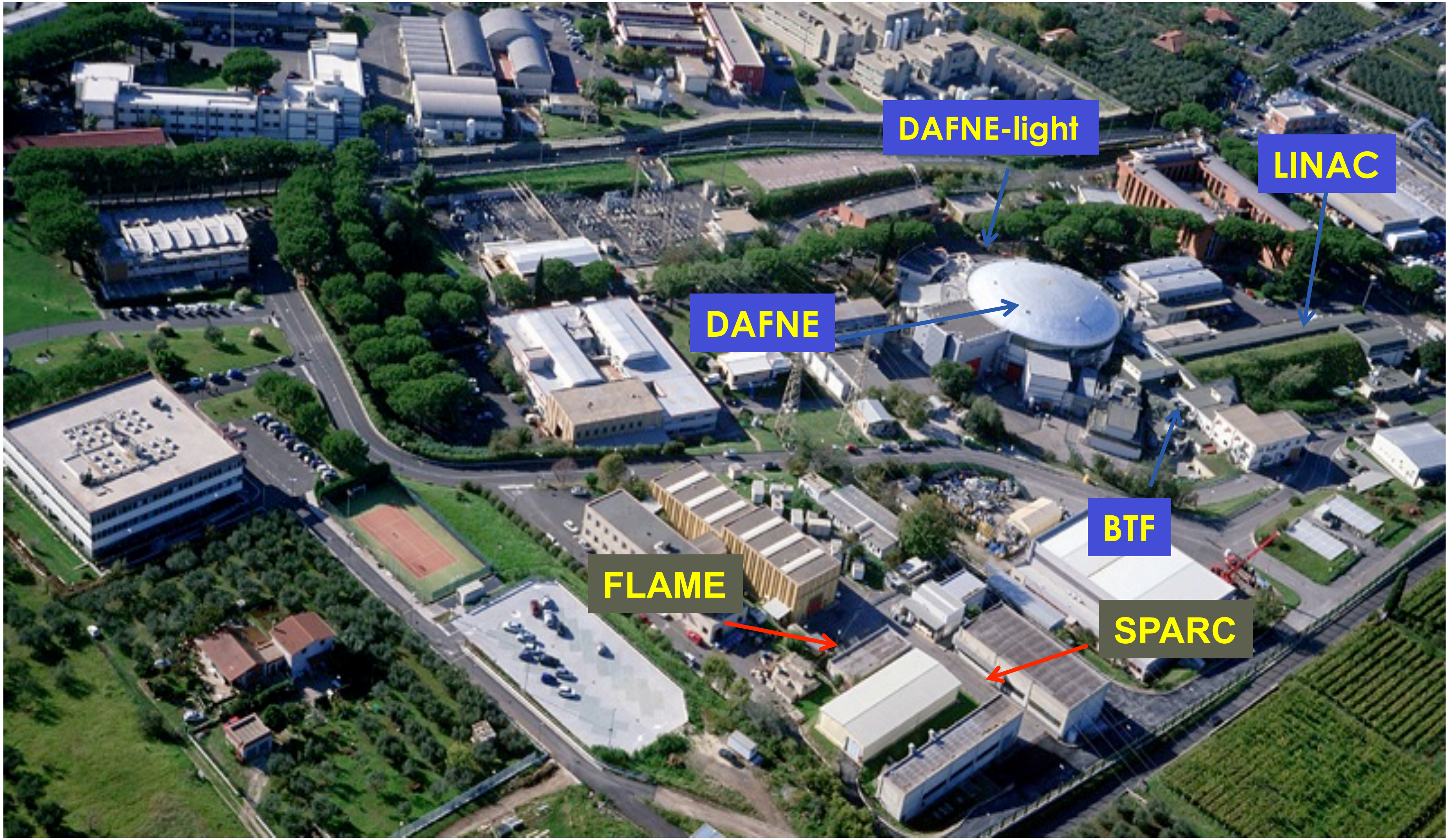
Status Report from Frascati Natl. labs

Umberto Dosselli

Accelerators infrastructures at LNF today



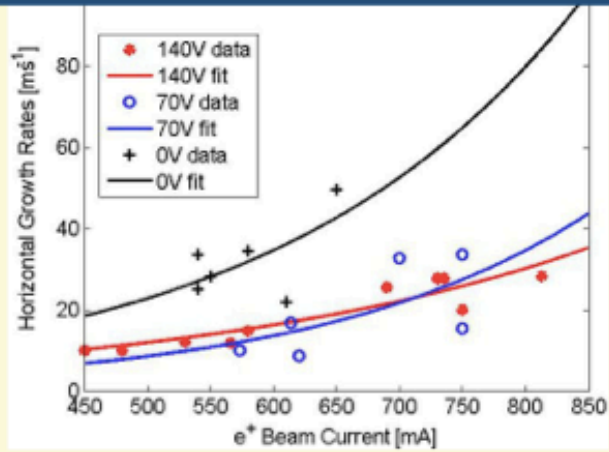
DAΦNE and KLOE-2

Clearing electrodes for *e-cloud* suppression

Electrodes let more stable operation with the positron beam, and allowed unique measurements such as: e-cloud instabilities' growth rate, transverse beam size variation, and tune shifts along the bunch train, demonstrating their effectiveness in restraining e-cloud induced effects.
(D. Alesini et al, Phys. Rev. Lett. 110, 124801 (2013)

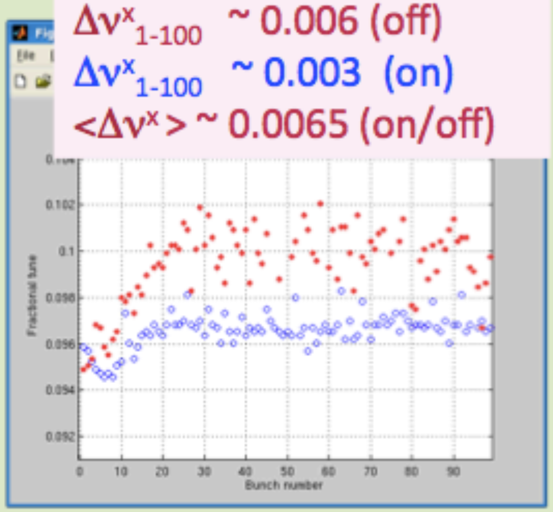
DAΦNE is the first collider operating routinely with long electrodes, for e-cloud mitigation.

Horizontal Instability Growth Rate measured busing bunch-by-bunch feedback as a function of the electrode voltage

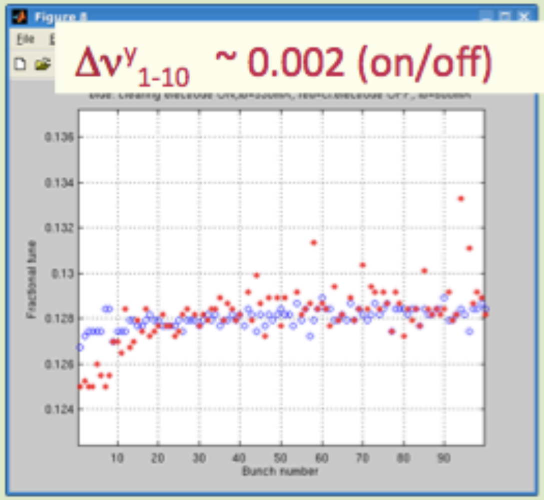


Tune Spread measurements

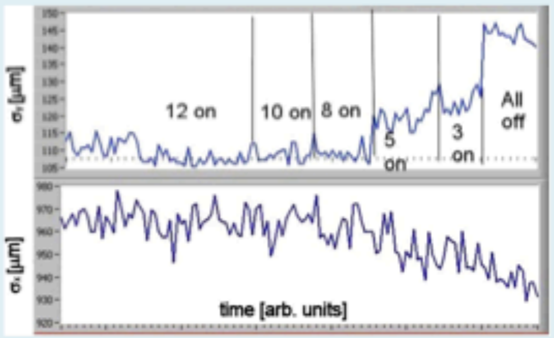
$\Delta\nu^x_{1-100}$ ~ 0.006 (off)
$\Delta\nu^x_{1-100}$ ~ 0.003 (on)
$<\Delta\nu^x>$ ~ 0.0065 (on/off)



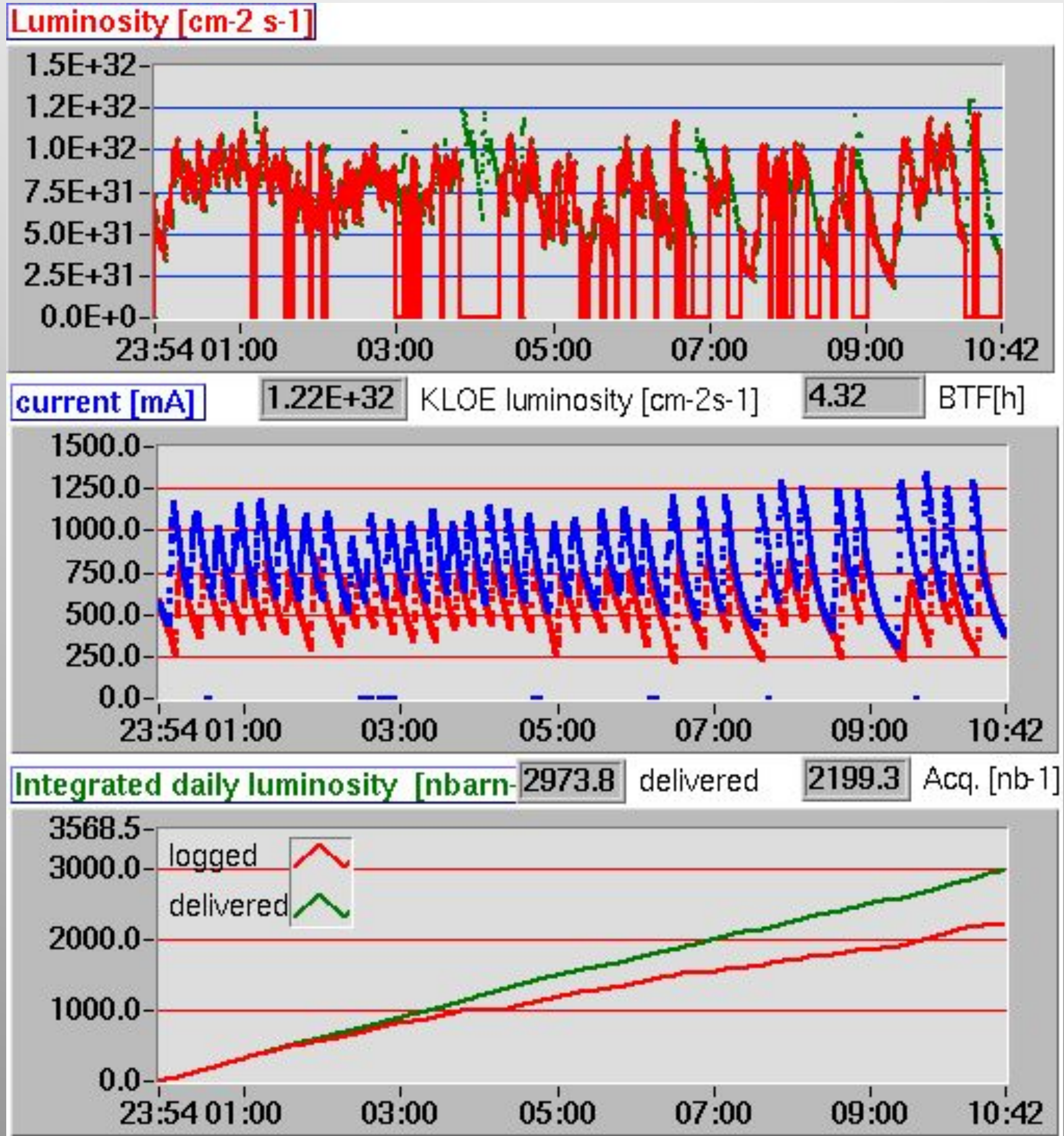
$\Delta\nu^y_{1-10}$ ~ 0.002 (on/off)



Beam Dimension

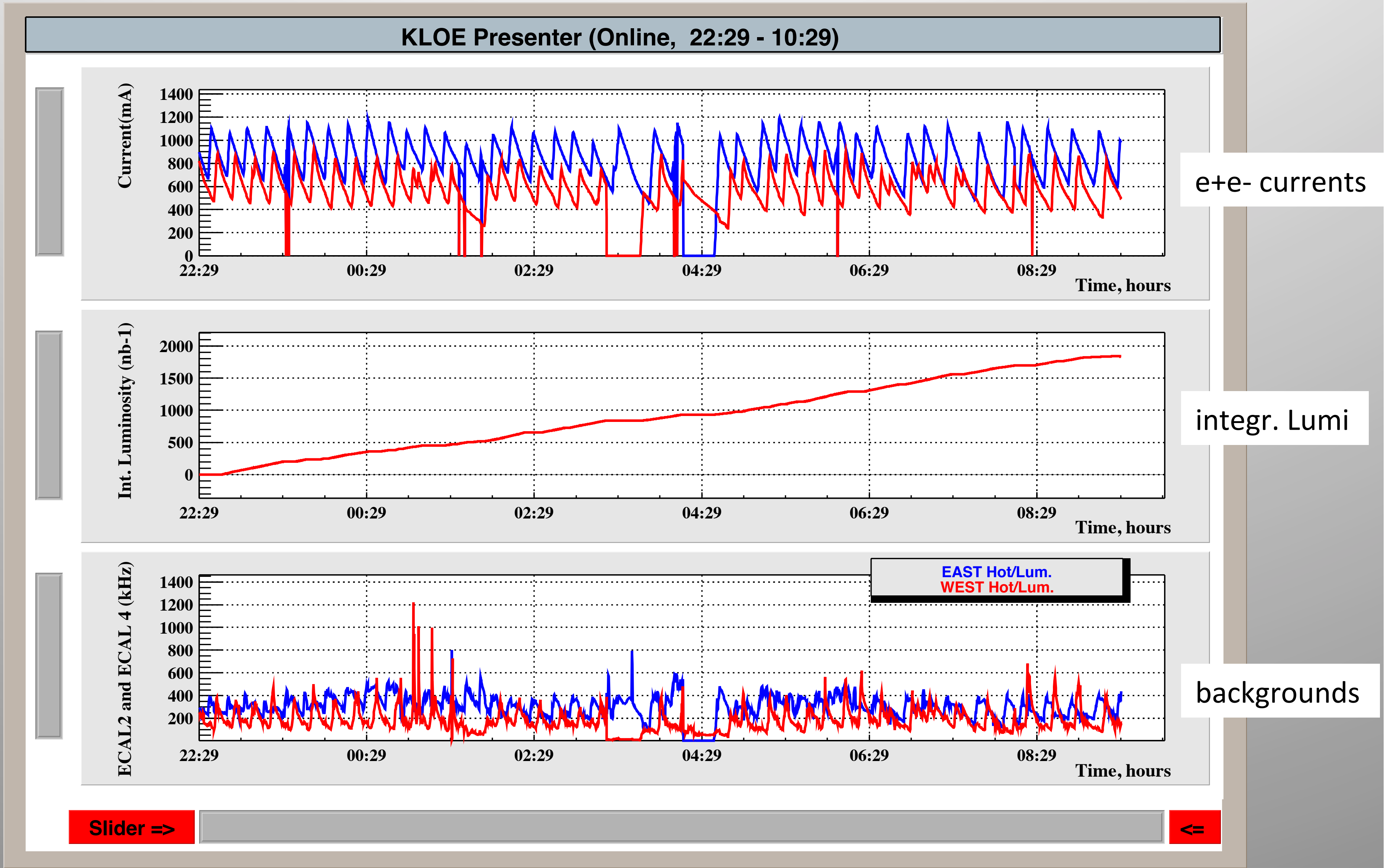


12 hour integrated luminosity



nov 19th (yesterday)

KLOE-2 data taking



Activity program

Four consecutive days a week dedicated to KLOE-2 data taking including:

adiabatic collider optimization

luminosity fine tuning

background minimization (injection & costing)

Three days a week for machine studies and developments, if necessary

Aiming at delivering 1 fb^{-1} after 8 months operation

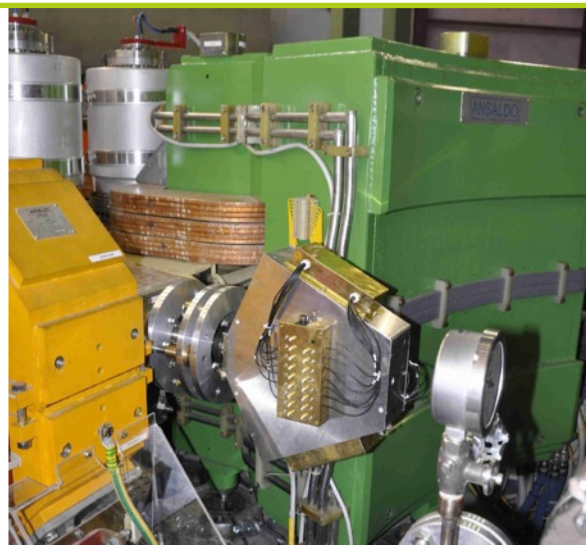
INFN Istituto Nazionale di Fisica Nucleare

Laborat

KLOE-2

Taggers for $\gamma\gamma$ reactions installed.

Low and high energy Tagger installations

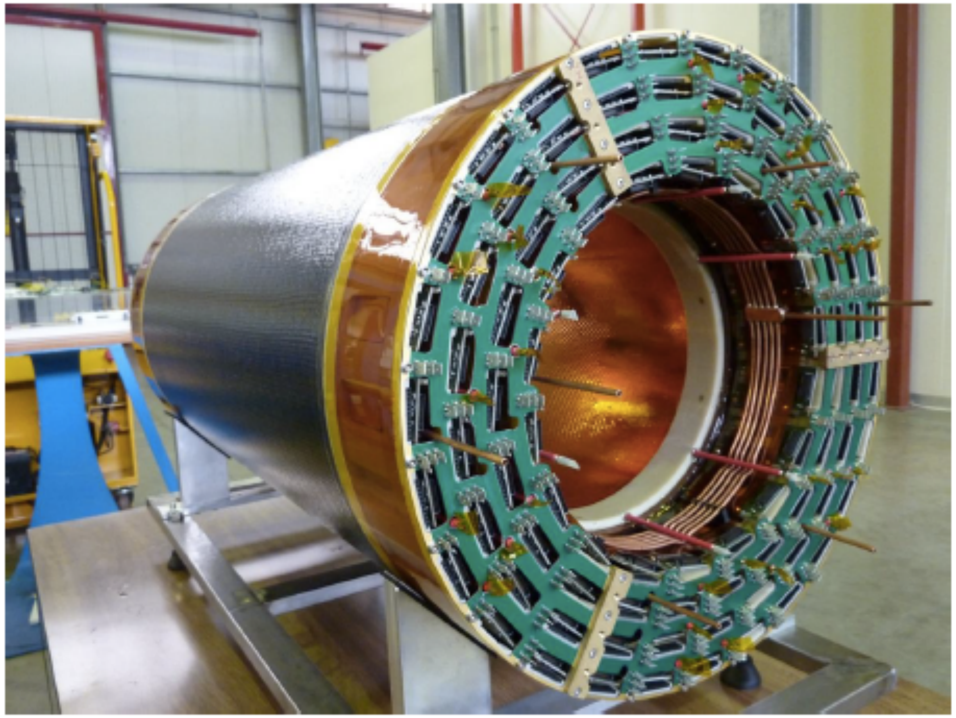


INFN
Istituto Nazionale
di Fisica Nucleare
Laboratori Nazionali di Frascati

New KLOE inner tracker: 4 layers cylindrical GEM (world first)

Status of the KLOE-2 Inner Tracker

The Inner Tracker was assembled on March, 14^{th} 2013!

