SPARC CONTROL SYSTEM OPERATION

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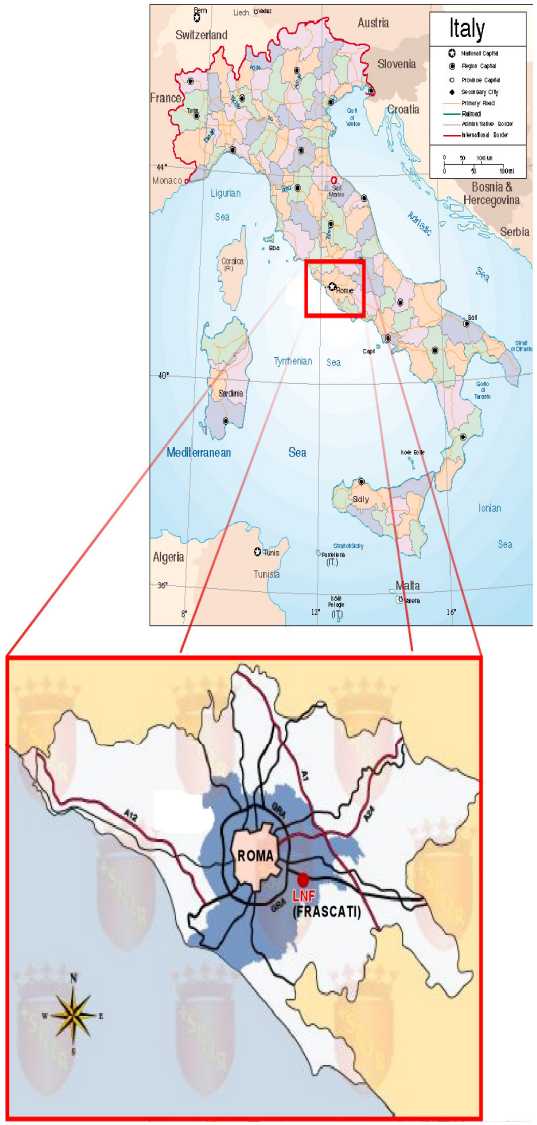
INFN Istituto Nazionale di Fisica Nucleare Laboratori Nazionali di Frascati

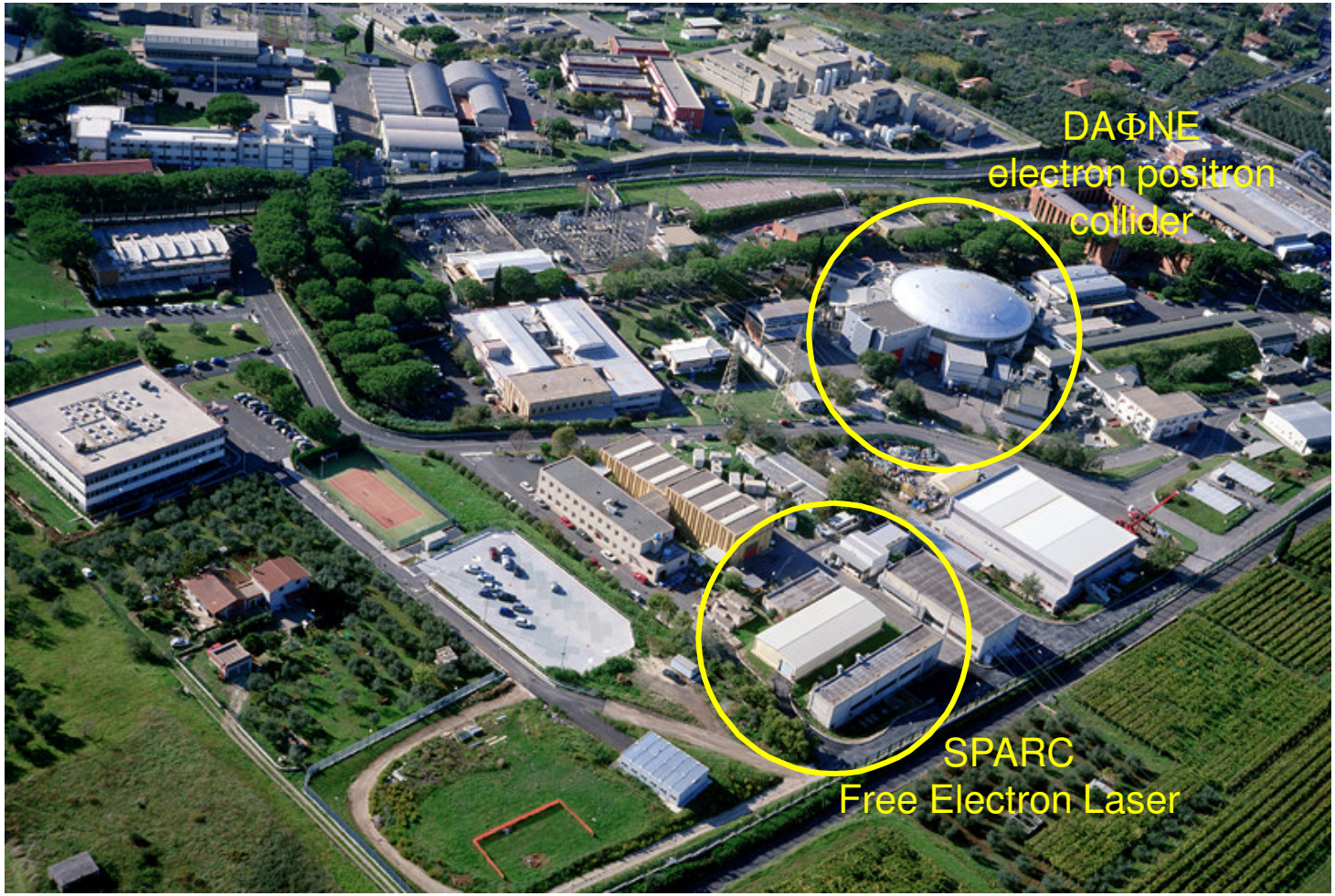
PeaPAe2008

SPARC

Get oriented



The Frascati Laboratory



S orgente

P ulsata

Self **A** mplificata di

R adiazione

C oerente

Self-Amplified Pulsed Coherent Radiation Source

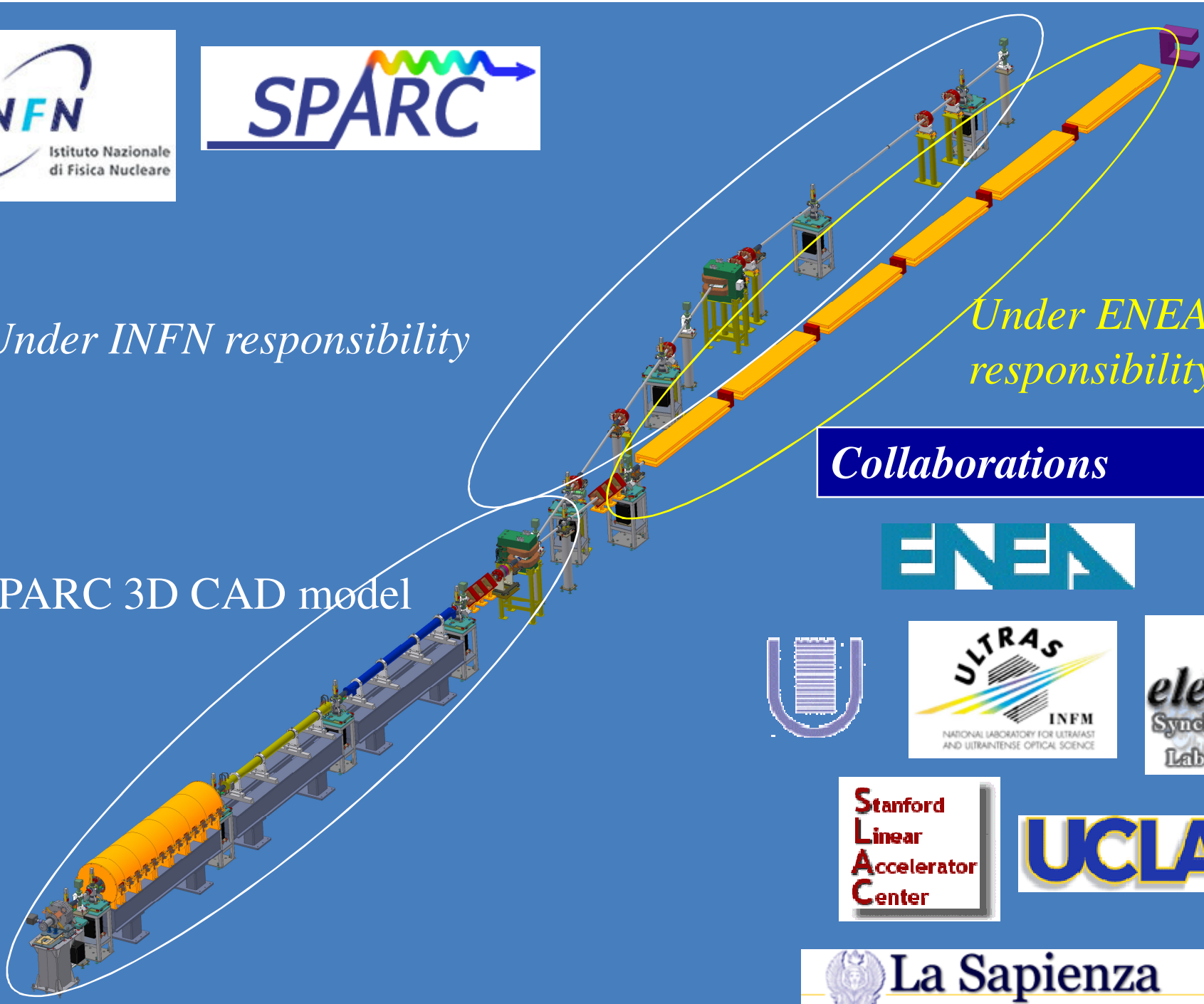
INFN Istituto Nazionale di Fisica Nucleare

