

EuCARD WP4 - Accelerator Networks

Frank Zimmermann, CERN/BE

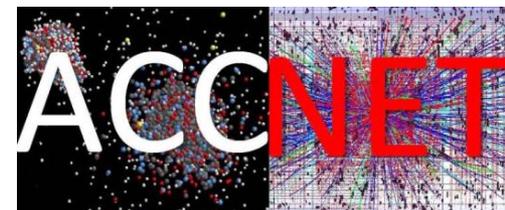
thanks to

Ralph Assmann, Mariusz Grecki, & Jean-Pierre Koutchouk

EuCARD 2013 Workshop
CERN, 10 June 2013



EuCARD-AccNet 2009-2013



partners/contributors: **DESY, GSI, INFN, CI, PSI, CERN, US-LARP, KEK, UJF, EU universities in particular Polish & French institutes, ANL, SNS, BINP, ... (>60 institutes!)**

3 scientific work packages:

- ***RFTech*** – RF technologies
- ***EuroLumi*** – high-intensity high-brightness accelerators and colliders (LHC upgrades, FAIR, etc.)
- ***EuroNNAc*** – novel accelerators *[added in 2010]*

impact/results:

43 workshops ; > 160 documents; new concepts & proposals (LHC crab cavities, (V)HE-LHC, TLEP, SAPPHiRE, AWAKE, RF SSA,...); new collaborations

first ACCNET meeting: 04.12.2008



Annual AccNet Steering meetings

e.g. 2nd general AccNet Steering meeting,
RAL, 13 April 2010





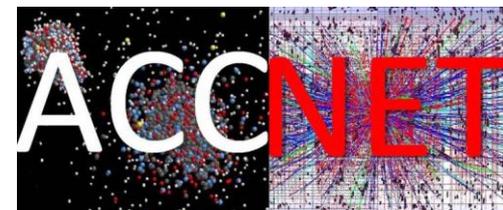
Annual AccNet Steering meetings

e.g. 3rd general AccNet Steering meeting,
CNRS, May 2011





EuCARD-AccNet coordination



Coordination & Management

coordinated by Walter Scandale [Alessandro Variola], IN2P3;
Peter Spiller, GSI ; Frank Zimmermann, CERN



Euro- Lumi

*accelerators & collider
performance*

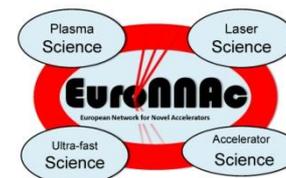
coordinated by
Frank Zimmermann &
Ezio Todesco, CERN



RFTech

sc & nc rf technologies

coordinated by
Jean-Marie de Conto,
UJF;
Mariusz Grecki, DESY ;
Wolfgang Weingarten,
CERN



EuroNNAc

novel accelerators

coordinated by
Ralph Assmann,
CERN; Arnd Specka,
[Henri Videau] E.Pol.;
Jens Osterhoff, DESY



EuroLumi: network on accelerators & collider performance

brainstorming & proposing novel concepts

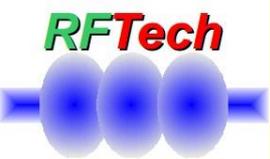
15+11 topical workshops in 4 years, gathering EU, Swiss, US, Japanese & Russian accelerator scientists and more

recognized place for **world-level discussions**, largely sponsored by participants

important source of proposals for CERN and European HEP:

- turned **crab cavities** into a realistic possibility for an optimal LHC upgrade: now CC's now at the heart of the LHC **luminosity upgrade**
- launched brainstorming on **higher-energy pp colliders: HE-LHC/VHE-LHC**
- launched brainstorming on **TLEP** as an alternative to LC's, with large potential for its **longer tunnel**
- launched brainstorming on **ERL based gg colliders – SAPPHiRE, HFiTT**

initiation of **new collaborations** with **ESA/ESTECH** space satellite community on electron-cloud modeling; with **Mexico** (CINVESTAV, CONACYT) on HL-LHC (e- cloud, crab cavities, H- source) ; with **laser industry, LLNL & ICAN** (SAPPHiRE)



RFTech: network on SC & NC RF technologies

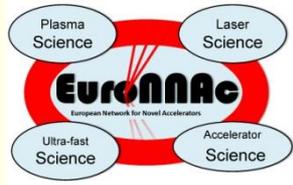
joining communities & exploiting synergies

4+18 topical workshops in 4 years, gathering EU, Swiss, US and Japanese accelerator scientists and more

joint meetings of RF experts from different communities, e.g. working on hadron and lepton beams, on accelerators and RF systems for space satellites, on light sources, NP or HEP facilities, on rings and linacs,...

- **exchange over all aspects of RF systems**: structures, electro-magnetic field calculations, LLRF, SS power amplifiers, RF for LHC, for FELs, for crab crossing, costing procedures & tools, ...
- important report on **strategy for SC technology and test stations**
- report on general **strategy for RF technologies in preparation**

initiation of **new collaborations** with *ESA/ESTECH* & *VALSPACE* space satellite community on multipacting simulations & high-gradient breakdown studies



EuroNNAc: network on novel accelerators

exploiting synergies & proposing novel concepts

5 topical workshops in 3 years, gathering EU, Swiss, US and Russian accelerator & plasma scientists and more

initiated as a voluntary EuCARD NA after exchanges with V. Malka (JRA), R. Assmann (EuCARD Deputy Coordinator at the time), and others.

Goals:

- creating a **stronger link between PWA and accelerator communities**;
- working together in EU to **combine forces**;
- creating new **infrastructures dedicated to PWA** (*“from acceleration to accelerators”*)

Impact:

- successful **workshops** to prepare a **roadmap**;
- **EuroNNAc PWA network included in EuCARD2**, links established **with initiatives in lasers and PWA (ICAN/IZEST,...)**



EuroLumi – main themes

improving LHC & preparing HL-LHC & FAIR

- LHC *optics* measurement & correction (2 workshops)
- *e- cloud* (3 workshops, collaboration w ESA & Mexico)
- *space charge* (1 CERN-GSI workshop)

HL-LHC

- advanced *crab cavities* to baseline! (2 workshops & Mex.)
- crystal collimations (2 workshops)
- LPA, *flat beams & crab-waist option* (together w WP11)

beyond HL-LHC

- HE-LHC (1 workshop)
- VHE-LHC (1 workshop)
- LEP3 & TLEP (5 workshops)
- SAPPHiRE (1 workshop)

*after start of CERN/EU
LHC HiLumi project;
EuroLumi activities refocused
on the time after HL-LHC*

EuroLumi (co-)organized events, 2009-10

- 16.-18.09.2009 [LHC-CC09, 3rd LHC crab cavity workshop](#), CERN
- 12.-13.10.2009 [AccNet EuroLumi Workshop on Anti E-Cloud Coatings that require no activation "AEC'09"](#), CERN
- 09.-10.11.2009 [EuCARD-AccNet-EuroLumi mini-Workshop on Crystal Collimation](#), CERN
- 07.-08.12.2009 [Working meeting on proton driven plasma acceleration PPA09](#), CERN
- 02.-04.02.2010 [AccNet Co-Sponsored Workshop on "Physics for Health in Europe"](#), CERN
- 11.-12.03.2010 [Workshop on Proton Driven Plasma Wake Field Acceleration](#), CERN
- 14.-16.10.2010 [HE-LHC'10, Mini-Workshop on High-Energy LHC](#), Malta
- 25.-26.10.2010 [Annual Workshop on Crystal Collimation](#), CERN
- 15.-17.12.2010 [LHC-CC10, 4th LHC Crab Cavity Workshop](#), CERN

EuroLumi (co-)organized events, 2011-12

- 07.-08.03.2011 [CERN-GSI Electron-Cloud Workshop](#), CERN
- 20.-21.06.2011 [Workshop on Optics Measurement, Correction & Modelling "OMCM"](#), CERN
- 21.-23.09.2011 [MulCoPim'11](#), Valencia
- 14.-15.11.2011 [LHC-CC11- 5th LHC Crab Cavity Workshop](#), CERN
- 05.-09.06.2012 [E-CLOUD'12](#), INFN-LNF/INFN-Pisa/LER/EuCARD-AccNet
Joint workshop, Elba
- 19.-25.09.2012 [ICAP 2012](#), Warnemuende/Rostock
- 18.06.2012 [1st EuCARD AccNet LEP3 Day](#), CERN
- 23.10.2012 [2nd EuCARD AccNet LEP3 Day](#), CERN
- 14.-16.11.2012 [2nd Joint HiLumi LHC - LARP Annual Meeting](#), Frascati,
Italy

EuroLumi (co-)organized events, 2013

- 10.01.2013 [3rd EuCARD AccNet TLEP3 Day](#), CERN
- 15.-16.01.2013 [EuCARD co-sponsored WAMSDO workshop on magnets quenches](#), CERN
- 19.02.2013 [EuCARD AccNet SAPPHiRE Day](#), CERN
- 21.02.2013 [Joint Snowmass-EuCARD/AccNet-HiLumi meeting 'Frontier Capabilities for Hadron Colliders 2013'](#),
a.k.a. EuCARD VHE-LHC Day, CERN
- 04.05.2013 [4th TLEP mini-workshop](#), CERN
- 16.-19.04.2013 [SpaceCharge2013](#), CERN, Switzerland
- 17.-18.06.2013 [LHC Optics Measurement and Corrections Review](#),
CERN
- 25-26.07.2013 [5th EuCARD TLEP mini-workshop](#), FNAL

