

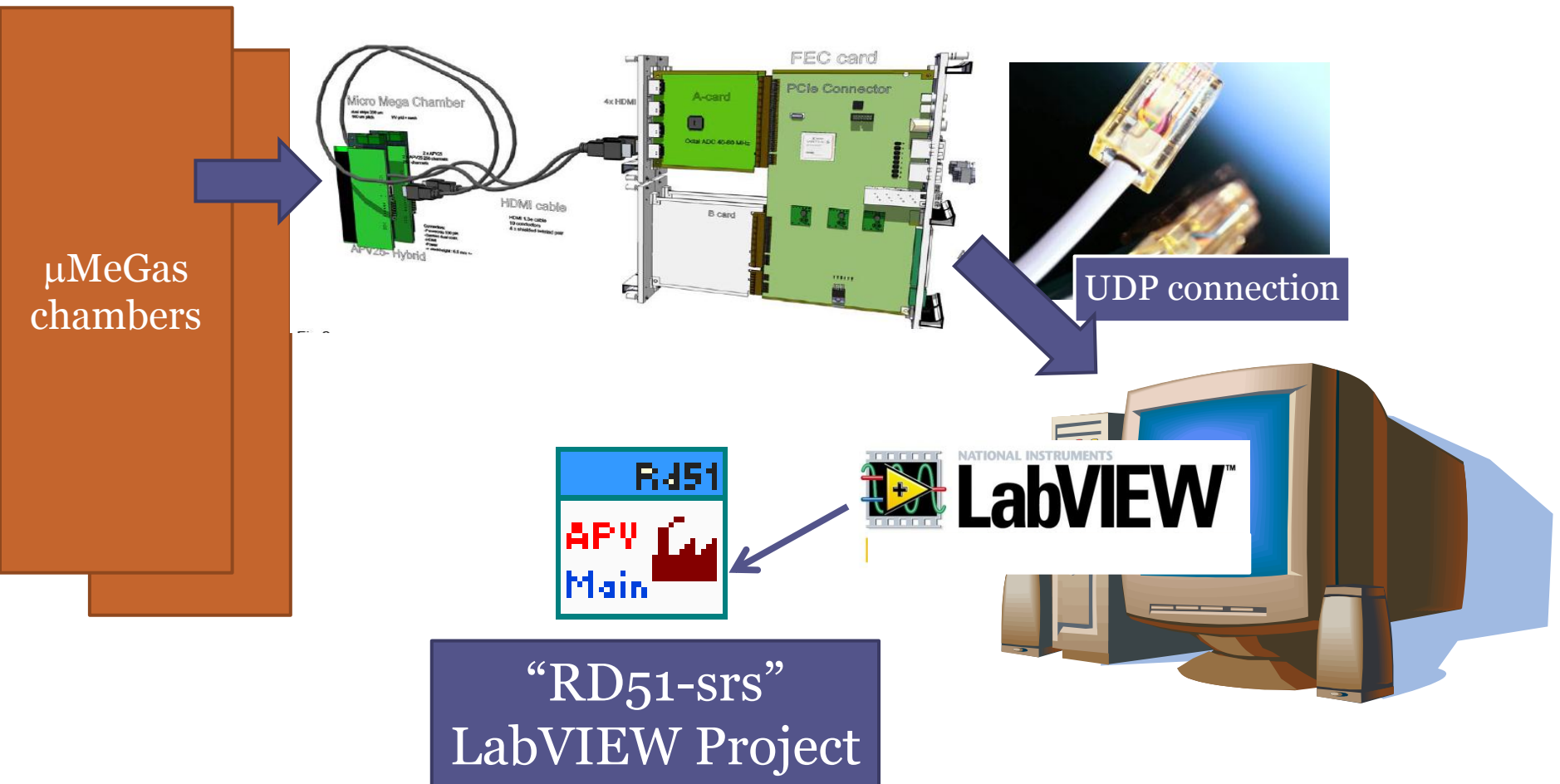
# Scalable Readout System Data Acquisition using LabVIEW

## III - Current status on June 2012

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# Remind: The LV Project for srs-DAQ



# Program Structure

- LabVIEW 2011 Development System
- ~ 40 modules developed (VIs)
- ~ 12 custom data structures for storage & data handling
- GUI (Graphical User Interface) as Main Panel
- Monitor Panels for data flow checks
- Strong parallel processing using multithreading and multicore features from the Machine and O.S.
- Data emulation from acquired datafile in order to allow check & (partially) development also without srs

