

# Scalable Readout System Data Acquisition using LabVIEW

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# Needs

- A flexible, portable and easy-to-use Data Acquisition program for APV readout via “srs”
- Useful for  $\mu$ MeGas in laboratory tests and Test Beams
- Compatible with existing analysis programs

The LabVIEW Project for «srs» DAQ

# ALTRO ?

- Till «yesterday» Data Acquisition on  $\mu$ MeGas detectors was made by using ALTRO System
- Hardware based on single channel P.A.  $\rightarrow$  Shaper  $\rightarrow$  ADCs  $\rightarrow$  Buffers  $\rightarrow$  DCS Cards  $\rightarrow$  RORc ...
- Software was a subset of the Data Acquisition for ALICE Experiment (DATE)
  - Several restrictions concerning compatibility between Linux and DATE versions
  - Need very often Experts to fix problems

Not so suitable as an “off the shelf”  
DAQ in the Laboratory or Test Beams

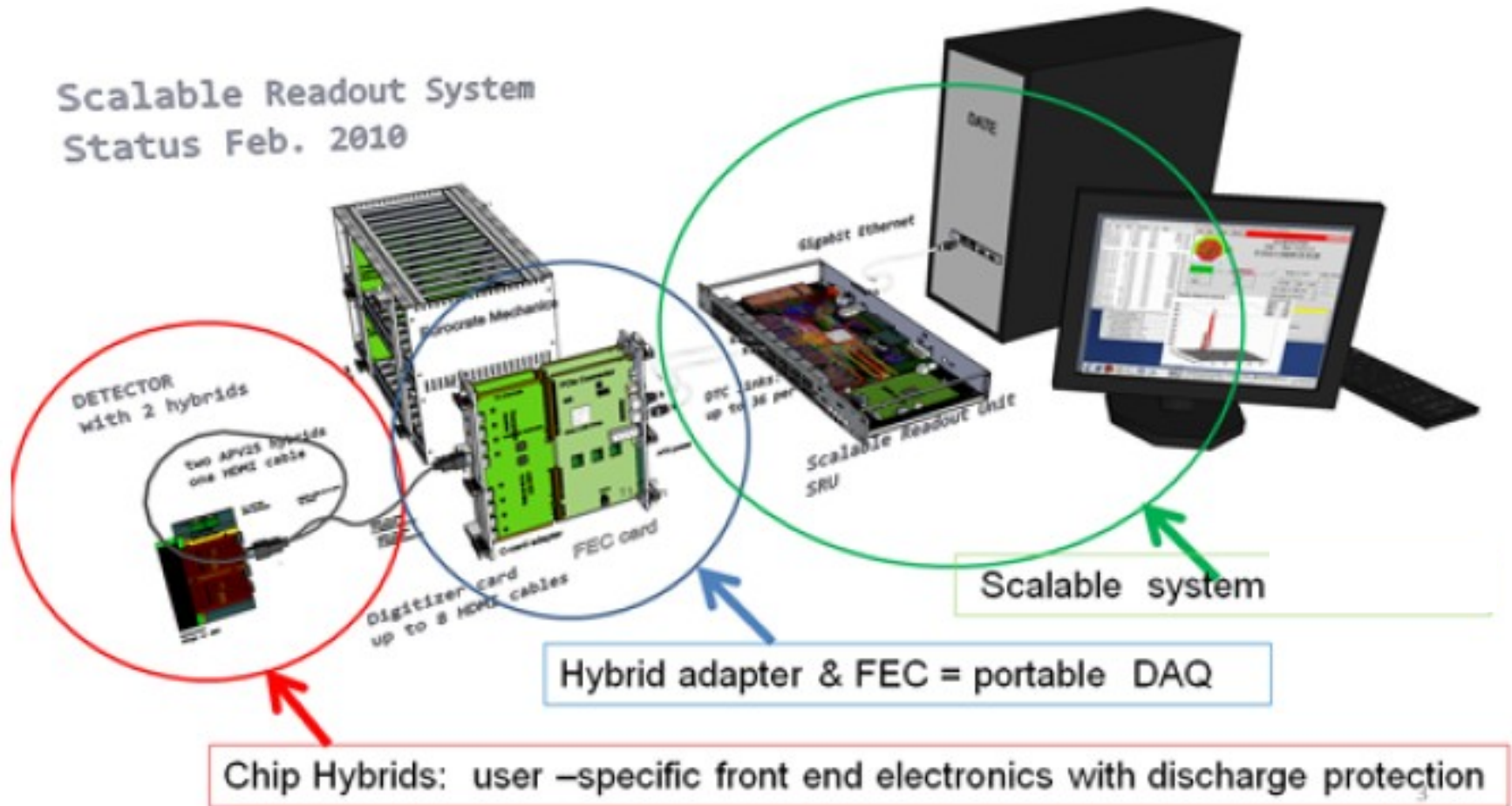
# SRS of RD51

- Scalable Readout System
- Compact and powerful signal sampling DAQ hardware
- Use of on-Detector PA (APVs)
- Front End Card (FEC) as hub and logic handler (including Trigger facilities) based on FPGA
- Data communication on Giga bit Ethernet (different protocols)
  - 1-Giga Ethernet card needed in the PC only !