MULCOPIM '11

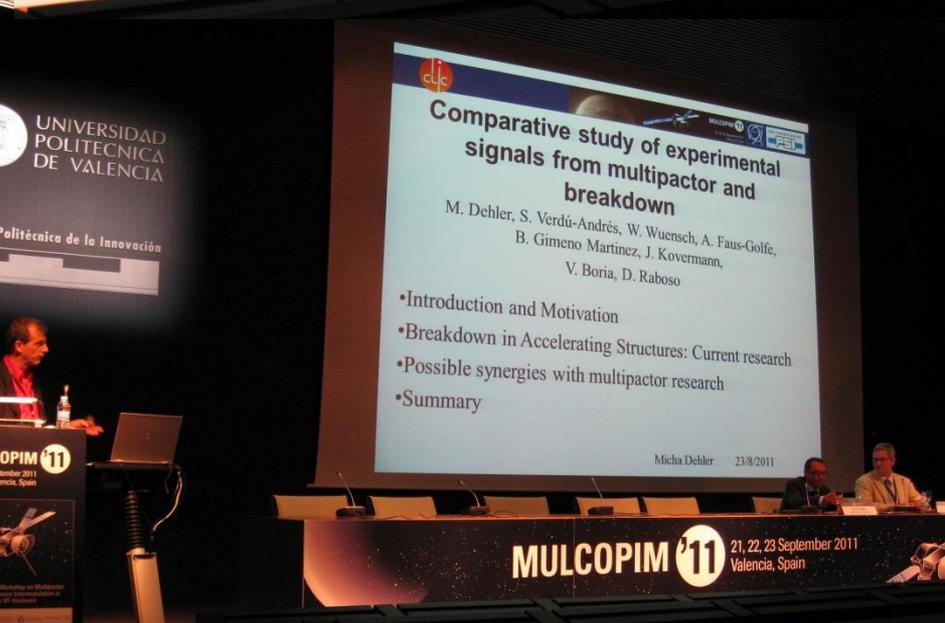
21, 22, 23 September 2011
Valencia, Spain



Particle Accelerators
technical sponsors



MulCoPim'11 Accelerator Session



MulCoPim topics: multipactor components, multipactor Tx lines, multipactor dielectrics; corona, multipactor experimental, multipactor software, multipactor multicarrie; PIM, SEY, Accelerators

LHC-CC09 workshop

LHC Crab Cavity Workshop,
jointly organized by CERN,
EuCARD-ACCNET, US-LARP,
KEK, & Daresbury
Lab/Cockcroft Institute
CERN, 16-18 September 2009



~50 participants, LHC Crab Cavity Advisory Board established



5th Joint EuCARD-AccNet – LARP – KEK – CI/DL workshop on LHC crab cavities, LHC-CC11

14-15 November 2011, CERN

<https://indico.cern.ch/conferenceDisplay.py?confId=149614>



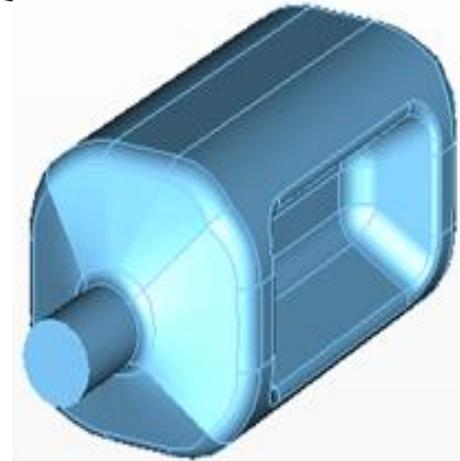
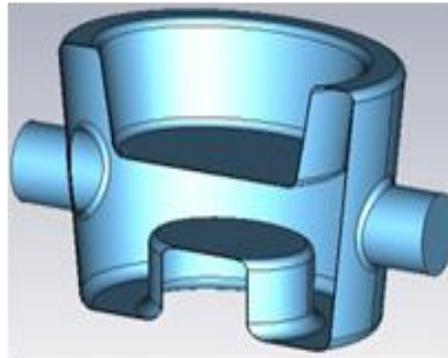
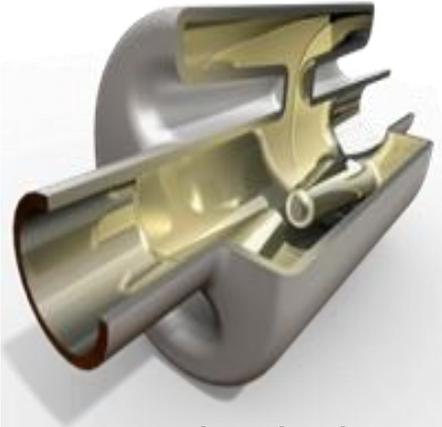
Participants: about 52 persons (many institutes in Europe, US, and Japan)
46+3 presentations

Main results: convergence to 2 (3) compact crab-cavity designs; first AI prototypes; detailed cavity specifications will be prepared by April 2012 based on initial set of HL-LHC parameters; beam test of the compact design in the SPS and the LHC are pre-requisites for a final installation in LHC Points 1 and 5.

Organizers:

Rama Calaga, Rogelio Tomas, Frank Zimmermann

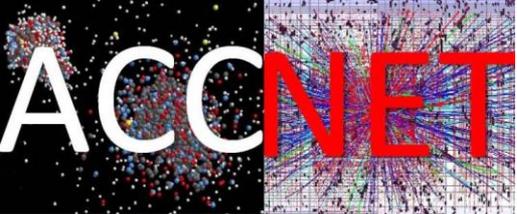
LHC crab cavities: *only 19 cm beam separation, but long bunches*
in 2004 considered on the “imaginary” axis, but now
thanks to AccNet part of HL-LHC baseline!



final compact cavity designs: 4-rod cavity design by Cockcroft I. & JLAB (left), $\lambda/4$ TEM cavity by BNL (centre), and double-ridge $\lambda/2$ TEM cavity by SLAC & ODU (right)



prototype compact *Nb-Ti* crab cavities for the LHC: 4-rod (left) and 2-ridge cavity (right)



AccNet mini-workshop on crystal collimation in 2010

CERN, 25-27 October'10, ~32 participants, about 1/3 from CERN, and others from Italy (INFN Ferrara, Legnaro, Napoli, Roma), Russia (JINR Dubna, IHEP Moscow, St. Petersburg), Germany (GSI Darmstadt), UK (Imperial College), USA (SLAC), and Switzerland (EPFL Lausanne).

<http://indico.cern.ch/conferenceDisplay.py?confId=109124>

topics:

- collimation procedures assisted by bent crystals for HL-LHC and future large colliders
- critical review of results from H8 line,
- results of collimation experiments in “low energy” storage rings, such as the SPS,
- possible use of bent crystals for LHC collimation
- other applications of crystals and alternative advanced methods of collimation in other laboratories

EuCARD Newsletter article



European Coordination for Accelerator Research and Development Newsletter

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Crystal clear ideas for beam collimation

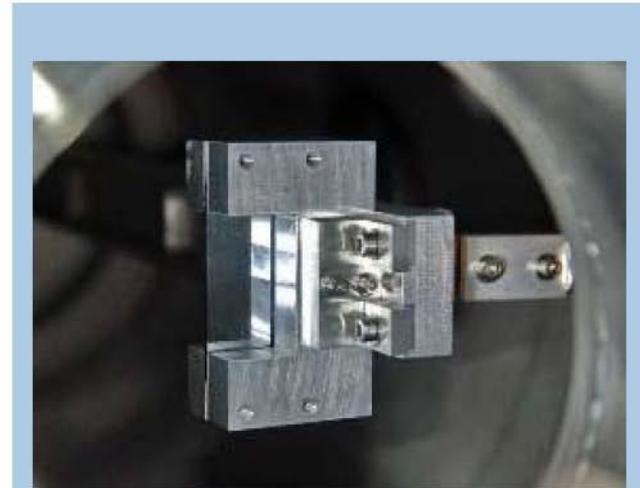
October marked the annual crystal collimation workshop at CERN, where encouraging results from tests in CERN's Super Proton Synchrotron (SPS) were revealed. These show potential for crystal collimation applications, possibly even in the LHC.

Crystallizing collimation ideas

In particle accelerators, collimators trim and filter a beam, removing stray particles and keeping the beam focused and on track. Collimator R&D forms part of the EuCARD project ([WPS](#)) and conventional collimators are usually made from about 1 metre of carbon, though designs vary (see newsletter [issue 3](#)).

What makes crystal collimation a novel approach is that it performs the role of the 1m of carbon with just half a centimetre of silicon crystal. Large magnetic fields created by the atoms of the crystal create a large deflection of the beam halo.

The current SPS experiment, known as UA9, is looking at effects of crystal collimation in a circular machine, where the beam interacts with the crystals many times.



This 2mm-thick transparent slice (shown here in a metallic frame) is a quasimosaic silicon crystal. It is one of the new crystals currently being tested in CERN's Super Proton Synchrotron (SPS). *Image courtesy of Walter Scandale. Thumbnail image main page courtesy of Nico van Diem, [sxc.hu](#).*

EuroLumi E-CLOUD'12, Elba, 5-9 June 2012

- reviewed recent e-cloud observations at LHC, DAFNE, PETRA-III, Cesr-TA, J-PARC,.. & e-cloud predictions for SuperKEKB, SuperB, Project-X, ISIS upgrade, RHIC upgrade, HL-LHC, HE-LHC, ILC,...
- established & strengthened links with space community (ESA, Val Space consortium, ONERA, ICMM, Princeton SPL, EPFL LEMA,...)
- discussed new powerful simulation tools (SYNRAD3D/Cornell, OSMOSEE/ONERA, PyE-CLOUD/CERN, WARP-POSINST/LBNL, BI-RME-E-CLOUD/EPFL, FEST3D/Aurora, ...)



