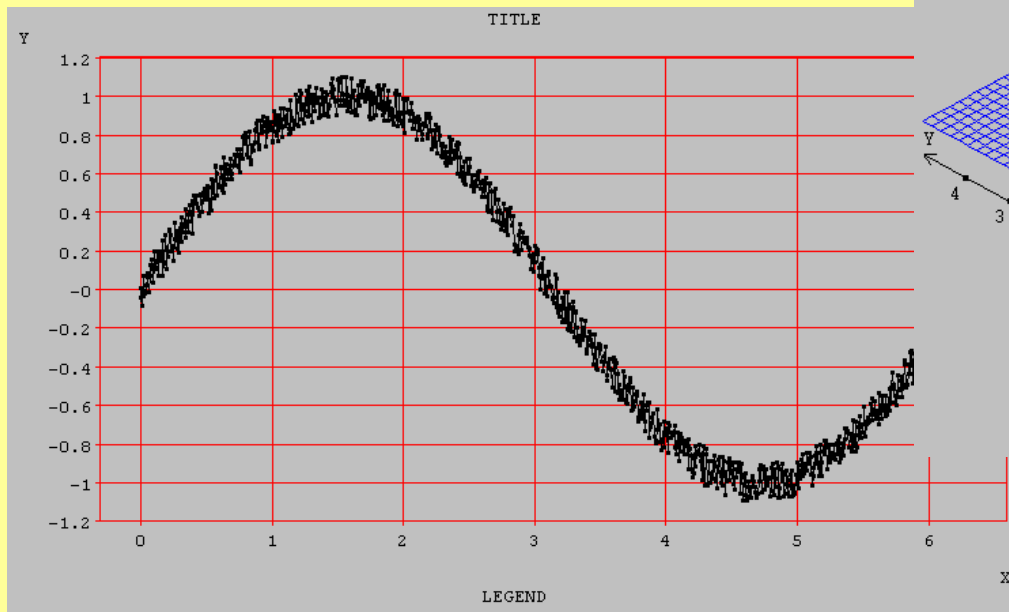- DAQ API - application programming interface (DAQ Pascal, DAQ Script and DAQ cofiguration languages)

Application level software

- Configurations
- Calibrations
- Programs on DAQ Pascal
- Mnemo-shemes

Graphic user's interface

- 2-D plotl
- 3-D plot
- Histograms
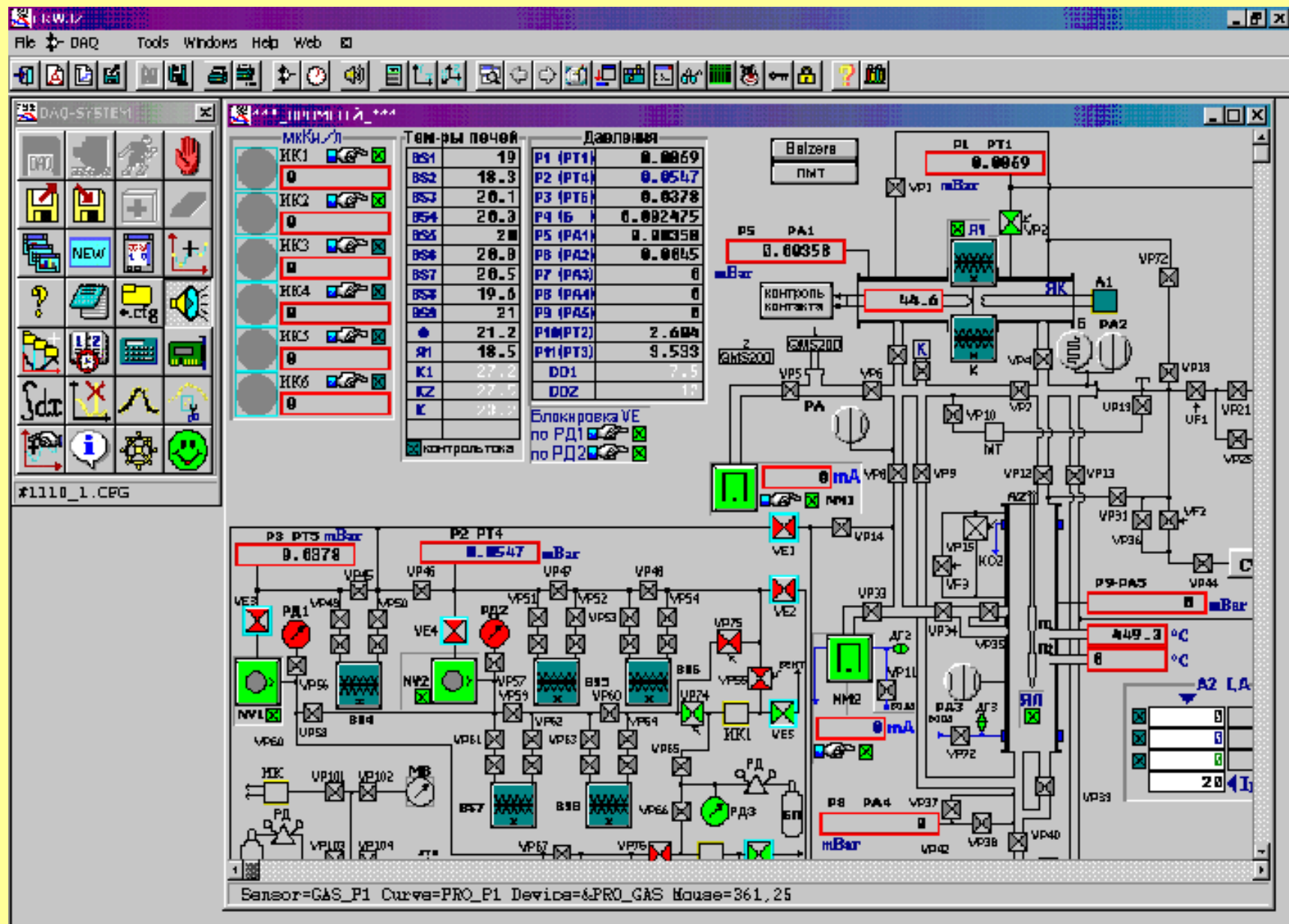- console messages
- Tables
- mnemonic shemes