# LabVIEW RD51-srs: several new features introduced

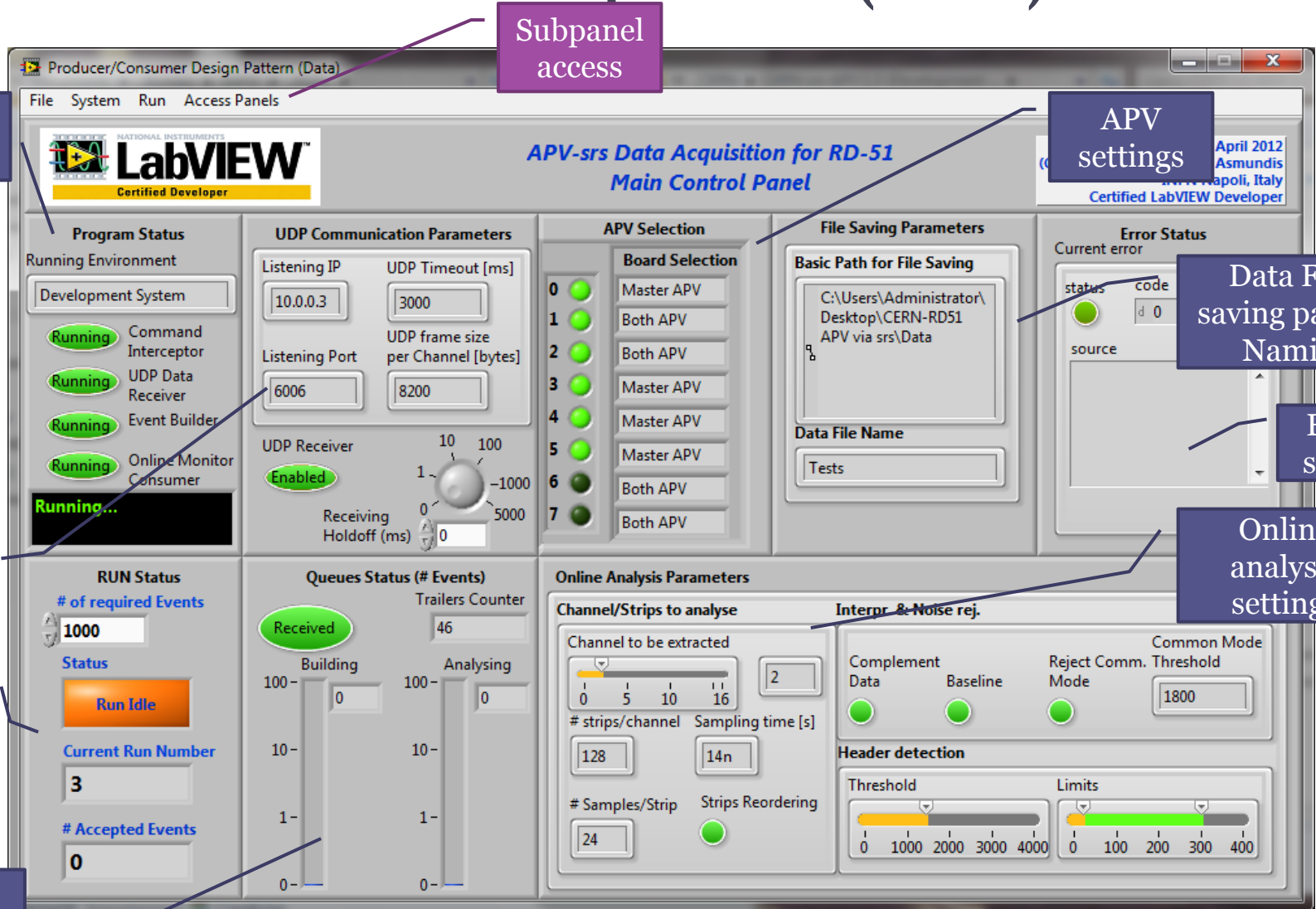
## “Old” features & characteristics

- UDP Connection
- Incoming data monitor
- Events filter based on data integrity
- Traceable Events builder (Header and APV Contents generation)
- Data file saving
  - Binary format U32-U16
  - Compatible with the existing Analysis program
  - No zero suppression for the moment (format needed)

## New features

- GUI (Graphical User Interface):
  - Separate panels for program settings
  - srs setups (Sorin’s Slow monitor) fully integrated
- Online Data quality monitor
  - Several fetures... → see following
- Standalone (executable) version available

# The main control panel (GUI)



# UDP Data Receiver

UDP Codes  
data  
monitor

Formatted  
internal  
Data

The screenshot shows the 'srs\_UDP Module WLoop.vi' interface, divided into three main sections: INPUTS, INTERMEDIATE, and OUTPUTS.

- INPUTS:** Includes a 'UDP Reference in' indicator, an 'Active?' toggle switch (currently on), and 'Reading Parameters in' with controls for 'Iterations in' (4), 'timeout in' (4000), and 'max size to be read' (8200). It also features an 'error in (no error)' status indicator with a green checkmark and a 'source' field.
- INTERMEDIATE:** Titled 'Read UDP Frame', it displays 'Received UDP Strings (Hexa)' in a scrollable text area. The data shown is a long hexadecimal string: 0000 0000 554E 4B00 0000 0000 F40A 440B 2D0B FE0A F90A 440B 350B 140B E20A 2D0B 240B 1C0B E40A 3B0B 210B 340B 040B 440B 2F0B 210B D40A 330B 110B 100B D10A 350B 2B0B 1C0B 110B 470B 440B 1D0B EE0A 450B 240B 070B FD0A 410B 420B 190B E80A 4C0B 250B 270B F30A 2D0B 120B 0C0B 0F0B 470B 220B 0E0B E80A 310B 180B 110B EC0A 2F0B 2F0B 240B 0C0B 1D0B 310B 1D0B EA0A 3C0B 370B 420B F10A 260B 170B 140B D20A 390B 280B 170B 050B 4F0B 370B 080B EE0A 220B 3F0B F90A F00A 1B0B 2B0B 060B C80A 4D0B 370B 110B 000B 2E0B 360B 0D0B 020B 2F0B FD0A 0D0B E20A 370B 2D0B 070B B00A 1C07 0E04 9F03 9D03 A003 BE09 0A0C 830C 880C EF06 2204 A103 D30A CD0A 110B EF0A 1C0B 1B0B 160B EE0A 2A0B 0F0B 060B EB0A 310B 2B0B F80A D40A 1A0B 240B 160B F40A 290B 1E0B FE0A DE0A 2A0B 180B 0F0B FC0A 390B 2C0B 060B.