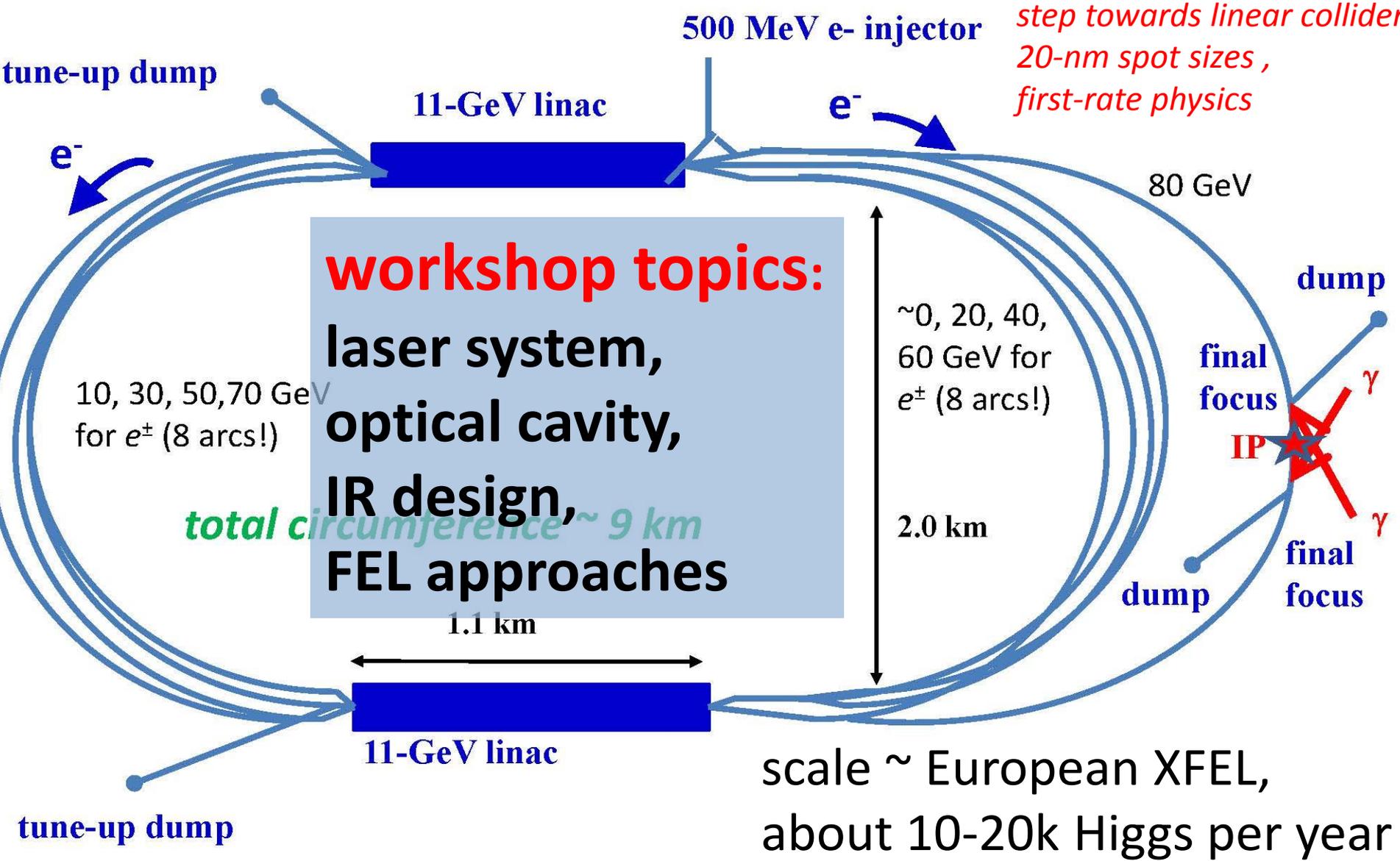
62
participants

E-CLOUD'12 photos



EuCARD *workshop proceedings* in print
(eds. R. Cimino, G. Rumolo, F. Zimmermann);
in addition PRST-AB special edition E-CLOUD'12

AccNet SAPPHiRE Day, 19 February 2013

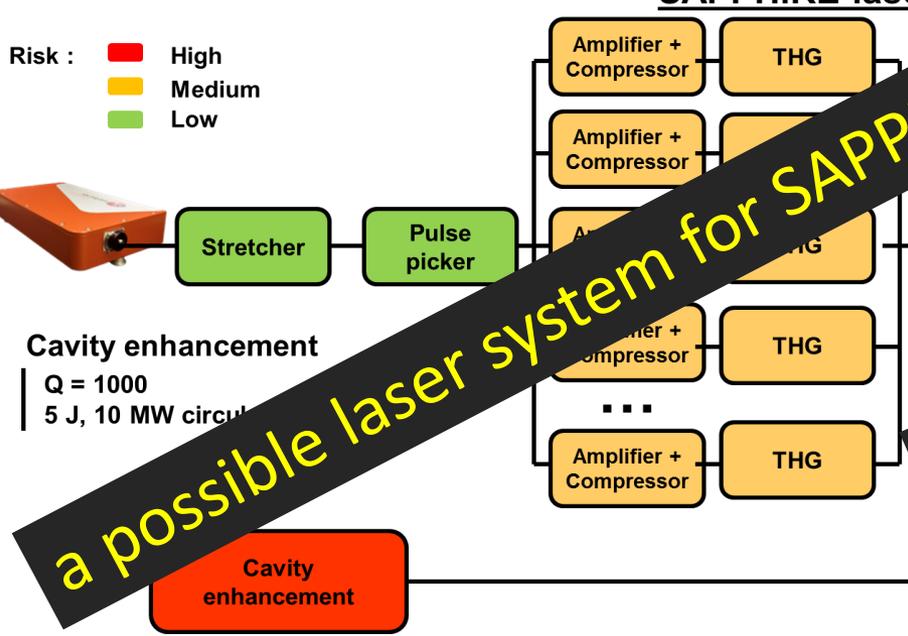


SAPPHiRE: Small Accelerator for Photon-Photon Higgs production using Recirculating Electrons

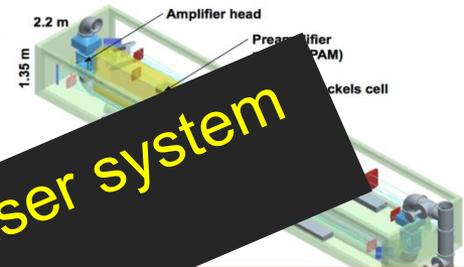
EuCARD-AccNet SAPPHiRE Day, 19 February: laser

SAPPHiRE laser

Risk :
■ High
■ Medium
■ Low



Cavity enhancement
 Q = 1000
 5 J, 10 MW circulator



- beam line :
- Pulses at 16 Hz
 - 8.125 kJ / pulse
 - 130 kW average power
 - ns pulse width

another possible laser system for SAPPHiRE

J. Gronberg, LLNL

Y. Zaouter, Amplitude Systems

Gerard Mourou et al., "The future is fiber accelerators," *Nature Photonics*, vol 7, p.258 (April 2013).



10 J at 10 kHz

a 3rd possible laser system for SAPPHiRE – synergy with ICAN!

a seed laser (1) ... with the final stages producing pulses of ... coherently, compressed (5) and focused (6) to produce a pulse with an energy ... kHz (7). [3]

G. Mourou, LOA;
 M. Velasco,
 Northwestern U.
 (after SAPPHiRE Day)

EuroLumi: HE-LHC & VHE-LHC

EuCARD-AccNet workshop HE-LHC'10, Malta, 14-16
October 2010

56 participants (13 US, 26 CERN)

Proceedings (ed. F. Todesco, F. Zimmermann)

*"EuCARD-AccNet-EuroLumi Workshop:
The High Energy Large Hadron Collider"*

arXiv:1111.7188 ; CERN-2011-003

→ HE-LHC included in HiLumi LHC WP16 (2011)

Joint Snowmass-EuCARD/AccNet/HiLumi LHC meeting

'Frontier Capabilities for Hadron Colliders 2013' a.k.a.

VHE-LHC Days, 21-22 February 2013

EuCARD Newsletter article



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Proposed increase in energy takes LHC even further into the future

Accelerator scientists from around the world came together in Malta in October to discuss the possibility of increasing the energy of the present LHC. Organised by [AccNet](#) within EuCARD, the High Energy (HE) LHC workshop was convened to discuss the possible future LHC upgrade to a 16.5 TeV beam machine.



Participants in the HE-LHC'10 workshop. *Image courtesy of Kazuhito Ohmi. Thumbnail image on main page courtesy of CERN.*

Joint Snowmass-**EuCARD/AccNet**-HiLumi LHC meeting 'Frontier Capabilities for Hadron Colliders 2013' a.k.a. **VHE-LHC Days**, 21-22 February 2013



1st EuCARD LEP3 Day, 18 June 2012

physics case, beam parameters, beam dynamics
(beamstrahlung), hardware (RF, vacuum, magnets), tunnel,...



followed by series of AccNet LEP3 & TLEP mini-workshops:

1st EuCARD LEP3 Day, 18 June 2012, CERN

2nd EuCARD LEP3 workshop, 23 October 2012, CERN

3rd EuCARD TLEP3 workshop, 10 January 2013, CERN

4th EuCARD TLEP mini-workshop, 4-5 April 2013, CERN

5th EuCARD TLEP mini-workshop, 25-26 July 2013, FNAL

AccNet article in *Accelerating NEWS* issue 3

Circulating ideas about a new Higgs factory



Frank Zimmermann (CERN)

Could the LHC tunnel one day house a high-luminosity electron-positron collider? This idea joined others at the LEP3 Day, held at CERN on 18 June 2012.

In 2011, early LHC indications suggested that the Higgs boson might be light, with a mass in the range 115-130 GeV. On Christmas' Eve 2011 the first concrete proposal for a high-luminosity circular electron-positron collider was presented after Alain Blondel of Geneva University realised that an object like this could be studied in the LHC tunnel at about 240-GeV centre-of-mass energy.

This, along with the numerous encouraging reactions to this proposal, led the EuCARD Work Package 4 "AccNet" to organise a "LEP3 Day", which was only a few weeks before the LHC's ATLAS and CMS experiments announced the discovery of a Higgs-like boson with a mass of 125 GeV. About 40 motivated accelerator physicists from Switzerland, Japan, Russia, US and the UK participated in this EuCARD LEP3 Day, including Steve Myers, CERN Director of Accelerators and Technology, the KEK trustee Yasuhiro Okada, and members of CMS and ATLAS. A full report on the LEP3 Day is now available.

[Read more >>](#)

Keywords: LEP3, EuCARD, LHC



Issue 3 – Autumn 2012 - article #5

www.acceleratingnews.eu

EuCARD "LEP3 Day" looks at circular Higgs factories

In 2011, early LHC indications suggested that the Higgs boson might be light, with a mass in the range 115-130 GeV. On Christmas' Eve 2011 the first concrete proposal for a high-luminosity circular *electron-positron* collider was presented¹ after Alain Blondel of Geneva University realised that an object like this could be studied in the LHC tunnel at about 240-GeV centre-of-mass energy. This, along with the numerous encouraging reactions to this proposal, led the EuCARD Work Package 4 "AccNet" to organise a "LEP3 Day", which was held at CERN on 18 June 2012, only a few weeks before the LHC's ATLAS and CMS experiments announced the discovery of a Higgs-like boson with a mass of 125 GeV. About 40 motivated accelerator physicists from Switzerland, Japan, Russia, US and the UK participated in this EuCARD LEP3 Day, including Steve Myers, CERN Director of Accelerators and Technology, the KEK trustee Yasuhiro Okada, and members of CMS and ATLAS.

