DAFNE-TF as facility for FCCee tests

Alessandro Drago

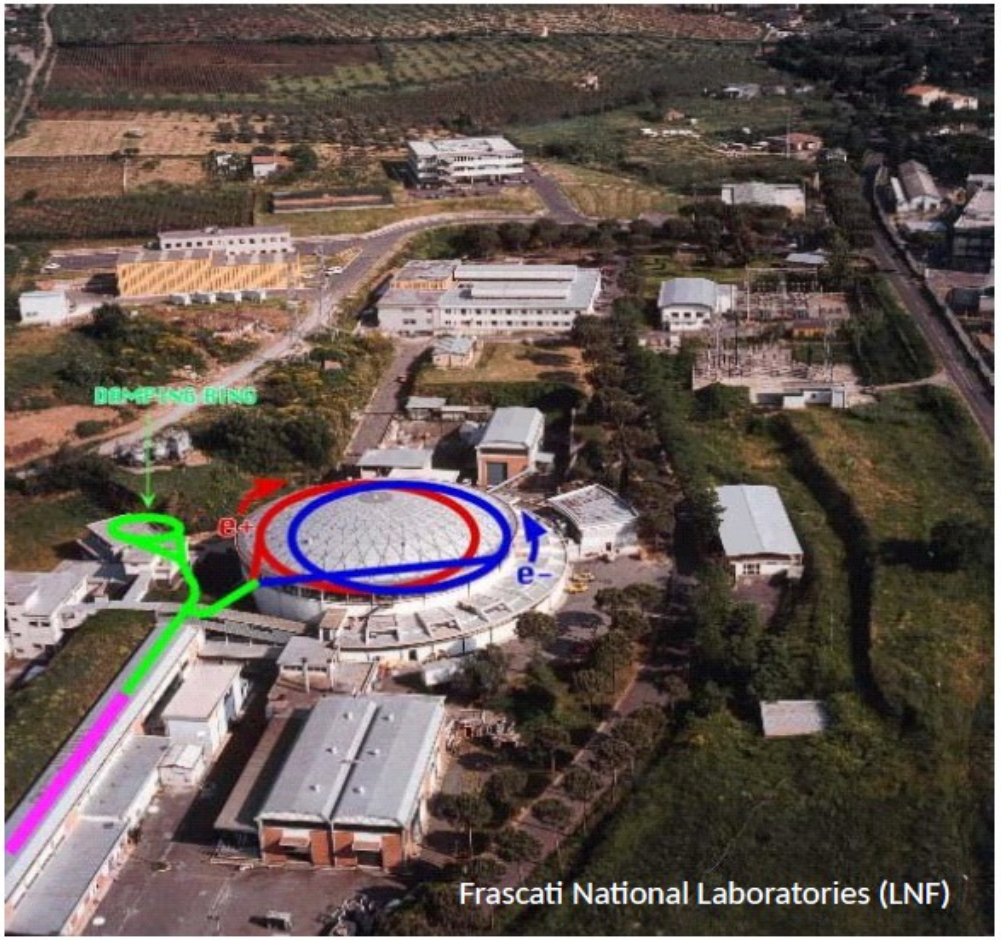
INFN Frascati & Tor Vergata Rome University

ARIES "Accelerator Performance and Concepts" (APEC)
10-12 December 2018
Flemings Hotel, Frankfurt am Main

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 730871.

Topics

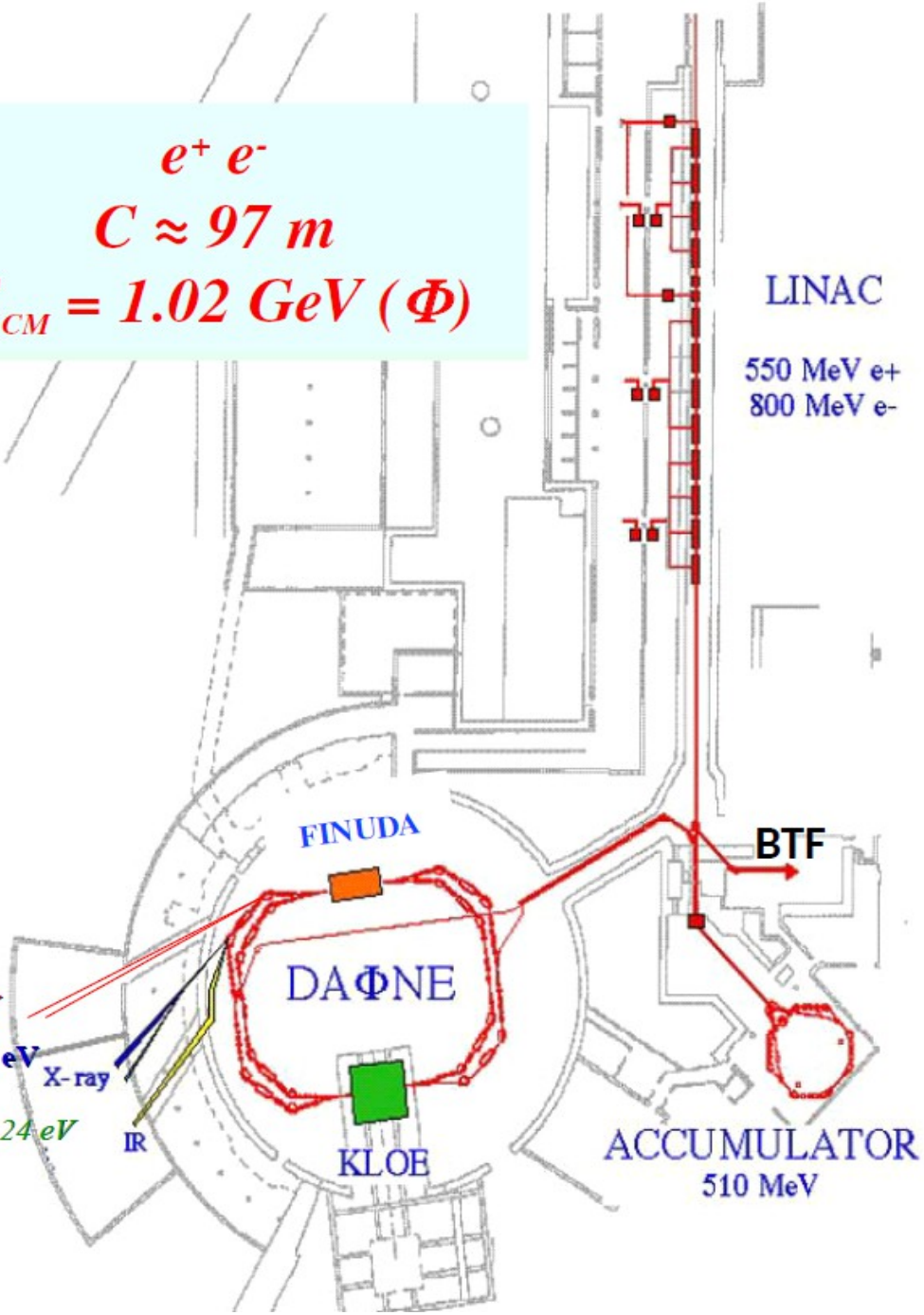
- DAFNE status and scheduled experiments until today
- DAFNE-TF workshop at LNF on 17 December to collect ideas and contributions for small experiments and technological tests
- DAFNE is going to become a Test Facility after the year 2020
- Workshop contributions correlated with FCC
- DAFNE feedback tests correlated with FCC-ee