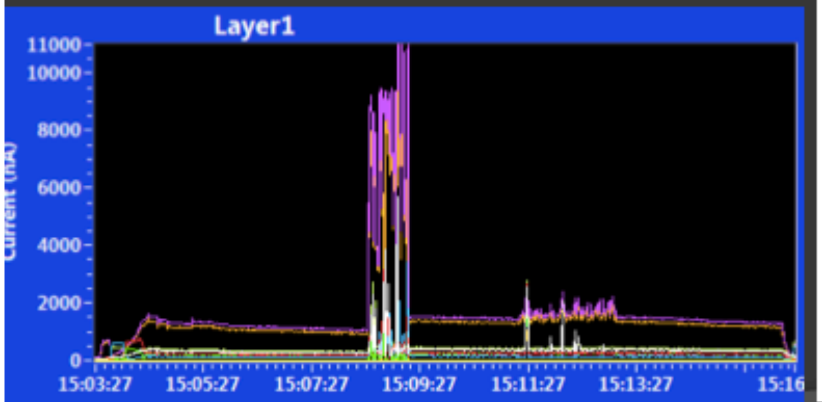


http://www.lnf.infn.it/public/index.php?option=com_content&view=article&id=359%3Agems-become-cylindrical&catid=21%3Anovita&Itemid=153&lang=it

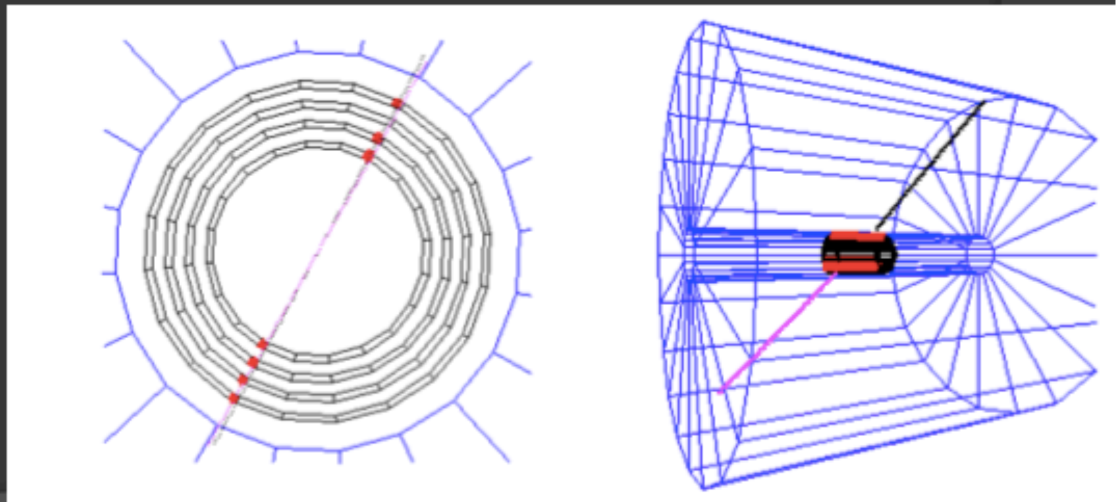
Status of Inner Tracker

- Monitoring Noisy/Dead channel Status & History
- Working point optimization: efficiency studies
- DC tracking with B=0: IT efficiency & Alignment/Calibration
- IT tracking with Kalman: IP position from Bhabha scattering events

Electron and positron injections as seen by the current monitor



Inner Tracker and Drift Chamber event display

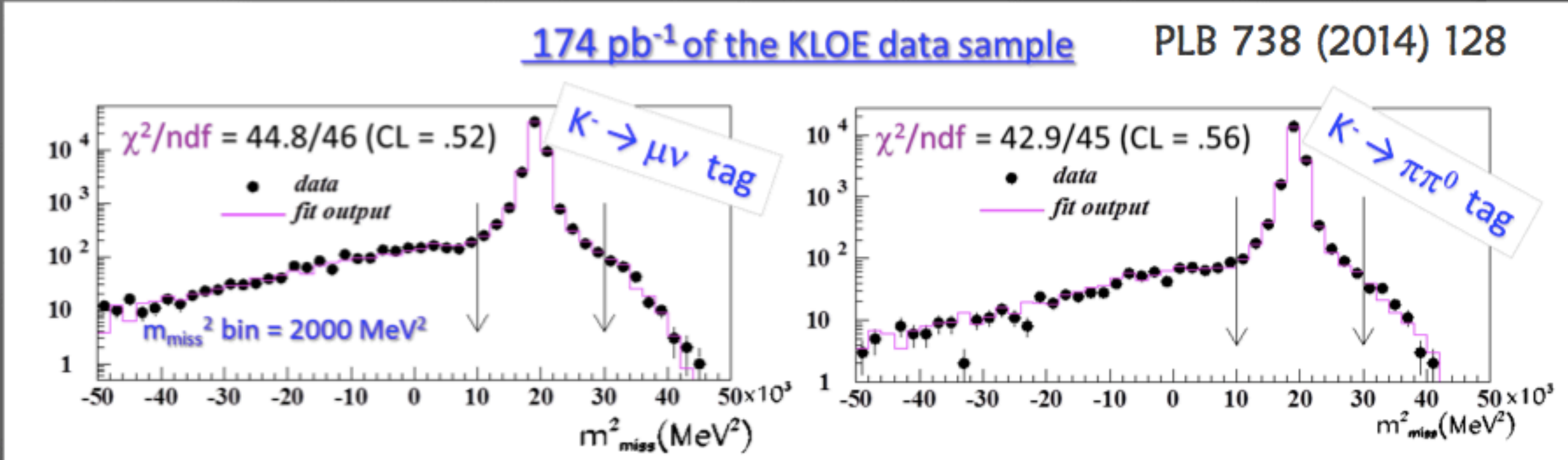


completed and ongoing analyses

CPT test with $\phi \to K_S K_L \to \pi^+\pi^-\pi^+\pi^-$	PLB 730 (2013) 89-94
Absolute BR of $K^+ \to \pi^+\pi^-\pi^+(\gamma)$	PLB 738 (2014) 128-133
BR and Transition Form Factor for $\phi \to \eta e^+e^-$ $(\eta \to \pi^0\pi^0\pi^0)$	Submitted to PLB (arXiv:1409.4582)
U boson search in $e^+e^- \to U\gamma$, $U \to \mu^+\mu^-$	PLB 736 (2014) 459-464
U boson search in $e^+e^- \to U\gamma$, $U \to e^+e^-$	Preliminary presented at ICHEP14
U boson search in $e^+e^- \to Uh'$, $U \to \mu^+\mu^-$, $h' \to$ inv.)	Draft paper
Dalitz plot analysis of $\eta \to \pi^+\pi^-\pi^0$	Check of systematics almost completed
T violation in $\phi \to K_S K_L \to 3\pi^0\ \pi l\nu$	In progress
BR and charge asymmetry in $K_S \to \pi e\nu$	In progress
Measurement of K^+ mass	In progress

Branching ratio of $K^+ \to \pi^+\pi^-\pi^+(\gamma)$

- Last KLOE measurement in Kaon sector: now all the six $K^\pm$ dominant BR and lifetime obtained with sub-percent precision
- Analysis strategy: the missing mass distribution from K^+ (obtained from the tag side) and the two selected π is used for event counting



Average of the two results accounted for correlations

$BR(K^+ \to \pi^+\pi^-\pi^+(\gamma)) = 0.05565 \pm 0.00031_{stat} \pm 0.00025_{syst}$

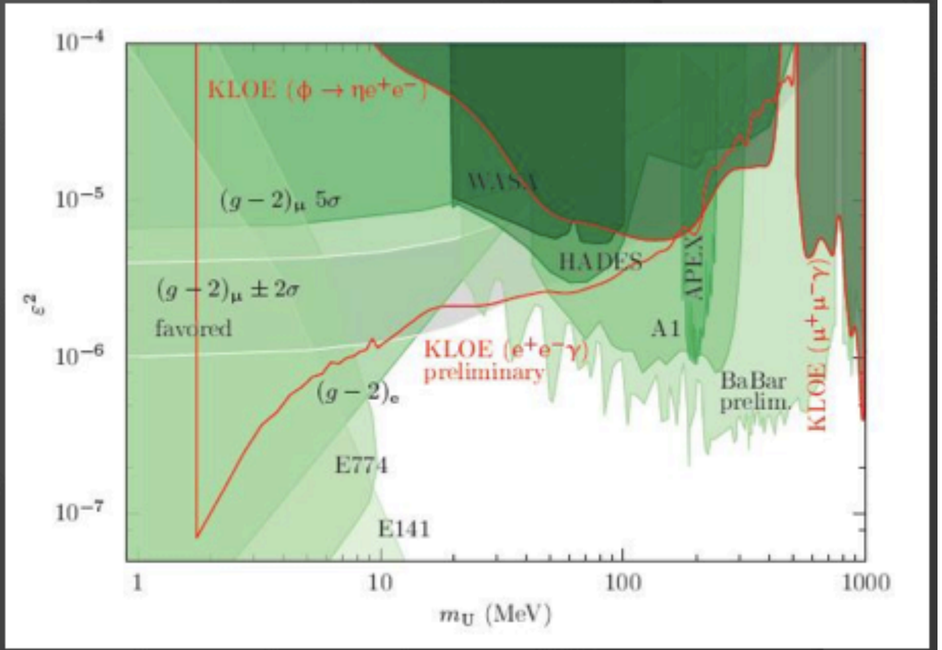
$\Delta BR/BR = 7.2 \times 10^{-3}$

Factor of 5 better accuracy wrt best previous result

U boson searches

No evidence of dark force mediator in

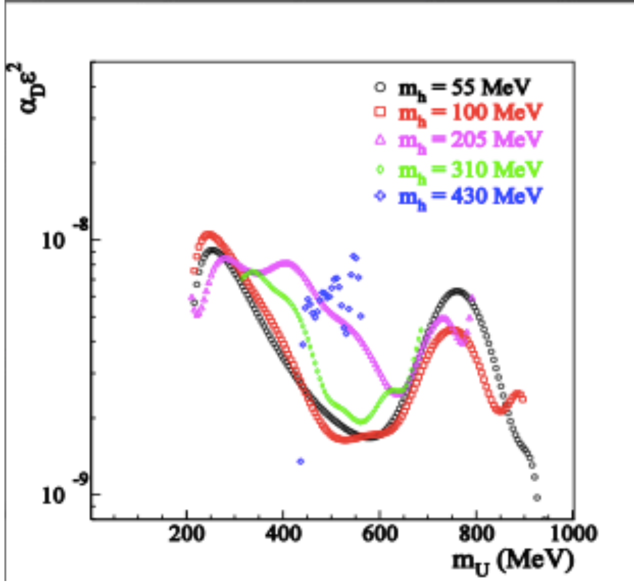
- $\phi \to \eta e^+e^-$ [PLB 720 (2013)]
- $e^+e^- \to \mu^+\mu^-\gamma$ [PLB 736 (2014)]
- $e^+e^- \to e^+e^-\gamma$ [PRELIMINARY]



Exclusion plot at 90% C.L. in the coupling-mass plane

higgs'-strahlung

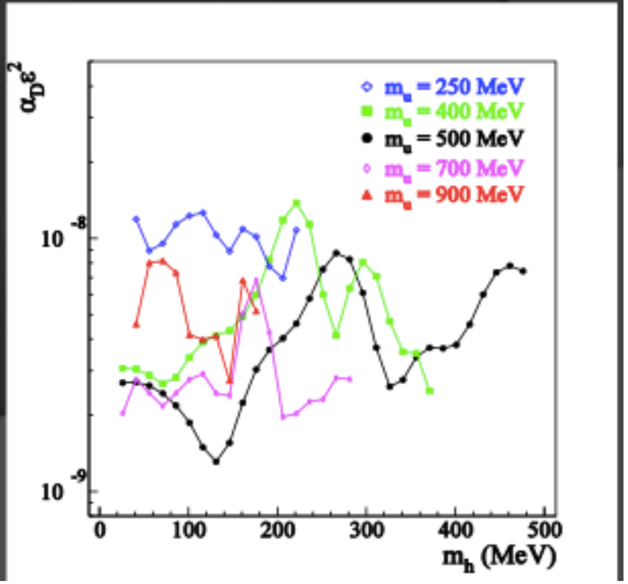
$e^+e^- \to U^* \to Uh'$, $U \to \mu^+\mu^-$, $h' \to$ invisible



Combined result from on peak and off peak data

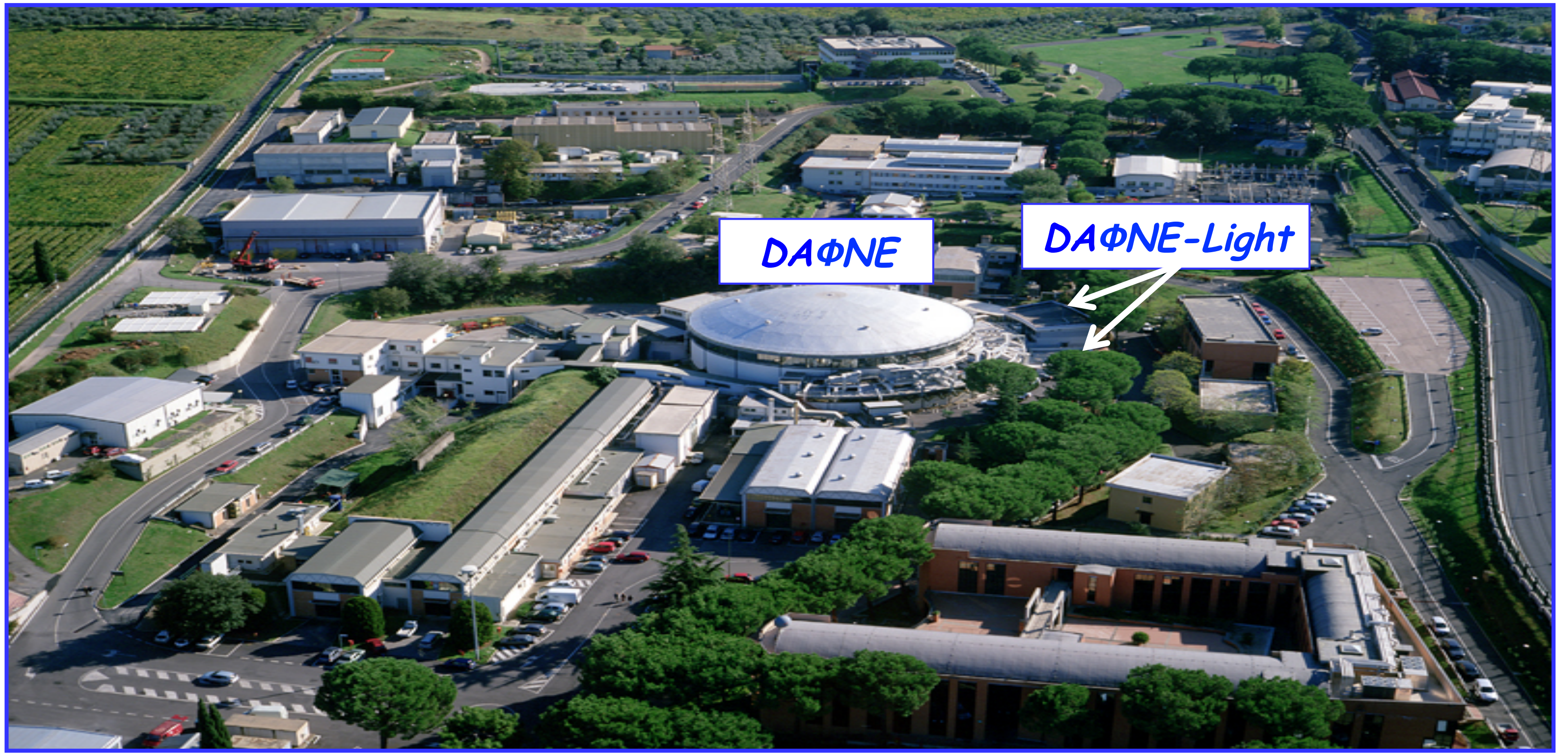
exclusion plots at 90% C.L. in the coupling-masses plane

Translates to a limit on $\alpha_D \epsilon^2$ from 10^{-9} to 10^{-8}



DAΦNE-Light

INFN-LNF Synchrotron Radiation Facility



1) SINBAD - IR beamline (1.24 meV - 1.24 eV)

2) DXR1- Soft x-ray beamline (900-3000 eV)

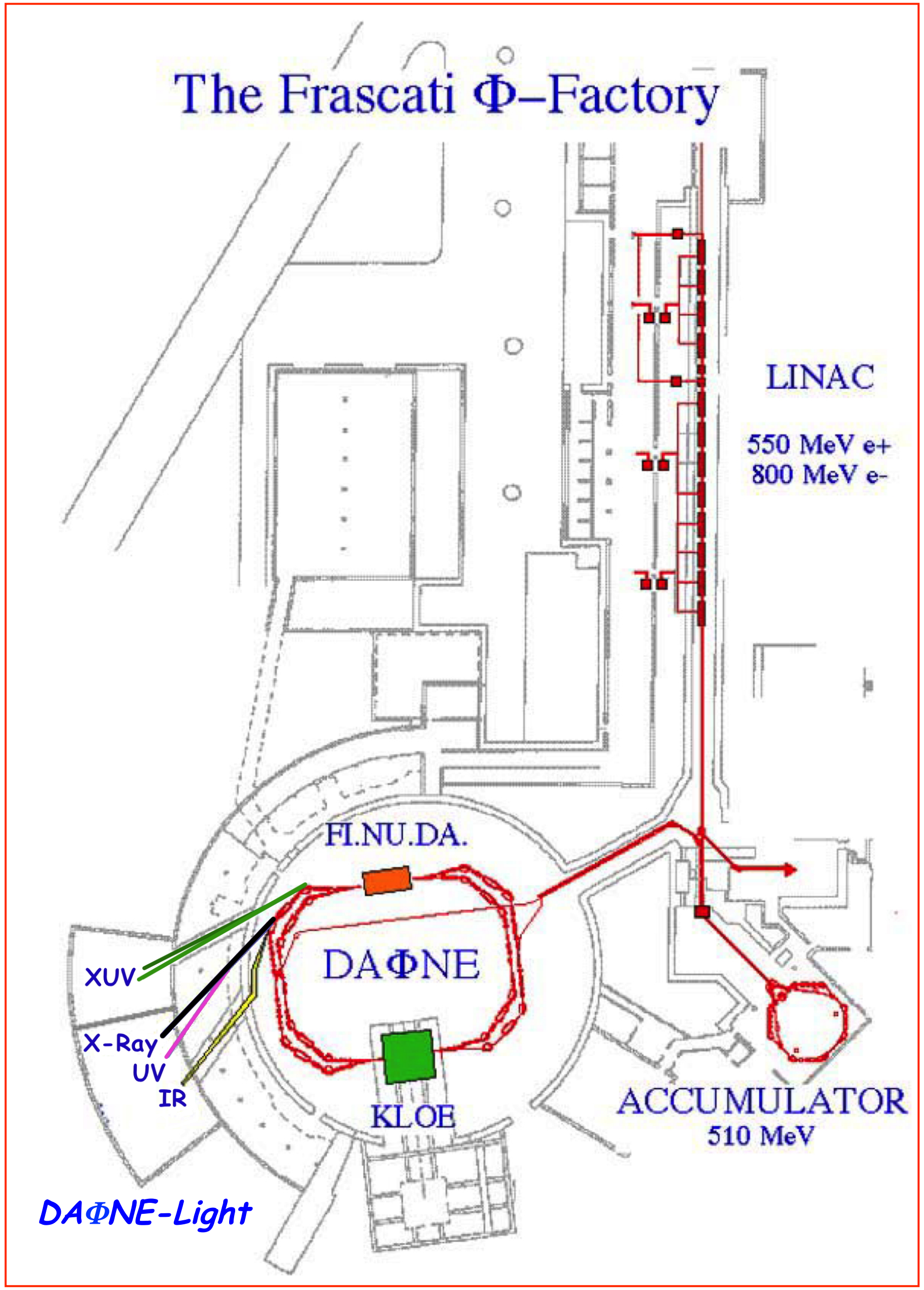
Open to Italian and EU users

3) DXR2 – UV-VIS beamline (2-10eV) new setup.

2 new XUV beamlines

4) Low Energy Beamline (35-200 eV) ready for commissioning;

5) High Energy Beamline (60-1000eV) ready for commissioning.



Available techniques

- FTIR spectroscopy, IR microscopy and IR imaging

- UV-Vis absorption spectroscopy

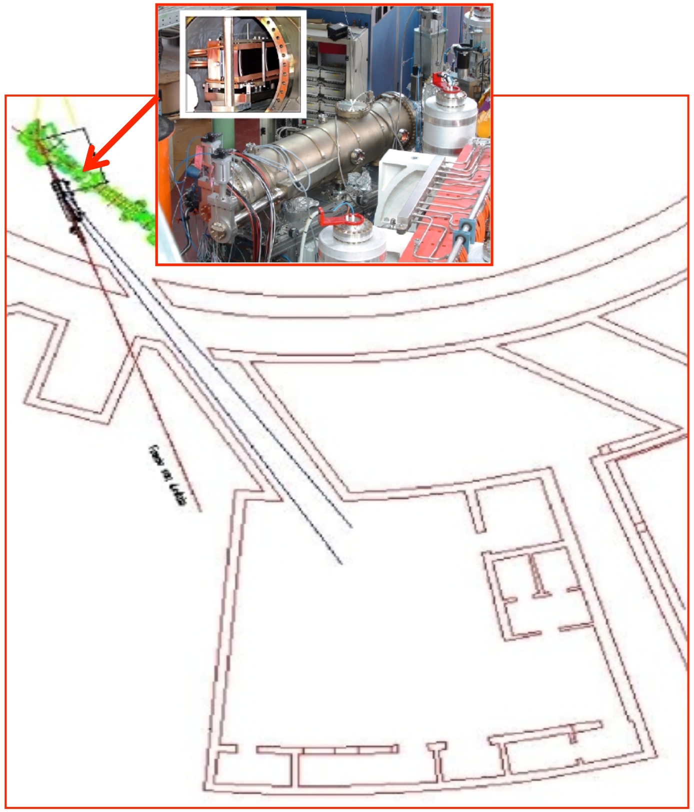
- Photochemistry: UV irradiation and FTIR micro-spectroscopy and imaging.