Graphic user's interface

Graphic user's interface

Build-in programming languages

The build-in DAQ Pascal compiler (designed on the base of classic Pascal-S compiler by Niklaus Wirth)

• is used for developing protected applied programs, so called "measurement scenario". It generates an intermediate P-code for the **virtual stack machine**, which is then executed by the build-in interpreter.
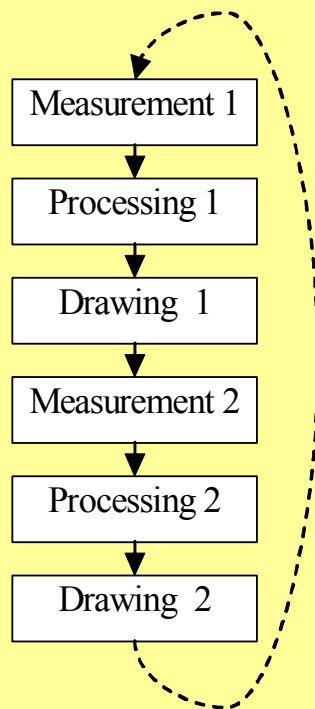
The build-in DAQ Script language is C-similar interpreter

•used for the needs of formula calculations in the interactive mode when the calculated expressions are unknown at the stage of compilation (for example, are input by the user in the dialog) and they are to be interpreted immediately.
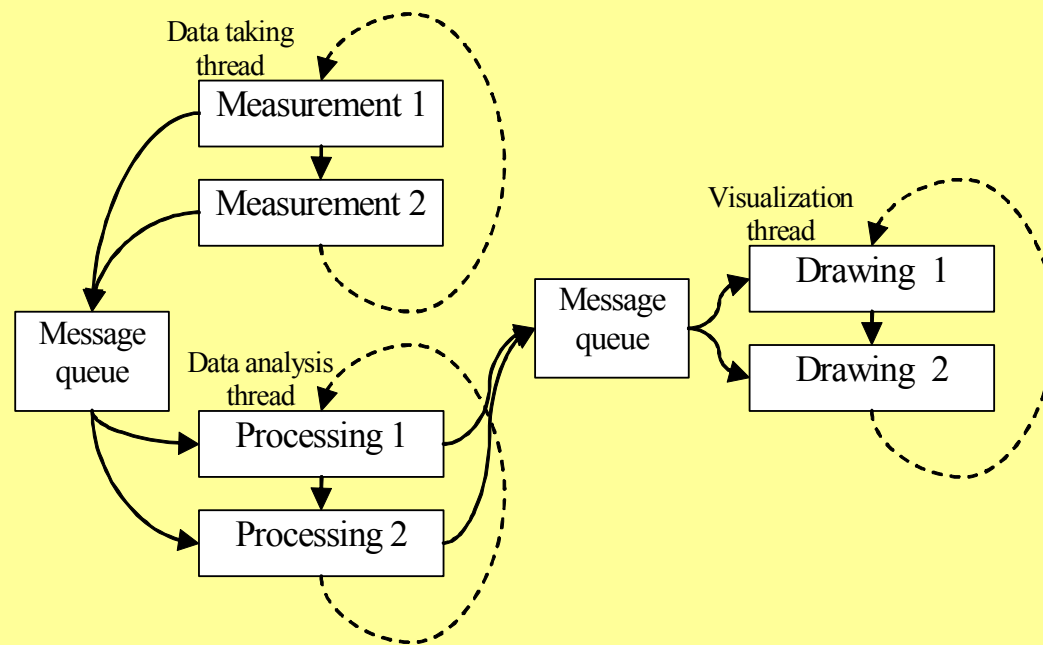
The integrated Object Pascal command line compiler allows to create dynamic link drivers in the form of *.DLL files, as well as executed *.EXE files usually activated as child processes from the applied DAQ Pascal software and interacting with the program by the anonymous pipe.