$e^+ e^-$

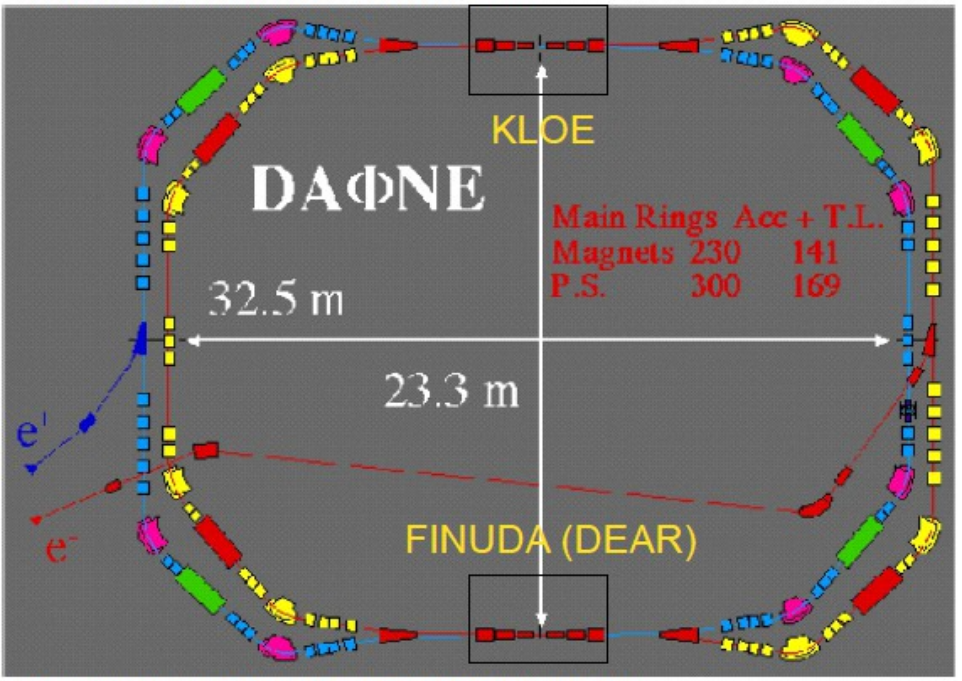
$C \approx 97\ m$

$E_{CM} = 1.02\ GeV\ (\Phi)$



LNF are also part of the European synchrotron light Infrastructures

P. Raimondi , *2° SuperB Workshop, March 2006,*
P.Raimondi, D.Shatilov, M.Zobov, physics/0702033,
C. Milardi et al., Int.J.Mod.Phys.A24, 2009.



"Proposal for a Φ-factory", LNF-90/031 (IR),1990.

	DAΦNE native	DAΦNE Crab-Waist
Energy (MeV)	510	510
$\theta_{cross}/2$ (mrad)	12.5	25
ε_x (mm•mrad)	0.34	0.28
β_x^* (cm)	160	23
σ_x^* (mm)	0.70	0.25
$\Phi_{Piwinski}$	0.6	1.5
β_y^* (cm)	1.80	0.85
σ_y^* (μm) low current	5.4	3.1
Coupling, %	0.5	0.5
Bunch spacing (ns)	2.7	2.7
I_{bunch} (mA)	13	13
σ_z (mm)	25	15
N_h	120	120