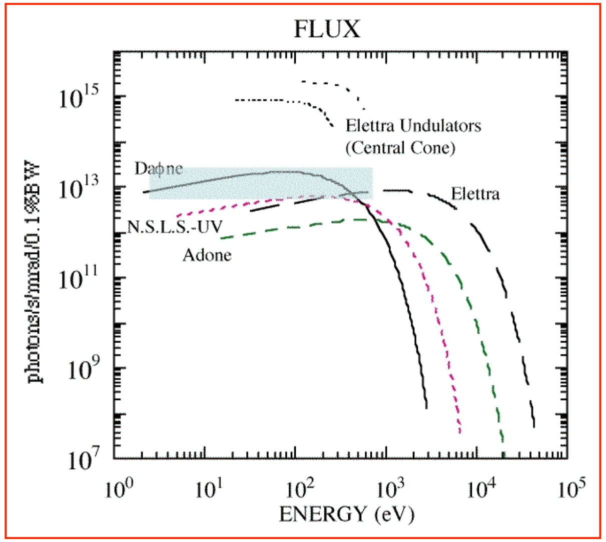
- Soft x-ray spectroscopy: XANES (X-ray Absorption Near Edge Structure) light elements from Na to S

- SEY (secondary electron yield) and XPS (X-ray photoelectron spectroscopy) – by electron and photon bombardment

New XUV beamlines

LEB (35-200 eV) ready for commissioning
HEB (60-1000 eV) ready for commissioning





Fields of interest:

Biology

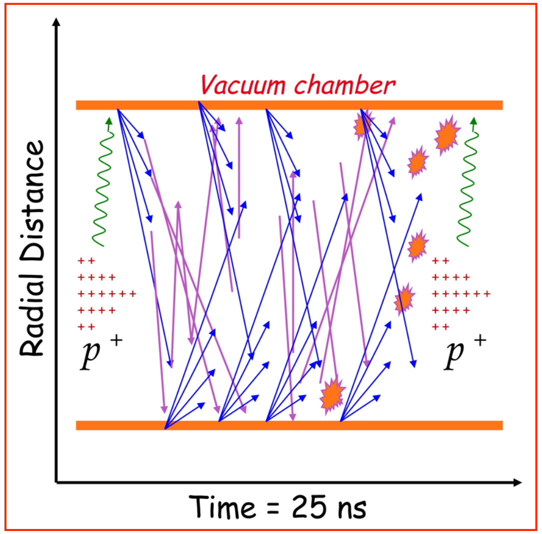
Surface Science

Material Science

R&D studies of INFN interest

IMCA

Innovative Materials and Coatings for Accelerators



The "e-cloud" phenomenon

The accelerated particle beam produces SR and/or e$^-$ that, by hitting the accelerator's walls generate photo-e$^-$ or secondary-e$^-$.
Such e$^-$ can interact with the beam (most efficiently for positively charged beams) and multiply, inducing additional heat load on the walls, gas desorption and may cause severe detrimental effects on machine performance.

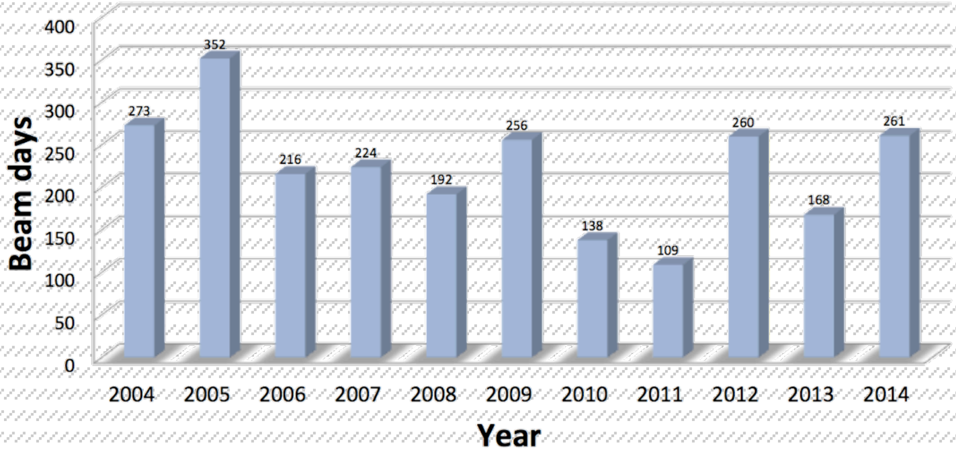
International collaborations*: *CERN, SLAC, ANKA, DESY, Cornell, RICH, BESSY 2

Electron cloud in accelerators, R. Cimino, T. Demma,, *Int. J. Mod. Phys. A* 29, 1430023 (2014)

Secondary electron yield of Cu technical surfaces: Dependence on electron irradiation, R. Larciprete, D. R. Grosso, M. Commisso, R. Flammini, and R. Cimino, *Phys. Rev. ST* 16, 011002 (2013)

Nature of the Decrease of the Secondary-Electron Yield by Electron Bombardment and its Energy Dependence. R. Cimino, M. Commisso, D.R. Grosso, T. Demma, V. Baglin, R. Flammini and R. Larciprete, Phys. Rev. Lett. ***109****, 064801 (2012)*

BTF status 2014



- **11th year** of consolidated and steady running
- Above average beam time: **260 days** (projected to Dec. 15th)
- **30%** of foreign users in the last three years
- **Well above 30%** of dedicated beam due to problems with DAFNE collider operations (aqueduct, cryogenics, …)

- **Good up-time of the linac, despite some problems and un-scheduled maintenance, and an unfortunate year from the point of view of the general infrastructure**
- **Consolidation of the linac has been very beneficial**
- **Consequences of the large accident of the aqueduct minimized thanks to the effort of the entire lab:**
  - **Essentially all systems off (large part of DAFNE complex, including damping ring, main rings, cryogenics, KLOE experiment and KLOE computing) apart from linac and BTF**
  - **Demonstrated the possibility of running linac and BTF with reduced power and a modest water flow**
  - **Separation of cooling tower of linac and BTF from the rest of the plant demonstrated to be very useful**

BTF schedule 2014

Legenda
Requested
Approved - **Main User**
Approved - *Co-user*
Cancelled or To Be Confirmed

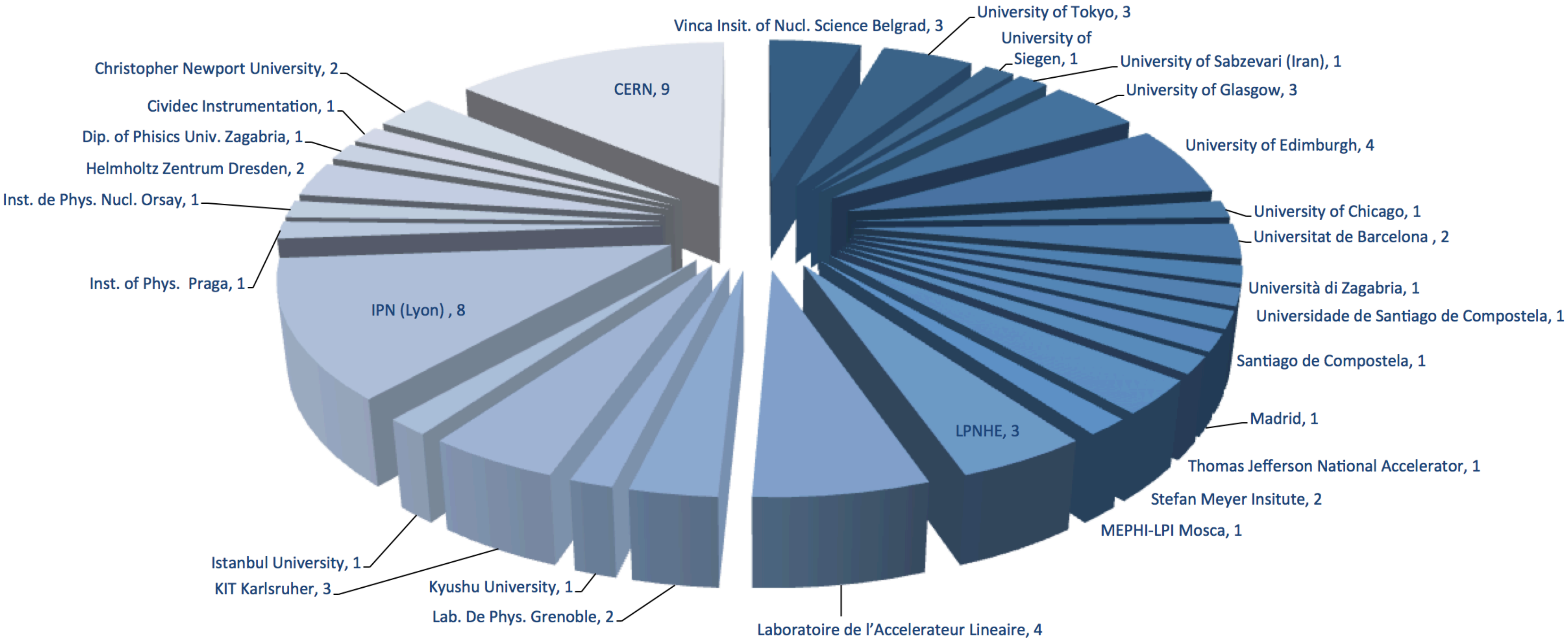
Start	End	User	Contact Person	Rollin/out (h)	beam (days)
2014-02-03	2014-02-10	**tof_diamonds**	Roberto Cardarelli	6	**7**
2014-02-10	2014-02-17	**MU2E**	Ivano Sarra	6	**7**
2014-02-17	2014-02-24	**UA9**	Gianluca Cavoto	24	**7**
2014-02-17	2014-02-24	**JLAB12-RICH**	Vincenzo Lucherini	6	**7**
2014-02-24	2014-03-03	**BTF-CHAOS**	Luca Foggetta	6	**7**
2014-03-03	2014-03-10	**VIPIX**	L. Servoli	6	**7**
2014-03-03	2014-03-10	**MIMOSA**	Spiriti Eleuterio	6	
2014-03-10	2014-03-17	**MEGII**	Francesco Grancagnolo	6	
2014-03-17	2014-03-24	**MEG-ATAR**	Gianluca Cavoto	6	
2014-03-24	2014-03-31	**Diamonds LHC**	Florian Burkart	6	
2014-03-31	2014-04-07	**JLAB12-RICH**	Vincenzo Lucherini	24	
2014-04-07	2014-04-14	**UA9**	Gianluca Cavoto	24	
2014-04-07	2014-04-14	**JLAB12-RICH**	Vincenzo Lucherini	24	
2014-04-15	2014-04-18	**C-SPEED**	Marcello Piccolo	6	
2014-04-22	2014-04-25	**BTFstaff**	Paolo Valente	6	
2014-04-28	2014-05-05	**CMSECALUP**	Paolo Meridiani	6	
2014-05-05	2014-05-10	**FAMU**	Andrea Vacchi	6	
2014-05-12	2014-05-19	**ITS**	Paolo Martinengo	6	
2014-05-19	2014-05-26	**IMCP**	Paolo Meridiani	6	
2014-05-26	2014-06-03	**PP@LPA**	Riccardo Faccini	6	
2014-06-03	2014-06-09	**BTFstaff**	Paolo Valente	6	
2014-06-09	2014-06-16	**BTF-CHAOS**	Luca Foggetta	6	
2014-06-16	2014-06-23	**ITS**	Paolo Martinengo	6	
2014-06-23	2014-06-30	**JLAB12**	Guido Maria Urciuoli	6	

2014-06-30	2014-07-07	**VIRHIS**	Massimo Zambelli	6	**7**
2014-07-07	2014-07-14	**atlasmup**	c. gatti, m. antonelli	6	**7**
2014-07-14	2014-07-21	**INSUB**	Michela Prest	4	**7**
2014-07-21	2014-07-28	**GAMMA-400**	Valter Bonvicini	6	**7**
2014-07-28	2014-08-04	**MEG2**	Flavio Gatti	6	**7**
2014-08-05	2014-09-07	**BTFstaff**	Paolo Valente	0	**33**
2014-09-08	2014-09-15	**tof_diamonds**	Roberto Cardarelli	6	**7**
2014-09-15	2014-09-22	**PICO**	Martino Marisaldi	6	**7**
2014-09-22	2014-09-29	**VIPIX**	L. Servoli	6	**7**
2014-09-22	2014-09-29	**MIMOSA**	Spiriti Eleuterio	6	**7**
2014-09-29	2014-10-06	**CRYSBEAM**	Gianluca Cavoto	6	**7**
2014-09-29	2014-10-06	**PADME**	Mauro Raggi	6	**7**
2014-10-06	2014-10-13	**BTFstaff**	Paolo Valente	6	**7**
2014-10-13	2014-10-20	**MEGII**	Francesco Grancagnolo	6	**7**
2014-10-20	2014-10-27	**IMCP**	Paolo Meridiani	6	**7**
2014-10-20	2014-10-27	**Pixel-tracker**	Spiriti	6	**7**
2014-10-27	2014-11-03	**B2ECL**	Pasquale Lubrano	6	**7**
2014-11-03	2014-11-10	**BTFstaff**	Paolo Valente	6	**7**
2014-11-10	2014-11-17	**SIDDHARTA/AMADEU**	Catalina Petrascu	6	**7**
2014-11-17	2014-11-24	**MU2E**	Ivano Sarra	6	**7**
2014-11-24	2014-12-01	**dBLM**	florian burkart	8	**7**
2014-11-24	2014-12-04	**PADME**	Mauro Raggi	6	**10**
2014-12-04	2014-12-15	**AMY**	Valerio Verzi	6	**11**

Year: **2014** Total days with accepted=1: **261**

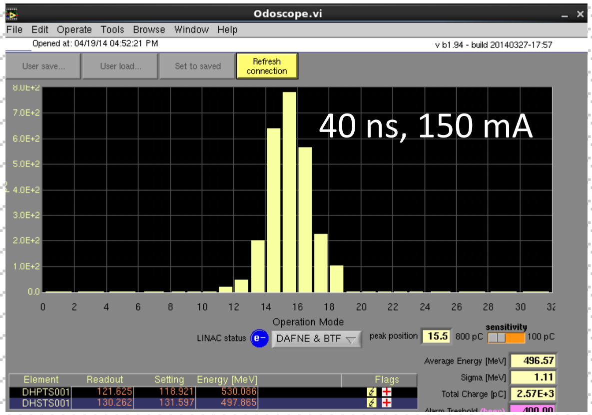
- Reduced "pressure" from users wrt 2013, mainly due to restart of CERN beams (PS, SPS)
- Still requests ≈150% of available slots
- Shifts reduction, some sharing of the beam (this weekend, ALICE ITS team from CERN)
- Already some "overflow" in 2015
- Call for 2015 closing end of December

Foreign institutions users



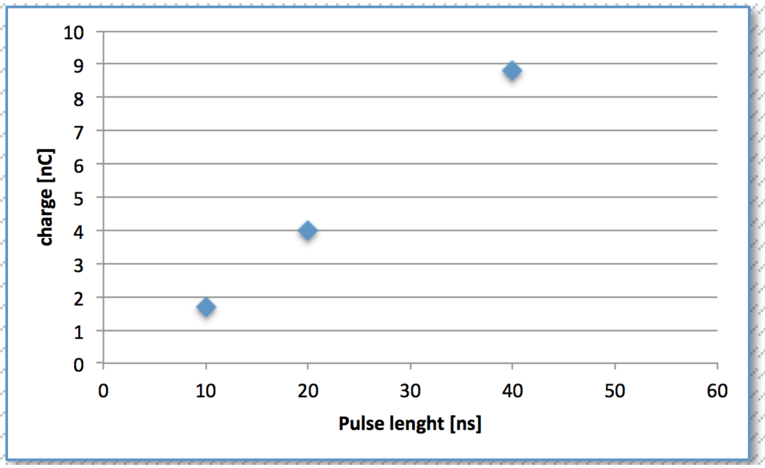
BTF users, coming from foreign institutions (multiple shifts counted once), during the last 3 years

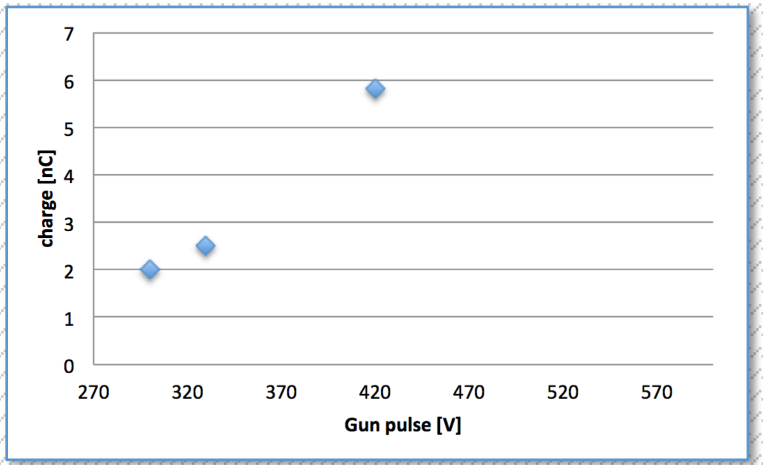
Improvements of the beam parameters



Driven by the requirements of possible future experiments:

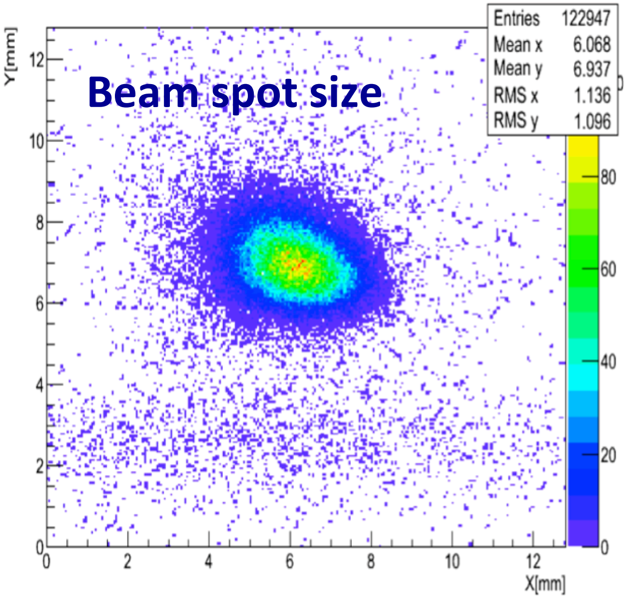
- **Make the linac pulses variable in length:**
  - Upgrade of the gun pulsing system, now capable of delivering pulses between 1.5 and 40 ns, in steps of 0.5 ns, and pulse height between 300 and 750 V in steps of 30 V
  - Studying the energy spread vs. pulse length, towards a ≈150 ns pulse
- **Verify all possible handles in order to increase the total pulse charge**
- **Optimize focalization at the exit of the gun, and the transport along the linac, in order to reach the maximum possible energy (both with electrons and positrons)**
- **Improve the diagnostics (BPM's all along the linac all connected and read-out)**

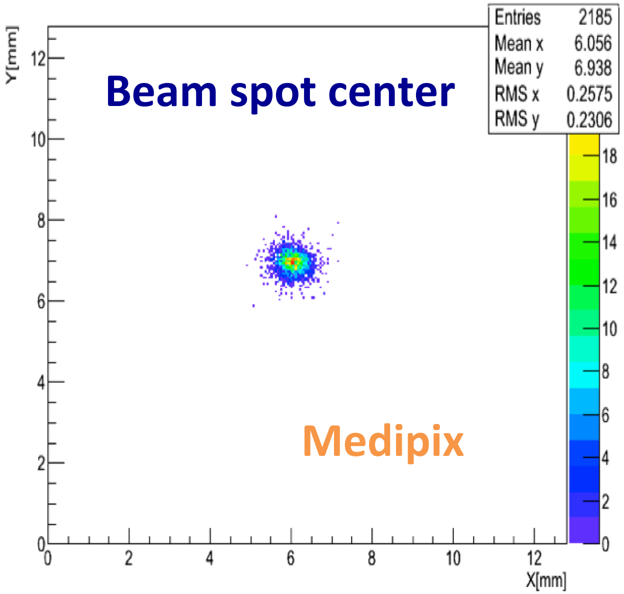


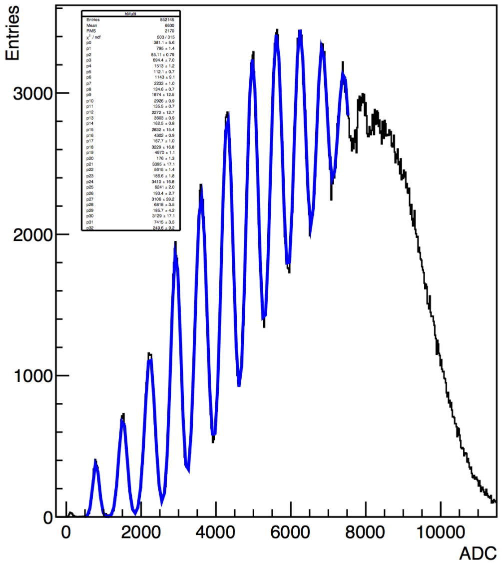


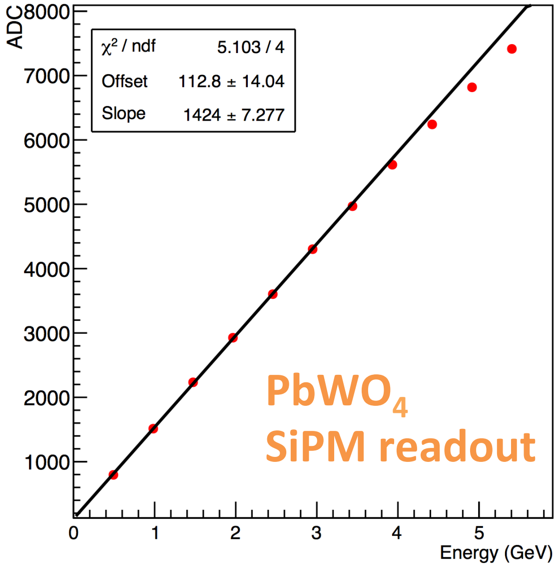
Improvements of the beam parameters

- Beam quality at the end of the BTF line: improve the focusing and the stability of the beam spot