Alain Blondel opened by recalling the short history and key elements of a high-luminosity circular collider Higgs factory, "LEP3," in the LHC tunnel. The projected target performance achieved 500 times the luminosity of LEP at 15% higher beam energy while respecting acceptable power consumption limits. This was made possible by three innovations: (1) using a lower-emittance optics (e.g. as for the LHeC project), (2) much stronger focusing at the collision point (albeit not quite as strong as for the SuperB factories), and, in particular, (3) complementing the collider ring running at constant energy with a fast cycling accelerator ring for top-up injection. He explained how this top-up injection is necessary at luminosities at the $10^{34}\text{cm}^{-2}\text{s}^{-1}$ level because the beam lifetime, due to radiative Bhabha scattering, will be only 15-20 minutes (for comparison at the former LEP2 it was a couple of hours).

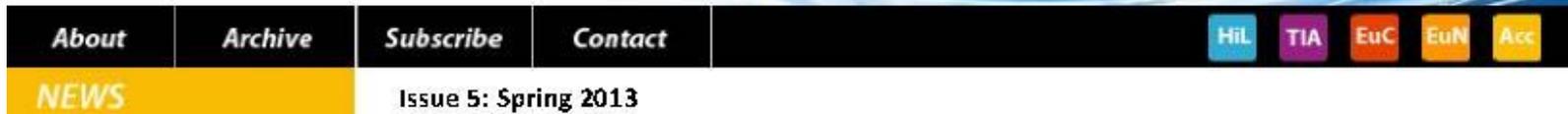
3rd EuCARD TLEP3 Day, 10 Jan. 2013



4th EuCARD TLEP WS, 4-5 April 2013



AccNet articles in *Accelerating NEWS* issue 5



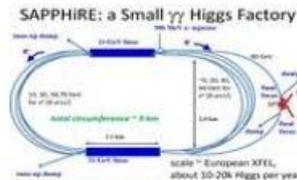
EuC **HiL** Targeting the Energy Frontier for next Accelerators
by Frank Zimmermann (CERN)

Recently two EuCARD-AccNet events explored options for the next accelerators at the energy frontier. The EuCARD “SAPPHiRE Day” on 19 February focused on the key components of a proposed g - g collider Higgs factory, based on a recirculating SC linac. The “Joint Snowmass-EuCARD/AccNet-HiLumiLHC meeting on Frontier Capabilities for Hadron Colliders 2013” on 21-22 February investigated the next generations of hadron colliders up to the 100 TeV scale. Both workshops attracted about 50 experts from around the world.

The proposed SAPPHiRE layout is a moderately expensive step towards a higher-energy linear collider, demonstrating the handling of 20-nm spot sizes while delivering first-rate physics results. The emphasis of the SAPPHiRE Day was on the laser system, optical cavity, interaction region design, and FEL approaches.

The joint workshop on frontier capabilities explored the parameters and 20-T magnets for a 33-TeV c.m. pp collider in the existing LHC tunnel and for a 100-TeV c.m. collider in a new 80-km tunnel. The workshop reviewed the high-field magnet development status and plans at CERN and LBNL.

[Read more >>](#)



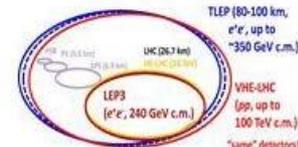
Layout of SAPPHiRE g - g collider Higgs factory delivering 10k Higgs per year.

Acc “TLEP” - Circular Higgs Factory and a Long-Term Perspective for High Energy Physics
by Frank Zimmermann (CERN)

Following the [first EuCARD “LEP3 Day”](#) on 18 June 2012 (see article ‘Circulating ideas about a new Higgs factory’ in [Accelerating News issue 3](#)), which revealed a great interest in a circular-collider “Higgs factory”, EuCARD Work Package 4, [AccNet](#), has been organizing several workshops discussing the key ingredients, the physics potential, experimental detector concepts, and synergies with other projects of such a facility.

Emphasis has shifted from LEP3, a machine installed in the 27-km LHC tunnel originally proposed, to TLEP, an electron-positron collider in a new 80 or 100-km long ring tunnel. Advantages are manifold: TLEP construction would be fully decoupled from LHC/HL-LHC operation. TLEP could achieve up to 5 times higher luminosity than LEP3, promising a precision for Higgs coupling measurements much better than any other planned or proposed machine. Such precision is needed to discover physics beyond the standard model at energies above 1 TeV. In addition, TLEP could possibly provide the infrastructure (tunnel, cryogenics, injector-ring magnets, detectors) for a future 100-TeV proton-proton collider in the same tunnel – the “Very High Energy LHC” or “VHE-LHC” –, paving a path towards extremely high hadron collision energies, while also allowing for highest-energy electron-proton collisions.

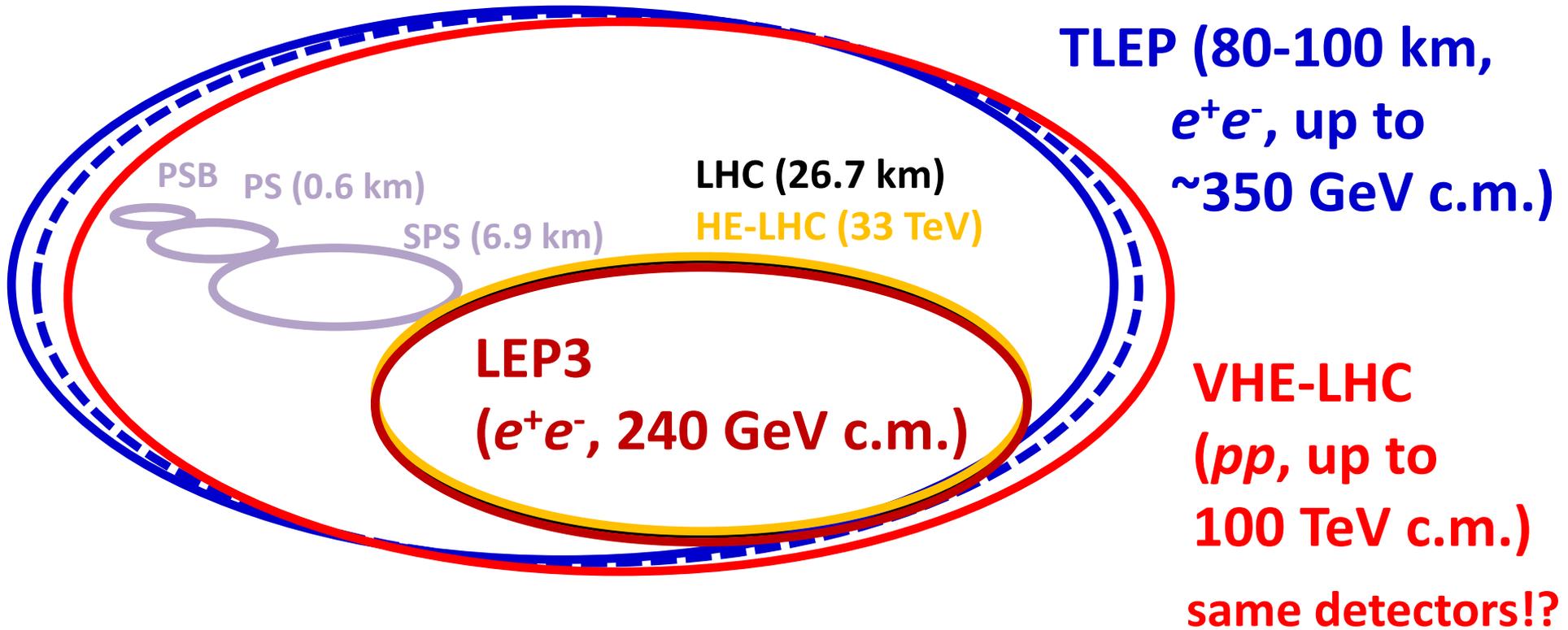
Presently a [TLEP conceptual design study](#) is being set up aiming at delivering a design report by 2014/2015.



& e^+ (120 GeV) - p (7, 16 & 50 TeV) collisions [(VHE)-]TLEP

A long term strategy for particle physics. The succession of TLEP & VHE-LHC could provide more than 50 years of e^+e^- , pp, AA, ep/A physics at highest conceivable energies. The sequence LEP3 & HE-LHC represents a less ambitious, but lower-energy alternative. s. Image credit: TLEP

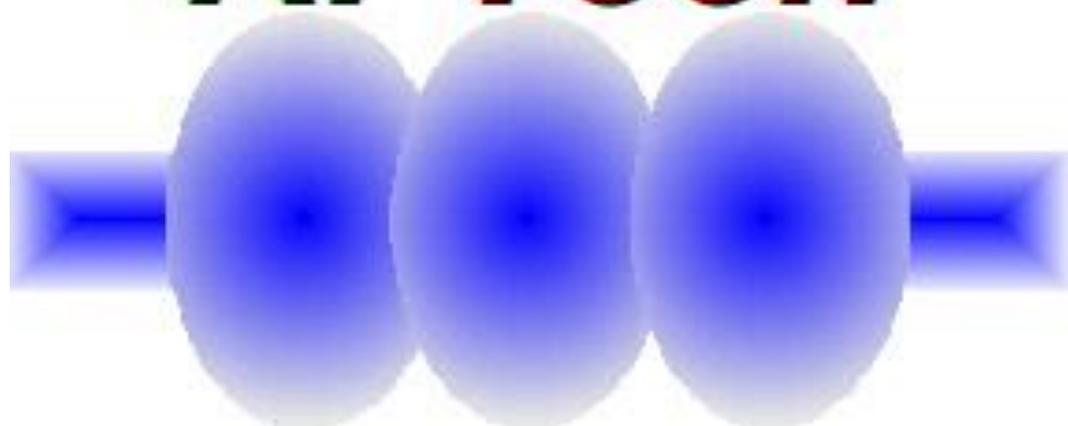
possible long-term strategy for HEP emerging from AccNet workshops & studies

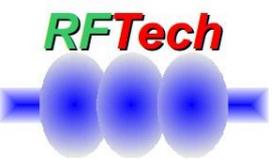


& e^\pm (120 GeV) – p (7, 16 & 50 TeV) collisions ([V]HE-]TLHeC)

≥50 years of e^+e^- , pp , ep/A physics at highest energies

RF***Tech***





RFTech – main themes

cavities, cryomodules, couplers

- Spiral-2 couplers, HIE ISOLDE cavity & test cryostat, LHC crab cavities, Perturbation methods for cavity calculation, finite integration Maxwell solvers and FEM schemes,...