SPARC

Under INFN responsibility

Under ENEA responsibility

SPARC 3D CAD model



Collaborations

ENEA

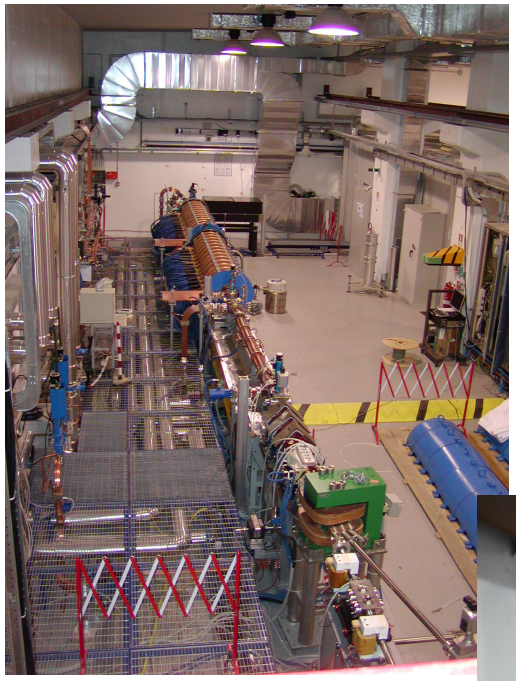
ULTRAS INFM NATIONAL LABORATORY FOR ULTRAFAST AND ULTRAINTENSE OPTICAL SCIENCE

elettra Synchrotron Light Laboratory

Stanford Linear Accelerator Center

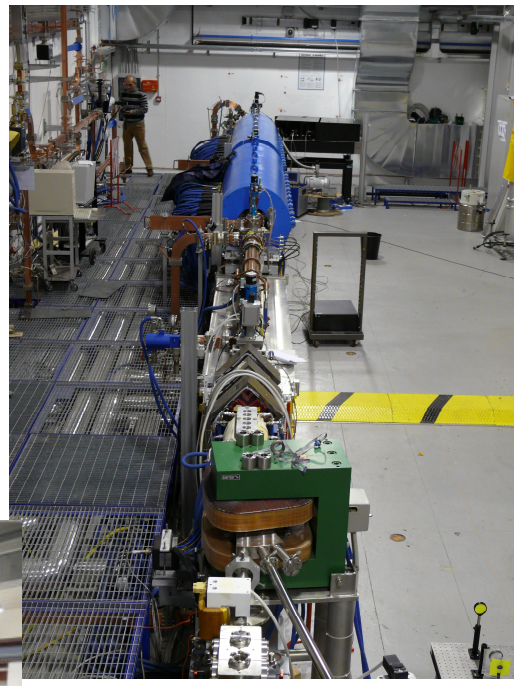
UCLA

La Sapienza Università degli Studi di Roma

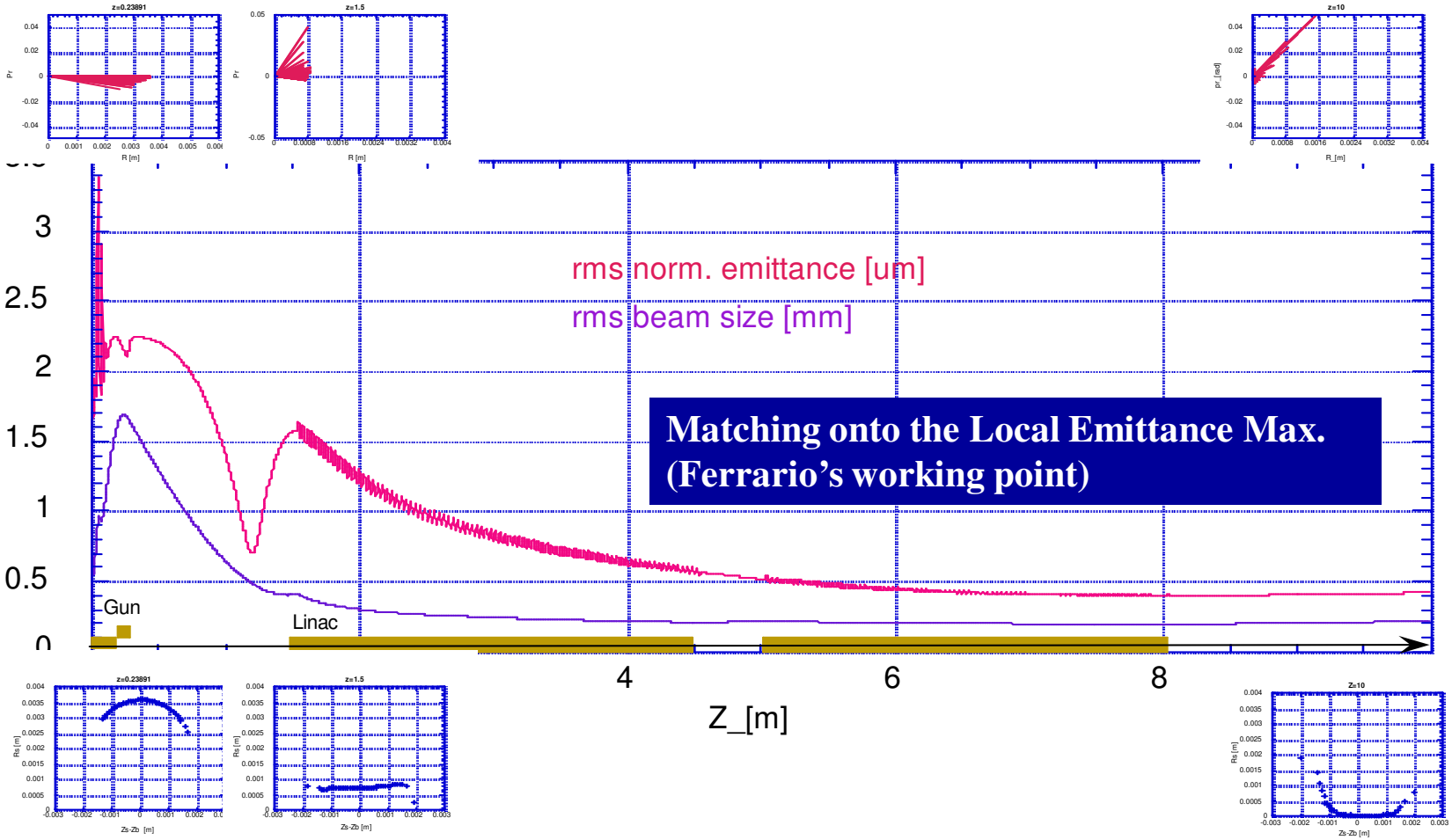


Spring 2008

today



Summer 2008

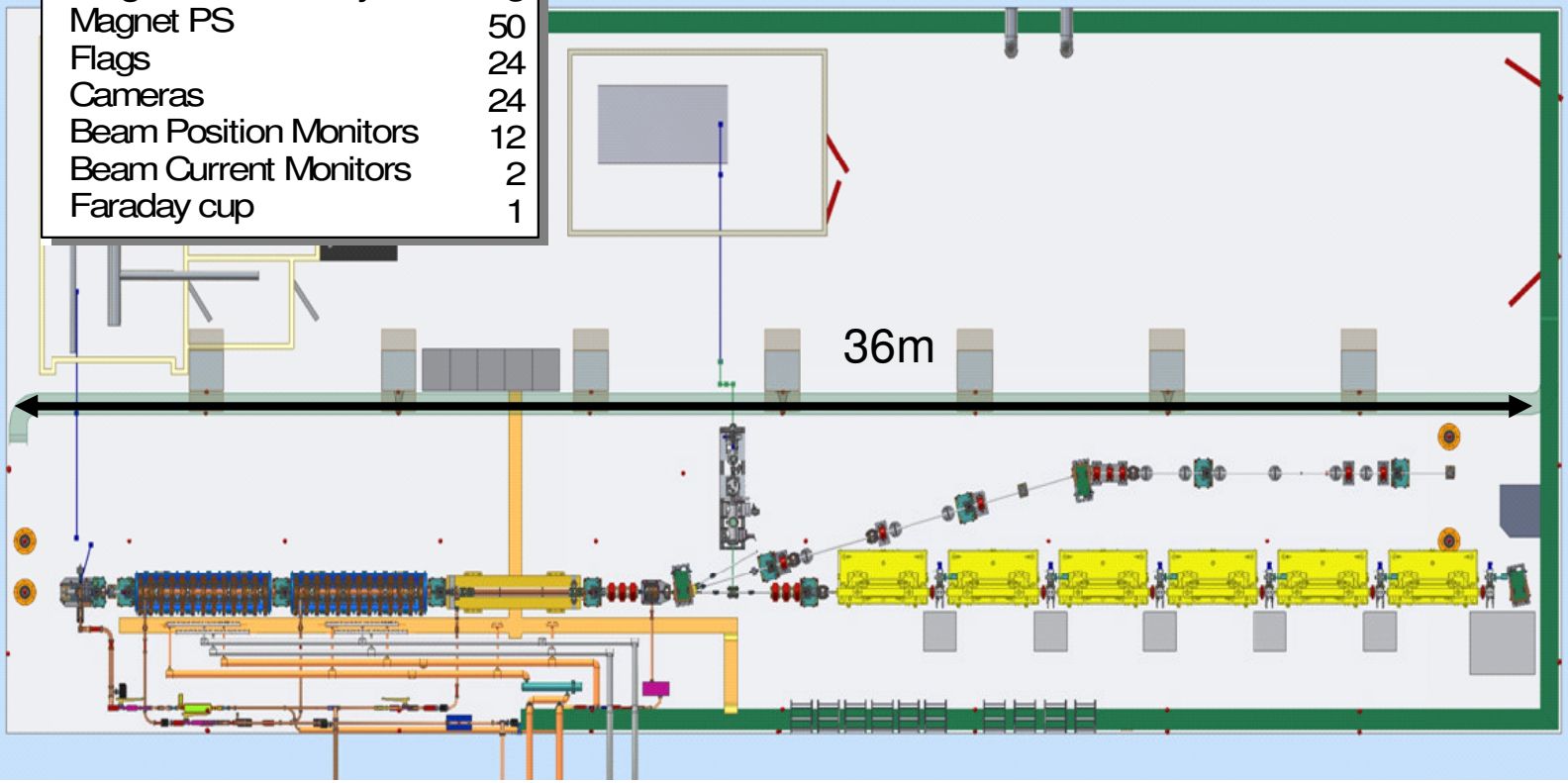

z=0.23891
z=1.5
z=10
rms norm. emittance [um]
rms beam size [mm]
Matching onto the Local Emittance Max.
(Ferrario's working point)
Gun
Linac
Z_[m]

ELECTRON BEAM PARAMETER LIST

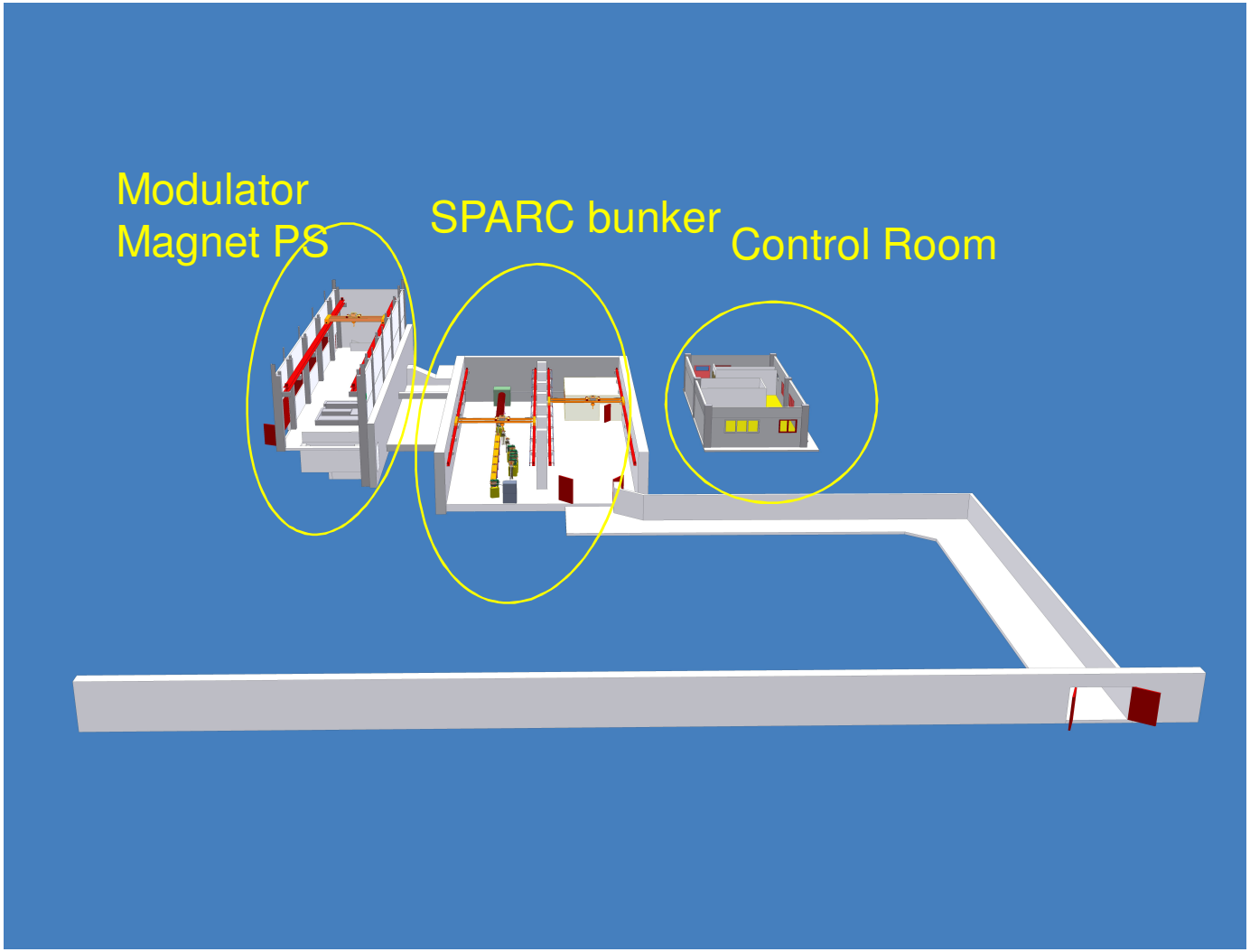
Electron Beam Energy (MeV)	**155**
Bunch charge (nC)	**1.1**
Repetition rate (Hz)	**1-10**
Cathode peak field (MV/m)	**120**
Peak solenoid field @ 0.19 m (T)	**0.273**
Photocathode spot size (mm, hard edge radius)	**1.13**
Central RF launch phase (RF deg)	**33**
Laser pulse duration, flat top (ps)	**10**
Laser pulse rise time (ps) 10%→90%	**1**
Bunch energy @ gun exit (MeV)	**5.6**
Bunch peak current @ linac exit (A) (50% beam fraction)	**100**
Rms normalized transverse emittance @ linac exit (mm-mrad); includes thermal comp. (0.3)	**< 2**
Rms slice norm. emittance (300 μm slice)	**< 1**
Rms longitudinal emittance (deg.keV)	**1000**
Rms total correlated energy spread (%)	**0.2**
Rms incorrelated energy spread (%)	**0.06**
Rms beam spot size @ linac exit (mm)	**0.4**
Rms bunch length @ linac exit (mm)	**1**

SPARC layout

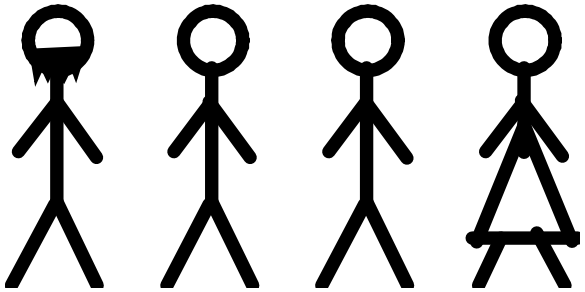
RF Modulators	2
Vacuum pumps	30
Vacuometers	12
Programmable delays	3
Magnet PS	50
Flags	24
Cameras	24
Beam Position Monitors	12
Beam Current Monitors	2
Faraday cup	1



The 3D vision of SPARC building



Design problem



- Few people involved full time on the control system
- Short time: in 3 years the machine to be operative.
- Delay in the information about the element to be controled

Design statements

- Commercial technologies as much as possible
- Easy development and maintenance
- Personal computers with native OS everywhere
- LabVIEW® as development environment for all the software

Why are we using LabVIEW®?