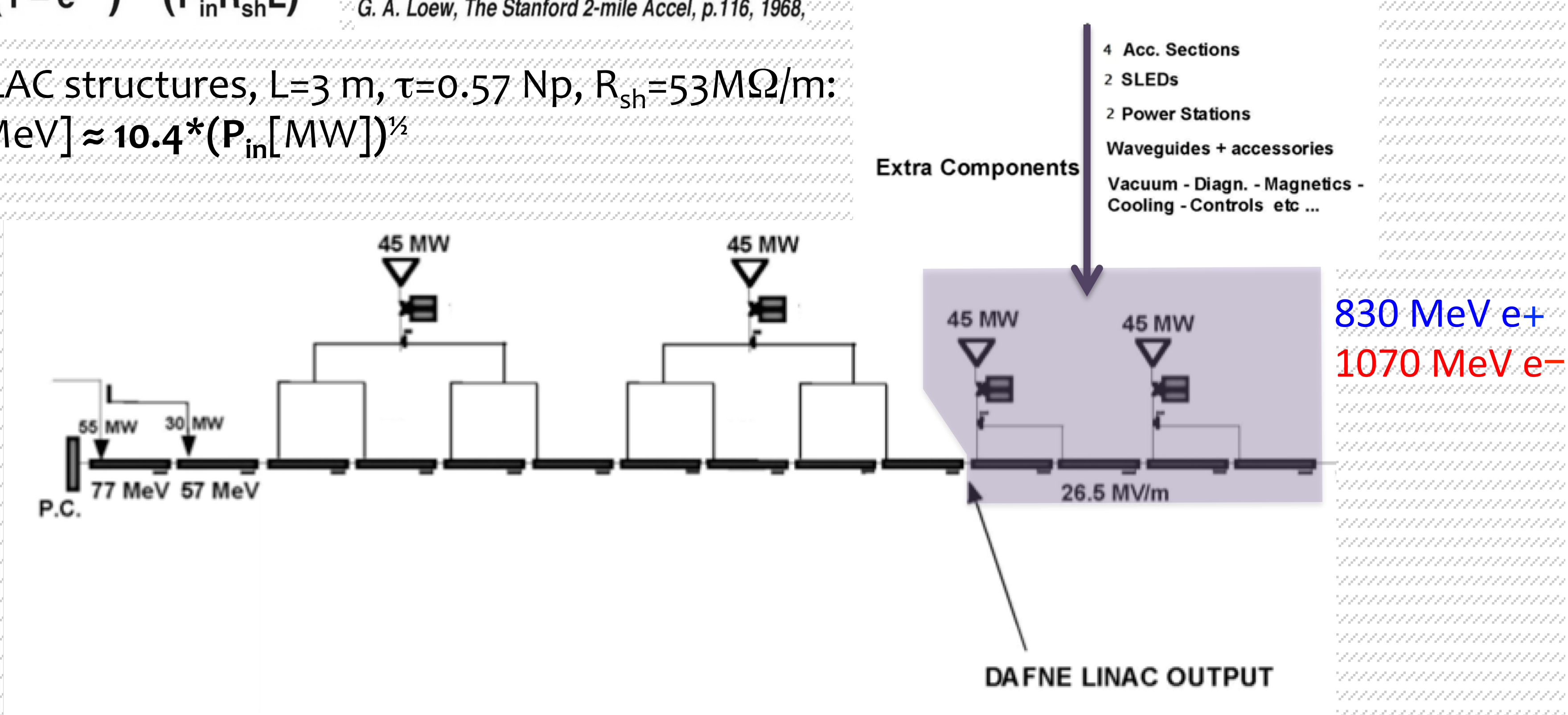
Revived proposal for linac energy upgrade:

- Very important for electron fixed-target experiments for light dark matter searches (dark photon)
- Also very useful for improving the potential of BTF in the field of detector testing

$U_0 = (1 - e^{-2\tau})^{1/2} (P_{in} R_{sh} L)^{1/2}$ *G. A. Loew, The Stanford 2-mile Accel, p.116, 1968,*

In SLAC structures, $L=3$ m, $\tau=0.57$ Np, $R_{sh}=53 M\Omega/m$:

$U_0[MeV] \approx \mathbf{10.4}{*}(P_{in}[MW])^{1/2}$



External programs

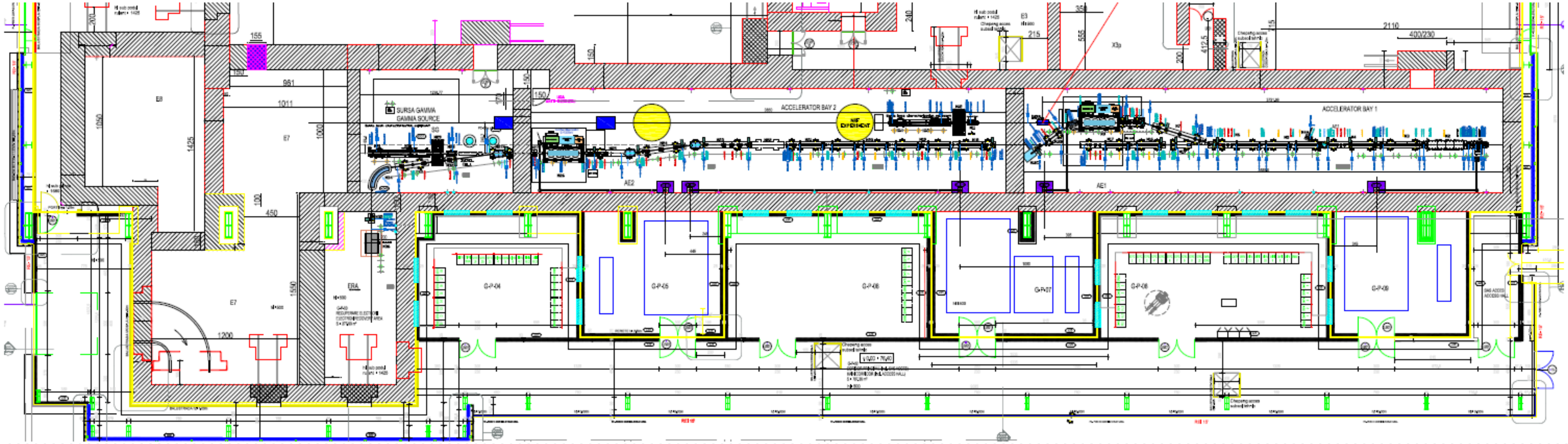
- ELI-NP 20 MeV gamma beam by Thomson Scattering – Magurele
- STAR 10 KeV X ray beam by TS- Cosenza
- HL-LHC High luminosity LHC studies - CERN
- FCC Future Circular Collider studies -CERN
- ESRF EU Synchrotron radiation facility upgrade - Grenoble

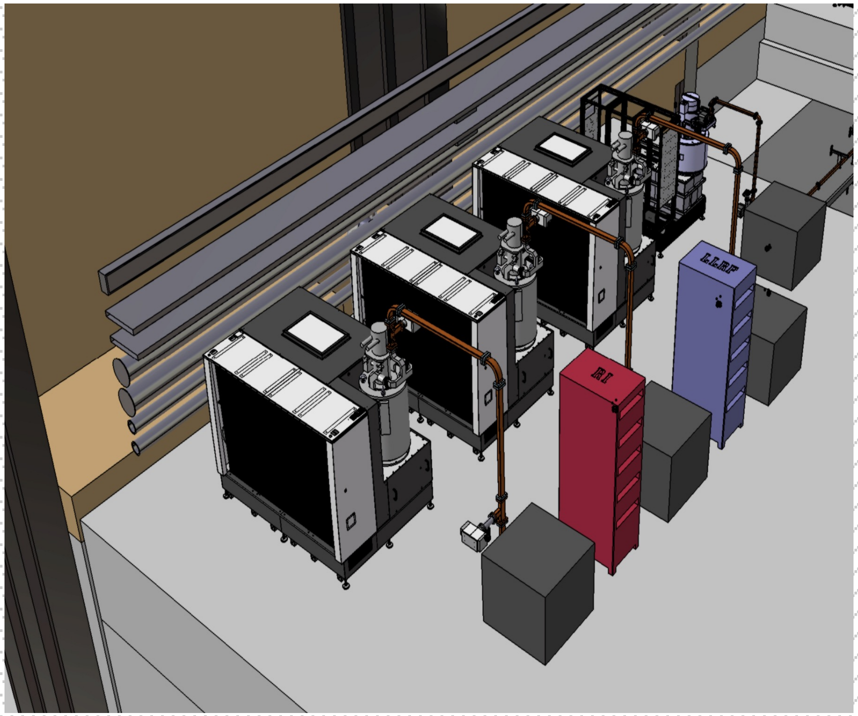
ELI-NP

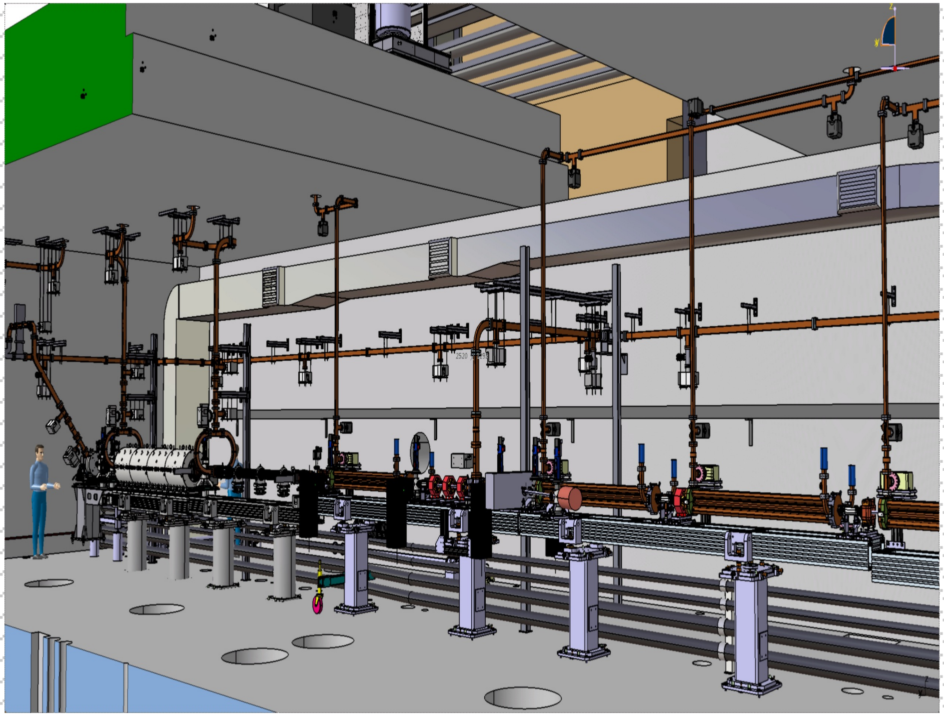
20 MeV Gamma photons source based on Thomson scattering

EuroGammas consortium participants:
INFN: LNF,Fe,Mi,CT,Fi
CNRS: LAL Orsay
Università "la Sapienza"
Alsyom
ACP-Amplitude
COMEB
Scandinova

Gamma source layout: 720 MeV Linac







Full C-Band
accelerating section
Brazing procedure in
INFN Legnaro lab

First section brazed
now under vacuum test

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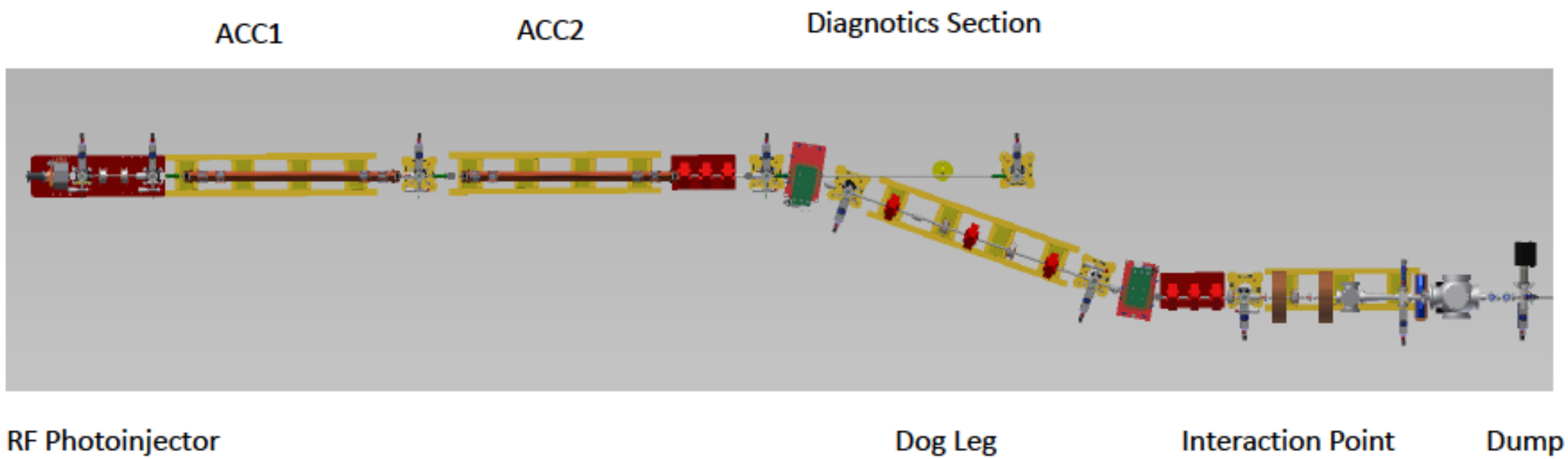
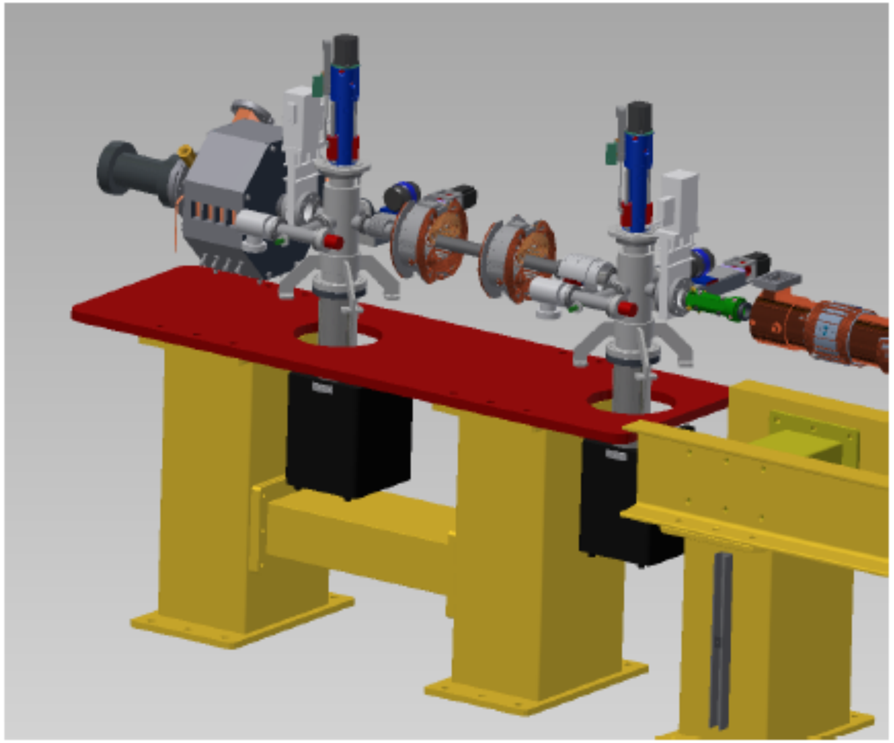
The STAR Project:
Southern european Thomson source for Applied Research



Photoinjector Layout



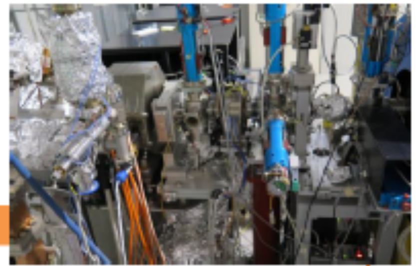


Table 1: Specifications of the RF Photoinjector System

Parameter	Value
Input power	9.5 MW
Output Energy	5 MeV
Operating Frequency	2.856 GHz
Normalized emittance*	≤ 1.0 micron at 500 pC
Repetition rate	Up to 100 Hz
Quality factor Q_0	13,800
Shunt impedance R'_{shunt}	60 MΩ/m
Peak surface field	102 MV/m
Peak cathode field	120 MV/m
External coupling factor (β)	2.0
Operating temperature	40° C
Materials	OFHC grade 1 copper, cross-forged 316L SST flanges, Aluminum stands
Magnetic permeability of flange material	< 1.05
RF flange type	LIL
Braze materials/steps	3-steps: 25/75, 35/65, 50/50 Au/Cu
Material certs	To be delivered to customer
Fasteners	All metric
Warranty	1 year from delivery

Vendor: RadiaBeam Europe

LNF Participation in HL-LHC Project

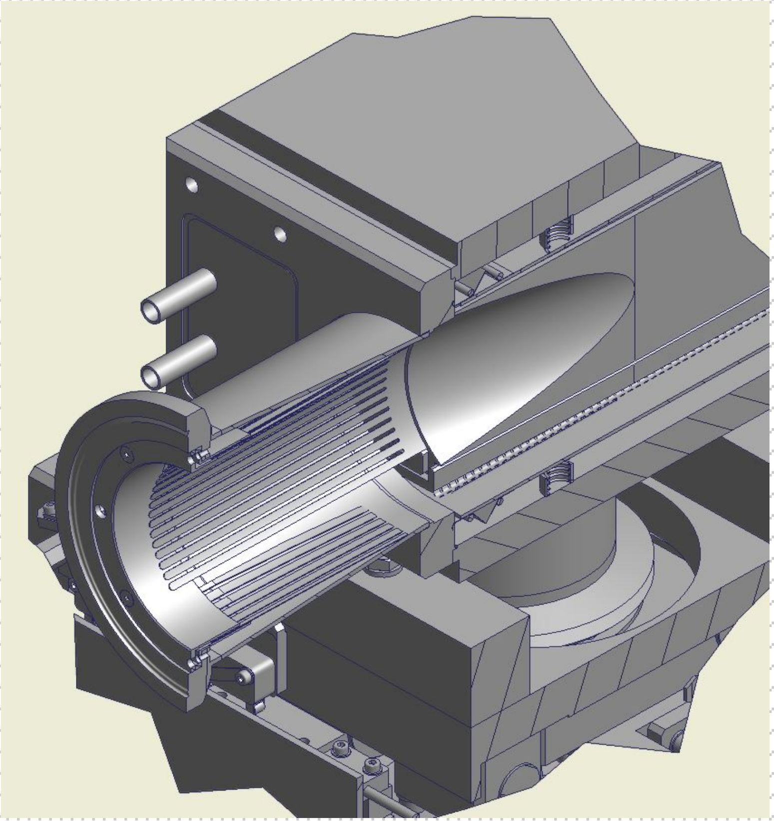
Participants (Accelerator Division)

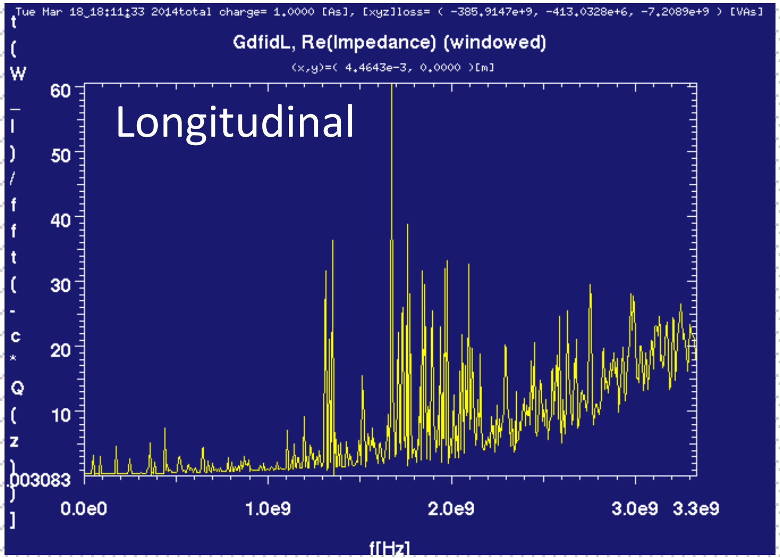
1. Zobov Mikhail - Local Coordinator
2. Alesini David
3. Drago Alessandro
4. Gallo Alessandro
5. Frasciello Oscar
6. Milardi Catia
7. Tomassini Sandro