CRW-DAQ as multithread application

- The CRW-DAQ systems are worked as the parallel structure.
- The package is made as a multithread application, in which up to 20-30 programming threads running.
- Each driver, system service or applied program (virtual machine) running in a separate programming thread with a regulated poll period and priority.
- Each thread resolves simple task (control a physical device, processes data) and interacts with other threads via messages and real-time database.
- The multithreading is accomplished naturally and doesn't require big efforts from the applied programmer. The package libraries and functions are developed specially for multithread applications.

Measurement 1

Processing 1

Drawing 1

Measurement 2

Processing 2

Drawing 2

Data taking
thread

Measurement 1

Measurement 2

Message
queue

Data analysis
thread

Processing 1

Processing 2

Message
queue

Visualization
thread

Drawing 1

Drawing 2

a)   Successive configuration of computing   b) Parallel configuration of computing

Network systems

For interprocess communication the package includes the technology called DIM (Distributed Information Manager) That technology based on the TCP/IP protocol was developed in CERN for experiments performed at accelerators, the technology realizes the high-level network mechanism for interaction between processes, which is related with the real-time control systems.

Drivers

There is a large set of built-in drivers for distributed measurement devices, and tools for creating new drivers.

- drivers for remote input/output modules marked as ADAM-4000, I-7000
- drivers for adapters for data acquisition and control for the ISA bus DIO-144, DIO-48, DIO-24, PCL-731, PCL-812, PCL-818;
- drivers for controllers for vacuum measurements TPG-256, TPG-252, and the quadrupole QMS-200 mass spectrometer (Balzers Instruments).
- drivers are made in the form of applied programs in DAQ Pascal for cards LA-1.5 ISA, LA-1.5 PCI, LA-2 USB (OJS "Rudnev-Shilyaev"), ELMB (CERN).

Calibrations

- a powerful built-in system for calibration of measurement channels with the database of standard calibrations (12 types of thermocouples, thermal diodes for cryogenic measurements, platinum and nickel resistive temperature sensors, and etc.)
- a set of mathematical tools for fitting calibration parameters over least squares method.
- the operator must do input calibration points and point out for sensor
- the calibration coefficients are automatically calculated.

CRW-DAQ access levels

- the package has self security system which 4 access levels:

- **Lock** –the computer is blocked, all operations are forbidden except the change of the access level. It is used for temporal block of access for unauthorized persons.

- **Guest** –It allows to view curves, observe the state of parameters, but access to the DAQ system control is locked.

- **User** - a level of an (experienced) user, protected by the password. It makes possible to guide the measurement system (start, stop, shutdown) however it is forbidden to edit the applied programs and configurations.

- **Root** –the administrator's level, protected by the password. This level is intended for developers and responsible persons of the measurement systems.

User guide

The CRW-DAQ package includes:

- an advances help system containing a large volume of documents.

- reference book on functions of DAQ Pascal and DAQ Script languages.

- the templates for configuration files and DAQ Paslal programs.

- Demo-programs of the complicated DAQ-systems.

Summary

- We have a longtime successful experience in applying the CRW-DAQ programming package for automation of the research facilities.

- The developed under CRW-DAQ software is very reliable and flexible.

- The CRW-DAQ package used not only in the field of tritium technologies.

Data acquisition and control systems under CRW-DAQ

- JINR, Dubna
- RFNC-VNIIEF
- MSU, Moscow
- SSU, S.Peterburg
- IPM (Inst. Physics of metals), Ekaterinburg
- CERN (Experiment ALICE)