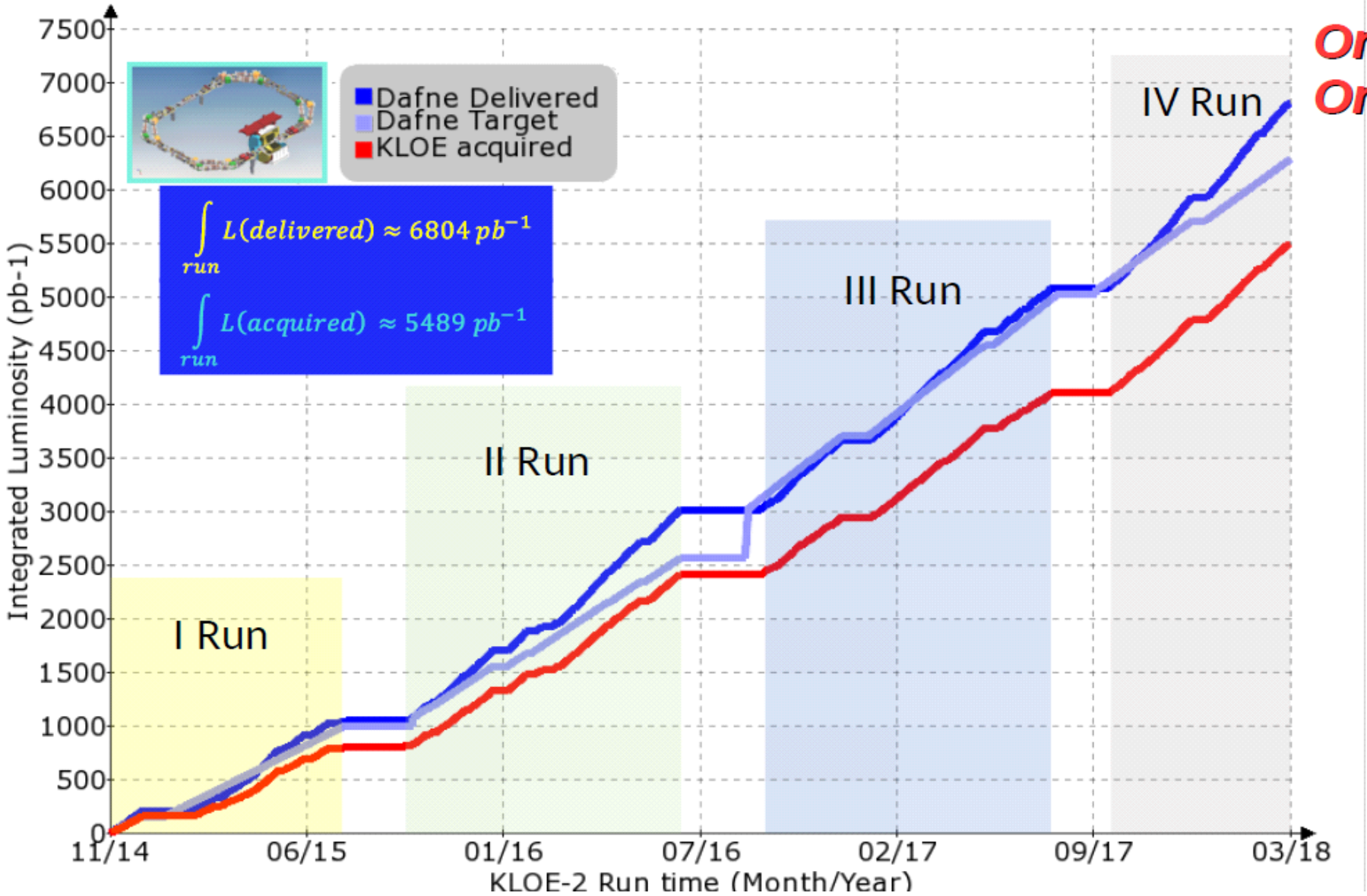
Colliding Beams have:
- *low E*
- *high currents*
- *short bunch spacing 2.7 nsec*
- *long damping time*

DAΦNE is a collider operating with high currents

Lepton Beam Currents achieved so far

	beam current I [A]	bunch population N_b [10^{11}]	rms bunch length [mm]	bunch spacing [ns]	comment
PEP-II	2.1 (e^-), 3.2 (e^+)	0.5, 0.9	12	4.2	closed
superKEKB	2.62 (e^-), 3.6 (e^+)	0.7, 0.5	7	6	commissioning
DAFNE	**2.4 (e^-), 1.4 (e^+)**	**0.4, 0.3**	**16**	**2.7**	
BEPC-II	0.8	0.4	<15?	8	
CesrTA	0.2	0.2	6.8	4	
VEPP-2000	0.2	1	33	80 (1 b)	
LHC (des)	0.58	1.15	75.5	25	
ESRF	0.2	0.04	6.0	2.8	
APS	0.1	0.02	6.0	2.8	
Spring8	0.1	0.01	4.0	2.0	
SLS	0.4	0.05	9.0	2.0	

KLOE-2 detector runs (2014-2018)



On Time
On Budget

Scheduled experiments in 2018-20

- After the end of *KLOE* data taking (30 March 2018) the DAFNE schedule is:
  - Installation of *PADME* in the BTF (completed in last September)
  - *PADME* data taking (October 2018 - March 2019)
  - DAFNE start commissioning for *Siddharta* detector (April - July 2019), e+/e- collisions
  - *Siddharta* data taking, e+/e- collisions (September 2019 - July 2020)
  - DAFNE as light source, with 5 beam lines, e- beam (April 2019 – July 2020)

PADME experiment at LNF (running now)

Breaking news…

The Guardian

Scientists hunt mysterious 'dark force' to explain hidden realm of the cosmos

Physicists say a fifth force of nature would 'completely change the paradigm'

Ian Sample *Science editor*
Mon 3 Sep 2018 06.00 BST

Scientists are about to launch an ambitious search for a "dark force" of nature which, if found, would open the door to a realm of the universe that lies hidden from view.

The hunt will seek evidence for a new fundamental force that forms a bridge between the ordinary matter of the world around us and the invisible "dark sector" that is said to make up the vast majority of the cosmos.

The chances of success may be slim, but should such a force be found it would rank among the most dramatic discoveries in the history of physics. The best theory of reality that physicists have explains only 4% of the observable universe. The rest is a mystery made up of dark matter, the strange material that lurks around galaxies, and the even more baffling dark energy, a substance called upon to explain the ever-accelerating expansion of the universe.

"At the moment, we don't know what more than 90% of the universe is made of," said Mauro Raggi, a researcher at the Sapienza University of Rome. "If we find this force it will completely change the paradigm we have now. It would open up a new world and help us to understand the particles and forces that compose the dark sector."

THE TIMES | Today's sections | Past six days

Scientists seeking dark forces to reveal the universe's missing mass

Later this month, in a laboratory just outside Rome, a beam of particles will hit a thin sheet of diamond, annihilate some electrons and send a…

Tuesday September 04 2018, 12:01am BST, The Times

ANSA

Parte dall'Italia la caccia alla forza oscura dell'Universo

Il suo 'messaggero' potrebbe svelare cos'è la materia oscura

Comincerà in Italia, nella seconda metà di settembre, la 'caccia' alla forza oscura dell'Universo, un nuovo tipo di forza ancora sconosciuta in natura la cui particella 'messaggera' potrebbe svelare di cos'è fatta la materia oscura che compone l'80% di tutta la materia dell'Universo.

Si metterà sulle sue tracce l'esperimento Padme (Positron Annihilation into Dark Matter Experiment), che verrà acceso nei Laboratori Nazionali di Frascati dell'Istituto Nazionale di Fisica Nucleare (Infn) sotto la supervisione di una collaborazione internazionale a guida italiana formata da una quarantina di ricercatori, a cui parteciperanno gli statunitensi di Cornell University, Iowa University, William and Mary College, insieme agli ungheresi dell'Istituto MTA Atomki di Debrecen e i bulgari dell'università di Sofia.