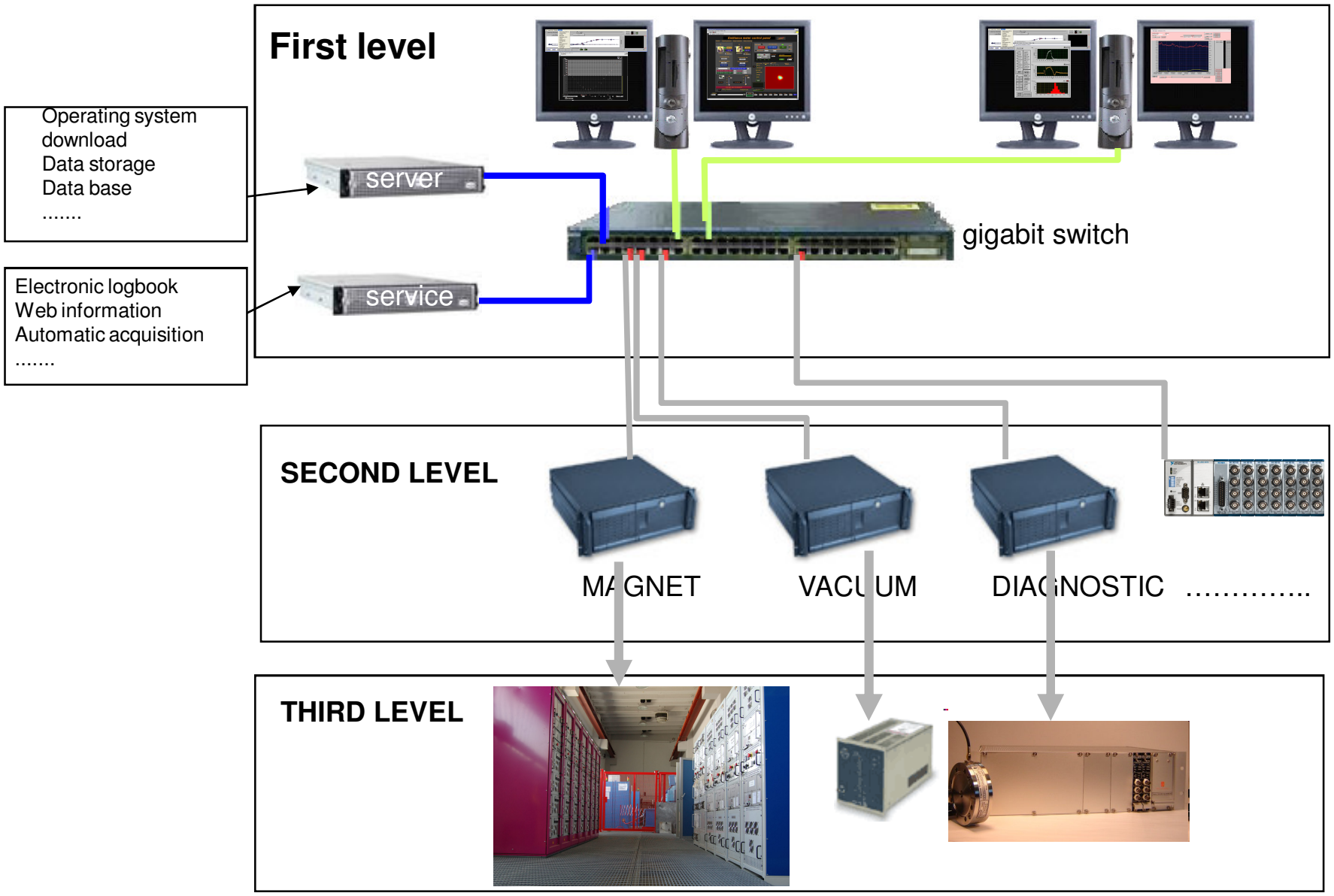
- LabVIEW® is used as development software in the DAFNE control system we can re-use the software;
- In LabVIEW® you can easily write a good GUI interface;
- You can find a lot of hardware from different manufacture with LabVIEW® driver;
- LabVIEW® is available on different operating systems;
- In our laboratory the use of LabVIEW® is diffused a lot of people know.

Main operation in a control system

- Data taking
- Display of information
- Analysis
- Command execution
- Storage
- Expandability
- Automatic feedback

What we control

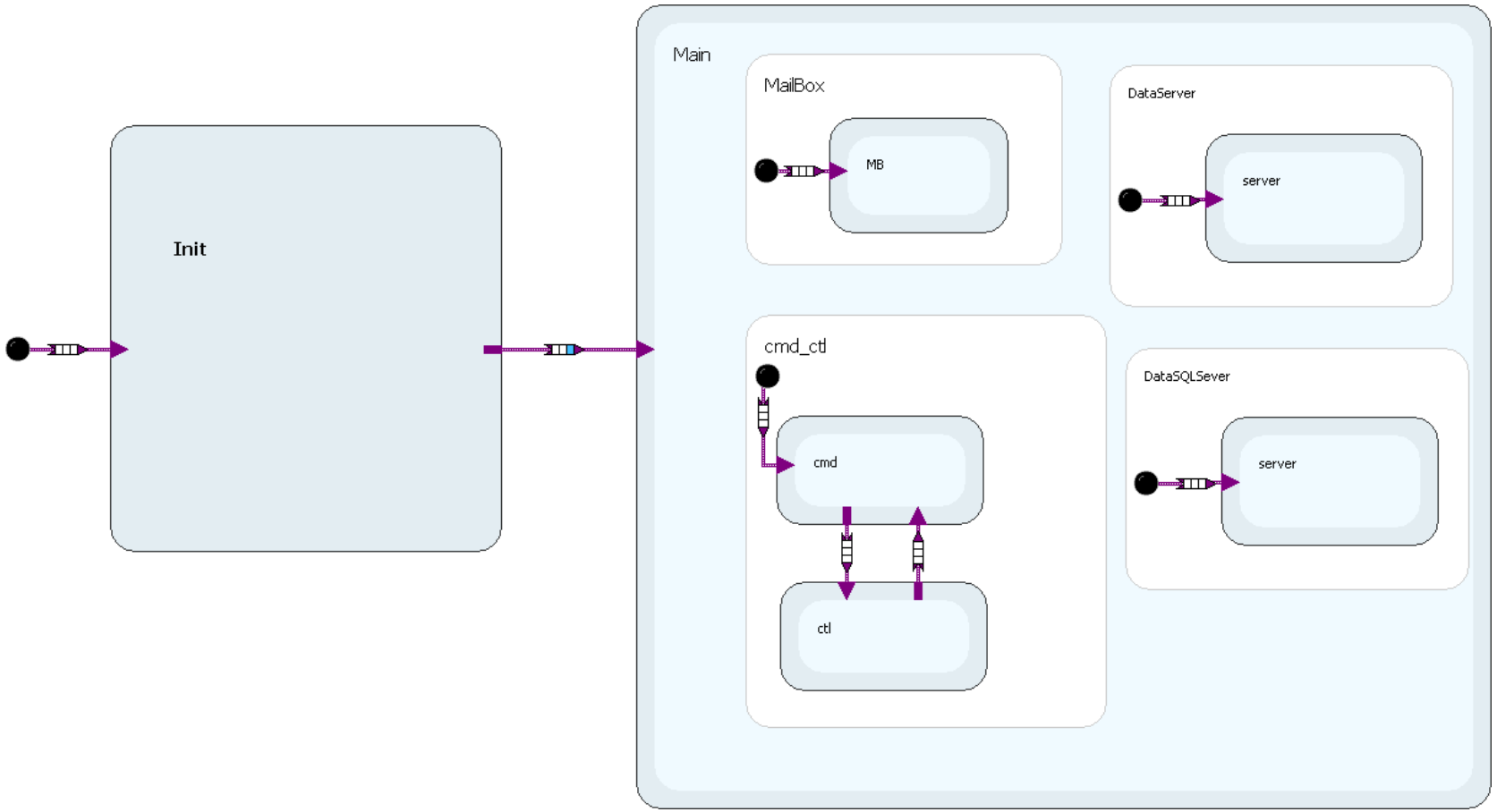
- Magnet control
- RF control
- Vacuum control
- Laser
- Diagnostics acquisition
- Analysis


First level
Operating system
download
Data storage
Data base
.....
server
Electronic logbook
Web information
Automatic acquisition
.....
service
gigabit switch
SECOND LEVEL
MAGNET
VACUUM
DIAGNOSTIC
.....
THIRD LEVEL

Front-end CPU choice

- Use the best processor in function of the element to be controlled.
- Industrial PC for serial or slow control
- To acquire the digital I/O or low speed ADC and DAC we will use a fieldbus like CAN, Fieldpoint or Profibus
- PXI for high performance application
- Real-time or embedded CPU.

Front-End skeleton program



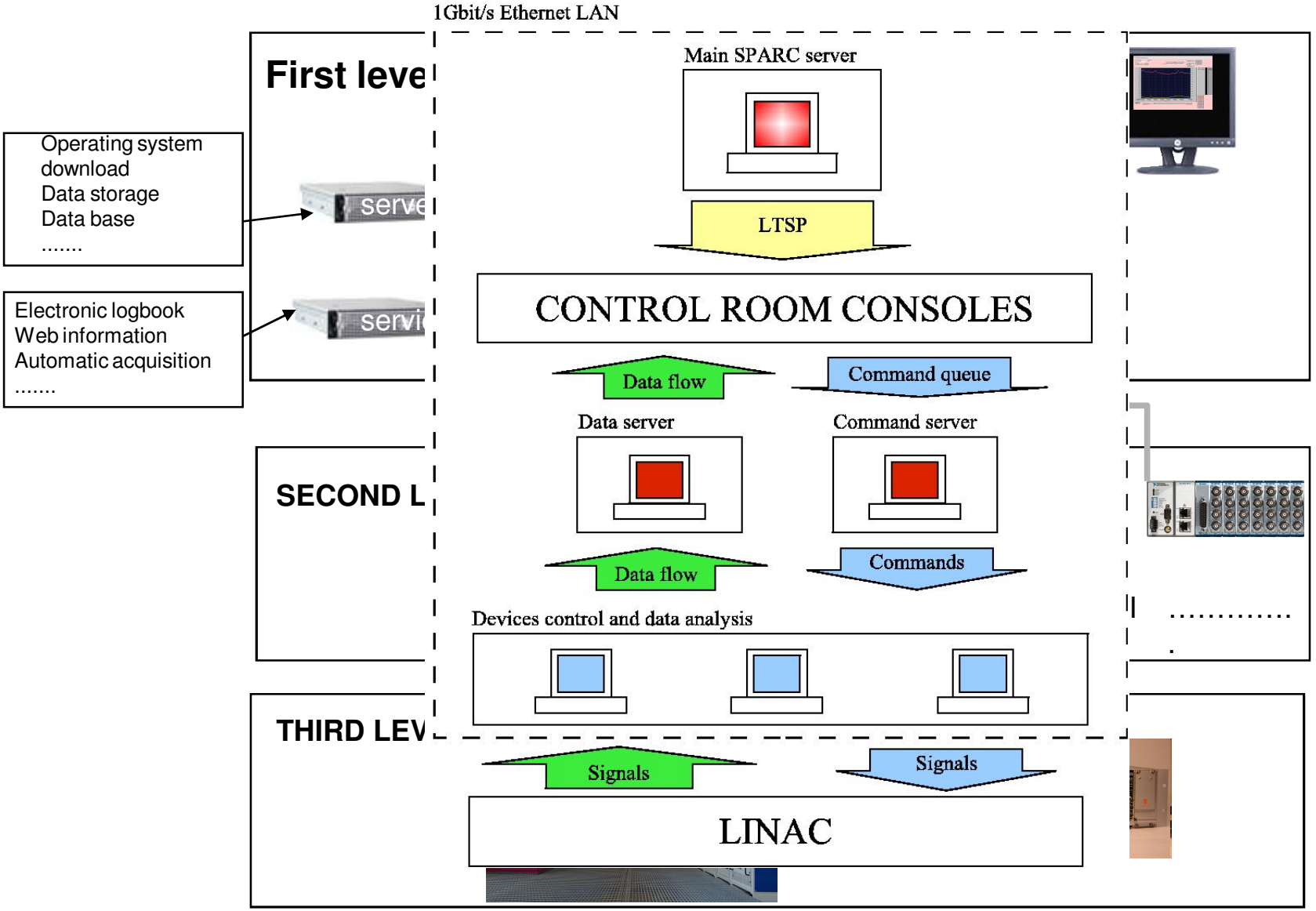
How to interconnect all computers

GigaBit Ethernet gives us all the necessary bandwidth.