**OUTPUTS:** Features a 'UDP Reference out' indicator, a 'UDP Data Cluster' box containing 'Received IP' (167772162) and 'UDP Frames' (a scrollable text area with the same hexadecimal data as the intermediate section). It also includes 'Timeout' and 'Over counting' status indicators (both green) and an 'error out' section with a green checkmark and a 'source' field.

# Event recognition and formatting

The screenshot displays the LabVIEW interface for `srs_Event_Builder.vi`, titled "APV-srs Data Acquisition for RD-51 Data Receiver and Event Building". The interface is divided into three main sections: **INPUTS**, **INTERNALS**, and **OUTPUTS**.

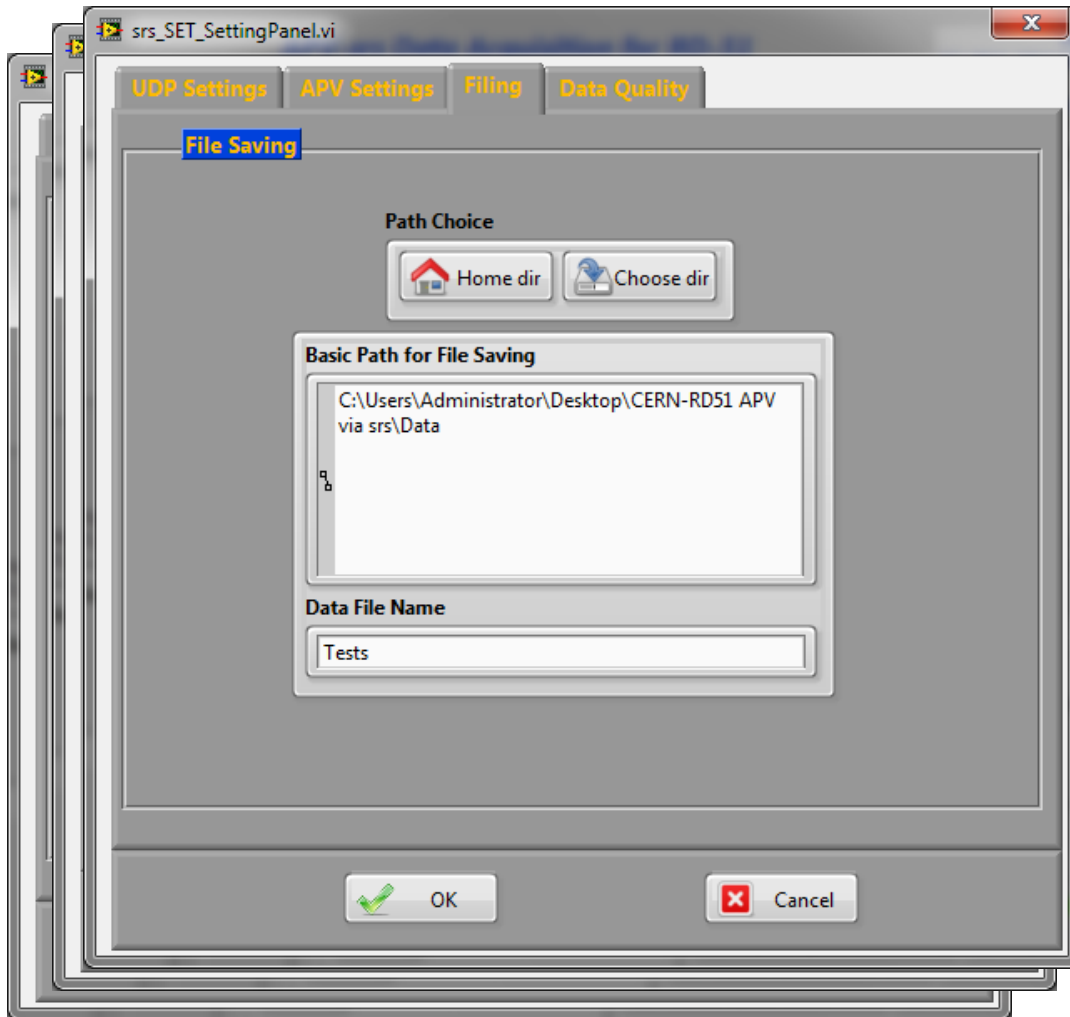
- INPUTS:** Includes controls for "Activate Event Filter" (checked), "Time out" (set to 12), "Initial index in" (set to 12), "Read Param. in" (Iterations in: 4, UDP timeout: 3000, Buffer size: 8200), and "UDP Data Cluster in" (Received IP: 1, UDP Frames: 0). A list of hexadecimal data is shown in the "UDP Frames" section.
- INTERNALS:** Contains "Event Filter Statistics" (54 good events, 0 corrected, 0 rejected, 11 timeout, 65 total) and an "Incoming Event Frame" plot. The plot shows a signal with multiple channels in different colors (green, red, white) over a position in stream from 0 to 3999. The y-axis represents "Value" from 768 to 3328.
- OUTPUTS:** Shows "Event Accepted" (checked), "Talking Channels List" (0, 1, 2), "FEC Board ID" (1), "subevent size" (4000), and "Total # of Trailers" (54). The "Formatted Event out" section displays the event header (0000605C) and payload (00000C69).