SC & NC linacs, rings, “projects”

- SPL, FLASH full beam loading, X & C band, SwissFEL, LHC RF limits, MYRRHA/MAX, CLIC, TESLA, ELI-NP, LHeC ERL, TLEP, LHC, PS Booster, MedAustron

RF power sources

- SSAs at PSI, ESRF and SOLEIL; klystron lifetimes & efficiency

low level RF

- LHC LLRF, xTCA, high reliability digital system, CERN PS renovation, SuperB, FLASH, uTCA for XFEL machines, synchronization

RF costing tools, RF diagnostics, reliability

SRF test & R&D infrastructure

- TUD SRF test stand, Grenoble SBT, Saclay, Orsay

RFTech (co-)organized events, 2009-11

- 16.-18.09.2009 [LHC-CC09, 3rd LHC crab cavity workshop](#), CERN
- 19.-22.10.2009 [LLRF09, Low-Level Radio Frequency Workshop](#), KEK
- 24.-27.06.2010 [MIXDES2010](#), Wroclaw
- 29.03. 2010** [First Annual RFTech Meeting](#), DESY
- 19.-22.10.2009 [LLRF09, Low-Level Radio Frequency Workshop](#), KEK
- 16.-18.09. 2009 [LHC Crab Cavities "LHC-CC09"](#), CERN
- 02.-03.12.2010** [Second Annual RFTech Meeting](#), PSI
- 15.-17.12. 2010 [LHC-CC10, 4th LHC Crab Cavity Workshop](#), CERN
- 6.-8.06.2011 [Linac Operation with Long Bunch Trains](#), DESY
- 16.-18.06.2011 [AccNet co-sponsored MIXDES 2011](#), Gliwice
- 21.-23.09.2011 [MulCoPim'11](#), Valencia, 21-23 September 2011

RFTech (co-)organized events, 2011-13

17.-21.10.2011 [LLRF-2011](#), DESY

14.-15.11.2011 [LHC-CC11 on LHC Crab Cavities](#), CERN

12.-13.12.2011 [Third Annual RFTech Meeting](#), Rostock

24.-26.05.2012 [MixDes2012](#), Warsaw,

11.-15.06.2012 IEEE [RT2012](#), Berkeley

25.-27.06.2012 [HOMSC2012](#) workshop, Daresbury

06.-08.008.2012 [LLRF collaboration meeting](#), Lodz

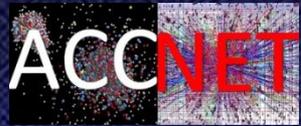
19.25.08.2012 [ICAP'12](#), Warnemünde

11.-12.12.2012 [uTCA workshop for Industry and Research](#), Hamburg

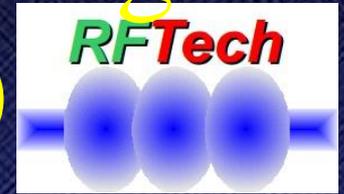
19.-21.02.2013 [Advanced Techniques in LLRF Control for XFEL](#), Swierk

24.-26.03. 2013 [Fourth Annual RFTech Meeting](#), Annecy

First Annual RFTech Meeting



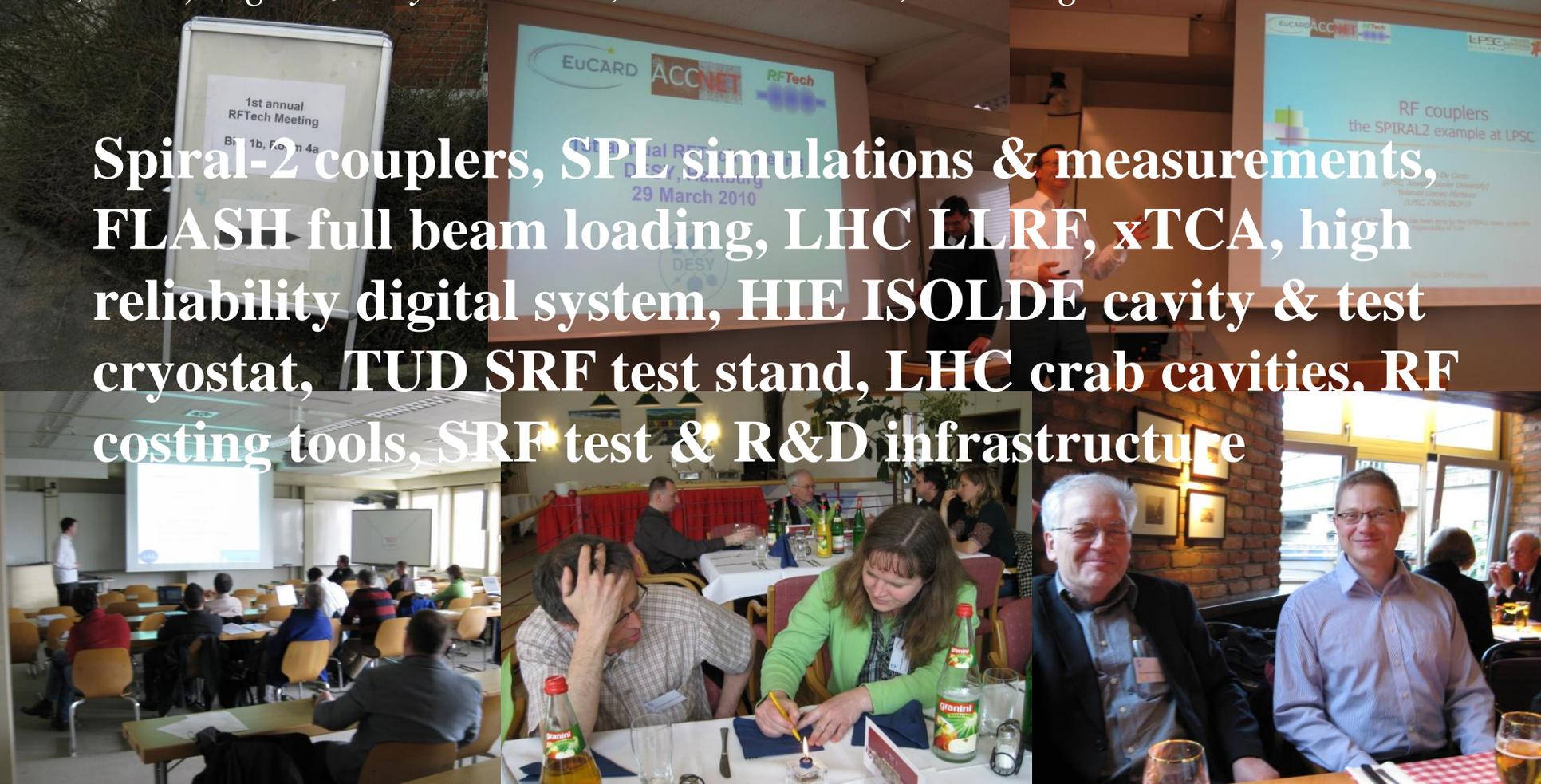
DESY, 29 March 2010



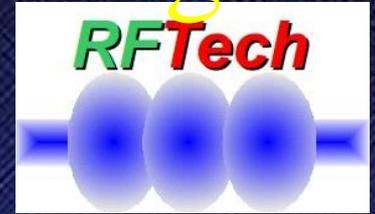
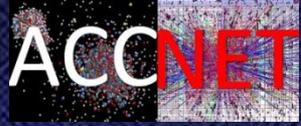
<https://indico.desy.de/conferenceDisplay.py?confId=2831>

17 participants (DESY, CERN, TUD, UROS, ASTeC, LPSC, UFJ, ESS, U London, TUL, UG, SINS) organized by M. Grecki, J.-M. De Conto, W. Weingarten & DESY

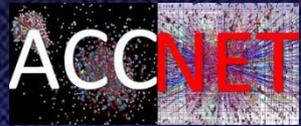
Spiral-2 couplers, SPI simulations & measurements, FLASH full beam loading, LHC LLRF, xTCA, high reliability digital system, HIE ISOLDE cavity & test cryostat, TUD SRF test stand, LHC crab cavities, RF costing tools, SRF test & R&D infrastructure



Second Annual RFTech Meeting PSI, 2-3 December '10



Second Annual RFTech Meeting



PSI, 2-3 December '10



<https://indico.desy.de/conferenceDisplay.py?confId=2831>

30 participants, ~2x 1st meeting! (BNL, DESY, CERN, CNRS, CEA, ESRF, IPJS, LU, LPSC, PSI, RHUL, SBT, SOLEIL, UJF, TUD, TUL, WU, ...) organized by T.Garvey, M.Grecki, J.-M.DeConto, W.Weingarten & PSI ; sharing experience among several fields of RF technology!