Repubblica

Parte la caccia alla materia oscura

Nei laboratori dell'Infn ricercatori impegnati nel progetto Padme

PADME experiment at LNF

- Devoted to search the "dark force", the 5th fundamental force of the universe to explain dark mass/dark energy
- Detector placed in the BTF area, using only linac and not compatible with the injection in the DAFNE main rings because of too long bunches (300 ns)
- There are DAFNE-TF contributions proposing to move the detector in the positron main ring after this run
- To use at the best the data taking the idea is to stretch the bunch in the MR and to extract the positrons very slowly by using 1/3 resonance technique (coasting beam without RF and feedback systems)

DAFNE e+/e- collider for *Siddharta*

The scientific goal

To perform precision measurements of kaonic atoms X-ray transitions

- unique information about QCD in the non-perturbative regime in the strangeness sector, not obtainable otherwise

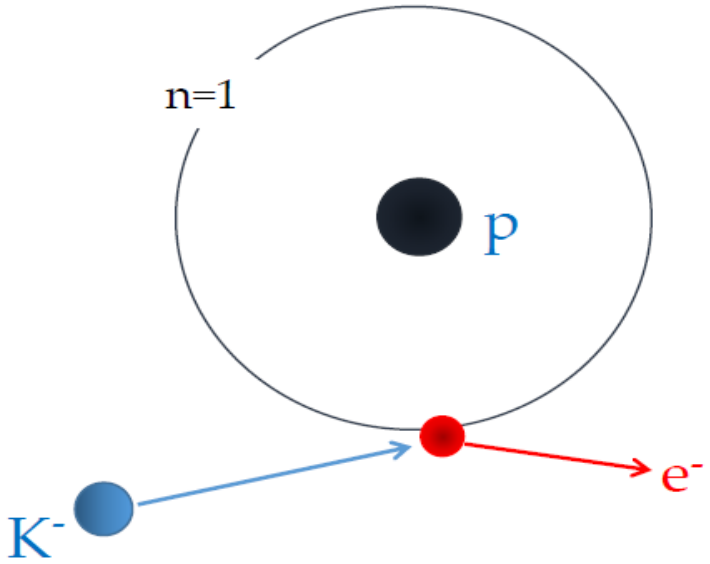
Started with the precision measurement of ***shift*** and ***width*** of ***kaonic hydrogen***

- **NOW first measurement of kaonic deuterium**
  to extract the antikaon-nucleon isospin dependent scattering lengths

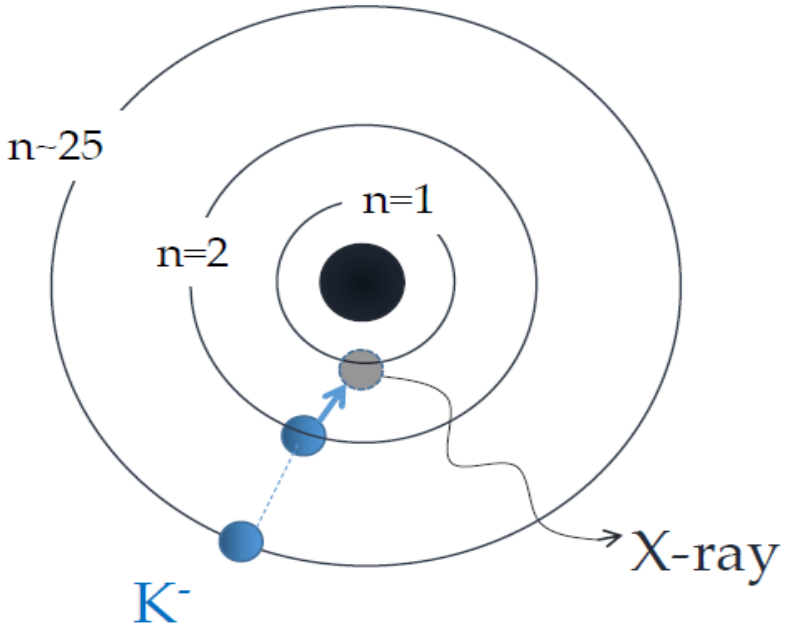
Siddharta experiment

FORMING "EXOTIC" ATOMS

"normal" hydrogen



"exotic" (kaonic) hydrogen



$$n \approx \sqrt{\frac{m_{\text{red}}}{m_e}} \cdot n_e$$

$2p \rightarrow 1s$
K_α transition

What next ?

- *Siddharta* will be the last "big experiment" for DAFNE as collider
- The idea is to run until 2023 (or even more) with small experiments mostly oriented to technology tests
- This should limit the activity per year at 50% of the time
- Tests and experiments can require two beams or single beam
- As light source (using only the electron beam) most likely DAFNE will continue to be operative
- An ARIES / ICFA workshop will be held next week in LNF to present and discuss contributions and ideas

17 December 2018 *INFN - Laboratori Nazionali di Frascati*

HOME PROGRAM PARTICIPANTS SUBMIT A CONTRIBUTION ACCOMMODATION INFO HOW TO REACH US CONTACT

ICFA Mini-Workshop on

DAFNE as Open Accelerator Test Facility in year 2020

The workshop will take place on **December 17th, 2018** at the Touschek Auditorium, Frascati Laboratory of INFN, Italy.

The workshop is intended to discuss the interest from scientists to access the DAFNE $e^+ e^-$ complex, which will conclude its physics program as collider in 2020. An infrastructure almost unique, that could open as Test Facility (DAFNE-TF) to the international community for studies of accelerator technologies and beam physics, for small experiments, and to be used as a test bed for enterprises active in the sector of components for accelerators.