Incoming Event

UDP data frame in graphical representation: channels in color, 1 sample per visible slot;

Formatted Event

# Setting program parameters on separate windows



## Example for File Saving Setting:

- Choice of path and base for filename.

displayed.

- Several important parameters are included here (time and # of sampling, #of strips per channel, thresholds,...)



# Srs\_Slow Control accessibility

LabVIEW Certified Developer

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

Version 1.3, April 2012  
(C) 2011-2012 INFN Napoli, Italy  
Certified LabVIEW Developer

**Program Status**  
Running Environment: Development System  
Running: Command Interceptor, UDP Data Receiver, Event Builder, Online Monitor Consumer, Running...

**UDP Communication Parameters**  
Listening IP: 10.0.0.3, UDP Timeout [ms]: 3000  
Listening Port: 6006, UDP frame size per Channel [bytes]: 8200  
UDP Receiver: Disabled, Receiving Holdoff (ms): 0

**APV Selection**  
Board Selection:  
0 Both APV  
1 Master APV  
2 Both APV  
3 Master APV  
4 Master APV  
5 Master APV  
6 Both APV  
7 Both APV

**File Saving Parameters**  
Basic Path for File Saving: C:\Users\Administrator\Desktop\CERN-RDS1\APV via srs\Data  
Data File Name: Tests

**Error Status**  
Current error: status code 0, source

**Online Analysis Parameters**  
Channel/Strips to analyse: Channel to be extracted 0, # strips/channel 128, Sampling time [s] 14n, # Samples/Strip 24, Strips Reordering  
Interpr. & Noise rej.: Complement Data, Baseline, Reject Comm. Mode, Common Mode Threshold 1800  
Header detection: Threshold 0-4000, Limits 0-400

**Queue Status (# Events)**  
Trailing Counter: 24  
Building: 0, Analysing: 0

**RUN Status**  
# of required Events: 1000  
Status: Run Idle  
Current Run Number: 3  
# Accepted Events: 0

srs\_SlowControlMain V3.vi

File Edit View Project Operate Tools Window Help

READ WRITE EXIT Dest IP: 10.0.0.2 SC port: 1777 timeout(ms): 5000 Destination port: 6039 MIO

Initialization APV Hybrid CCARD Control System Application B\_IJC General

Application Registers

| Register            | Addr | WrValue | radix | RplError | RdValue |
|---------------------|------|---------|-------|----------|---------|
| blk_mode            | 00   | 3       | hex   | 0        | 3       |
| blk_trgburst        | 01   | 3       | hex   | 0        | 3       |
| blk_freq            | 02   |         | dec   | 0        | 40000   |
| blk_trgdelay        | 03   |         | dec   | 0        | 256     |
| blk_tpdelay         | 04   |         | dec   | 0        | 128     |
| blk_rosync          | 05   |         | dec   | 0        | 300     |
| reserved            | 06   |         | hex   | 0        | 0       |
| reserved            | 07   |         | hex   | 0        | 0       |
| evbld_chmask        | 08   | 0003    | hex   | 0        | 3       |
| evbld_datalelength  | 09   |         | dec   | 0        | 2500    |
| evbld_mode          | 0A   | 0       | hex   | 0        | 0       |
| evbld_eventInfoType | 0B   | 2       | hex   | 0        | 2       |
| evbld_eventInfoData | 0C   |         | hex   | 0        | 0       |
| acqControl          | 0F   |         | hex   | 0        | 0       |
| api_status          | 10   |         | hex   | 0        | 10      |
| api_cmd             | 11   |         | hex   | 0        | 0       |
| api_apvselect       | 12   |         | hex   | 0        | 0       |
| api_nsamples        | 13   |         | hex   | 0        | 1       |
| api_zerosuppression | 14   | 8       | hex   |          |         |

Read Out Control: ON OFF APV Sync

REPLY ERROR (RX) [Indicator]  
ReqId Error [Indicator]  
REPLY ERROR (DECODE) [Indicator]

Tab Control: APV-Daq.lvproj/My Computer

# Online Data Quality Monitor

Most of these features have been developed on requests thanks to the experience in the Utilization of the software by Shikma Bressler (Weizmann Institute of Science).