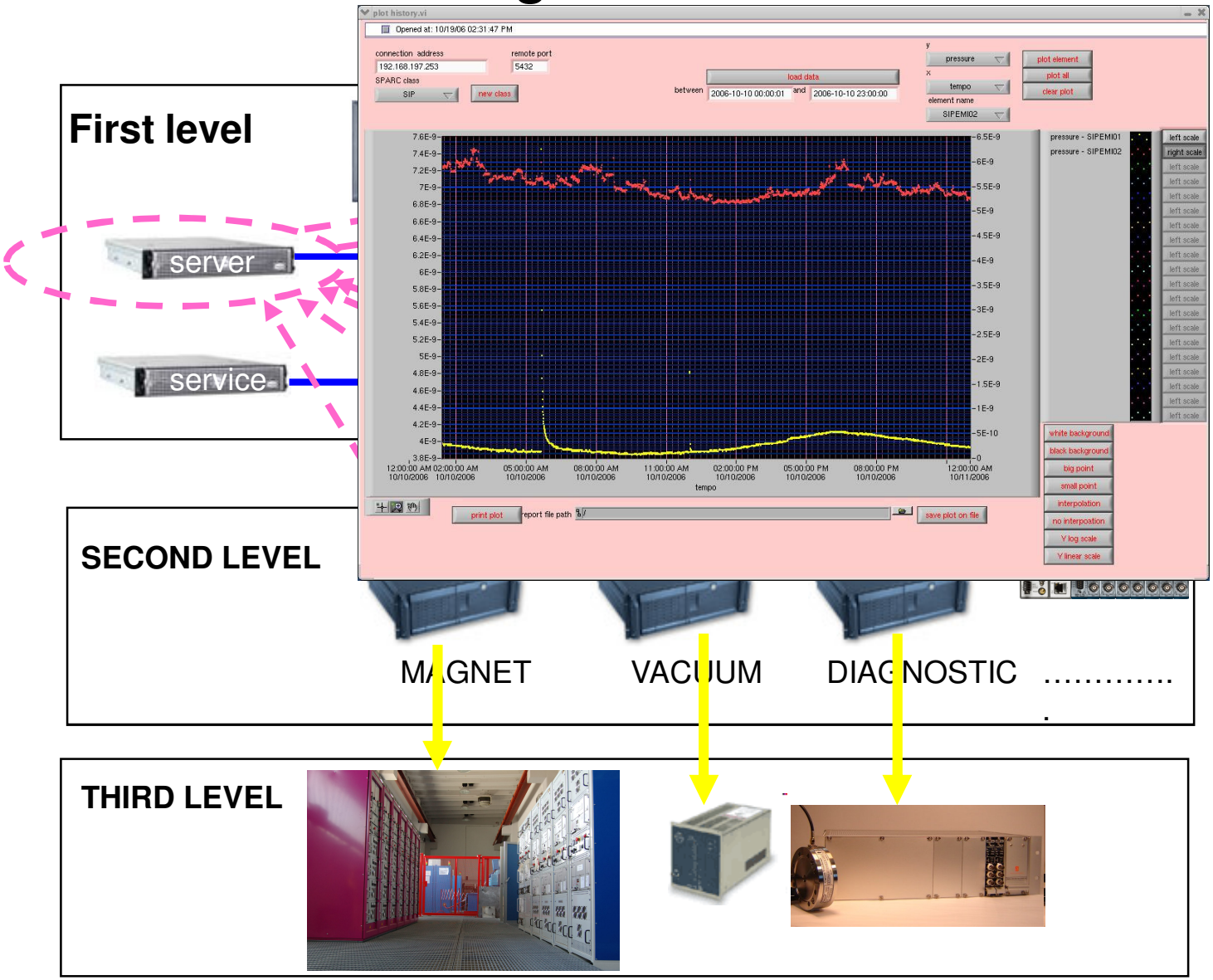
Today in every personal computer is available the Ethernet connection.

We can use the network as a channel between the fieldbus and the CPU reducing the number and the length of the cables.

CONTROL SYSTEM



Status log machine

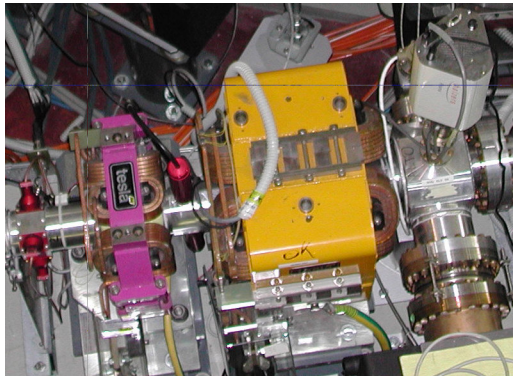


Based on TCP/IP database (PostgreSQL).

ELEMENTS

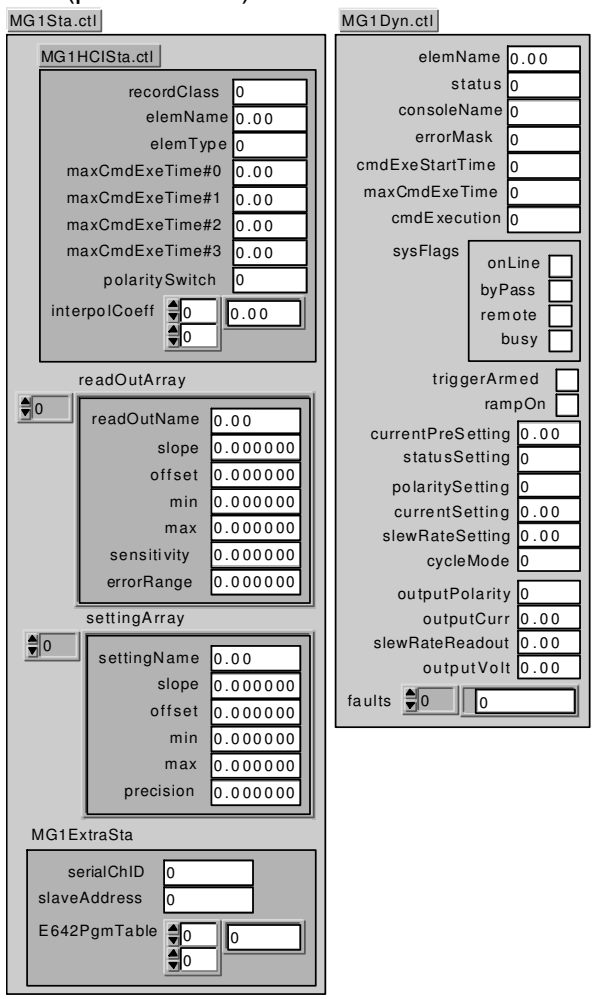
PCaPAC 2008, Ljubljana, Slovenia

Object abstraction



static variables (parameters)

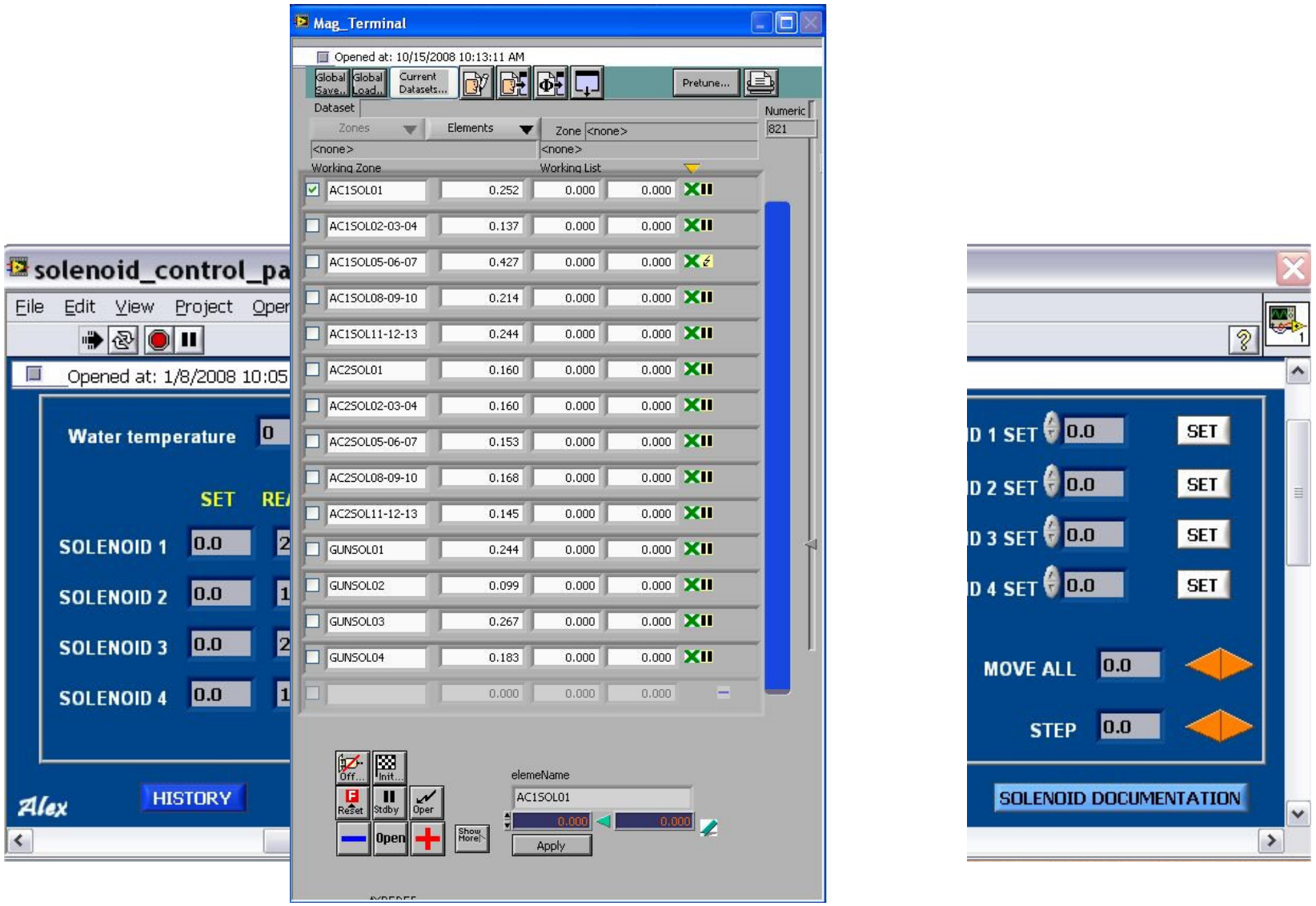
dynamic variables



Magnet

To control a magnet means to control a power supply.

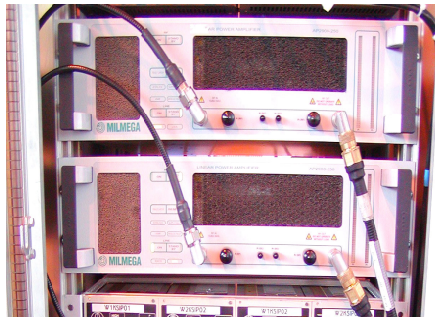
- 9 Solenoids — Modbus RS485 Hazemayer
- 20 Quadrupoles — Modbus TCP/IP Home made
- 3 Bendigs — Modbus TCP/IP
- 12 Correctors — Modbus TCP/IP


solenoid_control_pa
File Edit View Project Oper
Opened at: 1/8/2008 10:05
Water temperature
SET
SOLENOID 1
SOLENOID 2
SOLENOID 3
SOLENOID 4
Alex
HISTORY
Mag_Terminal
Opened at: 10/15/2008 10:13:11 AM
Global Save..
Global Load..
Current Datasets...
Pretune...
Dataset
Numeric
821
Zones
Elements
Zone <none>
<none>
<none>
Working Zone
Working List
AC1SOL01 0.252 0.000 0.000
AC1SOL02-03-04 0.137 0.000 0.000
AC1SOL05-06-07 0.427 0.000 0.000
AC1SOL08-09-10 0.214 0.000 0.000
AC1SOL11-12-13 0.244 0.000 0.000
AC2SOL01 0.160 0.000 0.000
AC2SOL02-03-04 0.160 0.000 0.000
AC2SOL05-06-07 0.153 0.000 0.000
AC2SOL08-09-10 0.168 0.000 0.000
AC2SOL11-12-13 0.145 0.000 0.000
GUNSOL01 0.244 0.000 0.000
GUNSOL02 0.099 0.000 0.000
GUNSOL03 0.267 0.000 0.000
GUNSOL04 0.183 0.000 0.000
Off...
Init...
Reset
Stdby
Oper
Open
Show More
elemeName
AC1SOL01
0.000
0.000
Apply
D 1 SET
D 2 SET
D 3 SET
D 4 SET
SET
MOVE ALL
STEP
SOLENOID DOCUMENTATION