Invitation Letter of Prof. Lenny Rivkin, Chair of the International Scientific Committee
INFN-18-10-LNF - "Proposal for a possible use of DAFNE as an open infrastructure (DAFNE-TF) for the study of physics and innovative technologies for accelerators"

Scientific Committee
L. Rivkin (EPFL and PSI, chair), C. Biscari (INFN-LNF), Y. Cai (SLAC), A. Ghigo (INFN-LNF), M. Giovannozzi (CERN), C. Milardi (INFN-LNF), N. Pastrone (INFN-Torino), A. Variola (INFN-LNF)

Organizing Committee
O. R. Blanco Garcia (INFN-LNF), A. De Santis (INFN-LNF), A. Drago (INFN-LNF, chair)

Secretariat
D. Ferrucci (INFN-LNF), M. Luciani (INFN-LNF)

dafne-tfw2018@lists.lnf.infn.it

Invitation letter from Lenny Rivkin chair of the International Scientific Commitee

Istituto Nazionale di Fisica Nucleare
LABORATORI NAZIONALI DI FRASCATI
Divisione Acceleratori

Frascati, 03/10/2018

Dear Colleagues,

on behalf of the International Scientific Committee, I am pleased to announce the *ICFA Mini-Workshop on DAFNE as Open Accelerator Test Facility in year 2020*, workshop 2018 under the sponsorship of the International Committee for Future Accelerators (ICFA). The event will be held in the INFN National Laboratory in Frascati (Rome, Italy), on December 17th 2018.

DAFNE is an electron-positron collider designed in the mid '90s and put into operation in 2000. It has been providing data in consecutive data-taking periods for the KLOE, DEAR and FINUDA experiments until 2006, for Siddharta in 2009, and again for the upgraded KLOE-2 between November 2014 and March 2018. It will continue operating for PADME (just using the upgraded Linac) and for Siddharta-2 later on, for about one year.

By 2020 the DAFNE accelerator complex, an infrastructure almost unique in the world, could become a test facility (DAFNE-TF) open to the international community for studies of accelerator technologies, beam physics, small physics experiments, and as a technological test bed for enterprises operating in the field of particle accelerators.

A preliminary version of the event web page has been prepared and is available at the address:

https://agenda.infn.it/conferenceDisplay.py?confId=16334

Registration is open.

Registrants are also invited to submit ideas and proposals inputs for scientific activities that could be carried out using DAFNE-TF characteristics at best. More information about the main parameters of DAFNE are available in the aforementioned workshop web page.

The International Scientific Committee will collect the documents (max 1 page, sent to dafne-tfw2018@lists.lnf.infn.it), that must arrive by November 10th 2018, and will integrate them, within the available time, in the scientific programme.

Hoping to see you in Frascati, I send you my best regards.

Lenny Rivkin
Chair of International Scientific Committee

Istituto Nazionale di Fisica Nucleare
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fax +39 06 9403 2256
http://da.lnf.infn.it/
PEC: Lab.Naz.Frascati@pec.infn.it

Total of registrants : 90

Italy 75,

Switzerland 9, USA 4, Austria 3, Germany 3, UK 2, China 1, Georgia 1, Sweden 1, Japan 1

Total of submitted contributions: 26

LNF + Roma1 + INFN	14
CERN + Switzerland	5
Austria	3
Germany	3
UK	2
USA	2

DAFNE-TF preliminary time schedule

Time	Title	Speaker
8:30 - 8:40	LNF Director Welcome	P. Campana
	Present and Future Test Facilities - chair A. Ghigo	
8:40 - 9:00	ATF2	G. White
9:00 - 9:20	The KIT accelerator test facilities: Karlsruhe Research Accelerator KARA, short-pulse linac FLUTE, and Magnet Characterization Facilities	A. Mochihashi
9:20 - 9:40	DAFNE as Open Accelerator Test Facility: DAFNE-TF	C. Milardi
	Positron Beam Lines and Crystal Technologies - chair N. Pastrone	
9:40 - 9:55	Proposal for Using DAFNE as Pulse Stretcher for the Linac Positron Beam	S. Guiducci
9:55 - 10:15	Dark sector experiments and test-beam facility based on the slow extraction of a positron beam from the DAFNE ring	P. Valente
10:15 - 10:35	Intense crystal-based hard-X and gamma sources with the DAΦNE beam	L. Bandiera
10:35 - 10:55	Crystal high quality positrons extraction from the DAΦNE accelerator ring	M. Garattini
10:55 - 11:05	Discussion	
11:05 - 11:25	*Coffee Break*	
	Collider issues: technology - chair A. Drago	
11:25 - 11:45	DAFNE as a test bench for innovative vacuum equipment and surface treatments	Chiggiato
11:45 - 12:05	Vacuum and e-cloud studies at DAFNE-TF	Malishev
12:05 - 12:35	DAFNE-TF as a Beam Diagnostic and Instability Control Test Facility	Fox
12:35 - 12:50	Using DAFNE to study the physics of the e+/e- beam interaction with vacuum devices	Casalbuoni
12:50 - 13:00	Discussion	
13:00 - 14:00	*Lunch*	
	Positron, photon and kaon facilities - chair C. Bloise	
14:00 - 14:20	Proposal of an experimental test at DAFNE for LEMMA	Boscolo
14:20 - 14:35	DAFNE-Light synchrotron radiation facility: status and perspectives	Cestelli
14:35 - 14:55	TBA	Zmeskal
14:55 - 15:10	A tagged polarized gamma-ray facility in the medium- to high- energy range as calibration tool for detectors in gamma-ray astrophysics	Cattaneo
15:10 - 15:25	DAFNE Compton ring for ultra high flux photons in the 100 KeV-1 MeV range	Alesini
15:25 - 15:35	Discussion	
15:35 - 15:55	*Coffe Break*	
	Collider issues: beam dynamics & beam-beam - chair M. Giovannozzi	
15:55 - 16:25	DAFNE-TF as FCC-ee Demonstrator	F. Zimmermann
16:25 - 16:45	Benchmark of Beam-beam and impedance models as input for the design of the FCC-hh and HE-LHC	T. Pieloni
16:45 - 17:05	Discussion	
17:05 - 17:30	Conclusive Discussion and remarks - chair: L. Rivkin	

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FCC-ee tests at DAFNE by Frank Zimmermann

Name: Frank Zimmermann (CERN)
Email: frank.zimmermann@cern.ch

Title: DAFNE-TF as FCC-ee Demonstrator

Text of Contribution:

Many features of DAFNE will render it a unique test facility for demonstrating and exploring key concepts of the proposed future FCC-ee collider, and for optimising the FCC-ee design. The particular DAFNE-TF features of interest for FCC-ee include the following: (1) high beam currents, with significant bunch charge; (2) availability of high-current positron beams; (3) crab-waist collisions; (4) low-beta insertion with detector; and (5) lepton injector including linac, positron source, and damping ring. Novel coherent beam-beam instabilities, anomalous emittance blow up, advanced feedback systems, high-current operation and HOM damping of novel RF cavities, various types of beam diagnostics, machine background sources, aspects of electron-cloud and ion effects, and numerous other FCC-ee concepts and prototypes can all be tested at DAFNE-TF.