DAQ Software must receive data via UDP protocol

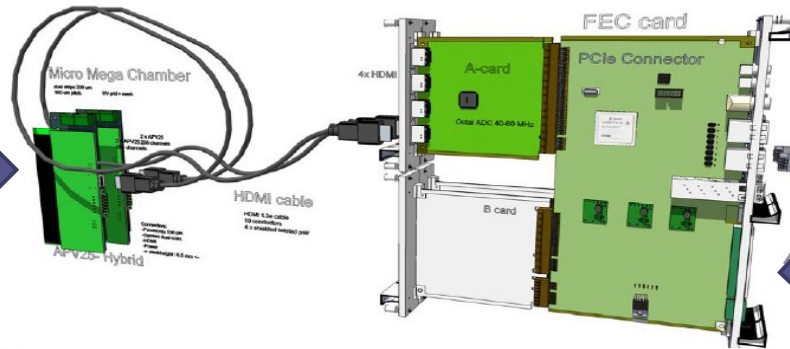
# physical overview SRS of RD51

Scalable Readout System  
Status Feb. 2010

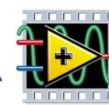


# The LV Project for srs-DAQ

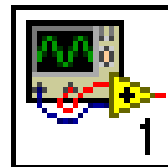
$\mu$ MeGas chambers



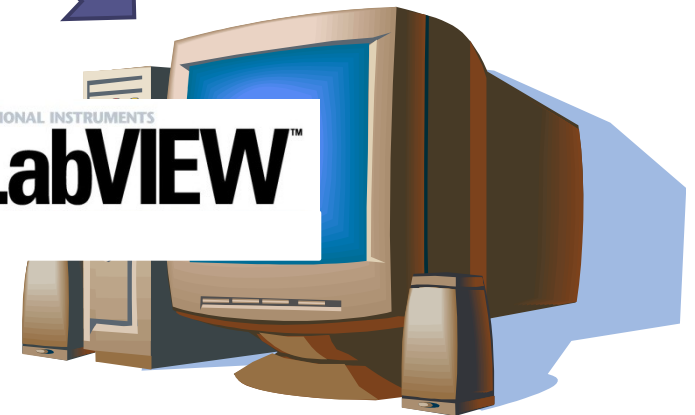