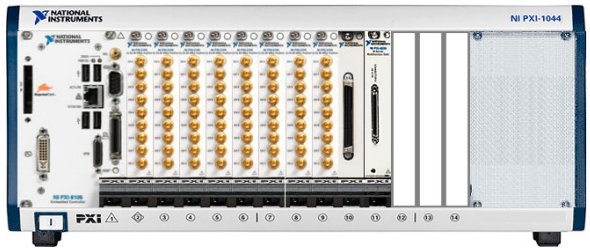
RF

Modulators: come with an Ethernet interface.
It is based on Siemens PLC it send at 10Hz
the complete status (proprietary protocol)

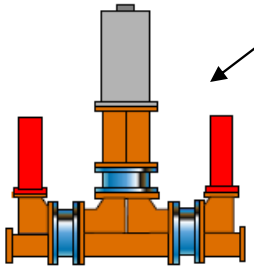
Amplifier (Milmega) is remote controlled
trough Ethernet (proprietary protocol)

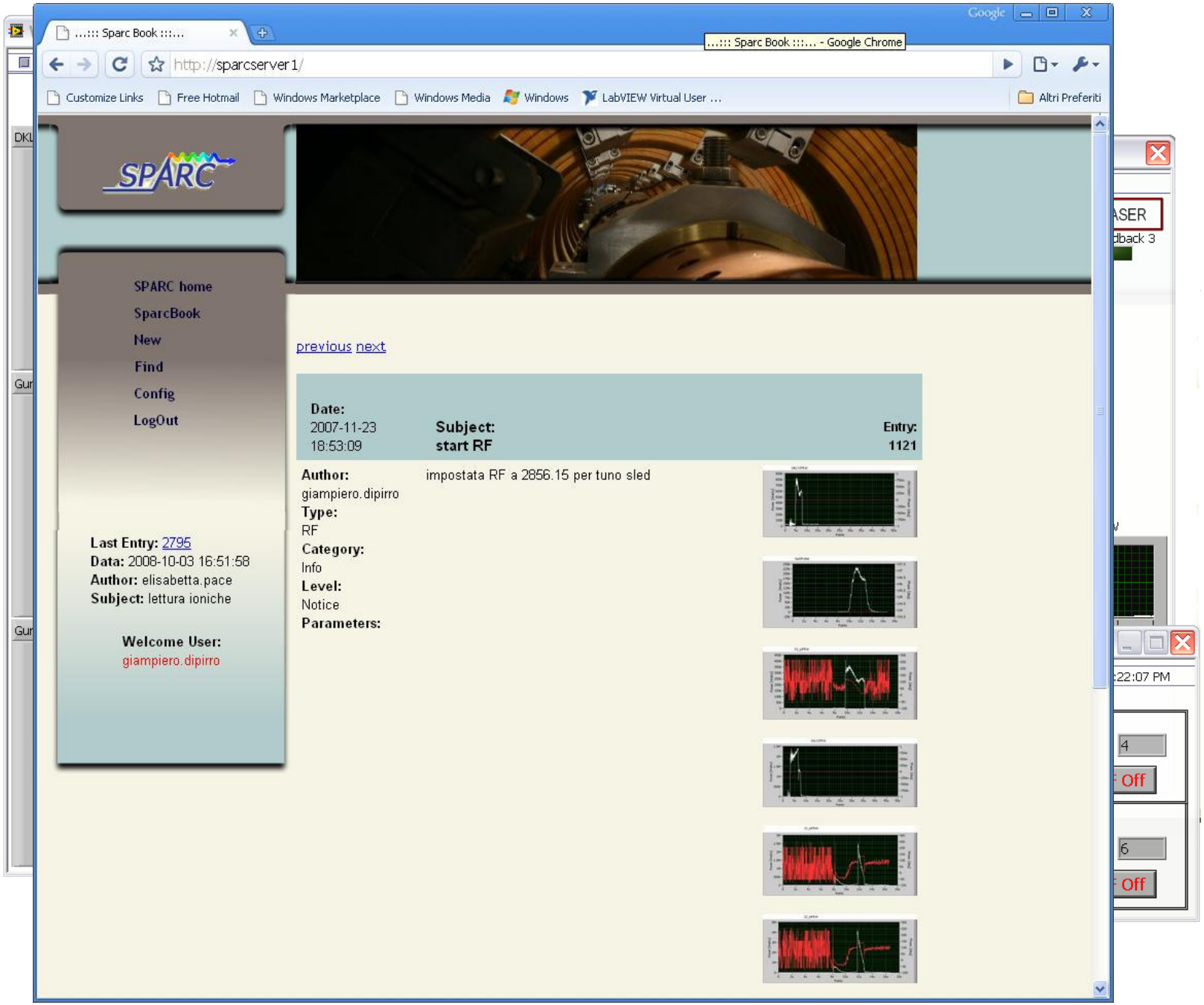


Defined number and type of control
50 pulse shape phase and amplitude readout
digitizer
5 attenuator and phase shifter motorized
4 analog signal
6 digital I/O

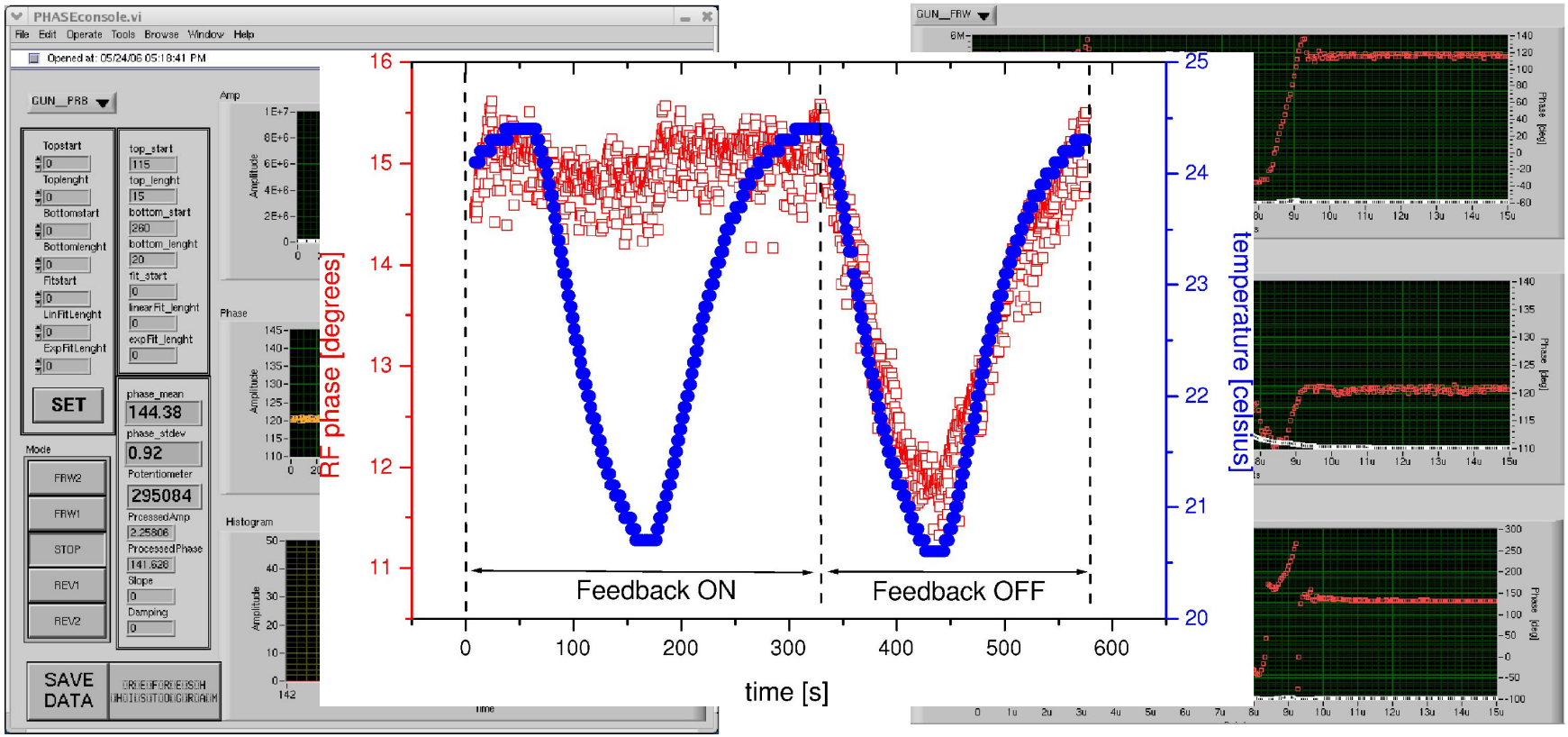


Attenuator and Phase shifter motor control
RS232 (proprietary protocol)




...::: Sparc Book :::...
...::: Sparc Book :::... - Google Chrome
http://sparcserver1/
Customize Links
Free Hotmail
Windows Marketplace
Windows Media
Windows
LabVIEW Virtual User ...
Altri Preferiti
SPARC
SPARC home
SparcBook
New
Find
Config
LogOut
Last Entry: 2795
Data: 2008-10-03 16:51:58
Author: elisabetta.pace
Subject: lettura ioniche
Welcome User:
giampiero.dipirro
previous next
Date:
2007-11-23
18:53:09
Subject:
start RF
Entry:
1121
Author:
giampiero.dipirro
Type:
RF
Category:
Info
Level:
Notice
Parameters:
impostata RF a 2856.15 per tuno sled

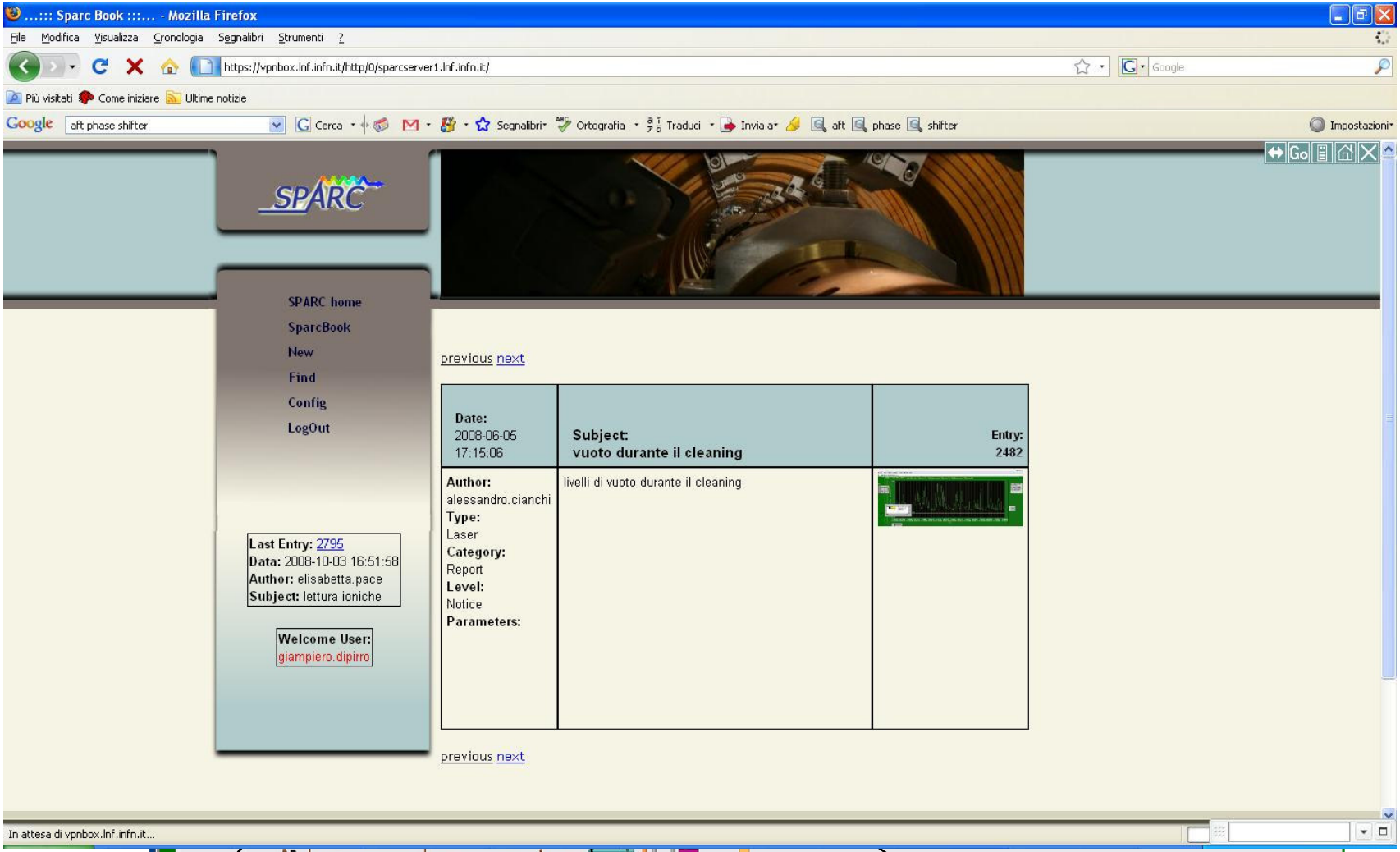
RF


PHASEconsole.vi
File Edit Operate Tools Browse Window Help
Opened at: 05/24/06 05:18:41 PM
GUN_PRB
Topstart
Toplenght
Bottomstart
Bottomlenght
Fitstart
LinFitLenght
ExpFitLenght
SET
top_start
top_lenght
bottom_start
bottom_lenght
fit_start
linearFit_lenght
expFit_lenght
phase_mean
144.38
phase_stdev
0.92
Potentiometer
295084
ProcessedAmp
ProcessedPhase
Slope
Damping
Mode
FRW2
FRW1
STOP
REV1
REV2
SAVE DATA
Amp
Phase
Histogram
RF phase [degrees]
temperature [celsius]
Feedback ON
Feedback OFF
time [s]
GUN_FRW