## Presentation features

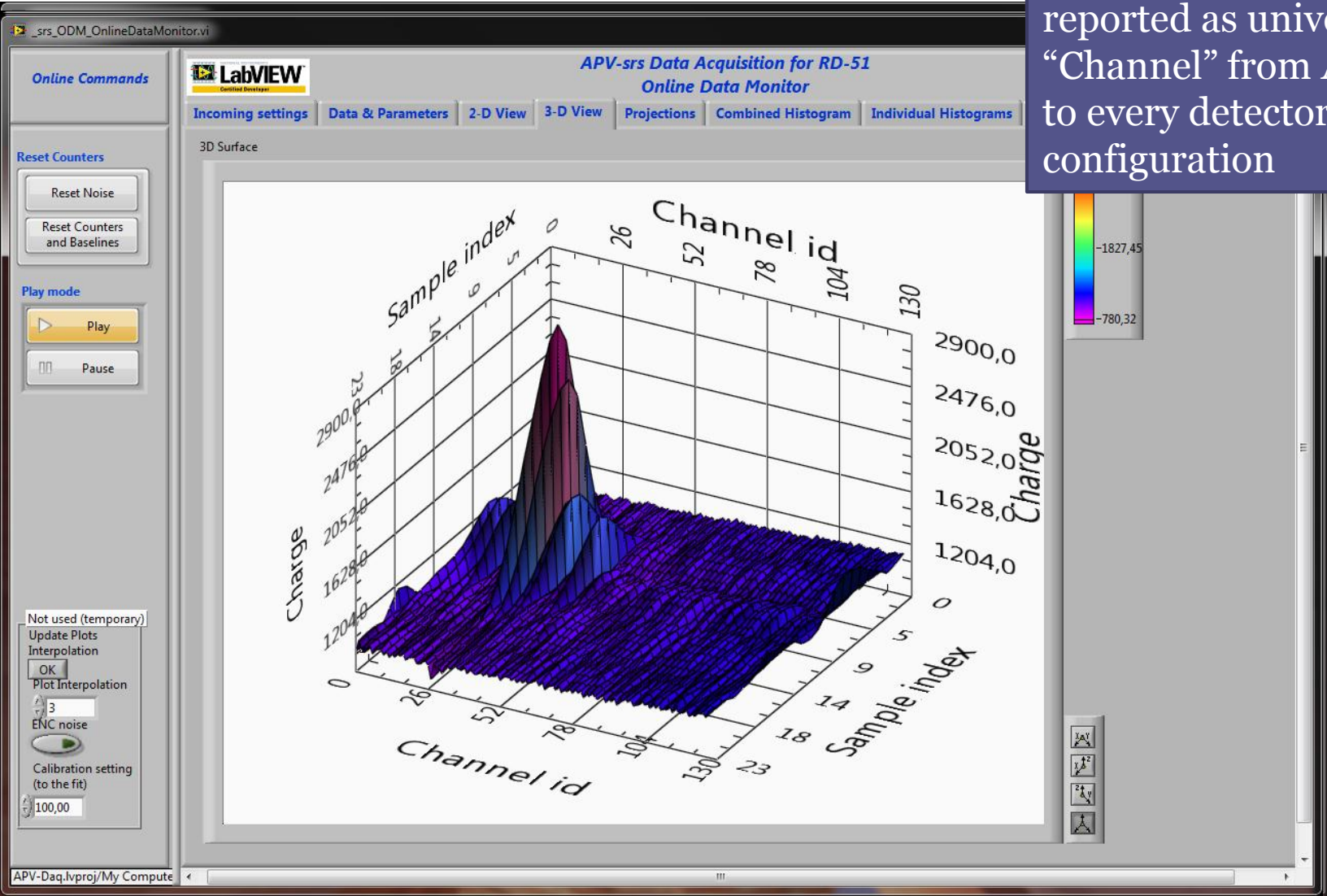
- Raw data view (incoming frames)
- 2-D View of hit strips or pads on the detector
- 3-D View of channel vs. time charge recorded
- Main projections:
  - amplitude vs. channel (strips)
  - Amplitude vs. time

## Data Quality Features

- Hold current event function for inspection
- Online Efficiency and Multiplicity calculation based on separate thresholds
- Total accumulated Charge and maximum detected charge histograms
- Single channels charge histograms

# Online Data Monitor: some samples

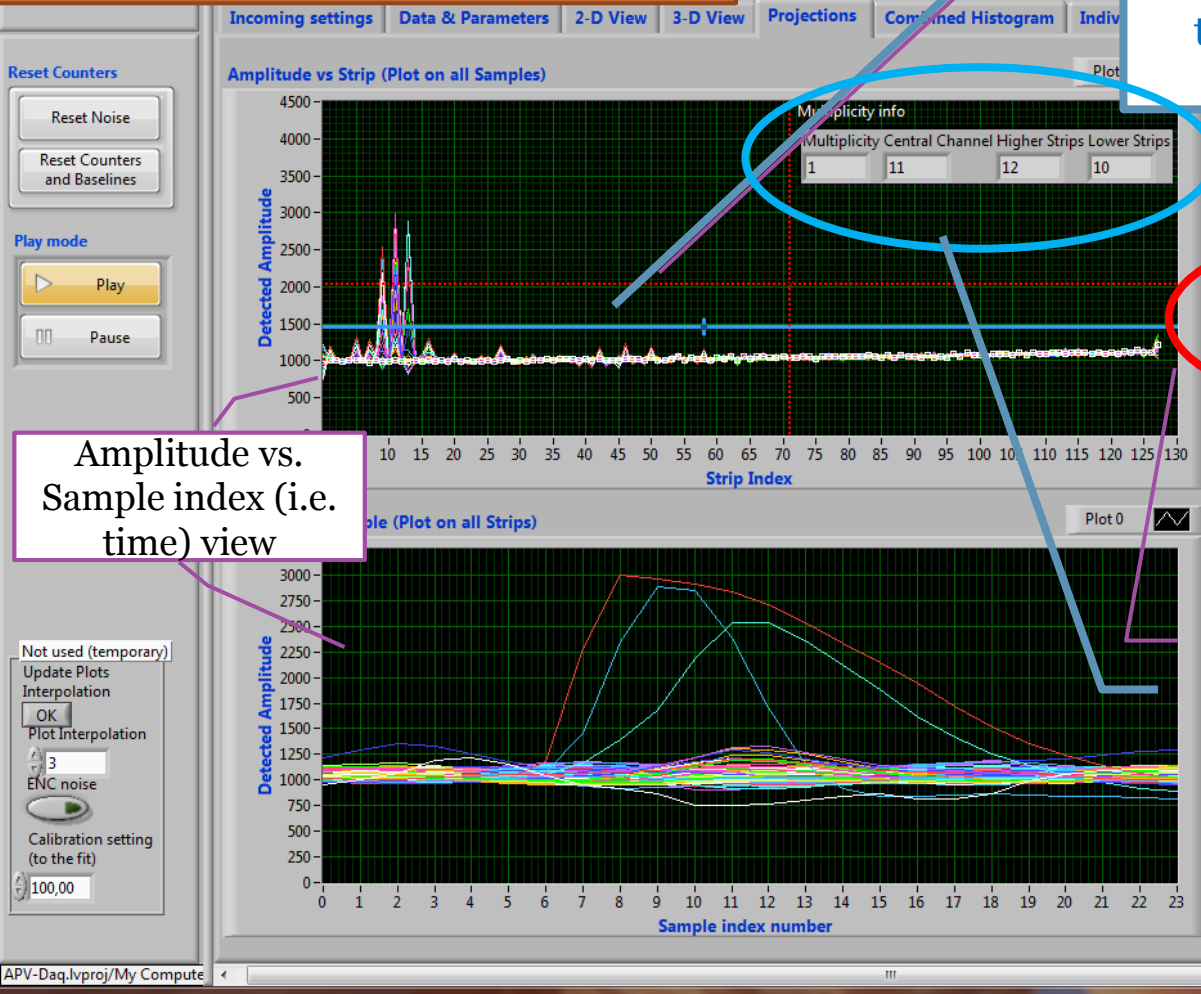
3-D view of a significant Event: here view is reported as universal “Channel” from APV to fit to every detector configuration