Name: Tatiana Pieloni (EPF Lausanne)
Email: tatiana.pieloni@epfl.ch

Title: Beam-Beam effects and impedance effects for the FCC-hh and HE-LHC design studies.

Text of Contribution:
Future hadron colliders under study at the Future Circular Collider collaboration plan to collide for the first time protons at energies of 13 and 50 TeV for the High Energy Large Hadron Collider (HE-LHC) and the Future Circular Collider hadron-hadron (FCC-hh), respectively. For the first time the effect of radiation damping become important for the proton dynamics and therefore it has to be included in the beam dynamics models. Present models of the electromagnetic interactions between the two colliding beams (so called beam-beam effects) for the Large Hadron Collider do not cover these effects since they are negligible. Due to the higher energies foreseen radiation damping becomes important and has to be modelled and the relevant experience and knowledge should be acquired. Beam-beam models from the LHC will have to be up-dated to take into account such effects (i.e. synchrotron radiation,

quantum excitations). The benchmark of the numerical models with the DAFNE collider data represents an important and unique opportunity.
The beam-beam parameter for such future colliders is now limited to maximum 0.03. The study of any possible extension or limitation of such value would be a fundamental input to the design.
We would like to propose to study the beam-beam effects for different radiation damping time scales to acquire data for the benchmark of the beam-beam models for the FCC-hh and the HE-LHC options. A list of studies to be performed is:
- Study the beam-beam effects for different radiation damping and for different beam-beam parameters. With and without beam-beam long-range encounters to understand differences and identify scaling laws where possible.
- Study the coupling of beam-beam coherent modes to the machine impedance modes. This coupling has been observed in one single dedicated experiment at the LHC for the case of one single beam-beam interaction. The extension to beam-beam long-range effects is still to be addressed.
- Effects of a finite crossing angle on the particle dynamics would also provide an important data sample for code benchmarking together with the exploration of the parameter space.
- DAFNE collider could represent a unique opportunity to collect data to train a model using machine-learning techniques to describe the collider performances in terms of losses and luminosity production. The model could be tested for predicting the performances and would represent an important data sample to possibly compare to LHC models under study at EPFL and CERN.
This opportunity is a unique possibility to transmit to students and post-doc of the FCC collaboration the knowledge and experience of beam-beam effects accumulated at DAFNE over the many years of operation of the collider. This will represent an extremely valuable training for the future generation of accelerator physicist that will be working on the design of the FCC-hh and HE-LHC collective effects.

FCC-hh & HE-LHC tests at DAFNE by Tatiana Pieloni

Name: Paolo Chiggiato (CERN, Technology department)
Email: paolo.chiggiato@cern.ch

Paolo Chiggiato: tests for HL-LHC & FCC

Title: DAFNE as a test bench for innovative vacuum equipment and surface treatments

Text of Contribution:

DAFNE offers a unique opportunity to test vacuum components and surface modifications with beams. Thanks to its flexible beam parameters, a large spectrum of applications can be covered and a multitude of experiments could be conceived.

A typical example is the study of photon interaction with surfaces exposed to synchrotron radiation. Indeed, DAFNE may provide photons, in either a large or narrow spectrum of energy, that can be focused on samples or distributed along metre-long vacuum vessels. In the framework of HL-LHC and FCC, CERN's Technology Department has a running collaboration with INFN on this theme.

The effect of specific surface treatments on electron multipacting can be measured with positively charged beams.

In that respect, DAFNE would be the ideal test bench to assess surface modifications and validate new concepts for electron pickups and other sensors.

New designs and materials could be tested for impedance reduction at different temperatures with beams having distinct characteristics.

In addition to the exceptional beam quality of DAFNE, LNF is equipped with key infrastructures, e.g. cryogenic facilities, and provides the expertise of skilled technical and scientific colleagues; both are essential for the success of those experiments.

Name: Oleg Malyshev (STFC Daresbury Laboratory)
Email: oleg.malyshev@stfc.ac.uk

Title: Possible NEG coating studies on DAFNE TF

Text of Contribution:
Various technological solution used inside the beam vacuum chamber of accelerators should not solve one problem introducing another one. ASTeC team is developing in-vacuum technologies for beach chamber that address multiple problems. A non-evaporable getter (NEG) coating of accelerator beam chamber was initially invented as a vacuum solution. It allows to reach specified vacuum even in a very confined space and narrow (5-20 mm) beam chambers. It is also an ideal solution to with a fast ion instability in negatively charged machines and an ion induced pressure instability in positively charged machines.
Later it was show that NEG coating can be deposited with a surface structure allowing to reduce SEY