Vacuum

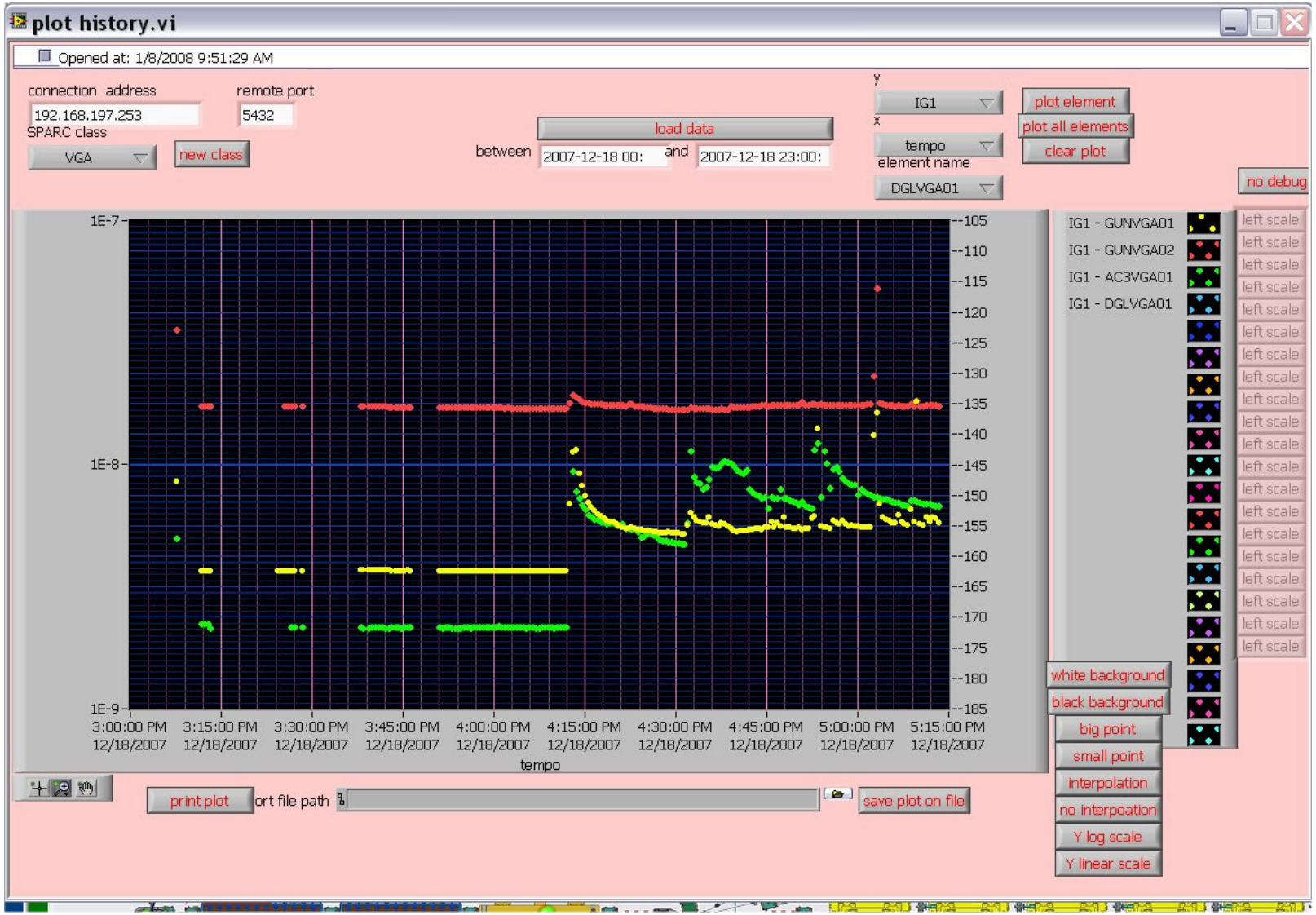
- Pump 30
  - Fieldpoint with Ethernet interface (3 ADC, 1 DI, 1 DO)
  - Serial RS232 with proprietary protocol
- Vacuumeter 12
  - serial RS232 proprietary protocol

For serial interface we are using an Ethernet to serial converter



$8\ 10^{-9}$ $2\ 10^{-9}$ $5\ 10^{-8}$

Vacuum

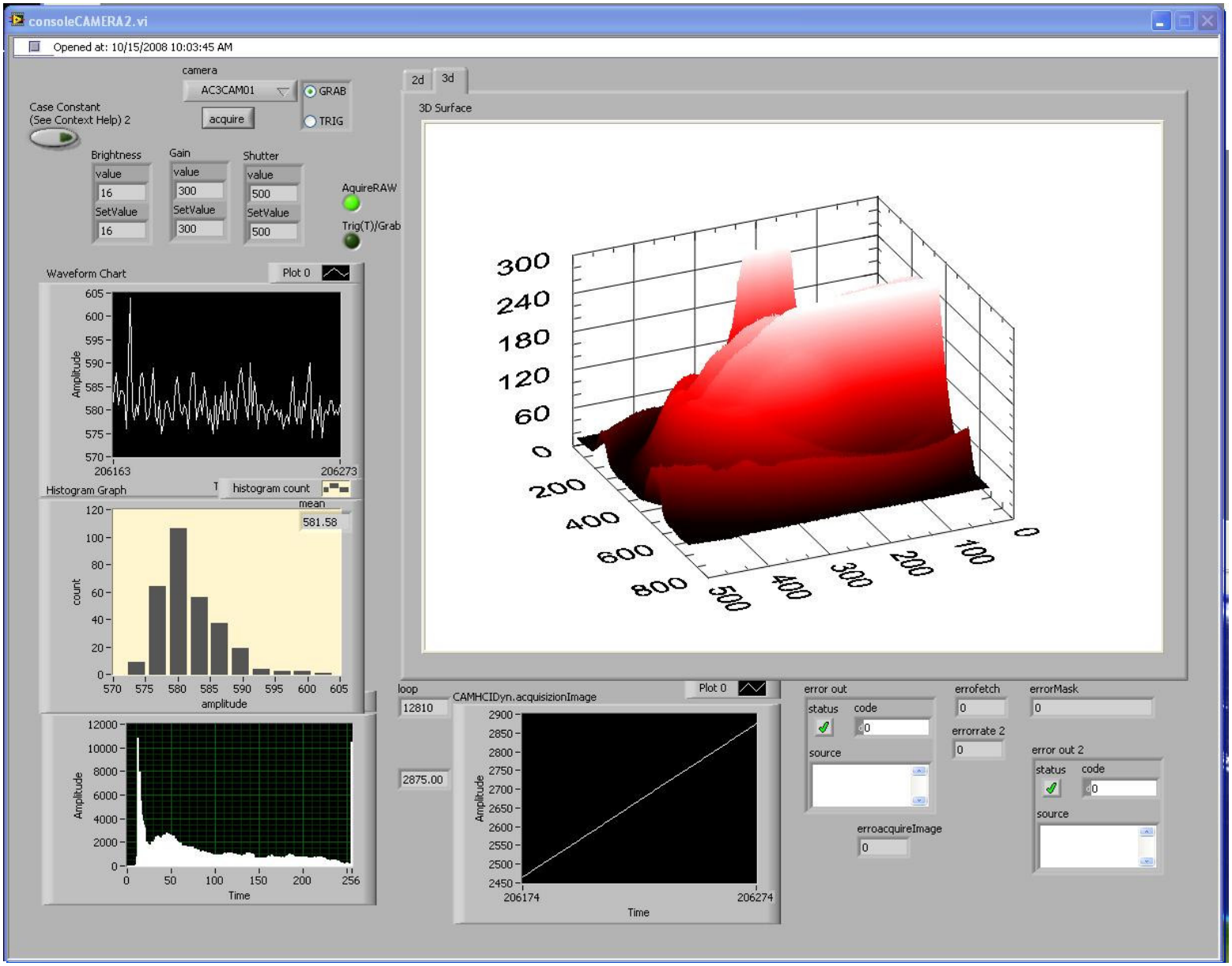

plot history.vi
Opened at: 1/8/2008 9:51:29 AM
connection address
192.168.197.253
remote port
5432
SPARC class
VGA
new class
load data
between
2007-12-18 00:
and
2007-12-18 23:00:
y
IG1
x
tempo
element name
DGLVGA01
plot element
plot all elements
clear plot
no debug
1E-7
1E-8
1E-9
3:00:00 PM 12/18/2007
3:15:00 PM 12/18/2007
3:30:00 PM 12/18/2007
3:45:00 PM 12/18/2007
4:00:00 PM 12/18/2007
4:15:00 PM 12/18/2007
4:30:00 PM 12/18/2007
4:45:00 PM 12/18/2007
5:00:00 PM 12/18/2007
5:15:00 PM 12/18/2007
tempo
IG1 - GUNVGA01
IG1 - GUNVGA02
IG1 - AC3VGA01
IG1 - DGLVGA01
left scale
white background
black background
big point
small point
interpolation
no interpoation
Y log scale
Y linear scale
print plot
ort file path
save plot on file

Diagnostic

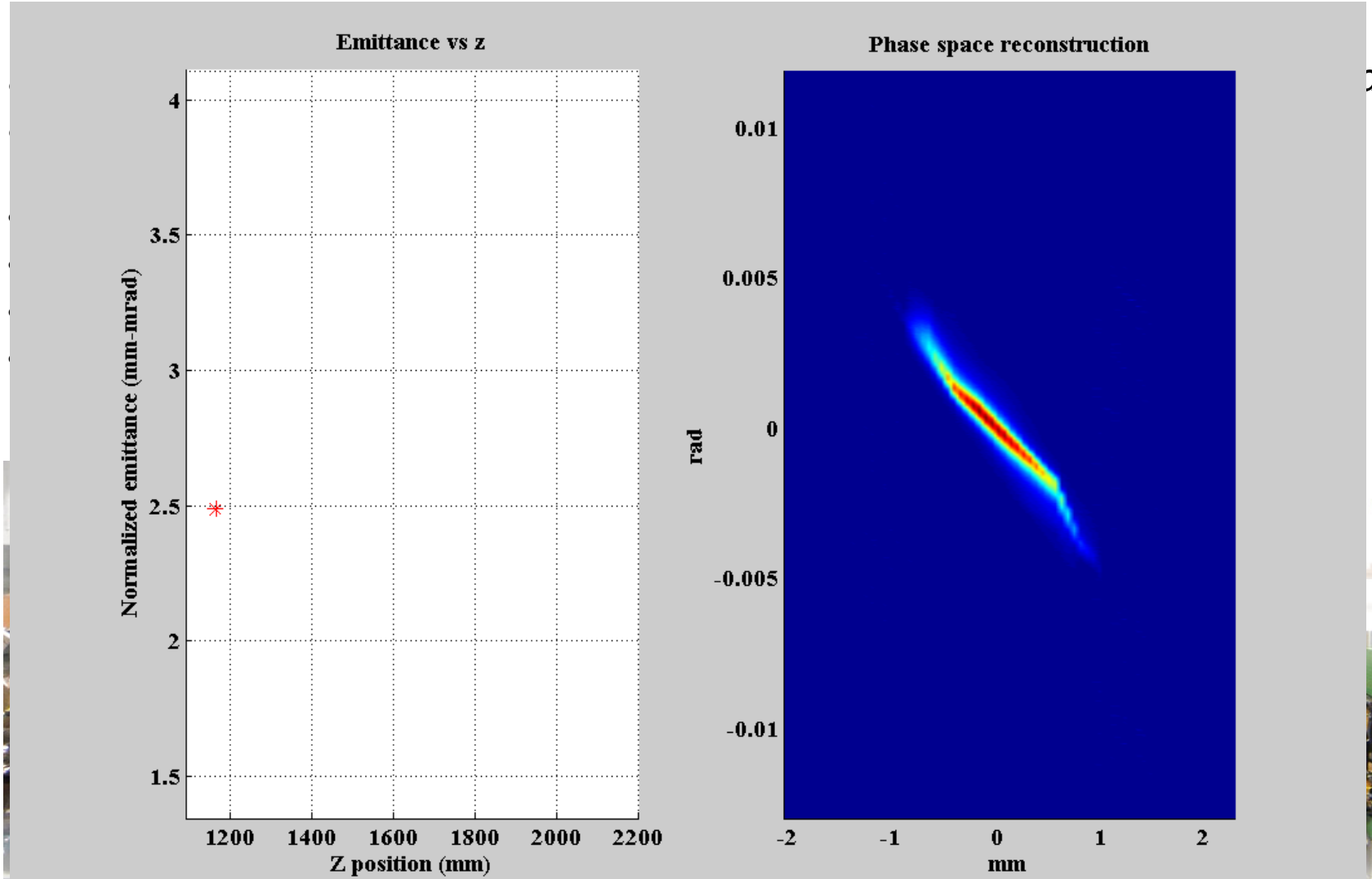
- Acquisition camera.
  - Interface IEEE1394 or GigE Vision
- Flag movement.
  - Stepper motor with fieldbus interface.
- BPM reading.
  - Bergoz electronics and ADC
- Charge monitor reading
  - Electronic from Bergoz with DIMM
  - Faraday cup and digitizer.