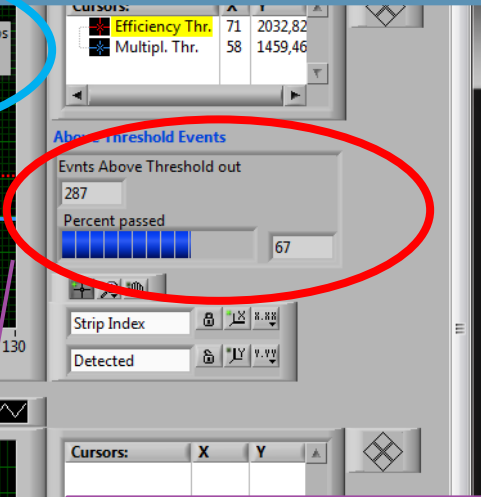
# Online Data Monitor: some samples II

Example of Efficiency tracing and Multiplicity calculation

## 2: Online Multiplicity Calculation



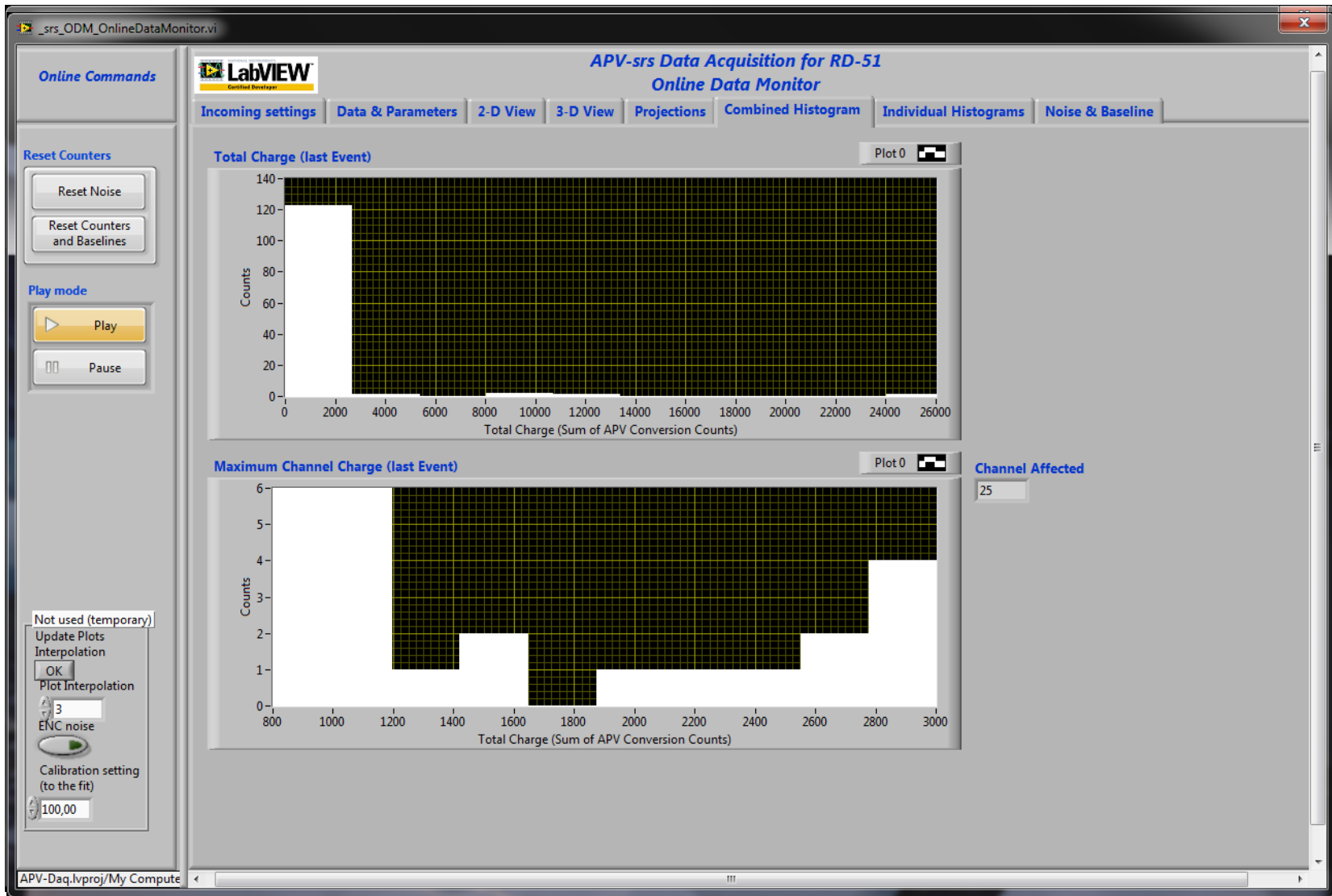
1: user sets a threshold for Multiplicity calculation using the mouse and graphical cursor