Name: Reza Valizadeh (STFC/ASTeC)
Email: reza.valizadeh@stfc.ac.uk

Title: Study of e-cloud mitigation efficiency with LASE surfaces at DAFNE TF

Text of Contribution:
The secondary electron emission (SEE) can cause an electron cloud build-up inducing an increase in beam instability, beam losses, emittance growth, vacuum pressure increase, a reduction in the beam lifetime, or, it can lead to additional heat loads on a cryogenic vacuum chamber. In the past few years we have established that Laser Ablation Surface Engineering (LASE) is a very effective way of producing surfaces which have Secondary Electron yields (SEY) >1. These can be achieved with a variety of laser pulse durations from nano- to pico seconds. The effect of such engineered surface on SEE reduction for copper has been successfully demonstrated by monitoring the electron cloud current in a dipole magnet in the SPS accelerator at CERN and similar test to determine Photon Stimulated Desorption (PSD) of such surfaces is currently being run at KARA. Unfortunately the features (i.e. moderately deep grooves and nano-particulates) that help to reduce the SEY also produce undesirable effects such as an increase in surface impedance and loose particulates. For reducing the depth of the surface altered layer femtosecond laser pulses has recently been used which generate wave-length-scale surface structures with directionality and periodicity, known as laser-induced periodic surface structure (LIPSS). The reduction in SEY in most cases so far has been less effective, but a few laser processing parameters have produced reasonable SEY values (less than 1 for primary electron energy below 400 eV).
It is important to note that the efficiency of ecloud mitigation with LASE surfaces recently investigated with a proton beam at SPS demonstrated the case of SEY driven e-cloud, as there was practically no synchrotron radiation. Ongoing experiment at KARA will report photon stimulated desorption from LASE. The advantage of experiments at the DAΦNE TF would be a complex study of ecloud build up in presence of photo-electrons and photon stimulated pressure increase. Thus, unlike the earlier experiment, three main sources of electrons ecloud will be present. Furthermore, this will provide an opportunity to measure the correlation between four input parameters required for modelling future machines: PSD, ESD, PEY and SEY.
It will be a good opportunity to test and optimise such laser engineered surfaces in comparison to other coating such as amorphous carbon and NEG.

Oleg Malishev

Vacuum and e-cloud studies at DAFNE-TF

Sara Casalbuoni (KIT)

Using DAFNE to study the physics of e+/e- interaction with vacuum devices

DAFNE is an excellent machine to study the interaction of electron and positron beams with vacuum chambers. In particular it could contribute to a deeper understanding of the beam heat load contribution to the cold bore, essential for the successful performance of circular colliders using superconducting magnets.

A beam heat load to superconducting magnets higher than predicted could cause a lower magnetic field seen by the beam, and therefore a lower center of mass energy for the collisions, up to a complete failure of the machine in case of a quench of a superconducting magnet (zero magnetic field). The measurements of the beam heat load on a cold bore are also essential to benchmark: different kind of simulations of beam heat load due to synchrotron radiation, impedance, and electron cloud. Insight on impedance, and electron cloud, which often causes harmful beam instabilities, can produce relevant improvement in terms of beam currents, and in turn of luminosity.

Studies on vacuum chambers for the successful performance of cryogenic insertion devices in low emittance light sources are also possible. In a first stage COLDDIAG, a cold vacuum chamber for diagnostics, developed by KIT in collaboration with CERN, DLS, Frascati National Laboratory, Rome University “La Sapienza”, STFC Daresbury Laboratory, STFC Rutherford Appleton Laboratory, University of Manchester, Cockcroft Institute of Science and Technology and Lund University MAX-lab, could be installed.

DAFNE feedback tests correlated with FCC-ee

John Fox

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Title: DAFNE-TA as a Beam Diagnostic and Instability Control Test Facility

Text of Contribution:
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This proposal covers 4 ideas, which can be expanded in scope as the workshop offers ideas and opportunities.

#1) New high-gain transverse instability feedback control methods for large rings or extremely high growth rates

The existing control schemes in common use have limitations from noise in the pickup and processing as well as group delay limits from the processing techniques which look problematic for future machines such as FCC. We propose to develop new processing methods that use multiple pickups (at unique betatron phases) to lower the noise and calculate high-gain correction signals in a single turn of latency. The goals would be both the development of low-noise processing as well as new algorithms for computation. We propose trying these methods out with DAFNE-TA and quantifying the performance limits of existing and new methods in a careful way, resulting in publications and demonstration technology that can guide new technology efforts. The scale of this can be modest (mostly built on the existing processing at DAFNE with judicious use of available pickups, revised firmware) or if resources allow technology development a complete new architecture and technology platform could be developed and evaluated at DAFNE-TA, with potential application to demonstrations at other facilities.

#2) Benchmarking and Characterization of novel Tune and Beam Diagnostics from instability feedback data processing streams

The experience using closed-loop noise spectra and other methods to characterize beam tune and other properties (such as collision induced beam-beam tune shifts) can be formally expanded to incorporate driven methods with special chirps and spectrally tailored excitations and control filters. This effort would use the DAFNE-TA machine to compare methods from a suite of analysis and operational tools, carefully benchmark these to establish regions of applicability, determine sources of systematic errors, and to characterize achievable error bars.
The goal is to provide more consistent, and possibly novel beam diagnostics.

John Fox

#3) Development of a hands-on Beam Instrumentation and Feedback school for training the next generation of Accelerator Scientists and Engineers

Various UPSAS, CERN, and Asian accelerator schools have tried to cover this topic. We think a resident school, with both lectures and hands-on experience with the beam and signals would be a more extensive training opportunity. This sort of 2 – 4 week in residence school would bring the students to readiness to understand and utilize modern control methods, it could also allow skills in the design of pickups and kickers, coding of algorithms, development on FPGA platforms, etc. We think having a group of expert instructors with live beam exercises, the opportunity to have lab sessions with hardware, kickers, RF components, etc. is the best way to build a new generation of experts for this area. This school could be twice yearly, or yearly, or even could be a several month in residence fellowship training opportunity with resident instructors and mentors.

#4) Development and Evaluation of novel wideband Beam Kicker structures

The recent experience developing intra-bunch instability methods has led to ideas for novel wideband kicker structures as well as demonstration hardware installed at the SPS. The scaling of this approach to future hadron machines such as HL-LHC or FCC machines requires new kickers at higher frequencies. We want to investigate the use of DAFNE-TA as a test bed for these new kickers, as the relatively long bunch length at DAFNE (and possible new optics with longer bunch lengths) may be consistent with test opportunities. The effort should explore all the options in the original Kicker Design Report (http://www.slac.stanford.edu/cgi-wrap/getdoc/slac-r-1037.pdf), and as consistent with the allowed impedance budget at DAFNE a wideband kicker could be designed, fabricated and commissioned for test with real beams

Other feedback studies in DAFNE correlated with FCC-ee

Sixth e-cloud workshop, **ECLOUD'18**, 3-7 June, 2018, La Biodola (Isola d'Elba), Italy

Intrabunch feedback system development at DAFNE

Alessandro Drago

INFN Frascati & Tor Vergata Rome University

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 730871.

A feasibility study for DAFNE ?