DIAGNOSTIC

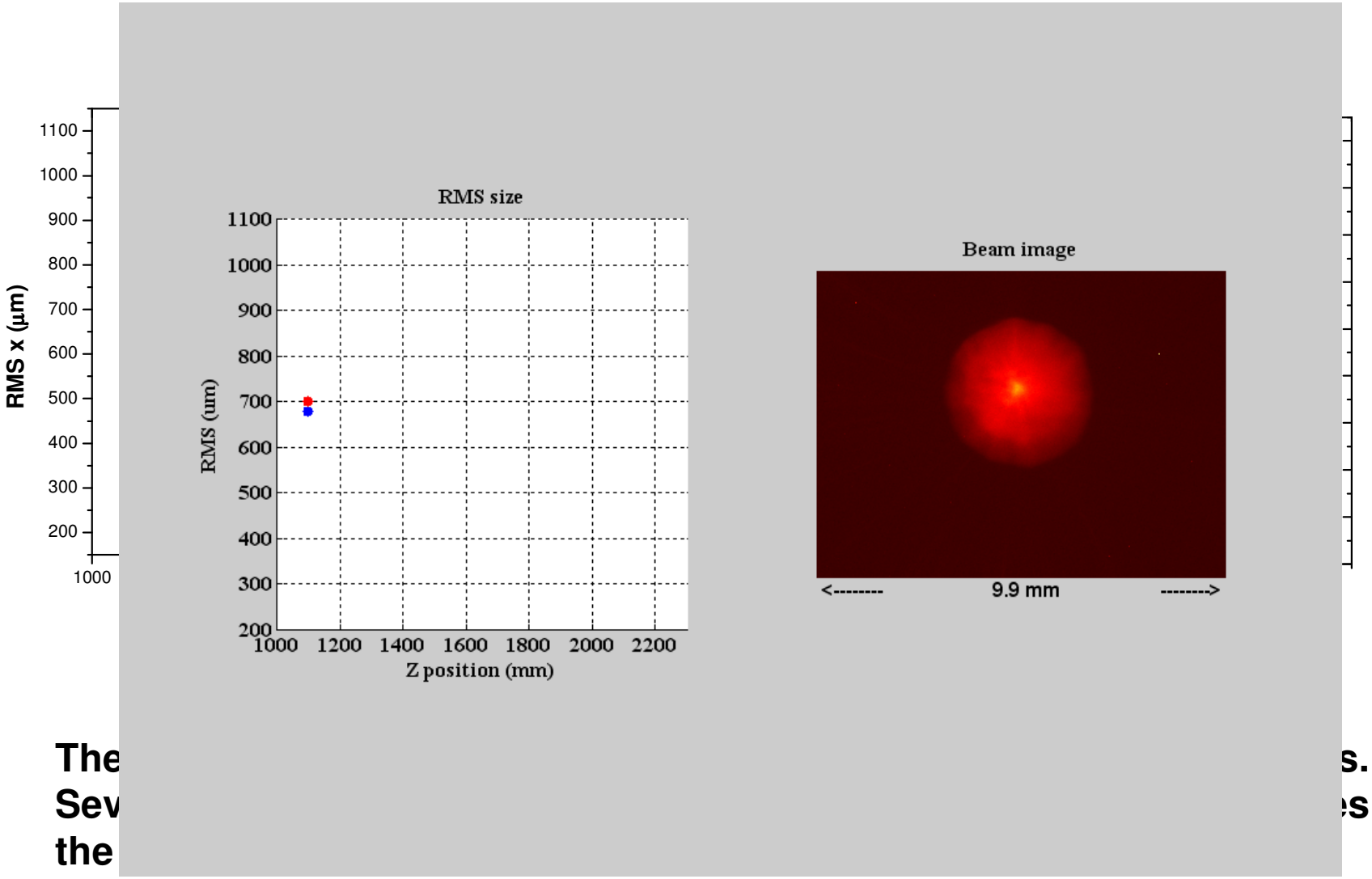

control_panel7.2.vi
File Edit Operate Tools Browse Window Help
Opened at: 10/19/06 02:04:04 PM
Emittance meter control panel
SPARC
Monitor
Preparing measure
Image acquisition
Data processing
Y
MOVE OUT
MOVE IN
Vertical
Steps Y
1.000E+0
Y actual position step
0.0000E+0
Potenziometer readout Y
0.02
STEP RESET
X
MOVE IN
MOVE OUT
Horizontal
Steps X
1.000E+0
X actual position step
0.000E+0
Potenziometer readout X
0.03
STEP RESET
Light control
YAG target control
Insert YAG
Insert Calibration
Out
YAG in
calib in
Light indicator
Yag step
Yag Potenziometer
YAG Position
1598.5
Main Bellow
1299.6
298.902
MOVE
to position
AUTOMATED ENVELOPE SCAN
AUTOMATED Emittance SCAN X
AUTOMATED Emittance SCAN Y
Slit position X
Slit position Y
Show Profile
TEXT COLOR
Profile Zoom
PALETTE
Gradient
Filter on
calculate grid
draw grid?
Display RMS
Average
Center
SAVE
Gain
Shutter
SET GAIN
SET SHUTTER
STOP PANEL ONLY FOR DEBUGGER
Subtract Background
Background image
error status
calibration
15.44
APPEND
SAVE OFF
xmedio
Dxmedio
Ymedio
DYmedio
sigmax
Dsigmax
sigmay
Dsigmay
PLOT


consoleCAMERA2.vi
Opened at: 10/15/2008 10:03:45 AM
camera
AC3CAM01
GRAB
TRIG
acquire
Case Constant
(See Context Help) 2
Brightness
value
16
SetValue
16
Gain
value
300
SetValue
300
Shutter
value
500
SetValue
500
AquireRAW
Trig(T)/Grab
2d
3d
3D Surface
Waveform Chart
Plot 0
Amplitude
Histogram Graph
histogram count
mean
581.58
count
amplitude
Amplitude
Time
loop
12810
2875.00
CAMHCIDyn.acquisizionImage
Plot 0
Amplitude
Time
error out
status
code
source
errofetch
errorrate 2
errorMask
error out 2
status
code
source
erroacquireImage

Emittance automatic measure



The high measurement resolution allows to precisely reconstruct not only the second moment but the entire transverse trace space distribution (x-x' or y-y')



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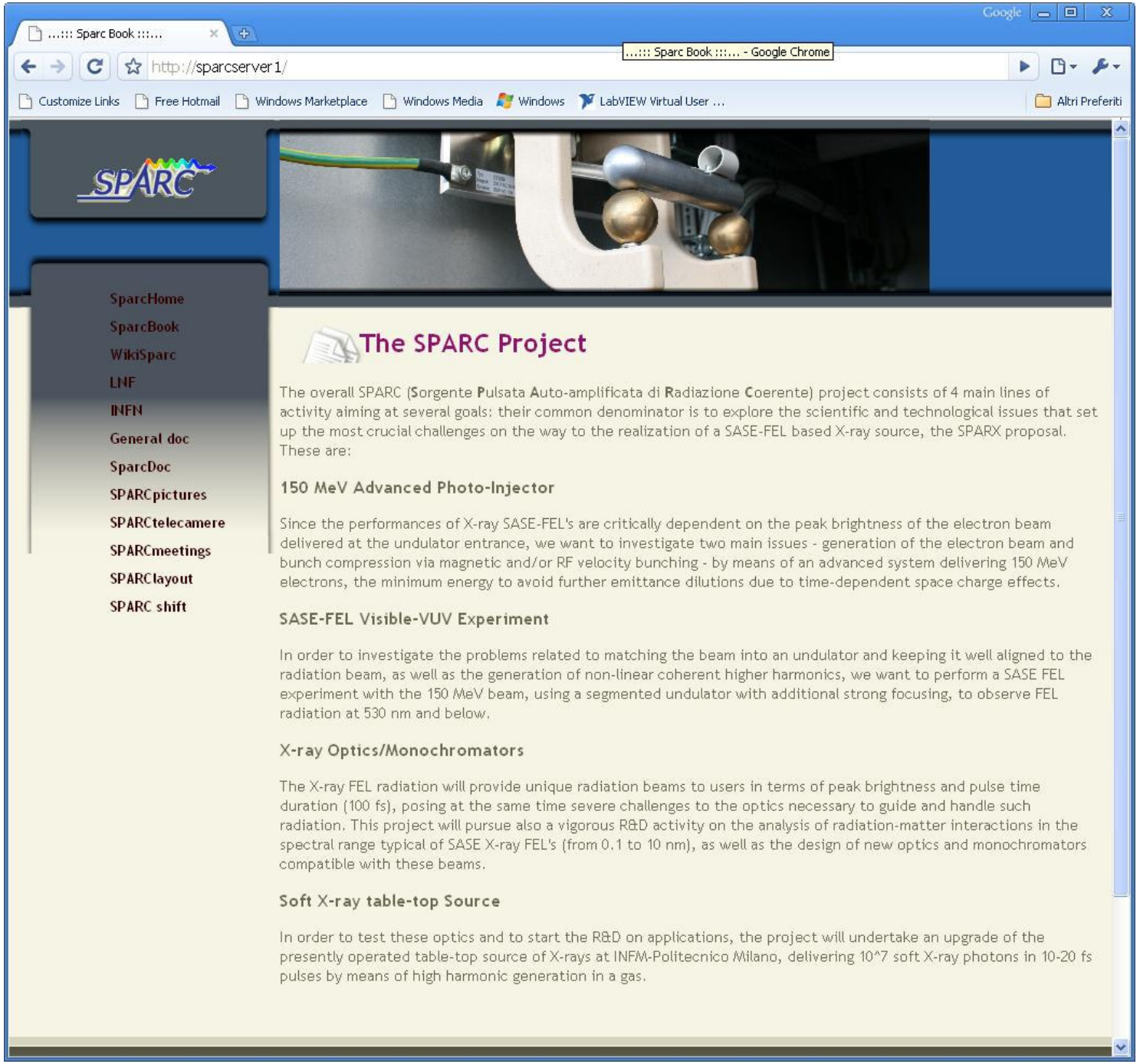
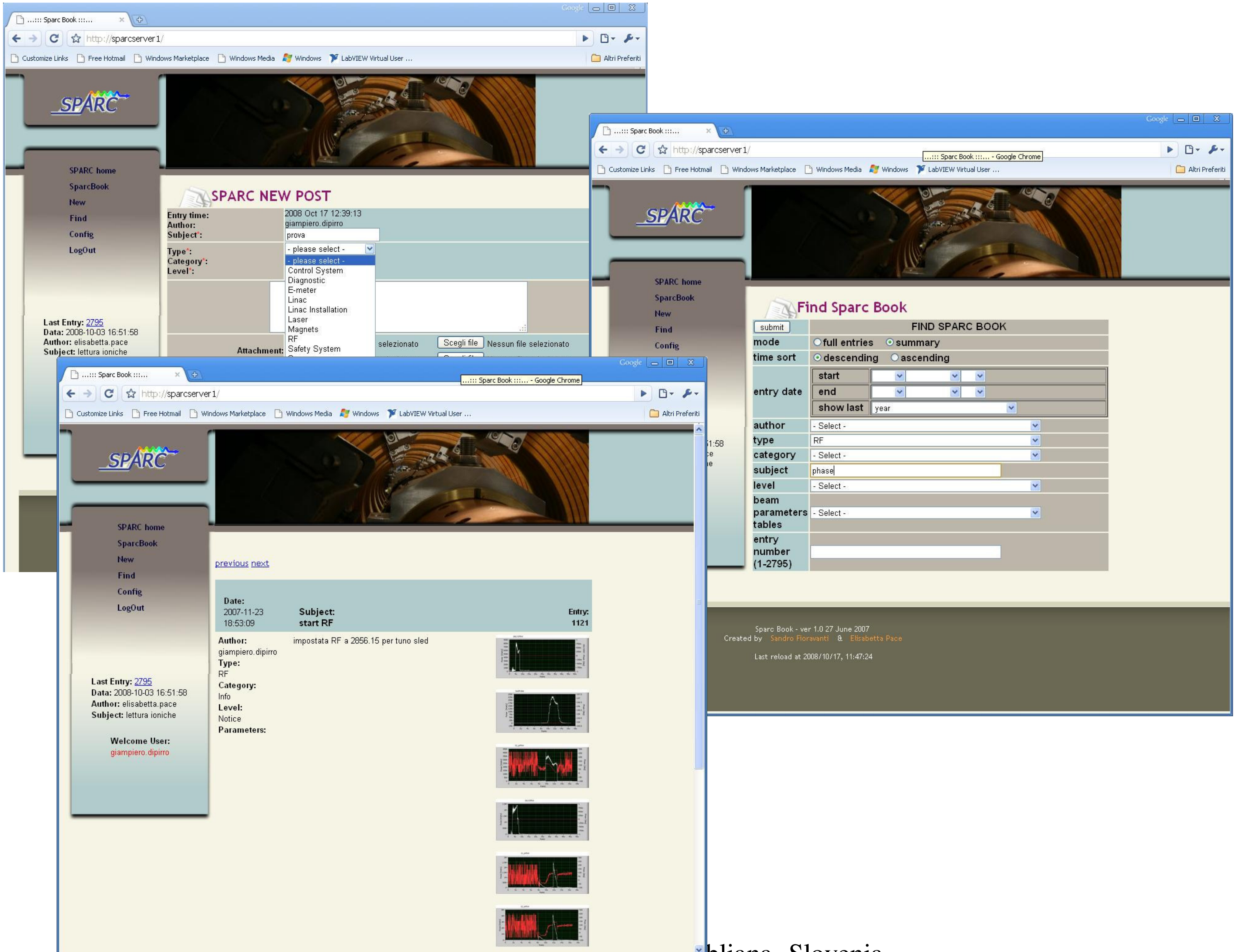
SPARC WEB PAGE