2: the Multiplicity of hitted strips or pads is shown here. # of chn. over thresh., central ch., higher and lower chns. are shown.

# Online Data Monitor: other stuffs

Combined Histograms: total charge



# Datafile Dump

- Saved files can be inspected thanks to a specific program.
- Accessible from the Main Panel
- Very interactive, “recorder” style
- Graphical representation of data

“Recorder” control

Data file under inspection

APV Data Acquisition for RD-51 File Data Dump

COMMANDS

INTERNALS

File Parameters

File Size (Bytes)  
14576204

Record Index  
0

Position Before Reading  
7404

Record Length  
7268

Last # of Words read  
1800

Last # of bytes read  
7200

Explored File Positions History (byte)  
0

Header  
7

Contents  
0

File path in use  
C:\Users\Riccardo\Documents\LV Projects\CERN\CERN srs-APV 1.3 (Development Version)\Data\0000-11-01-16-08-08-2012-14-00-00-15

OUTPUT

Sequence of indexes for Pattern found  
0 1 0

Corresponding Event Header/Last header

| Event Size (Bytes)  | Magic Number        | Header Size      | Version          |
|---------------------|---------------------|------------------|------------------|
| x00001C64           | xDA1E5AFE           | x00000044        | x00030009        |
| Event Type          | Run Number          | Ev ID (1)        | Ev ID (2)        |
| x7                  | x00000062           | x00000002        | 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        | xFFFFFFFF        |
| Timestamp           | 1332258345          |                  |                  |