- **Low Level RF:** CERN's PS complex LLRF renovation, SuperB project, FLASH system, as well as use of specific components like uTCA for XFEL machines
- **Solid State Amplifiers**, both in general and particular techniques as well as some specific developments, like at PSI, ESRF and SOLEIL
- **RF technology for FELs:** normal- and superconducting RF aspects (X Band structures, the Swiss FEL project, cryomodule technology) , summary of XFEL RF synchronization workshop
- **RF limitations related to LHC ultimate beam**
- **Cavity optimization:** crab-cavity design for the LHC, HOM free copper cavities
- **Superconducting RF**, e.g. cryomodule assembly in Saclay, SRF infrastructures in Saclay/Orsay, SBT in Grenoble, with **analysis and round-table discussion** on the need of a European SRF test infrastructure for R&D and test of cavities & cryomodules. Presenting **work of young scientists**, about cavity design & modelling

Third Annual RFTech Meeting

U Rostock, 12-13 December '11

<http://lpsc.in2p3.fr/Indico/internalPage.py?pageId=2&confId=646>

17 (young) participants (DESY, CERN, TUD, UROS, GANIL, PSI, LPSC/CNRS, UFJ, TUL) organized by Ursula van Rienen, Jean-Marie De Conto, Mariusz Grecki, & UROS

RF cavity and couplers design

Perturbation methods for cavity calculation, Finite integration Maxwell solvers and FEM schemes, Progress of crab-cavities (HL-LHC + general)

HOM based diagnostics

Diagnostic via Beam excited HOMs models and experiment

Cavity tuning

Tuning issues for flat fields (FLASH)

LLRF

associated software, instrumentation, workshops FLASH, developments

RF systems highlights

CERN, SPIRAL2, Large CERN panorama, Review of Darmstadt activities

SRF infrastructure: completed

Reliability

may be strengthened?

Costing tools?

RFTECH Advanced Techniques in LLRF Control for XFEL, Swierk, 19-21.2.2013

development of the LLRF system for XFEL
and FLASH accelerators



4th & Final Annual RFTech Meeting Annecy, 24-26 March '13

<http://lpsc.in2p3.fr/Indico/internalPage.py?pageId=2&confId=862>

33 participants (DESY, CERN, INF-INFN, TUD, UROS, GANIL, PSI, LPSC/CNRS, UJF, TUL, ISE-WUT) organized by J.-M. De Conto and M. Grecki

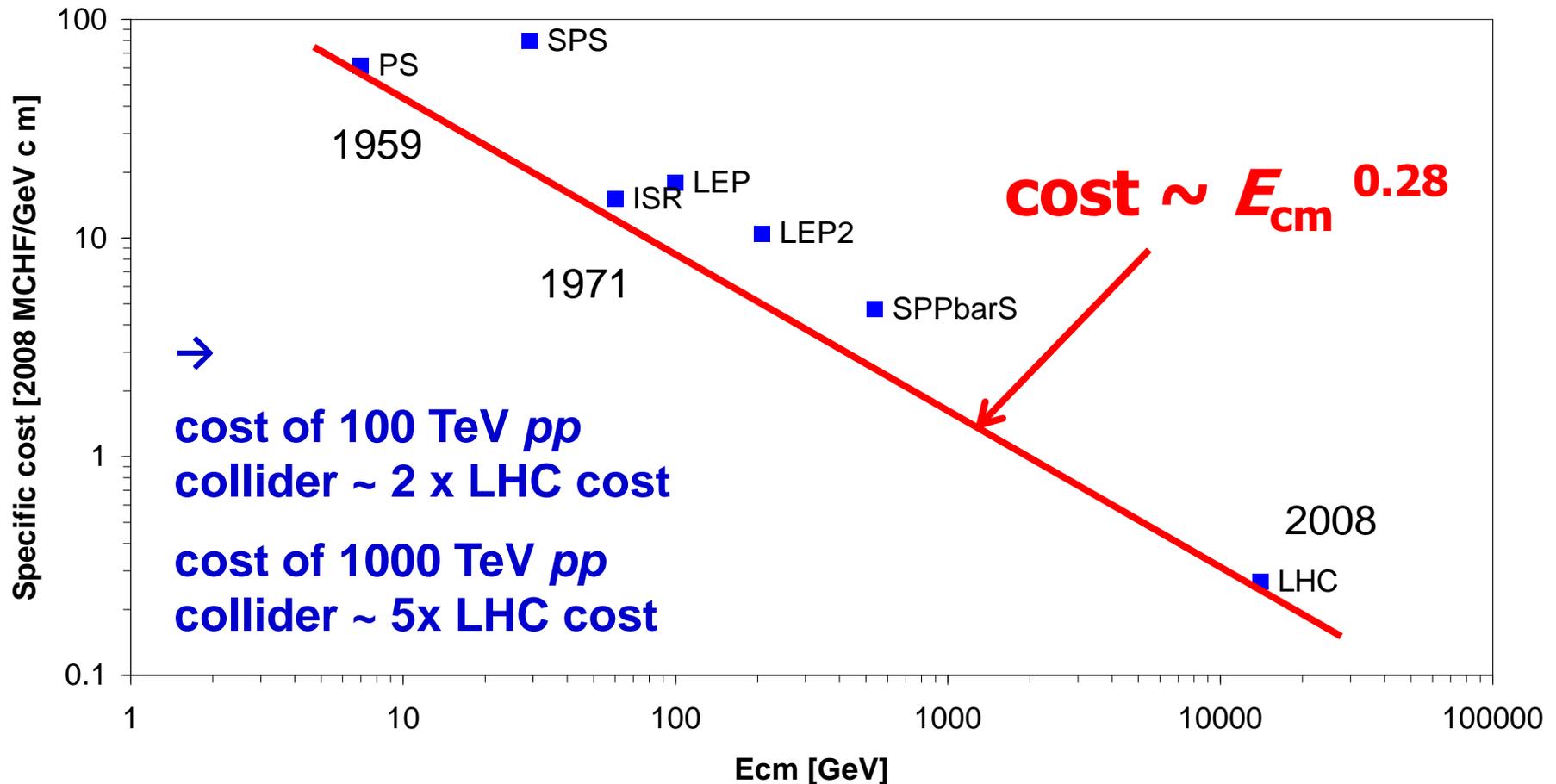
Projects: SPIRAL2, MYRRHA/MAX, CLIC, TESLA, ELI-NP, LHeC
ERL, TLEP, LHC, FLASH, PS Booster, MedAustron, SwissFEL

RF topics: C-band RF, X-band RF, reliability, LLRF, RF diagnostics,
reliability, costing, breakdown, operation, klystron lifetime, efficiency,



A sustained decrease in specific cost

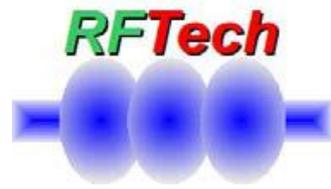
Specific cost vs center-of-mass energy of CERN accelerators