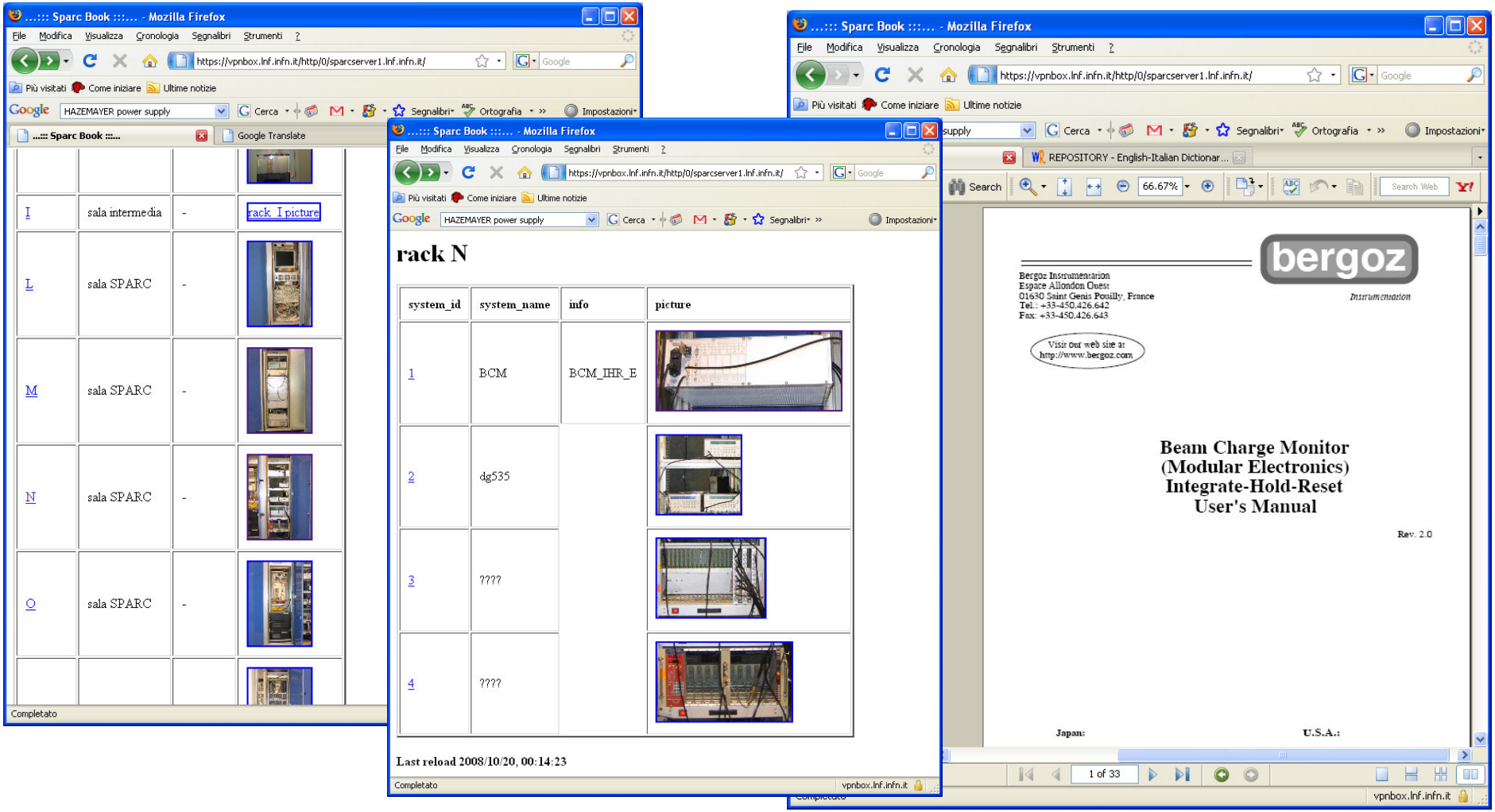
PCaPAC 2008, Ljubljana, Slovenia


...::: Sparc Book :::...
...::: Sparc Book :::... - Google Chrome
http://sparcserver1/
Customize Links
Free Hotmail
Windows Marketplace
Windows Media
Windows
LabVIEW Virtual User ...
Altri Preferiti
SPARC
SparcHome
SparcBook
WikiSparc
LNF
INFN
General doc
SparcDoc
SPARCpictures
SPARCtelecamere
SPARCmeetings
SPARClayout
SPARC shift
The SPARC Project
The overall SPARC (Sorgente Pulsata Auto-amplificata di Radiazione Coerente) project consists of 4 main lines of activity aiming at several goals: their common denominator is to explore the scientific and technological issues that set up the most crucial challenges on the way to the realization of a SASE-FEL based X-ray source, the SPARX proposal. These are:
150 MeV Advanced Photo-Injector
Since the performances of X-ray SASE-FEL's are critically dependent on the peak brightness of the electron beam delivered at the undulator entrance, we want to investigate two main issues - generation of the electron beam and bunch compression via magnetic and/or RF velocity bunching - by means of an advanced system delivering 150 MeV electrons, the minimum energy to avoid further emittance dilutions due to time-dependent space charge effects.
SASE-FEL Visible-VUV Experiment
In order to investigate the problems related to matching the beam into an undulator and keeping it well aligned to the radiation beam, as well as the generation of non-linear coherent higher harmonics, we want to perform a SASE FEL experiment with the 150 MeV beam, using a segmented undulator with additional strong focusing, to observe FEL radiation at 530 nm and below.
X-ray Optics/Monochromators
The X-ray FEL radiation will provide unique radiation beams to users in terms of peak brightness and pulse time duration (100 fs), posing at the same time severe challenges to the optics necessary to guide and handle such radiation. This project will pursue also a vigorous R&D activity on the analysis of radiation-matter interactions in the spectral range typical of SASE X-ray FEL's (from 0.1 to 10 nm), as well as the design of new optics and monochromators compatible with these beams.
Soft X-ray table-top Source
In order to test these optics and to start the R&D on applications, the project will undertake an upgrade of the presently operated table-top source of X-rays at INFM-Politecnico Milano, delivering 10^7 soft X-ray photons in 10-20 fs pulses by means of high harmonic generation in a gas.

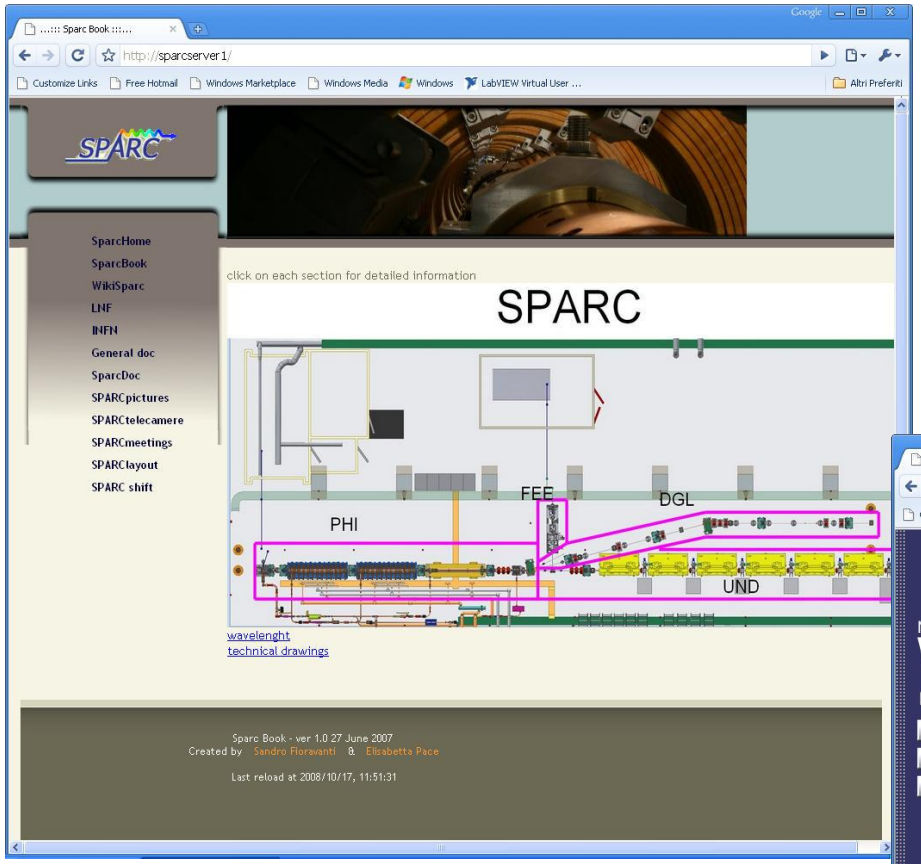
Home Page


SPARC NEW POST
Find Sparc Book
FIND SPARC BOOK
Sparc Book - ver 1.0 27 June 2007
Created by Sandro Fioravanti & Elisabetta Pace

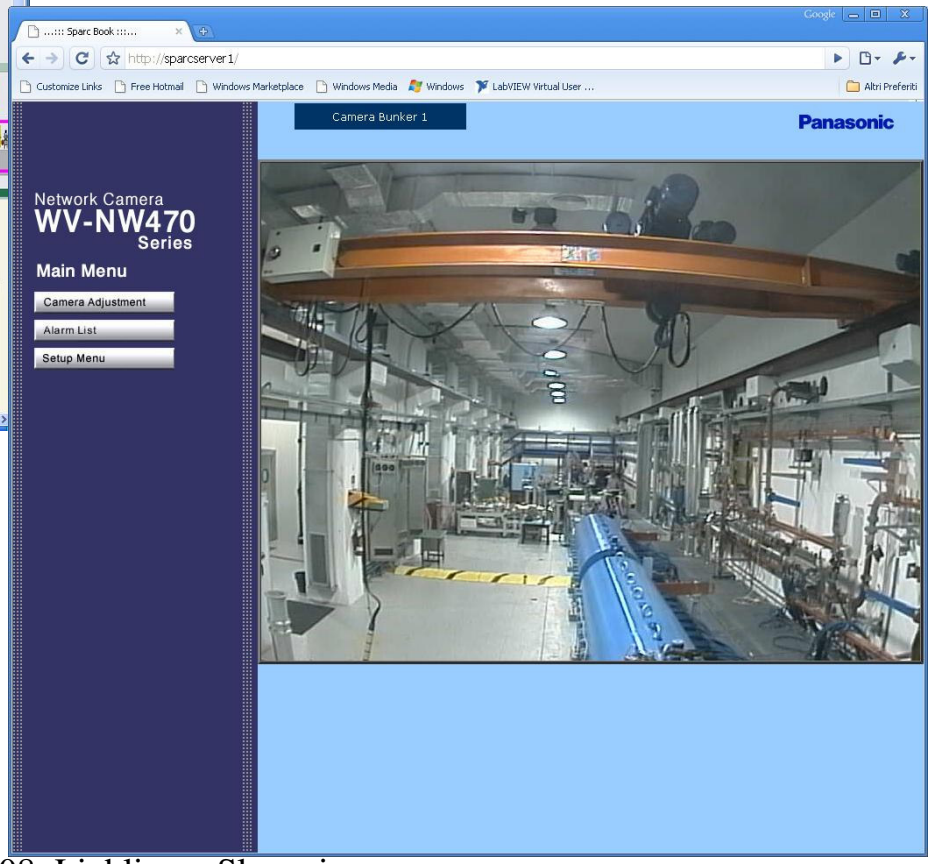
LogBook



Documents repository



Layout



Camera

Conclusion

- The control system (hardware & software) is completely defined, tested and used.
- All the main element of the machine are under control

Complete the laser, seeding, and undulator integration in the control system