Time Stamp Correction  
0.59.59,000  
01/01/1970

Corresponding Time Stamp  
16.45.44,000  
20/03/2012

Frame Contents

Contents

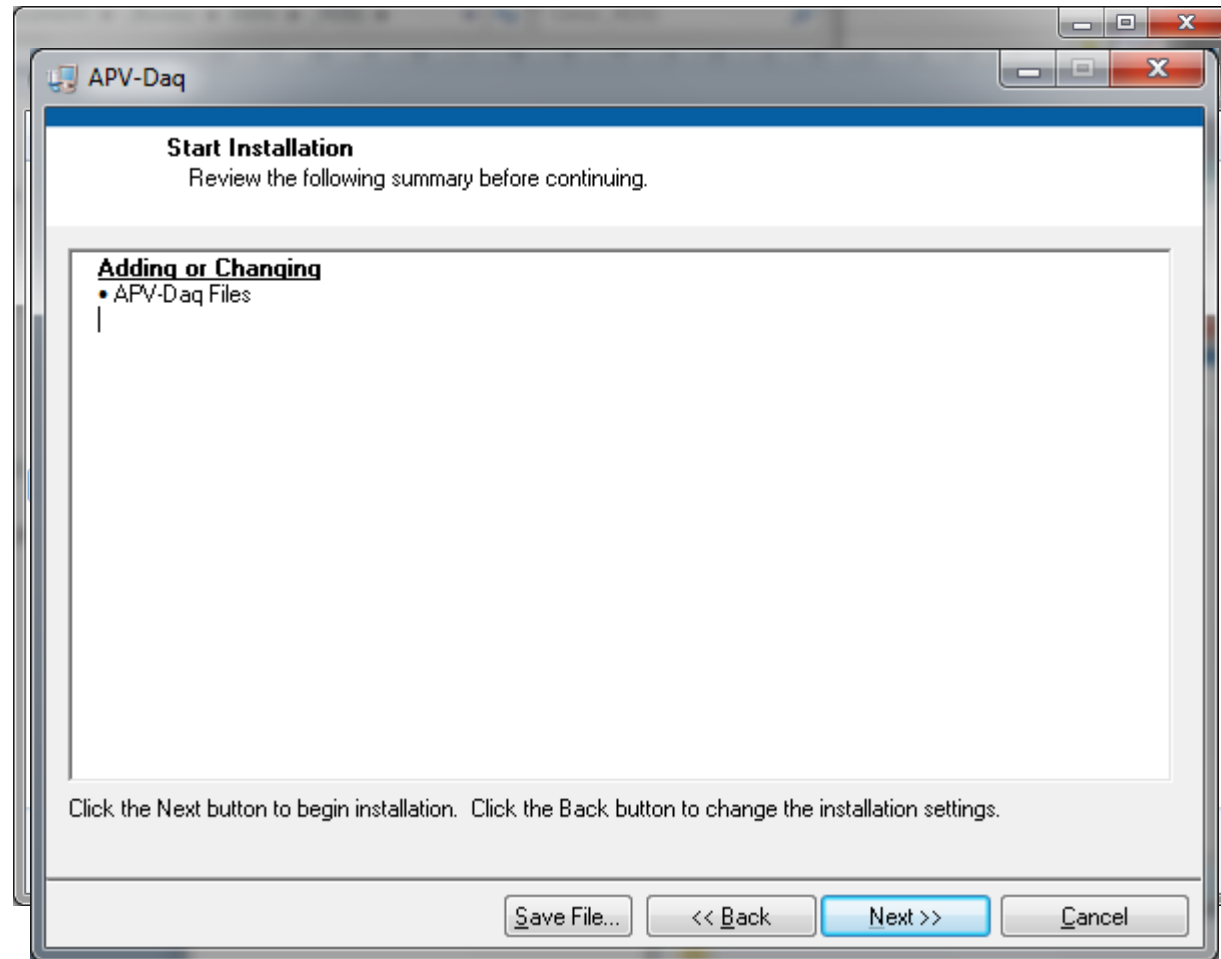
Stream Position

Event Header

Event Dump

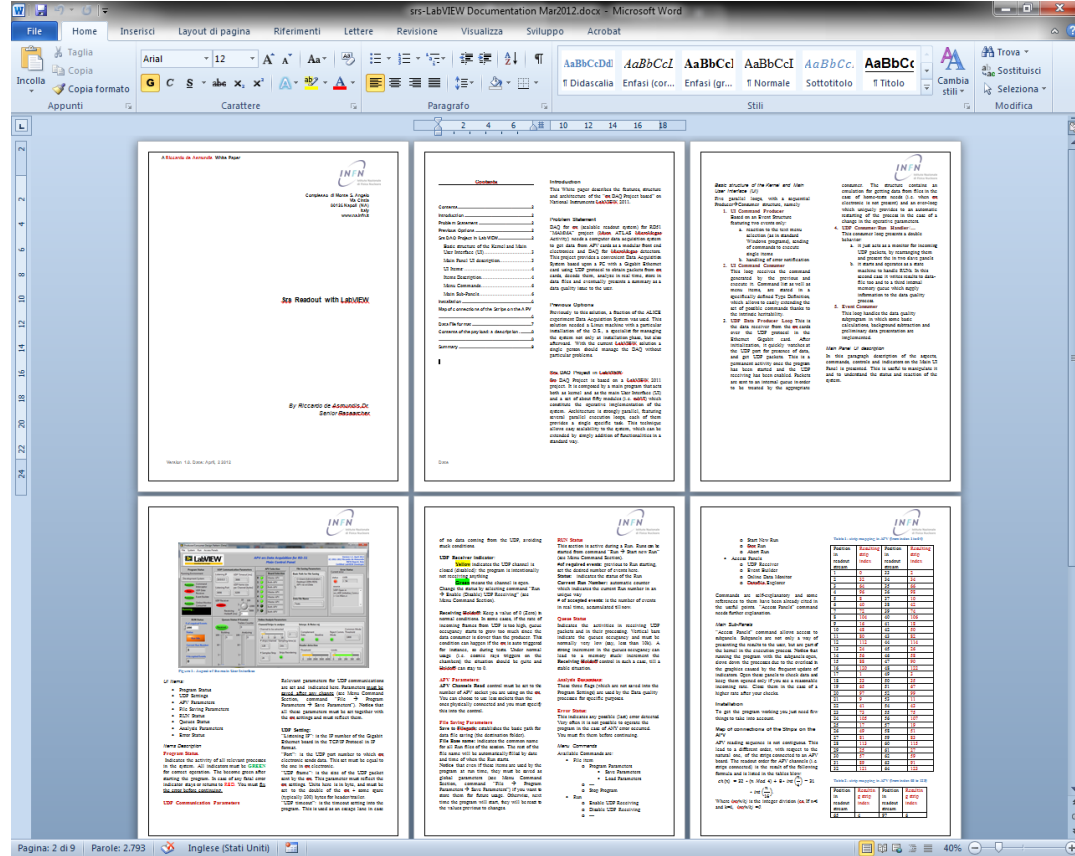
# Standalone version

- Ready
- Easily portable
- Standard, professional Installation Program
- Needs LV 2011 Runtime Engine (can be embedded in the installation program)



# Documentation

- A Word «White Paper» is under writing
- From details of program structure to data file format.
- From GUI description and instruction to installation procedure
- ... to be completed !





# Immediate further development

- Fully integrate the srs\_SlowMonitor as a transparent part in the GUI.
  - Use of simple, direct, smart setting windows
  - Leave the current Slow Monitor as “expert” view.

# LabVIEW RD51-srs:conclusions & perspectives

- Smart
  - Not big in Files and Modules occupancy
  - Standalone version available (Pen Drive transportable, 166 MB with installer)
- Flexible
  - Able to acquire a full Fec (16 APV). Extensible for more Fecs.
- Portable
  - Easily portable on different machines and Operating System (standalone and installer are platform dependent)
- Scalable
  - Relatively easy for developing of new features
- Fast
  - Able to handle different parallel processes with fine priorities tuning
- Compatible
  - Data file format compatible with existing analysis

Available from now for daily laboratory usage or Test Beams.  
Looking for Beta tester !