UDP connection



NATIONAL INSTRUMENTS  
**LabVIEW™**



“RD51-srs”  
LabVIEW Project



# LabVIEW RD51-srs

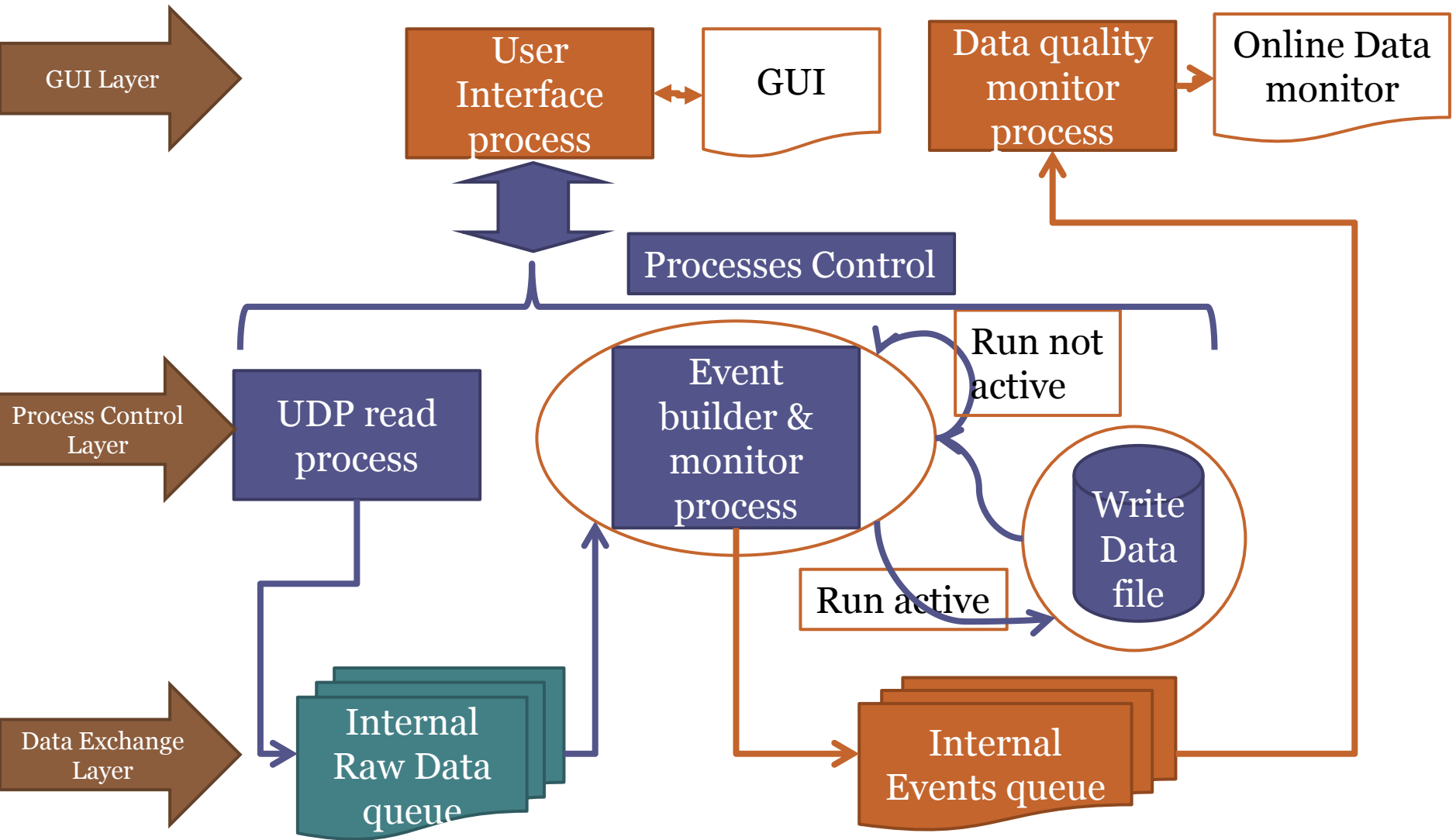
- ~30 modules developed (VIs)
- GUI (Graphical User Interface)
- Monitors for data flow
- RUN handling
- File saving
- Data quality monitor (under development)