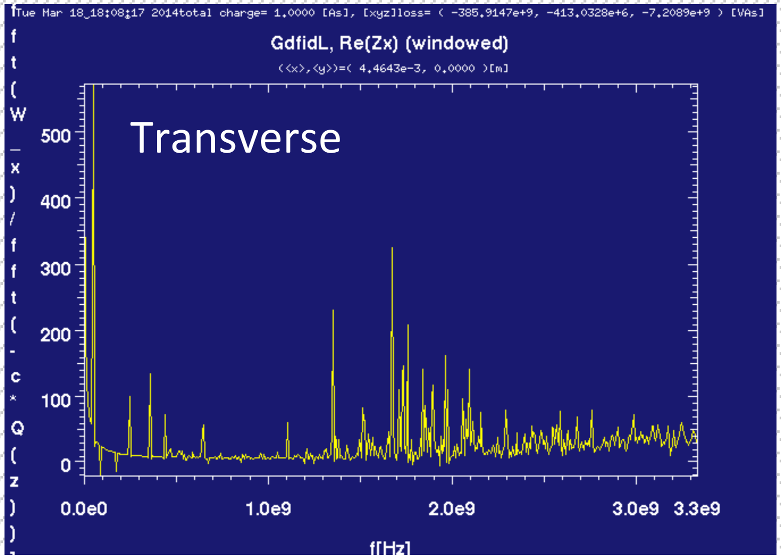
Subjects to Study for LHC Upgrade (WP2)

1. Optics and beam-beam effects studies
2. Impedance calculations of LHC collimators
3. Electromagnetic design of 800 MHz cavity
4. Electromagnetic design and impedance studies for SPS coaxial slotted kicker
5. Collective effects studies (e-cloud)

LHC Collimators Impedance Calculations

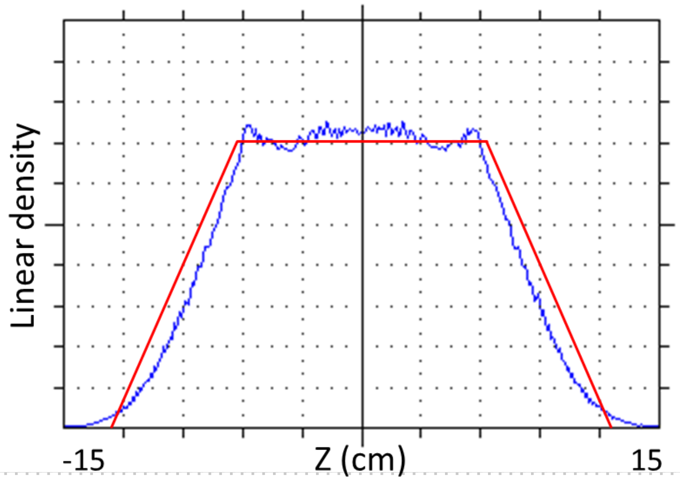


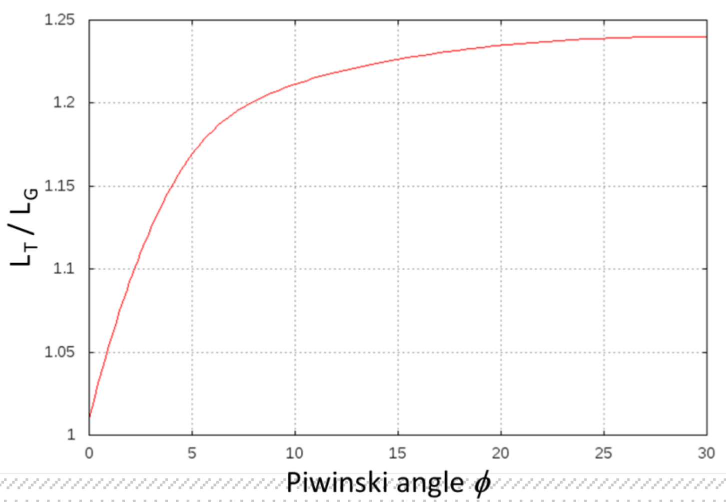


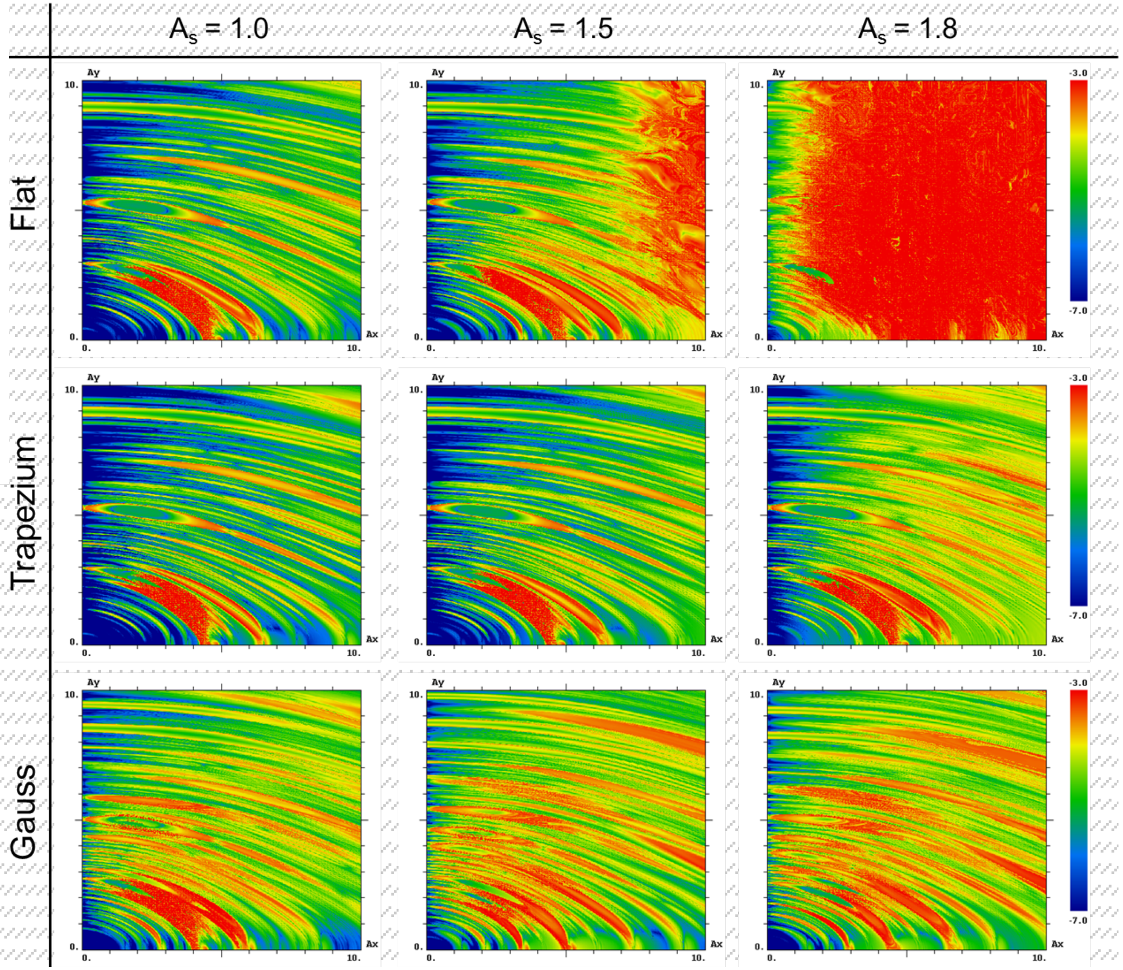


O.Frasciello, S.Tomassini, M.Zobov

Study of flat beam collisions for LHC upgrade



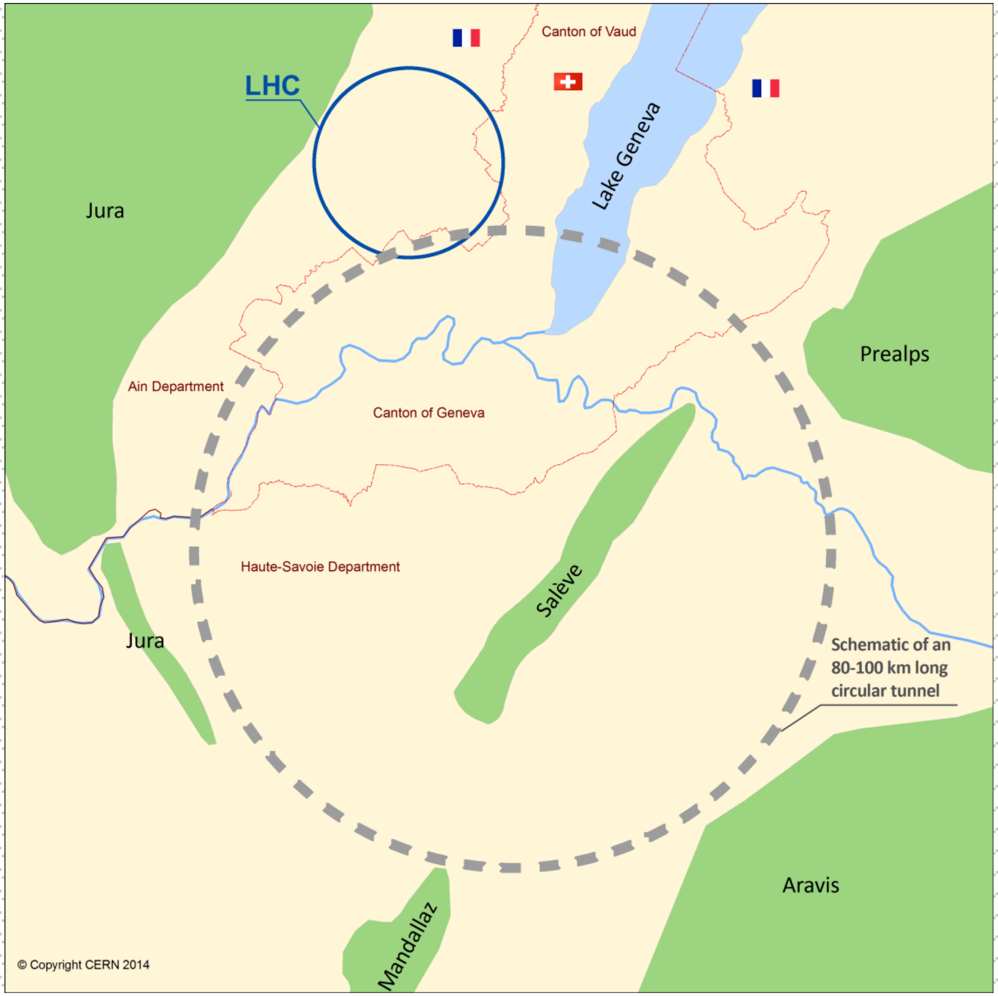




M.Zobov, D.Shatilov

FCC- Future Circular Collider study

- pp collider (FCC-hh) E_{beam}= 50 TeV -> defines infrastructure
  - B = 16 T ⇒ 100 km
  - B = 20 T ⇒ 80 km
- e^+e^- collider (FCC-ee) E_{beam}= 40-175 GeV -> as intermediate step
- e-p option
- Infrastructure in the Geneva area
- International collaboration is taking shape: *First ICB at CERN in September*



CDR and cost review for the next European Strategy Update in 2018

DA-LNF Collaboration with FCC

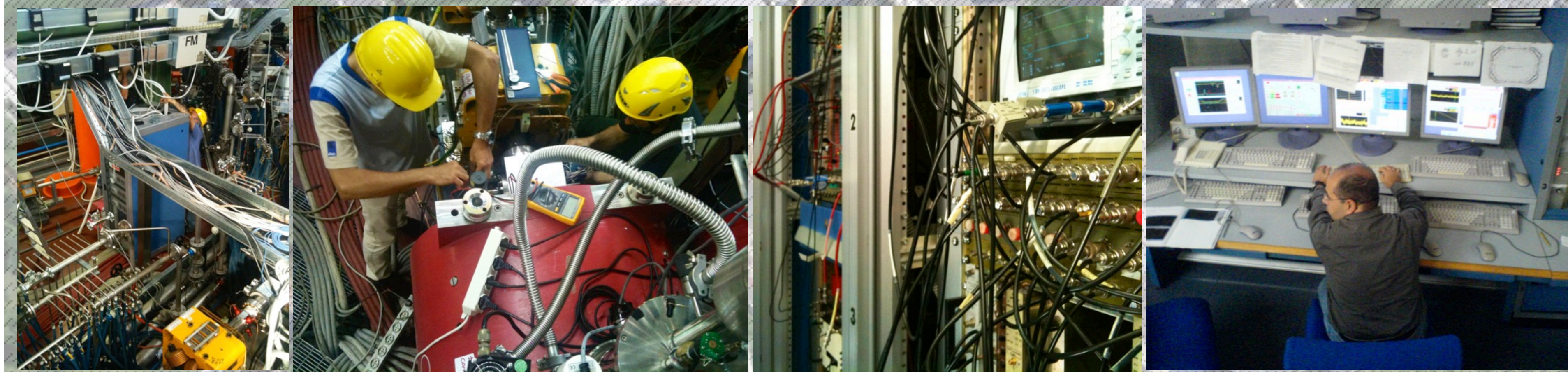
- MDI studies for FCC-ee (convenership)
- Contribution to MDI studies for FCC-hh (in the EuroCircol framework)
- Contribution to IR optics Design for FCC-ee

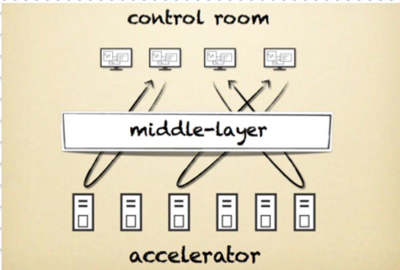
- Contribution to design of cryo-magnet beam-pipe system for FCC-hh (Res. Div., in the EuroCircol framework) INFN Mi & Ge
- Impedance Budget evaluation for FCC-ee (Univ. La Sapienza)

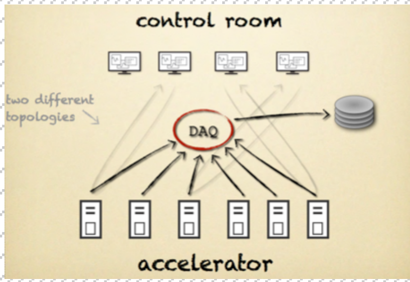
!CHAOS

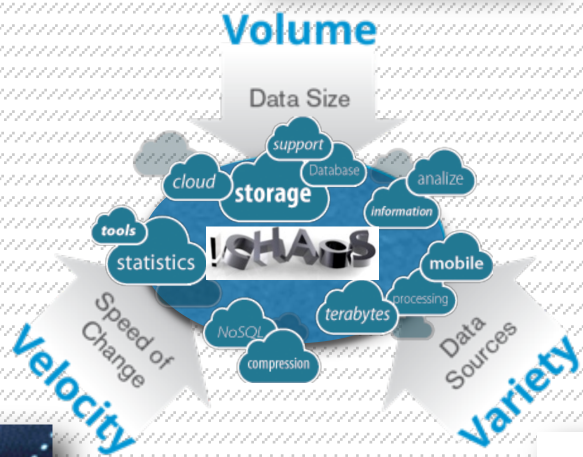
Why, when & where the project started

plant → sensors/actuators → front-end → control room

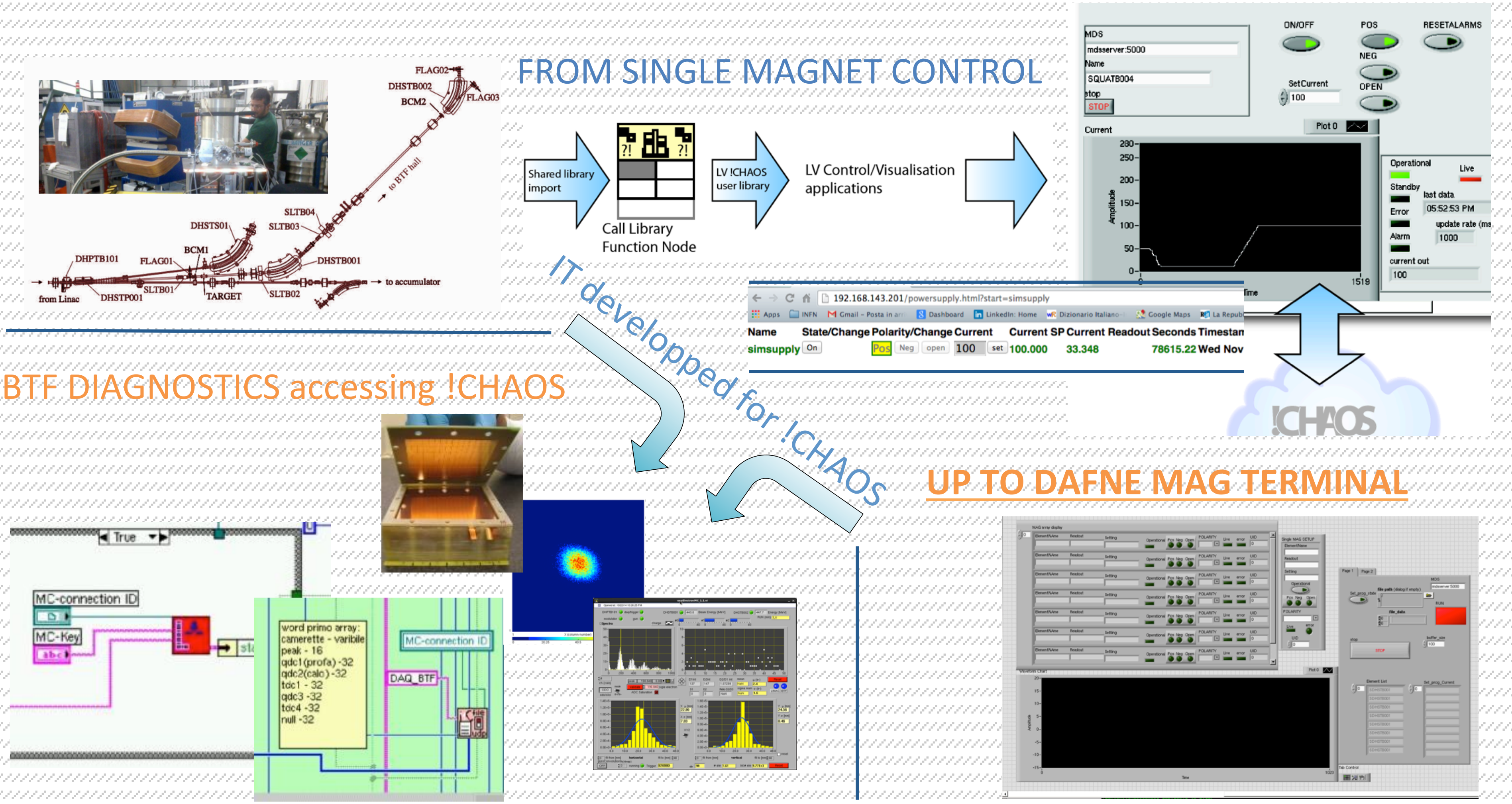


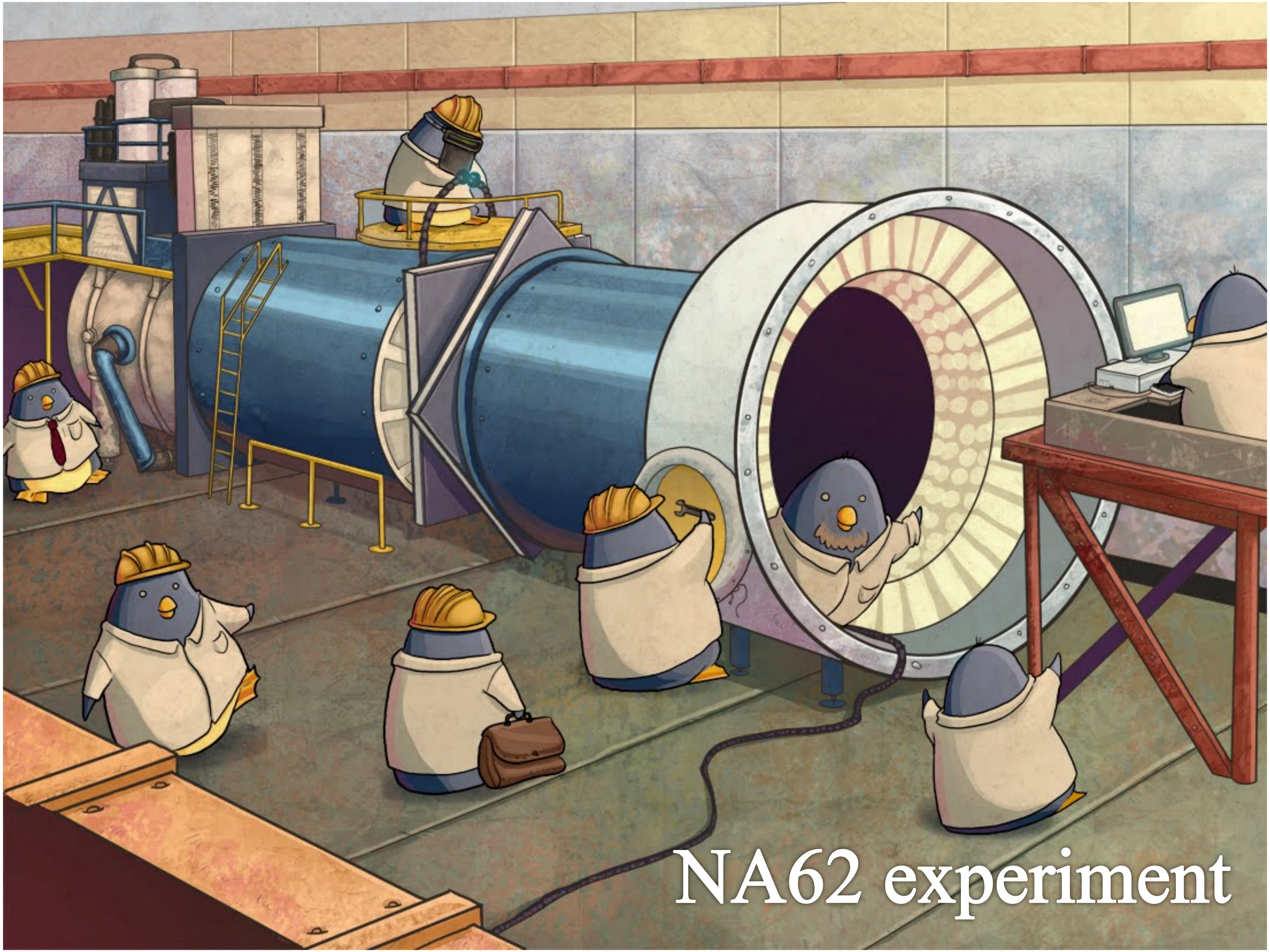

control room
middle-layer
accelerator


control room
two different topologies
DAQ
accelerator


Volume
Data Size
support
cloud
storage
Database
analize
information
tools
statistics
!CHAOS
mobile
processing
terabytes
NoSQL
compression
Speed of Change
Velocity
Data Sources
Variety