- In the 2020 DAFNE should stop to work as a collider
- The idea to continue activities is to propose DAFNE-TF (DAFNE Test Facility) to run for small experiments.
- They are still to be defined and funded
- It could be an occasion to implement in DAFNE e+ main ring, a wideband feedback system for diagnostics and testing purpose working in the horizontal plan.
- This plan can be more convenient for DAFNE, where the e-cloud effects are more evident in horizontal than in the vertical plan.
- First of all, it would be necessary to have a longer bunch. So we need to study how to achieve this goal.

A feasibility study for DAFNE ?

- For the pickup we need at least 2GHz bandwidth pickup, that maybe it will be not so difficult to have
- Given that the slotted kicker seems the more compact solution for back end, we can use the 1.1 meter space that we have where now the dump kicker is placed
- We should design and make a slotted kicker fitting in the space considered
- We need to buy two 250W / 1GHz power amplifiers
- We need electronics and fast processing units
- The cost of the experiment could be limited to about 300k€

DAFNE feedback upgrade for the next run for *Siddharta*

- In DAFNE the stored beam current in the positron ring is always been lower than in the electron ring
- This is for the e-cloud parasitic effect causing strong horizontal instability with extremely fast growth rate (of the order of 10-15 turns)
- Another effect is the beam vertical enlargement
- Clearing electrodes with good results but they are too fragile: in 5 years 10 of 12 electrodes are broken
- Risks to have a too low positron beam current in the next run
- Solution; increasing the e+ horizontal feedback power
- This is easier to implemented by adding a 2nd horizontal feedback

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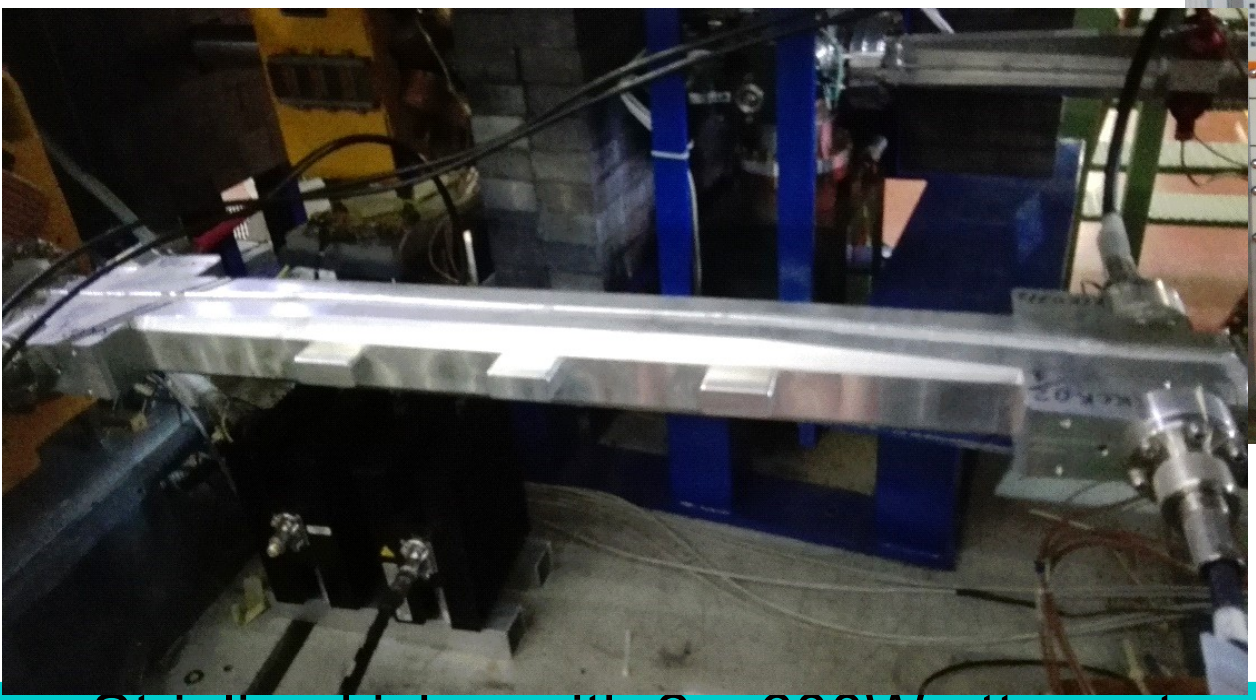
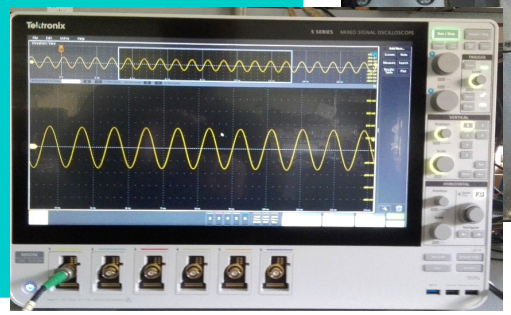
- A "path to reduce residual noise levels of bunch-by-bunch feedback systems is to use multiple *(N)* processing channel [216].
- Replacing one system with several systems does not affect the maximum achievable damping (as long as all systems use the same feedback topology), but it does provide a $\sqrt{(N)}$ reduction of the residual motion.
- [216] A.Drago, *DAFNE horizontal feedback upgrade*, Proceedings PAC'09 (2009) 4123-4125.

A 2nd horizontal feedback has been installed in the e+ ring





- Stripline kicker with 2 x 600W attenuators
- 2 x 500W power amplifiers
- 1 iGp unit added
- 1 oscilloscope for monitoring

Which studies can be carried on

- Comparison between the damping rates of the two systems that have different power (2x250W vs. 2x500W)
- Comparison between the increasing of the vertical size induced by the noise of the two feedback loop
- Evaluation of the cumulative effect given by the two cooperative systems that should doubling the total damping rate and making possible to increase the top current

Conclusion

- In DAFNE plans for 2019-mid 2020, there are work in progress about feedback systems and material science with application to vacuum and e-cloud studies
- After mid 2020 DAFNE will be closed as collider for big experiment but it *can* continue as test facility
- Many contribution will be discussed next week at the Frascati workshop
- A new phase for evaluating the contribution feasibility and for searching funds *should* begin in the next year