# Features

- UDP Connection monitor
- Events recognition based on data integrity
- Events building (Header and Payload composition)
- Data file saving
  - Binary format
  - Compatible with the existing Analysis program
- Parallel processing for:
  - GUI commands handling
  - Watch UDP connection and packets receiving
  - Events recognition by discarding incoherent data
  - File saving using a “Run” sessions logic
- Online Data quality monitor (under development)



# Processes logics



# Main control panel

Producer/Consumer Design Pattern (Data)

File Run Panels

**APV Data Acquisition for RD-51 Main Control Panel**

**Program Status**  
Command Producer   
UDP Data Producer   
UDP Data Consumer   
Event Monitor   
**Running**

**UDP Comm. Parameters**  
UDP Setting  
Listening IP: 10.0.0.3 UDP timeout ms: 2000  
port: 6006 UDP frame size/chn: 8200  
UDP Receive Active

**APV Parameters**  
Read APV Channels: 7 6 5 4 3 2 1 0

**File Saving Parameters**  
Save to filepath  
C:\Users\Administrator\Desktop\CERN-RD51 APV\Data  
File Base name: srs\_DataRun  
File Saving?  Enable

**RUN Parameters**  
Number of required Events: 100

**Holdoff**  
20 30  
10 ~ 0 ~ -40 ~ 50

**RUN Status**  
Current Run Number: 32  
Status:   
# Accepted Events: 0

**Queues Status (# Events)**  
Awaiting  
Building: 0  
Analysing: 0

**Analysis Parameters**  
Analysis flags:  
baseline correction  ON  
invert data  ON  
Reject Common Mode  ON

**Error Status**  
error out  
status:  code: 0  
source

Running Processes control

APV settings

Data Files saving paths & Naming

Online analysis parameters

Error status

UDP Parameters

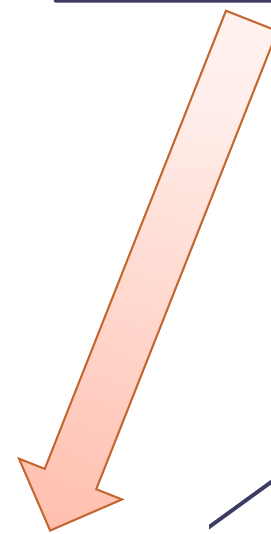
RUN status control

Internal queues occupancy

# UDP Data Receiver

Open panles from Menu Items

The screenshot shows the 'APV Data Acquisition for RD-51 Main Control Panel'. It features several control panels: 'Program Status' with 'Running' indicators for 'Command Producer', 'UDP Data Producer', 'UDP Data Consumer', 'Event Monitor', and 'Running'; 'UDP Comm. Parameters' with fields for 'Listening IP' (10.0.0.3), 'UDP timeout ms' (2000), 'port' (6006), and 'UDP frame size/chn' (8200); 'APV Parameters' with 'Read APV Channels' (7 6 5 4 3 2 1 0) and 'RUN Parameters' (Number of required Events: 1000); 'File Saving Parameters' with a file path 'C:\Users\Administrator\Desktop\CERN-RD51\APV\Data' and 'File Base name' 'srs\_DataRun'; 'RUN Status' showing 'Current Run Number' 31 and 'Status' 'Idle'; 'Queues Status (# Events)' with 'Receiving' status and 'Trailing Counter' 12; 'Analysis Parameters' with 'Analysis flags' (baseline correction, invert data, Reject Common Mode) all set to 'ON'; and 'Error Status' with 'error out' status 'code' 0.



UDP Codes data monitor

The 'Read UDP Frame' sub-panel shows 'INPUTS' (UDP Reference in: Active?, Iterations in: 5, timeout in: 2000, max size to be read: 8200), 'INTERMEDIATE' (Received UDP Strings (Hexa) list), and 'OUTPUTS' (UDP Reference out, Timeout, UDP Data Cluster with Received IP 167772162, UDP Frames, and error out status code 0).