!Chaos @ BTF


FROM SINGLE MAGNET CONTROL
Shared library import
Call Library Function Node
LV !CHAOS user library
LV Control/Visualisation applications
FLAG02
DHSTB002
BCM2
FLAG03
to BTF hall
SLTB04
DHSTS01
SLTB03
BCM1
DHPTB101
FLAG01
DHSTB001
SLTB01
TARGET
SLTB02
from Linac
DHSTP001
to accumulator
MDS
mdsserver:5000
Name
SQUATB004
STOP
ON/OFF
POS
NEG
OPEN
RESETALARMS
SetCurrent
100
Current
Plot 0
Amplitude
Time
Operational
Live
Standby
last data
05:52:53 PM
Error
update rate
1000
Alarm
current out
100
192.168.143.201/powersupply.html?start=simsupply
Name
State/Change Polarity/Change Current
Current SP
Current Readout
Seconds
simsupply
On
Pos
Neg
open
100
set
100.000
33.348
78615.22
Wed Nov
!CHAOS
IT developped for !CHAOS
BTF DIAGNOSTICS accessing !CHAOS
UP TO DAFNE MAG TERMINAL
True
MC-connection ID
MC-Key
word primo array:
camerette - varibile
peak - 16
qdc1 (profa) -32
qdc2(calo) -32
tdc1 - 32
qdc3 -32
tdc4 -32
null -32
MC-connection ID
DAQ_BTF


NA62 experiment

LNF responsibilities on photon veto system

The LNF group responsibilities in the Large Angle Veto (LAV) detectors

- Coordination of the photon Veto System
- Design of the LAV vessel & construction equipment
- Test and calibration of the PbGl blocks
- Assembly of the LAV stations
- Vacuum, HV and electronics tests
- LAV installation on ECN3 cavern

The LNF group responsibilities in the LAV readout

- Design and testing of new HV dividers for the R2238 PMTs
- Project and development of FEE + calibration pulser
- Production, validation and testing of the final FEE board
- Installation and commissioning of the LAV readout in ECN3
- Firmware for the L0 LAV trigger primitive generation

The LNF group responsibilities Small angle Vetos

- Final design assembly and installation of the Intermediate Ring Calorimeter

The LNF group responsibilities in software and MC

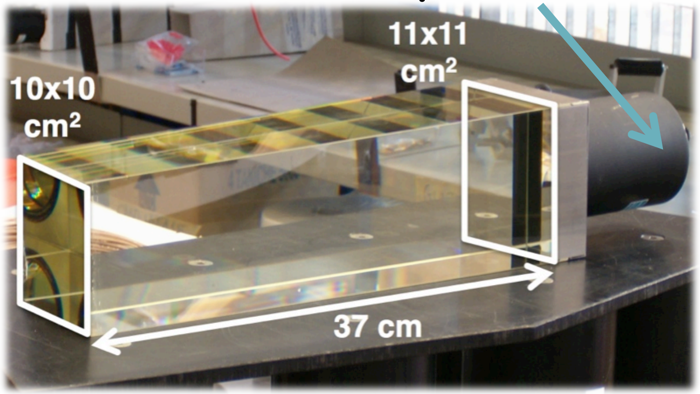
- Leading role in the LAV MC reconstruction

The Large Angle Veto detectors

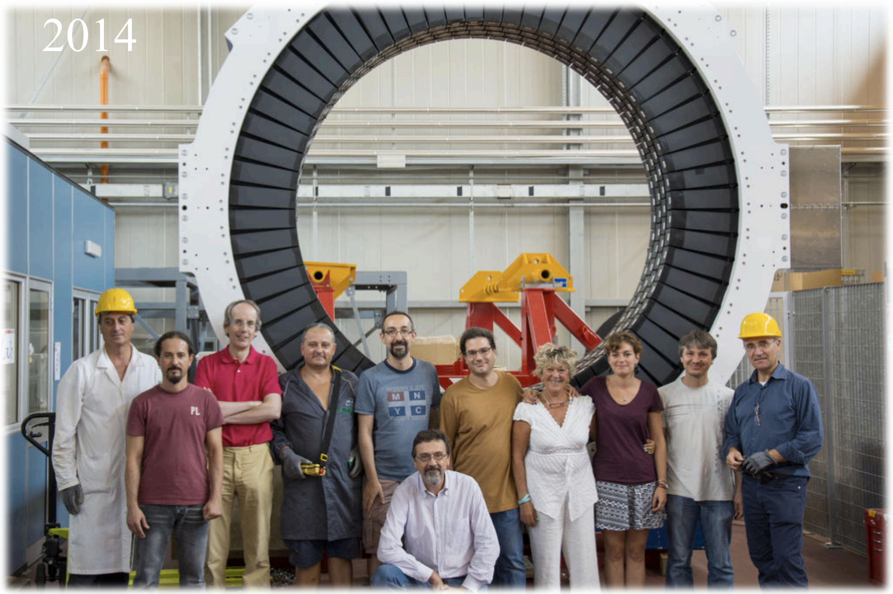
LAV numbers

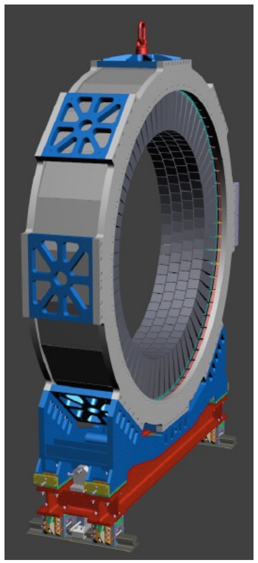
- 12 stations
- 11 stations in vacuum
- 4-5 rings/layer
- 32-64 blocks/layer
- 2500 blocks total
- All particles from axis cross min 3 blocks ($20X_0$)

R2238 76-mm PMTμ-metal case

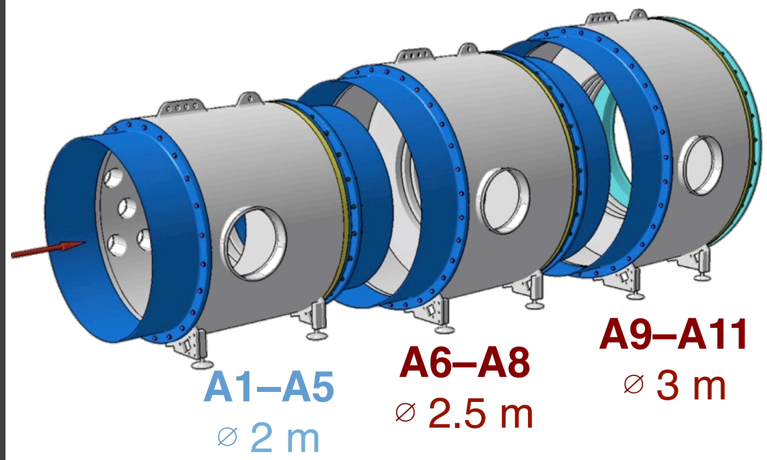


Lead-glass blocks from OPAL EM barrel
Schott SF57 lead glass



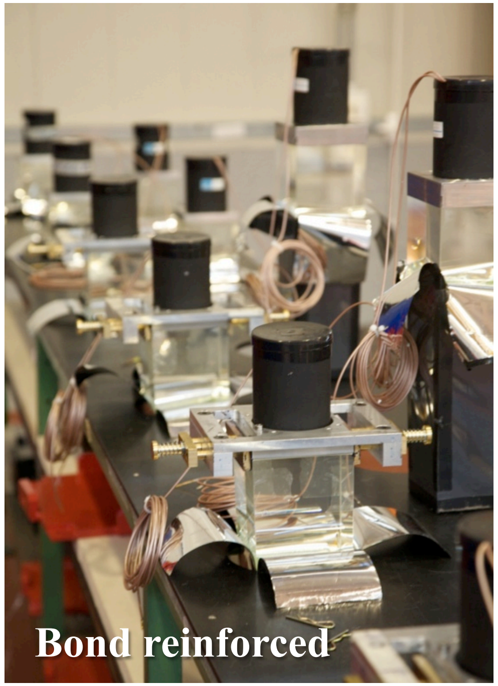


11 rings installed in vacuum tank
+1 ring in air before LKr



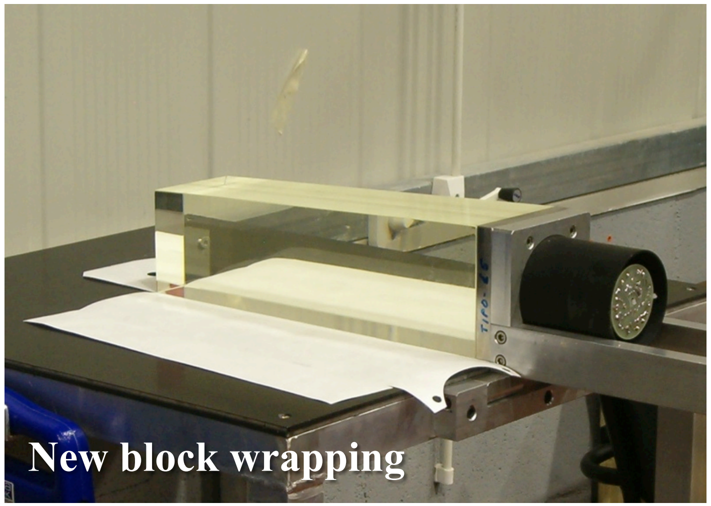
LAV construction @ LNF 2008-2014

Water damage



Bond reinforced

"Banana" assembly

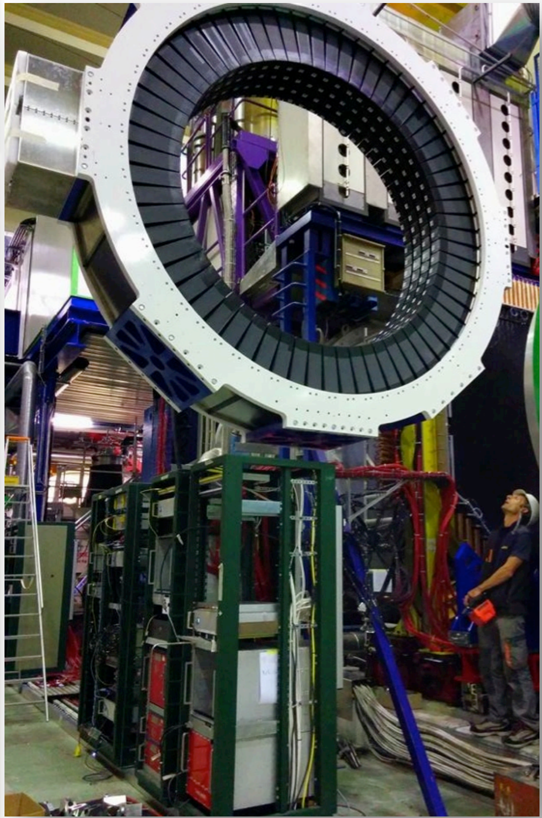


New block wrapping

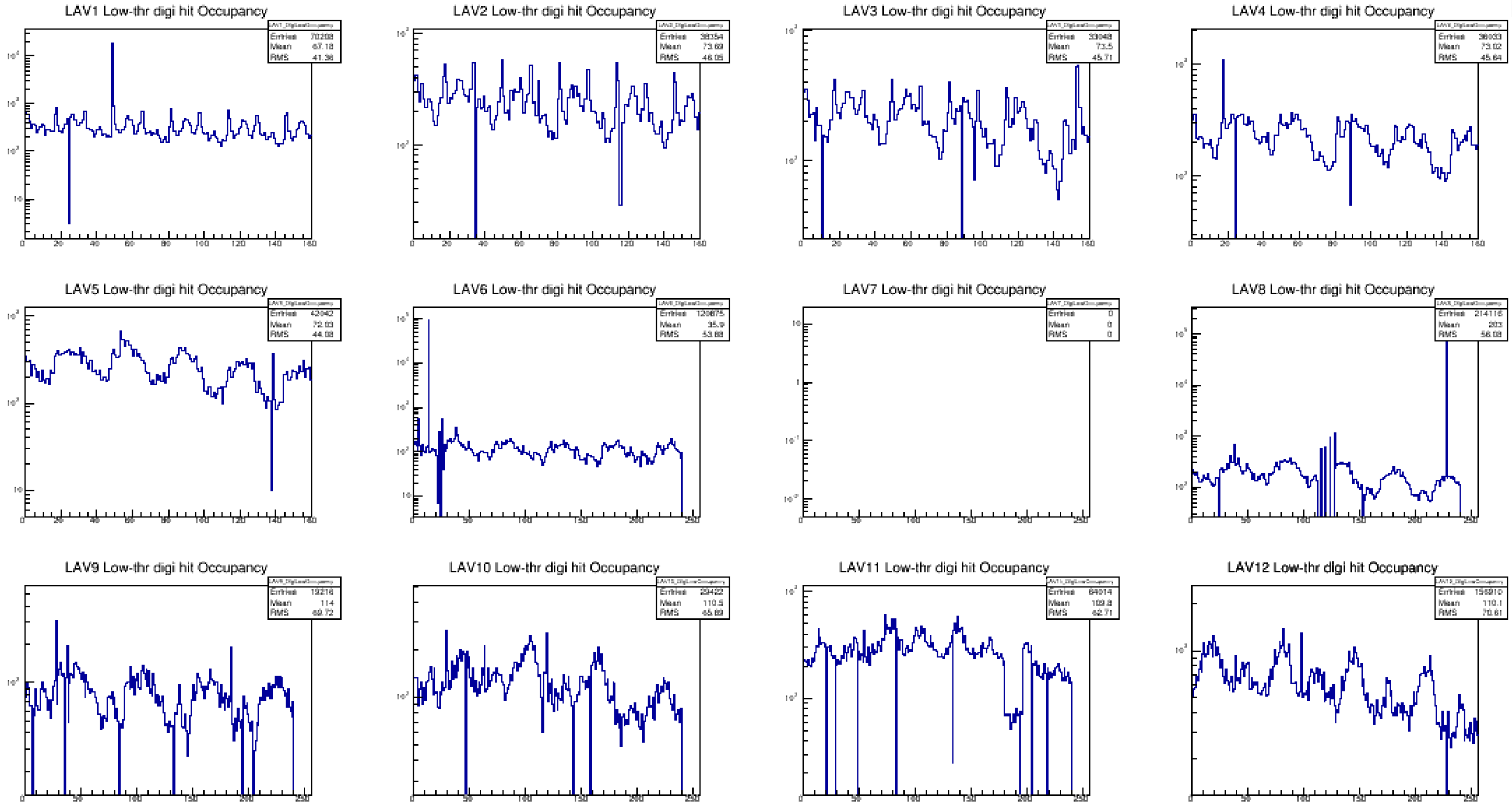
Banana installation

LAV installation complete

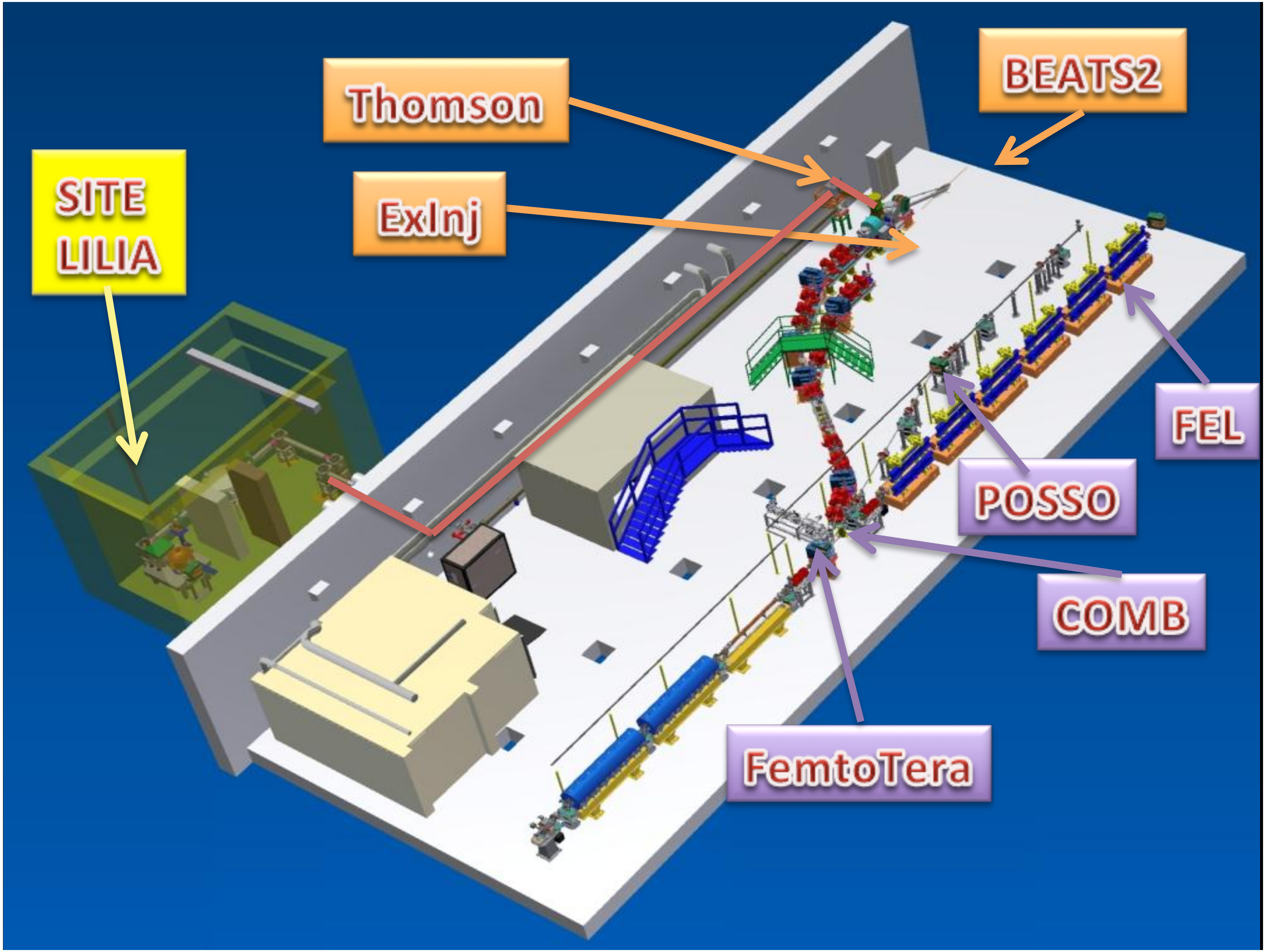
- We installed all the 12 LAV stations already in September 2014
- The decay region has been evacuated to the pressure of ~10^{-6}
- All 12 LAV are already in use in the NA62 run fully equipped with readout