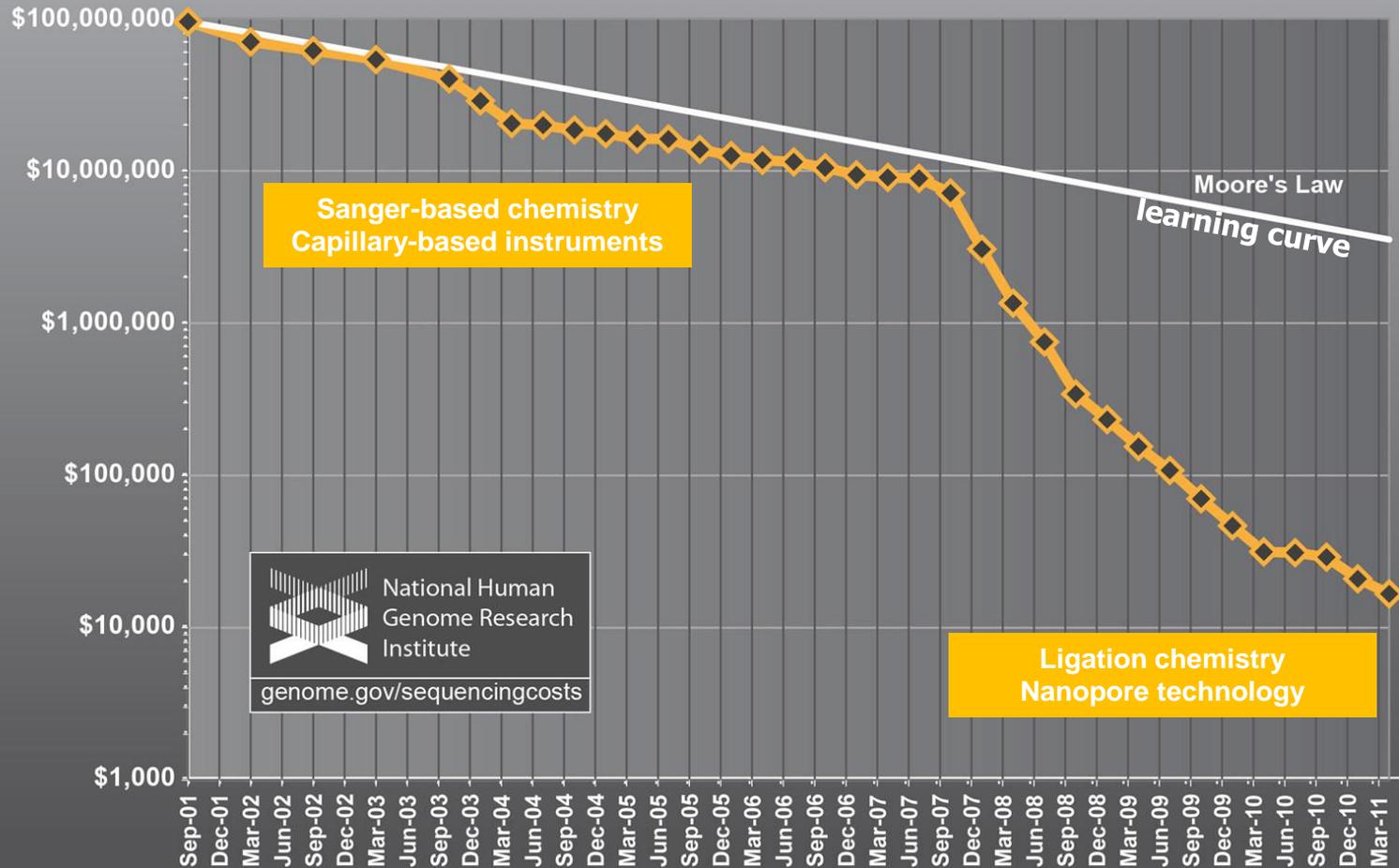
The learning curve is not everything

Breakthrough vs gradual progress in genome sequencing



P. Lebrun, RFTech2013

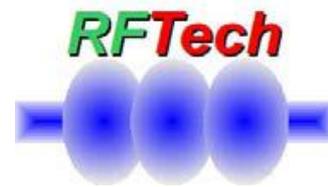
Cost per Genome



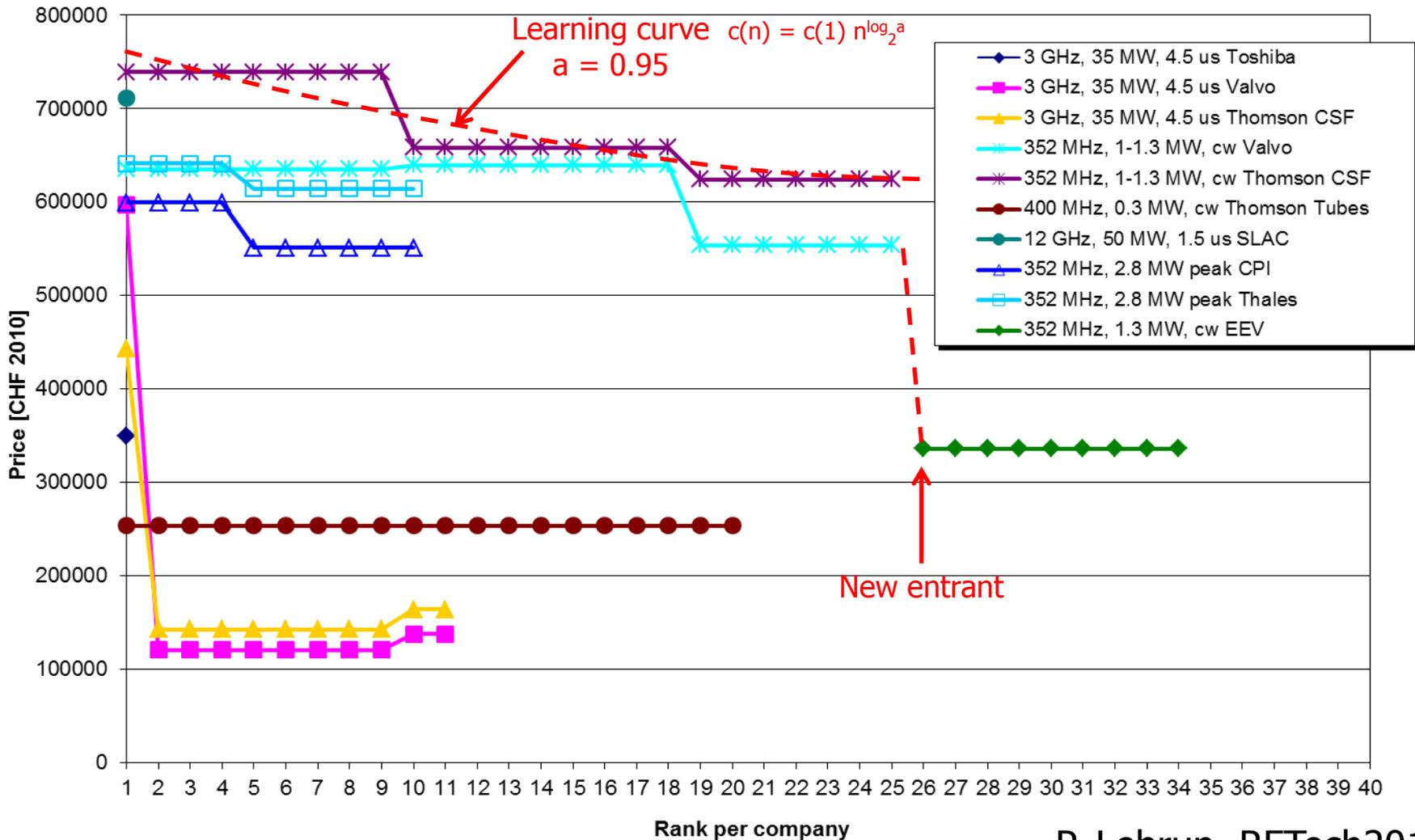


The learning curve is not everything

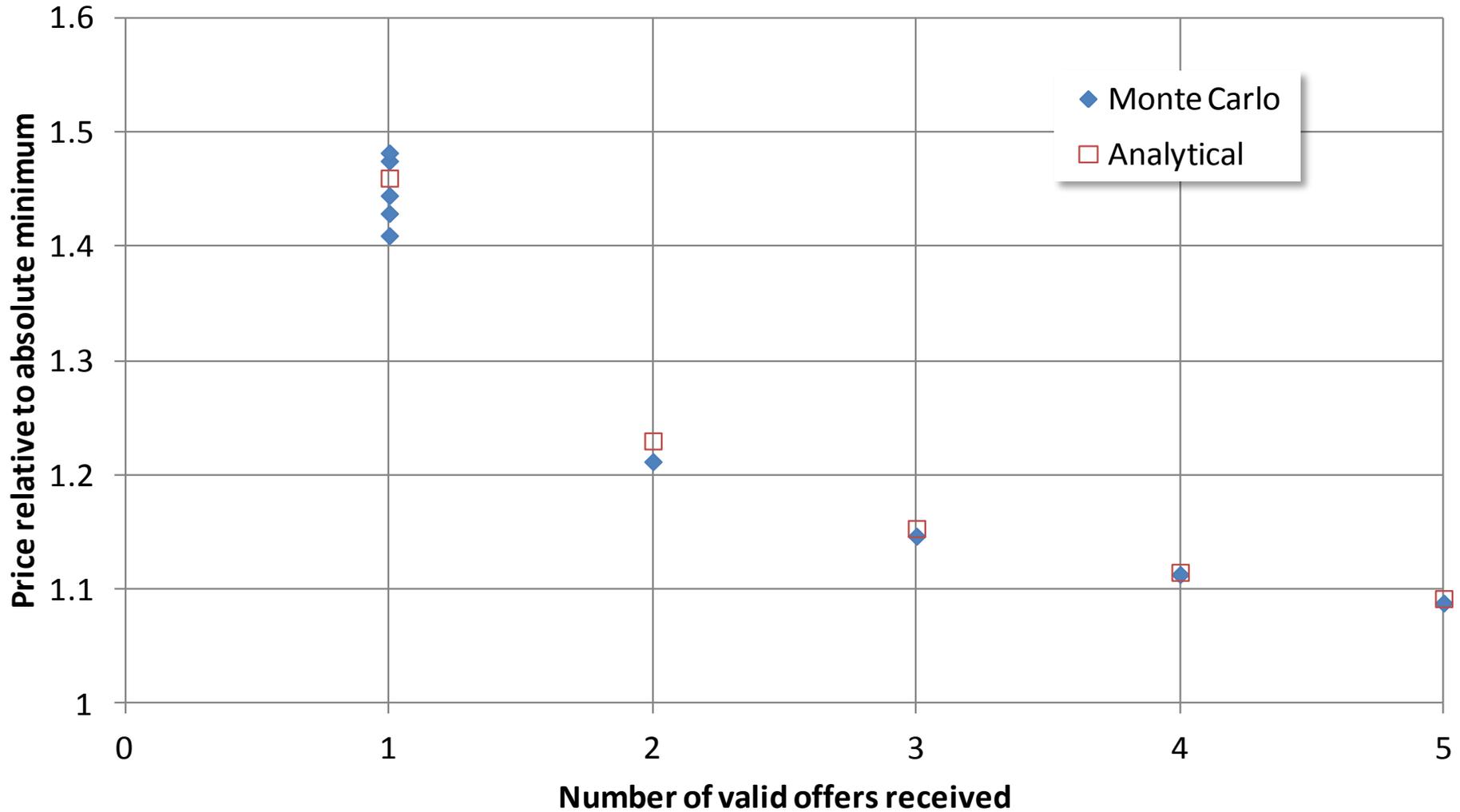
Commercial competition remains a prime mechanism for cost reduction



Price of klystrons purchased by CERN (1982-2010)
Source: CERN FC adjudications, prices indexed by CERN material index