Formatted internal Data "cluster" as Output

# Event recognition and formatting

The screenshot shows the 'APV Data Acquisition for RD-51 Main Control Panel' with the following sections:

- Program Status:** Command Producer, UDP Data Producer, UDP Data Consumer, Event Monitor, and a 'Running' indicator.
- UDP Comm. Parameters:** Listening IP (10.0.0.3), UDP timeout ms (2000), port (6006), UDP frame size/chn (8200), and a Holdoff knob set to 20.
- APV Parameters:** Read APV Channels (7 6 5 4 3 2 1 0) and RUN Parameters (Number of required Events: 1000).
- File Saving Parameters:** Save to filepath (C:\Users\Administrator\Desktop\CERN-RD51\APV\Data) and File Base name (srs\_DataRun).
- RUN Status:** Current Run Number (31), Status (Idle), and # Accepted Events (0).
- Queues Status (# Events):** Receiving (Building, Analysing) and Trainers Counter (21).
- Analysis Parameters:** Analysis flags (baseline correction ON, invert data).
- Error Status:** error out (status: green check, code: 0).

The screenshot shows the 'APV Data Acquisition for RD-51 Data Receiver and Event Building' interface with the following sections:

- INPUTS:** Activate Event Filter, Initial index in (12), and UDP Data Cluster (Received IP: 167772162, UDP Frames: 0).
- INTERNAL:** Incoming Frame plot showing Value vs. Position in stream (0 to 4005).
- OUTPUT:** Received Channels List (0, 1, 2, 3), # Trailers Found (21), Sending Board ID (2), and Event Cluster U32 (Event Accepted, Header: 00007C88, Payload: 970C970C).
- error out:** status: green check, code: 0, source.

UDP data frame in graphical representation

Formatted Event

# Data Dump

- A preliminary Dumping program has been written in order to check Data Files for correctness

The screenshot shows the 'srs\_DataDump.vi' application window. The title bar includes 'File Edit View Project Operate Tools Window Help'. The main area is titled 'APV Data Acquisition for RD-51 File Data Dump' and is divided into several sections:

- INPUTS:** Contains a 'Pattern to be recognized (U32)' field with the value 'DA1E5AFE' and a 'Global iteration' field with the value '3'.
- INTERNAL:** Contains a 'File Size (bytes)' field with the value '319004'.
- OUTPUT:** Contains a 'Record Length found (1st Word)' field with the value '31880' and a 'Contents' list showing a sequence of hexadecimal values starting with 'DA1E5AFE'.
- COMMANDS:** Contains a 'Words to read' field with the value '7969' and a 'Recorder Control' section with navigation buttons (<, <, >, >|) and a 'STOP' button.
- Event raw Data:** A table showing event details, highlighted in orange. It includes columns for Event Size, Magic Number, Header Size, Version, Event Type, Run Number, Ev ID, Trigger Pattern, Detector Pattern, Ev Attribute, Ldc id, Gdc id, and Timestamp.

Event Size (Bytes)	Magic Number	Header Size	Version
x00007C88	xDA1E5AFE	x00000044	x00030009
Event Type	Run Number	Ev ID (1)	Ev ID (2)
x7	x0000001F	x00000001	x00000000
Trigger Pattern (1)	Trigger Pattern (2)	Detector Pattern	Ev Attribute (1)
x00000000	x00000000	x00000000	x00000000
Ev Attribute (2)	Ev Attribute (3)	Ldc id	Gdc id
x00000000	x00000003	x00000001	xFFFFFFF
Timestamp	1302686154		

“Recorder” control

Event raw Data

Event Header

# LabVIEW RD51-srs

- Portable
  - Easily portable on different machines and Operating System
- Scalable
  - Ready to accept new features if required
- Fast
  - Able to handle different parallel processes with fine priorities tuning
- Compatible
  - Data file format compatible with existing analysis

Suitable for daily Laboratory usage  
or Test Beam activities