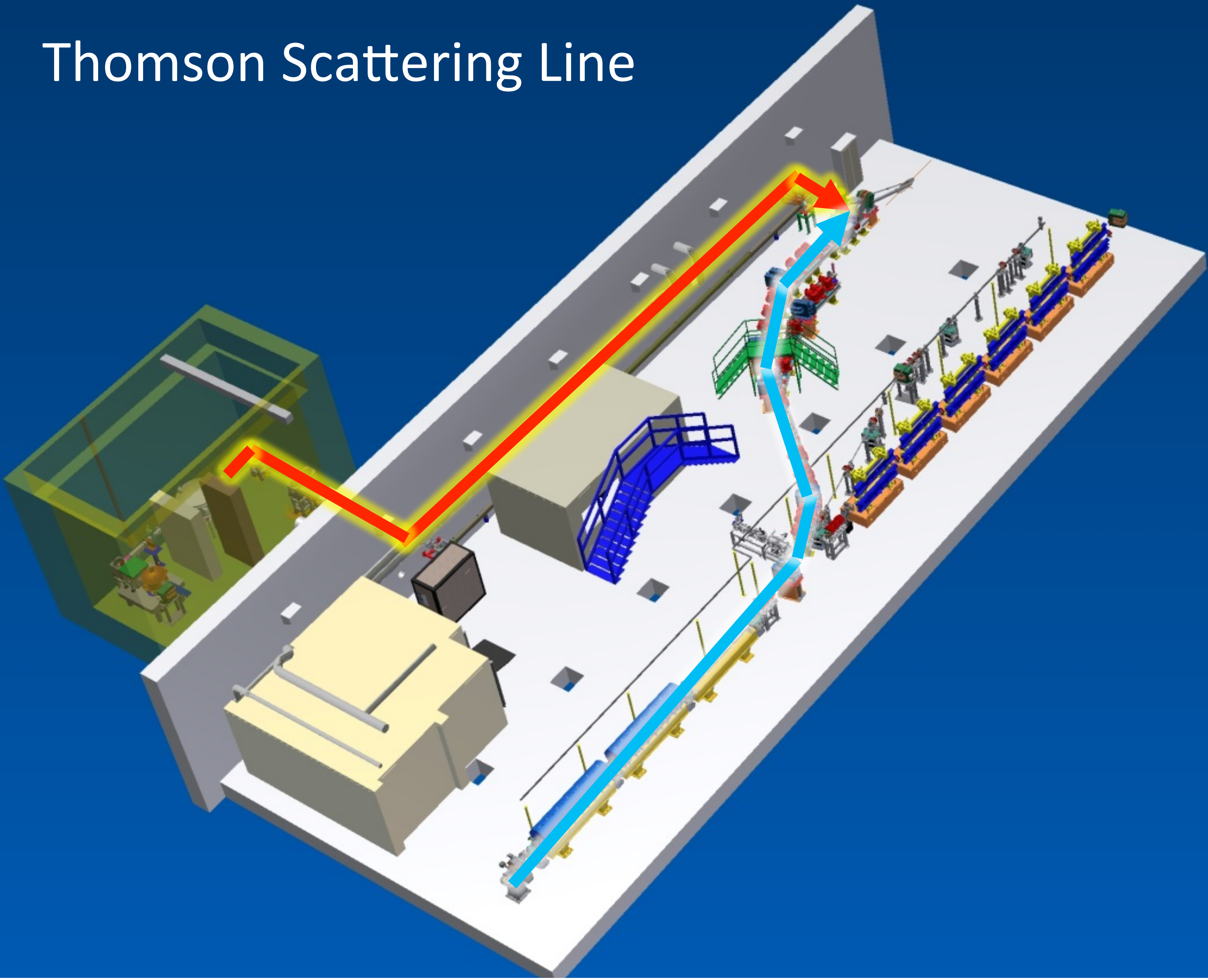
Online monitor plot



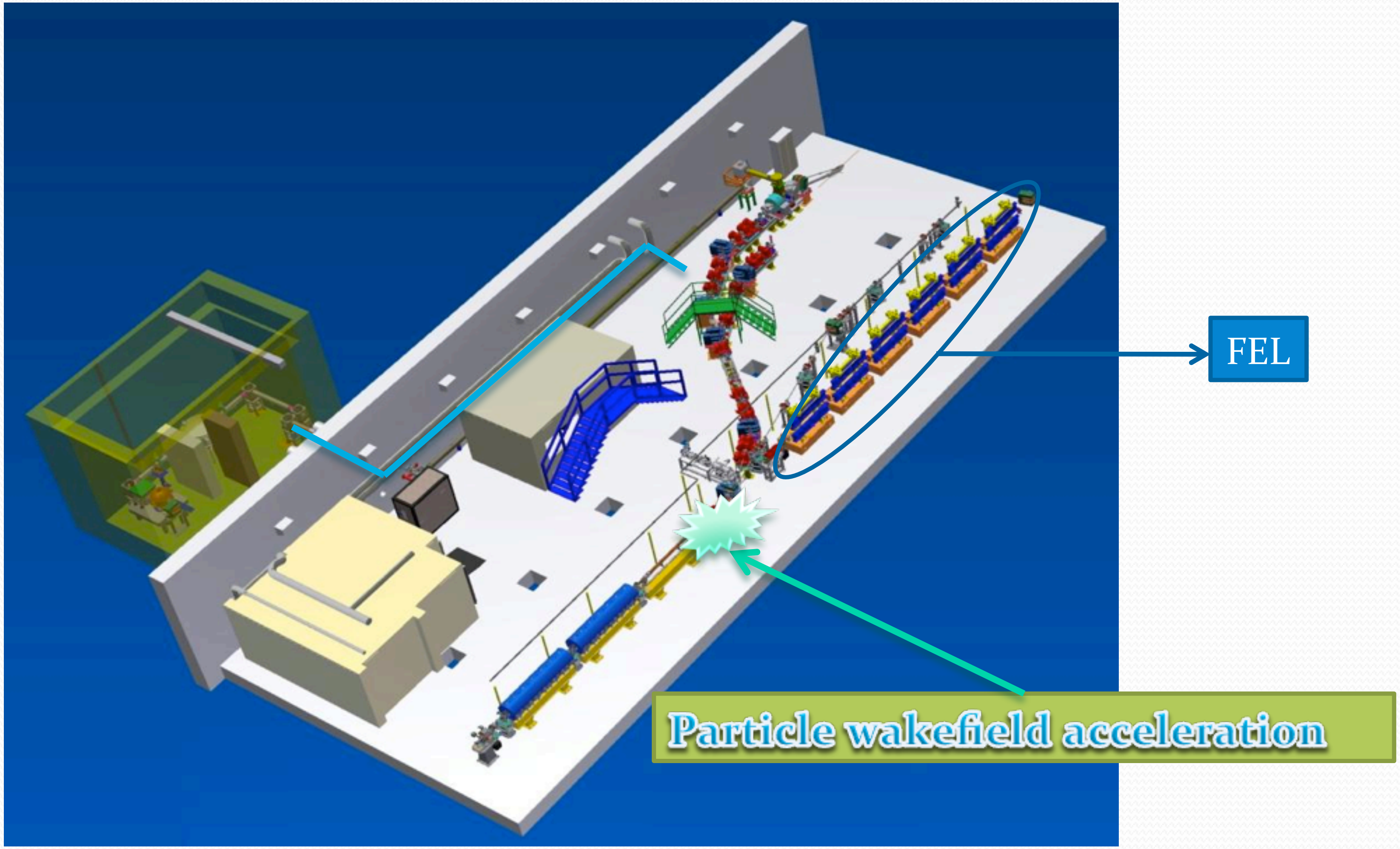
~1% dead channels and LAV7 off due to HV problem in this specific run


Thomson
BEATS2
SITE
LILIA
ExInj
FEL
POSSO
COMB
FemtoTera

Thomson Scattering Line



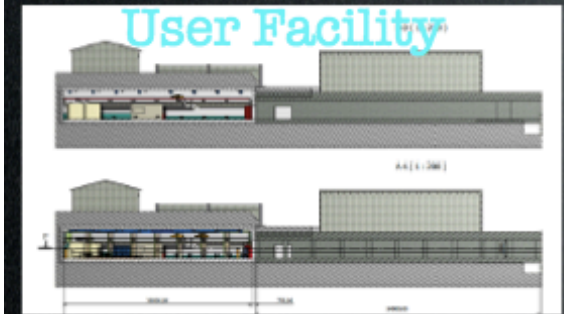
Particle wakefield acceleration



Future scenarios

Consolidation: on going, ~3 years, ~ 4 M€ allocated

- FLAME maintenance
- Injector upgrade (C-band, X-band)
- THz user beam line upgrade
- Thomson and Plasma beam lines final commissioning
- FEL new undulator



Upgrade: proposed, ~5 years

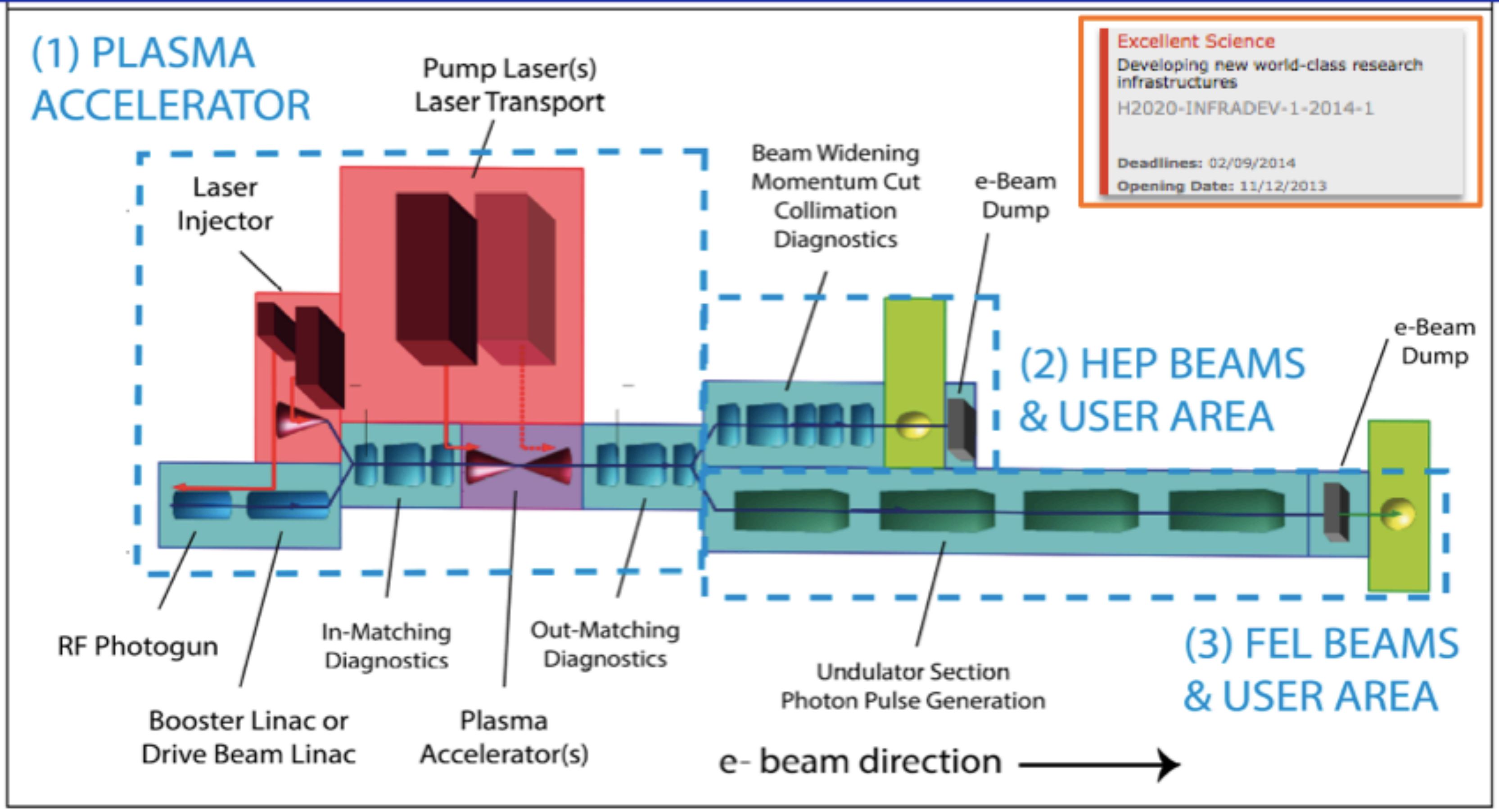
- Infrastructure extension 4 M€
- Linac upgrade ~1 GeV (C-X-band, multibunch) 9 M€
- THz, X-ray Compton and FEL user facility) 11 M€
- Advanced FEL schemes (oscillator?) 7 M€
- FLAME upgrade towards 1 PW 10 M€
- Positron production and plasma acceleration 2 M€
- AND RELIABILITY !!!!

European Facility, ~10 years, ~200 M€

- Plasma based FEL Pilot User Facility
- Plasma based HEP beam line
- (Photon-Photon Collider?)

Design Study on the
"European Plasma Research Accelerator with eXcellence In Applications" (EuPRAXIA)

Submitted to HORIZON 2020 INFRADEV, 4 years, 3 M€



Plasma based electron accelerators have reached high gradient (~ 50 GV/m) with good electron beam quality → Is time to think about a Plasma based pilot user facility

EuPRAXIA goal is to produce a conceptual design report for the worldwide first plasma-based accelerator user facility at 5 GeV

- The technical focus is on designing accelerator and laser systems for improving the quality of plasma-accelerated beams, similar to the methods used in conventional accelerators. These methods require significant space and investment.
- The scientific focus is on developing beam parameters, two user areas and the use cases for a femto-second Free Electron Laser (FEL) and High Energy Physics (HEP) detector science.
- The managerial focus is on developing an implementation model for a common European plasma accelerator. This includes a **comparative study of possible sites in Europe**, a cost estimate and a model for distributed construction in Europe and installation at one central site.

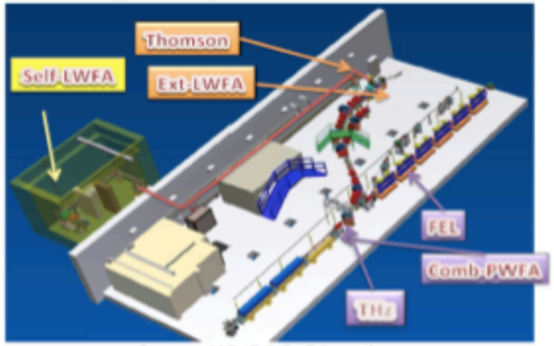
An upgraded (1 GeV, 1 PW) SPARC_LAB facility could be a strong candidate for the EuPRAXIA site

WHAT NEXT AT SPARC_LAB ?
M. Ferrario on behalf of the SPARC_LAB Collaboration

April 24, 2014

1- INTRODUCTION

SPARC_LAB [1] (Sources for Plasma Accelerators and Radiation Compton with Lasers And Beams) is an inter-disciplinary laboratory with unique features in the world. Born from the integration of a last generation photo-injector (SPARC)[2-7], able to produce electron beams up to 200 MeV energy with high peak current (> 1 kA) and low emittance (<2 mm-mrad), and of a high power laser (> 200 TW) (FLAME) [8,9], able to produce ultra-short pulses (<30 fs), SPARC_LAB has already enabled the development of innovative radiation sources and the test of new techniques for particle acceleration using lasers.



Layout of SPARC_LAB beam lines

In particular the following highlight results have been achieved:

- a Free Electron Laser has been commissioned producing coherent radiation tunable from 500 nm down to 40 nm and new regimes of operation like Seeding, Single Spike, Harmonic Generation and Two Colors have been observed [10-14];
- a source of both broad band, narrow band (<30%) and high energy (> 10 μJ) THz radiation has been tested, first experiments with users are underway [15,16];
- electrons have been accelerated up to 100 MeV in 4 mm long plasma wave excited by the high power laser FLAME [9];

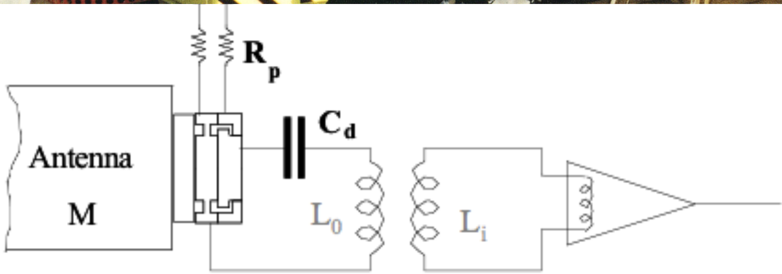
NAUTILUS
LNF - FRASCATI

Bar Al 5056 M = 2270 kg

L = 2.91 m Ø = 0.6 m

ν_A=935Hz @ T = 3 K

Cosmic ray detector



Capacitive transducer

Al 5056
m_t = 0.75 kg
ν_t= 916 Hz
C_t = 11 nF
E = 5 MV/m

Superconducting Low-dissipation Transformer

Lo=2.86 H
Li=0.8μH
K=0.8

dc-SQUID

M_s = 10 nH
Φ_n= 3 ·10^{-6} Φo/√Hz

LNF as a hub for detector constructions

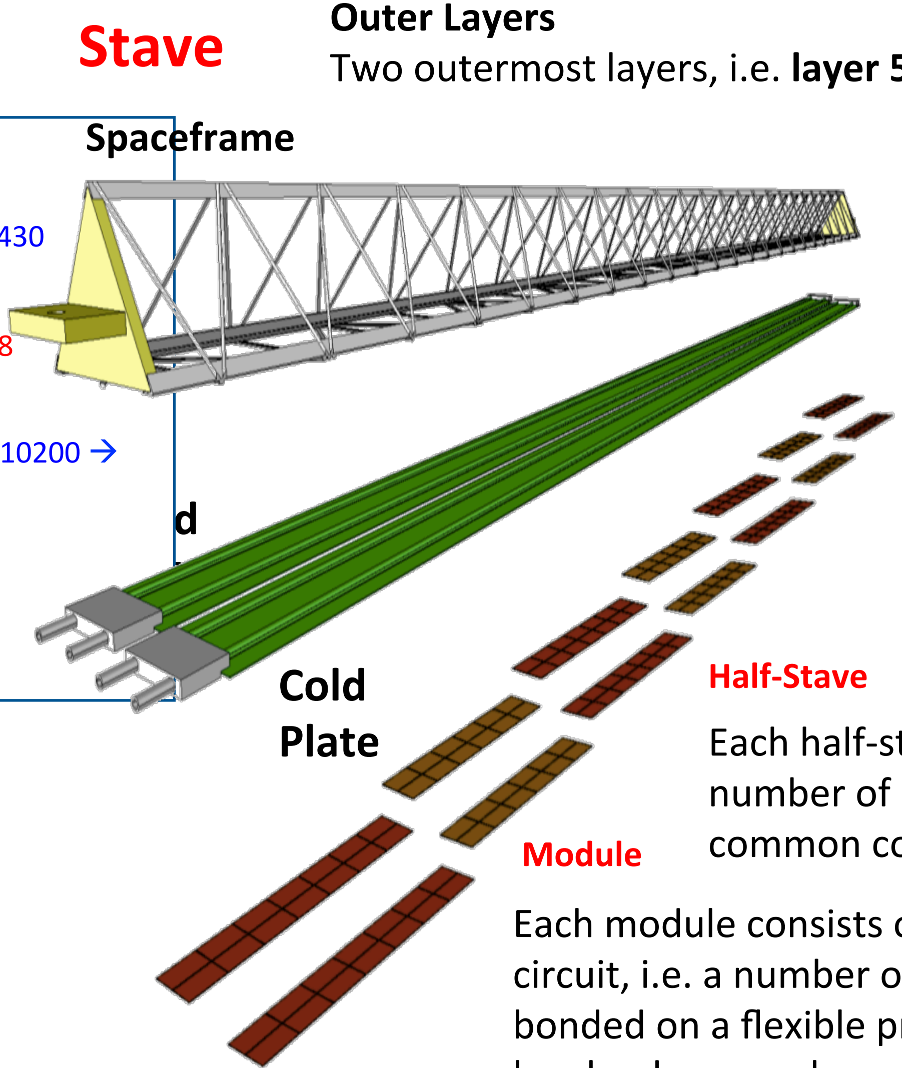
- Currently building VETO system (huge!) for NA62 ✓ **DONE !**
- Participation in many LHC upgrades:
  - ALICE new ITS assembly
  - Atlas: FTK, new small wheels (assembly hub)
  - LHCB: mwpc spare chambers construction, new FE
  - CMS: new GEM for fwd muon
- Construction of the new cylindrical GEM inner chamber for BES-III (1st layer funds from Ministry for Foreign Affairs)
- MutoE, g-2 & Belle2

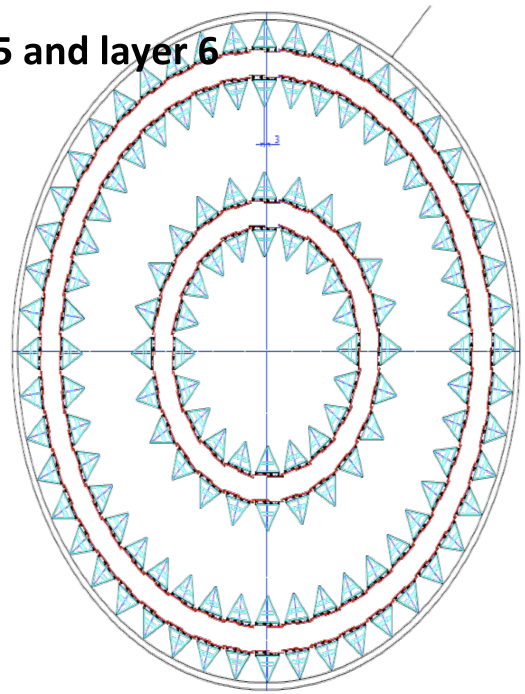
ALICE - ITS upgrade

Preparation for ITS upgrade
LNF as national production center and test

Baseline for the Outer Barrel Stave in the TDR

Middle Layers
Two inner layers of the Outer Barrel, i.e. **layers 3 and layer 4**
Outer Layers
Two outermost layers, i.e. **layer 5 and layer 6**





ALICE UPGRADE
ITS Outer Barrel (OB): 4 layers pixels
Radial position (mm): 200, 220, 410, 430
Length in z (mm): 843, 1475
Nr. of modules: 48, 52, 96, 102 → 298
Nr. of chips/module: 28, 28, 52, 52
Nr. of chips/layer: 2688, 2912, 9600, 10200 → 25400
Pixel size: ~ 20 μm x 20 μm or bigger
Material thickness: ~ 0.3% X_0
Throughput: < 6 Mbit / sec·cm^2

Work at LNF:
1.5 week per stave needed
66 staves ~ 2.5 years
Preparation and start in 2014

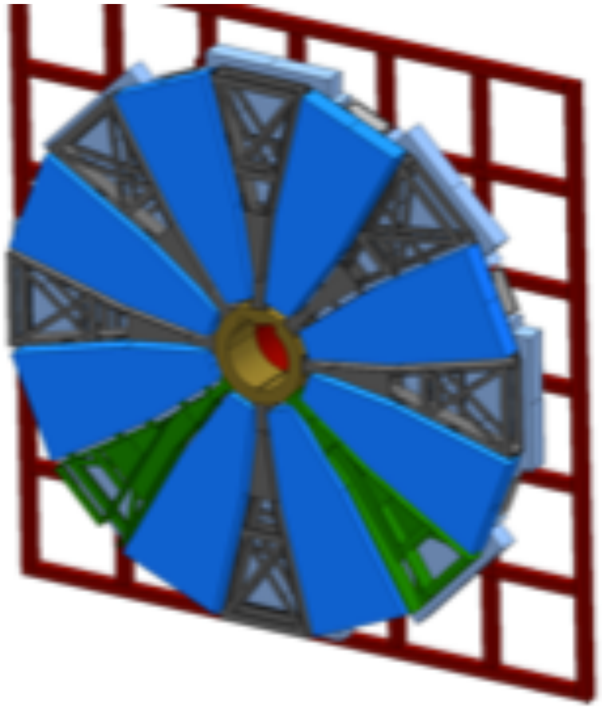
Half-Stave
Each half-stave will consists of a number of modules glued on a common cold plate

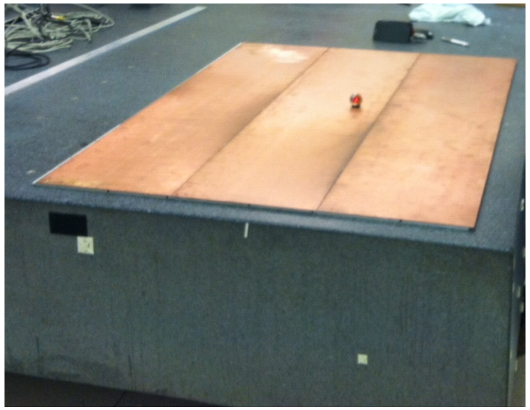
Module
Each module consists of a hybrid integrated circuit, i.e. a number of pixel chips (e.g. 2 x 7) bonded on a flexible printed circuit, which might be glued on a carbon ply

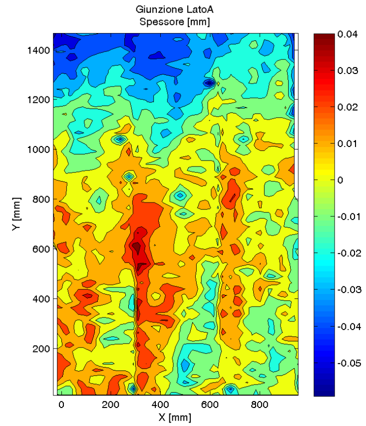
ATLAS Muon spectrometer upgrade: nSW

New Small Wheel for the muon system
Precision tracking based on Micromega's
1° time use on large area detectors

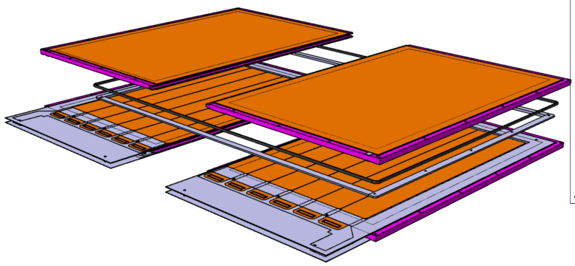
Frascati is 1 of the 3 construction sites

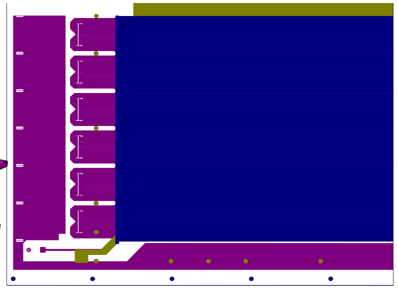






Responsibility for Technological transfer

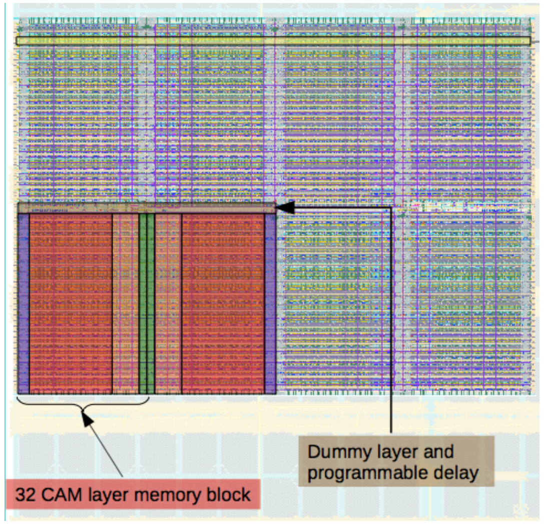




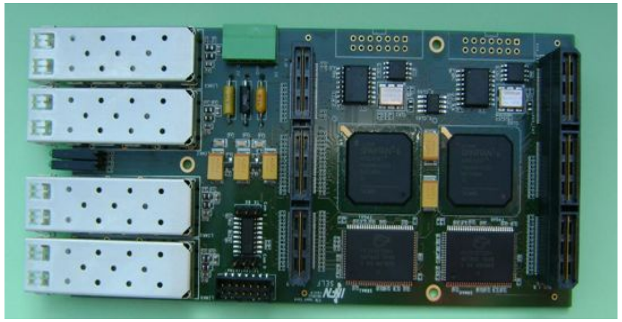
Successful assembling tests already performed

Large area prototype with PCB from company

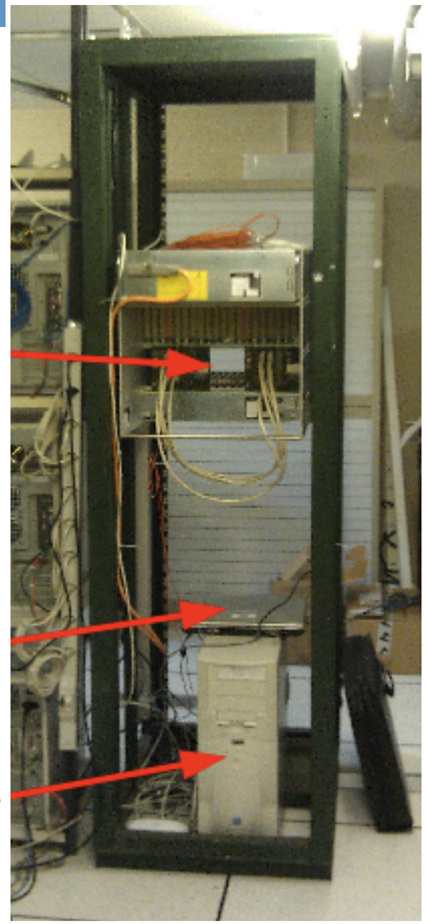
ATLAS Fast-Track trigger project



New Associative Memory ASIC 65nm
Pattern density x20, speed x2.5
With ~ same power consumption!!



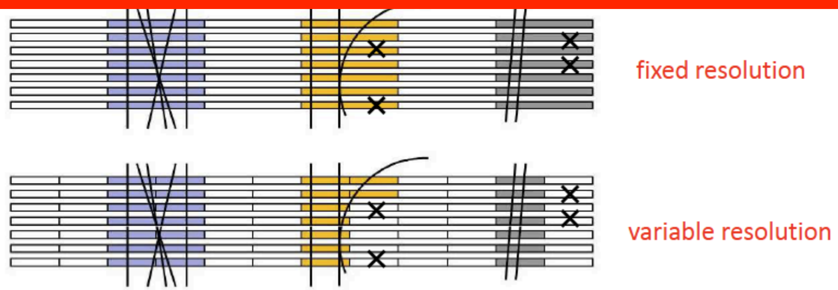
Vertical slice integration



Fast Tracker simulation:
simulation of a super-processor with conventional processors!

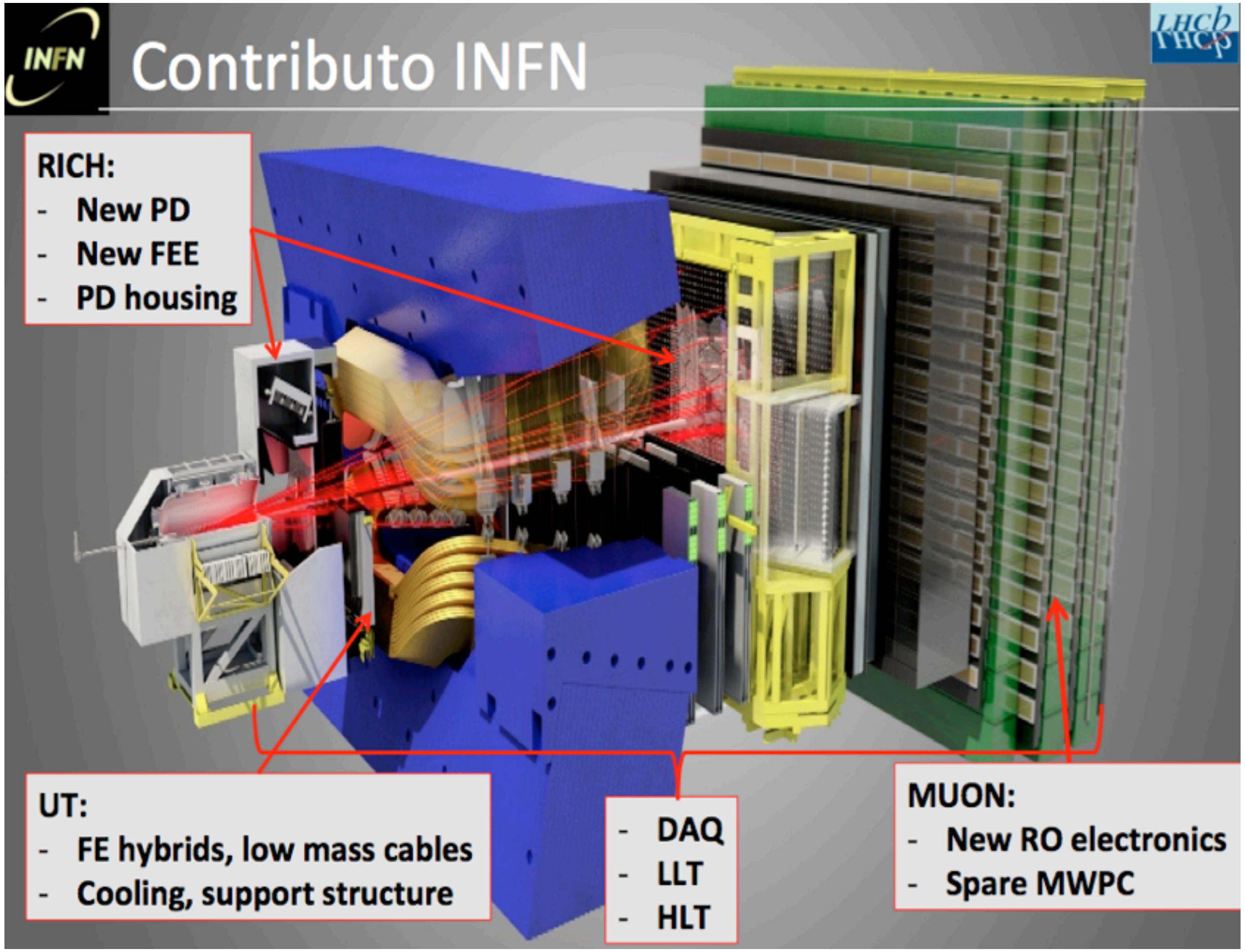
FTK input & clustering

Invention of variable resolution patterns



The LHCb detector upgrade

- Increase current readout from 1MHz → 40 MHz
- Full software trigger, replace FEE electronics
- Apply new technologies to subdetectors (higher radiation dose and occupancies)



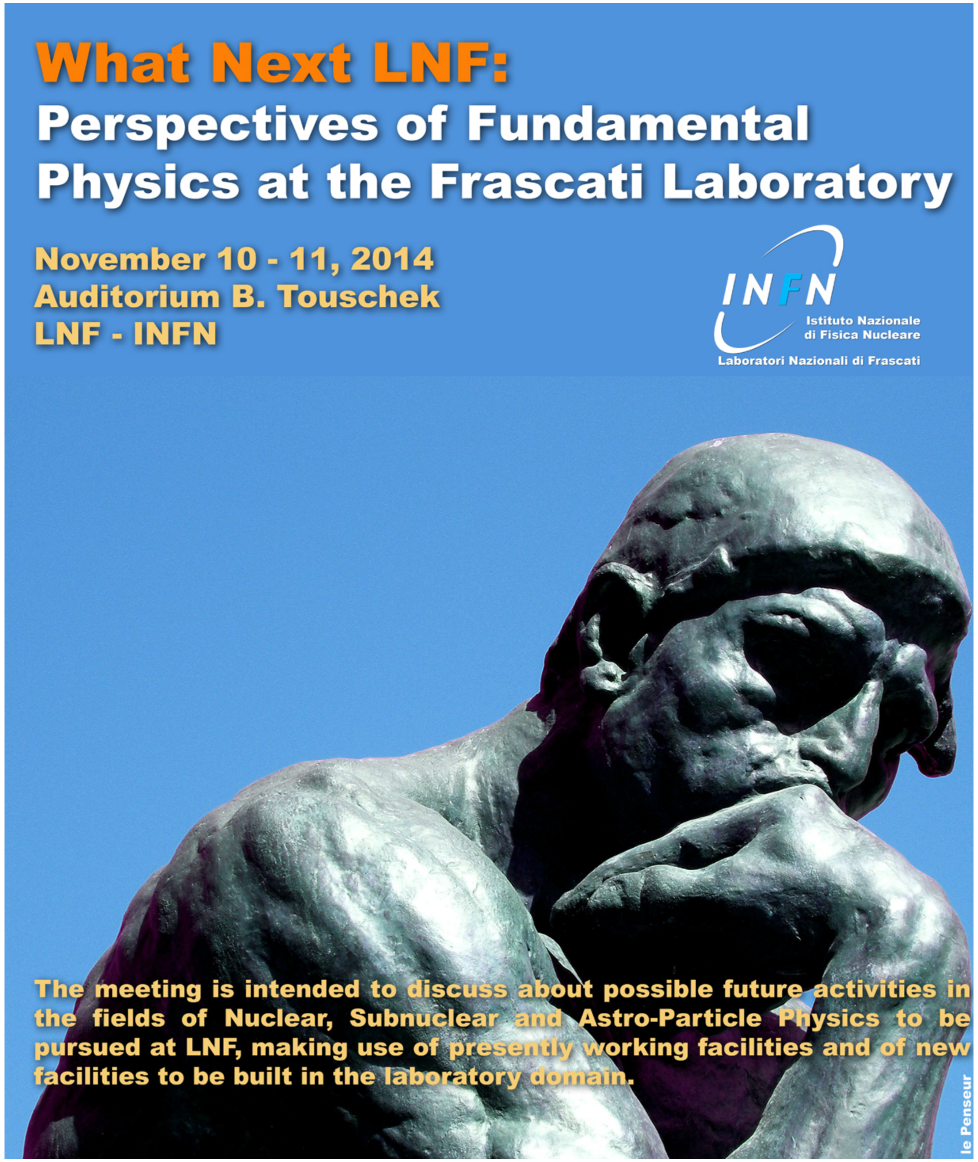
LNF is strongly committed in the upgrade of the muon detector*:

- production of spare MWPCs
- development of new FEE
- production of GEM chambers for the most irradiated regions

*** ~50% of the muon detector was built at LNF**

… recently in LNF …

(https://agenda.infn.it/conferenceOtherViews.py?view=standardshort&confId=8563)

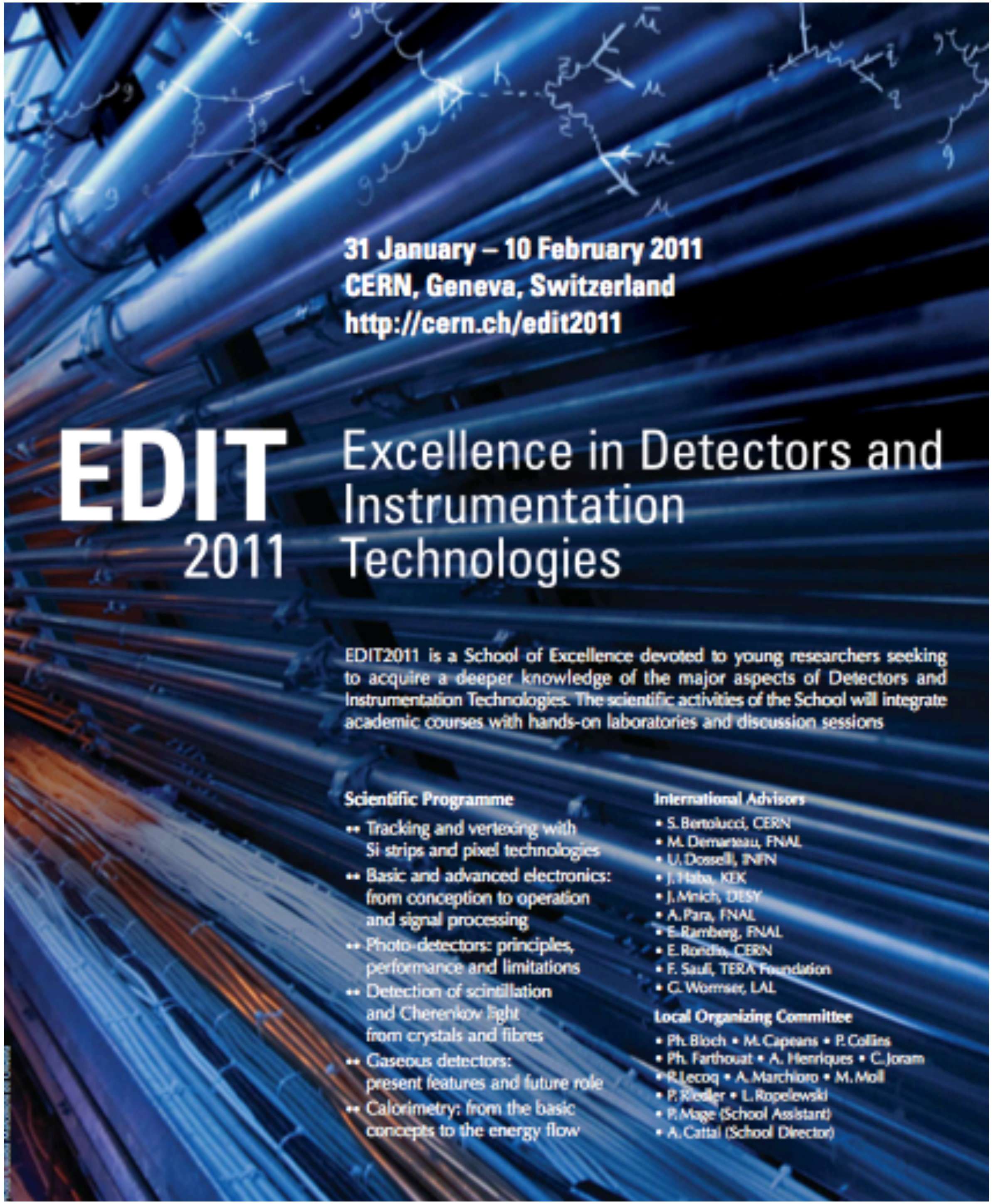


Workshop to address physics & infrastructural possibilities in LNF beyond present

Good attendance, many ideas

- strangeness nuclear physics @ Dafne
- Search for Light Dark Matter
- Dafne as ATF
- Future of PWA
- LNF as HUB for INFN Space activities
- Detectors R&D
- …

soon document to INFN



EDIT 2011 at CERN

EDIT 2012 at FNAL

EDIT 2013 at KEK

EDIT 2015 in Frascati


Thank you !!!