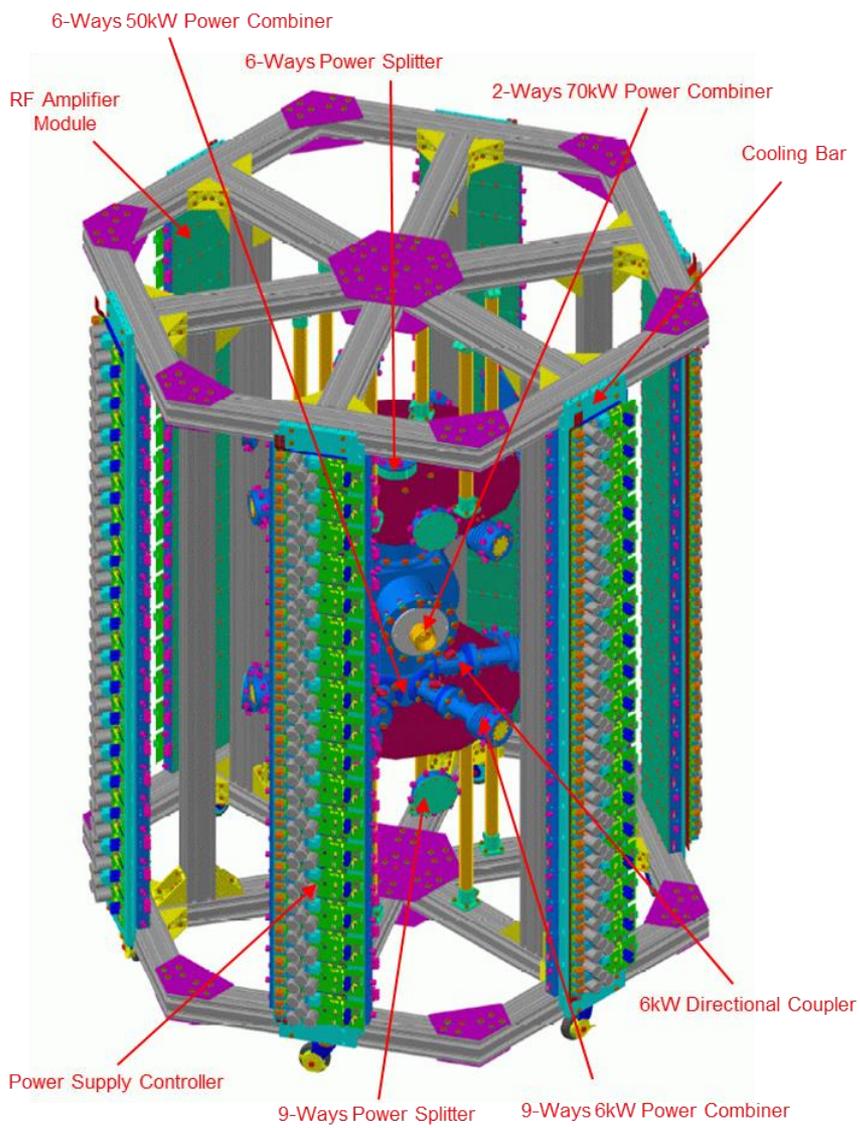


Mean price applying lowest-bidder purchasing

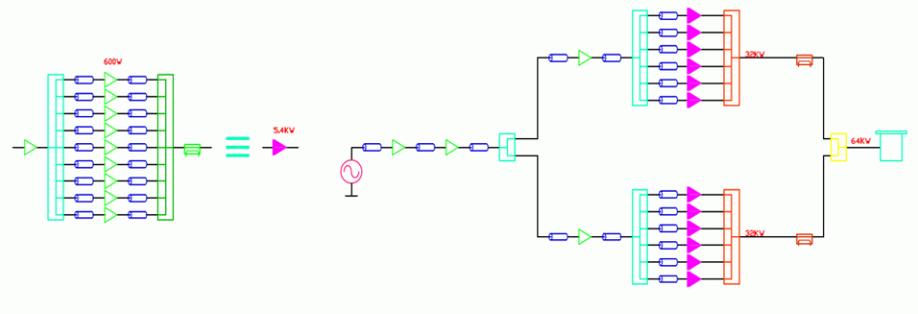


Solid State Amplifier Development

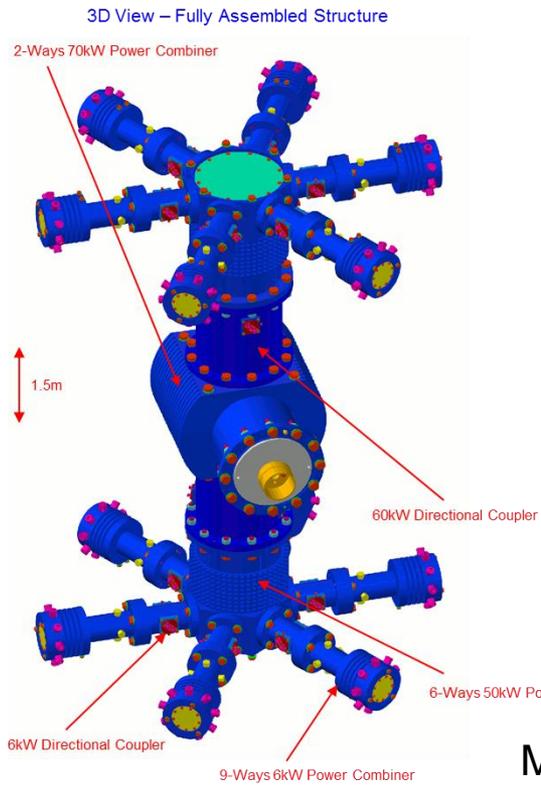
ex.: PSI 500 MHz (other efforts at SOLEIL & ESRF)



3D-View of 60kW 500MHz Amplifier System



Block Diagram of 60kW 500MHz Amplifier System



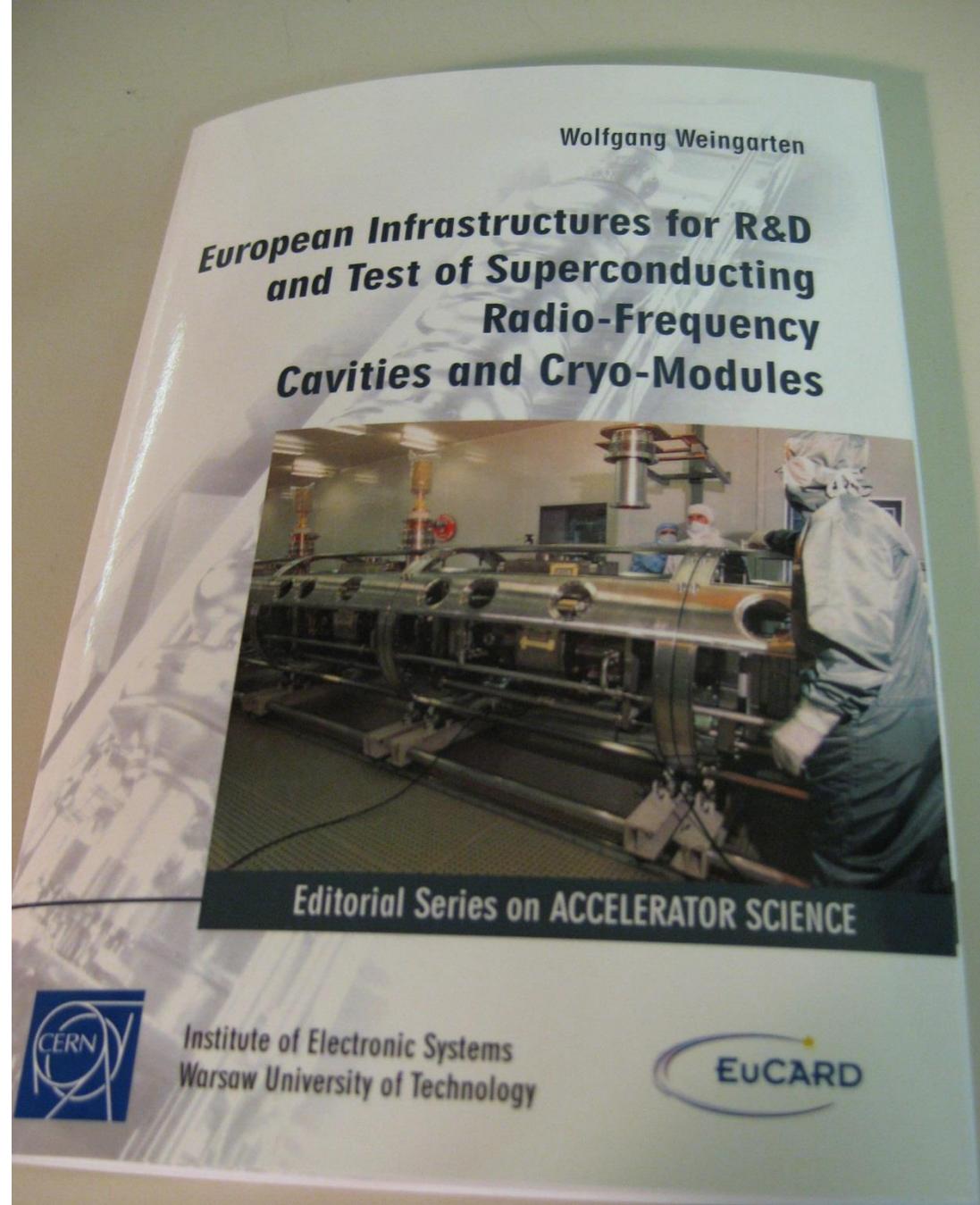
3D View – Fully Assembled Structure

- Expected Max. CW Output Power (Complete System): > 70kW
- Expected "Wall-Plug" Efficiency at Maximum Output Power (Complete System): ~ 60%.

AccNet RFTech
Deliverable
D4.3.2

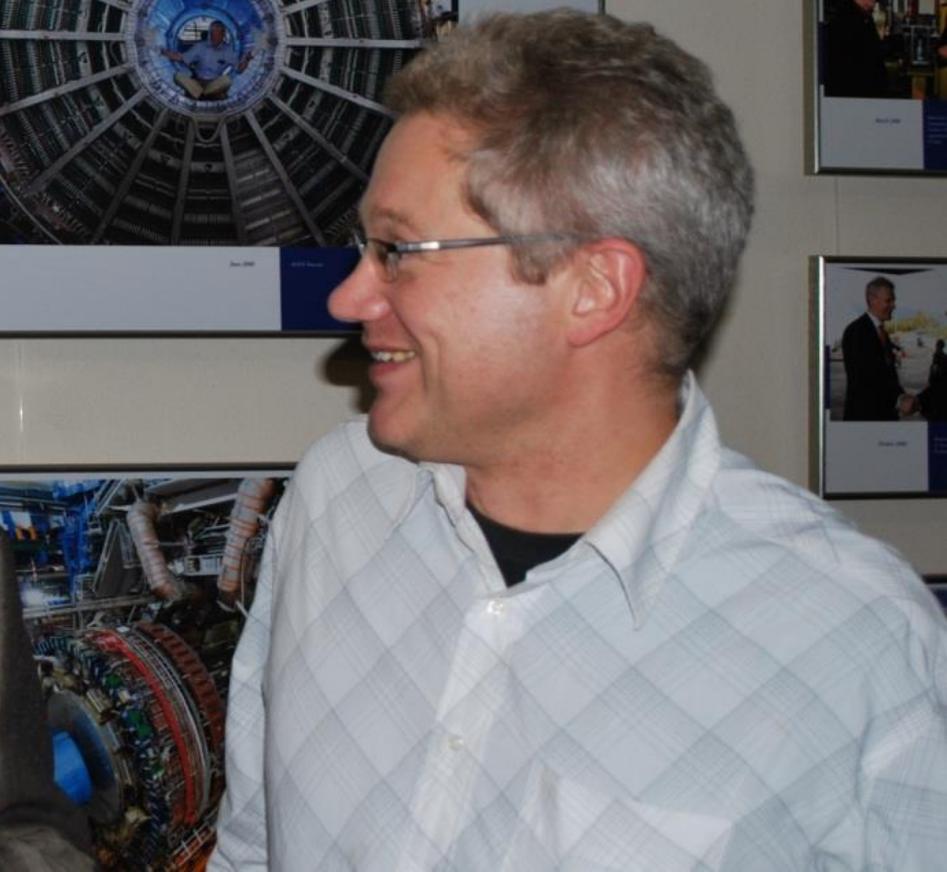
—
“Strategy/result
for SRF test
infrastructures”
—

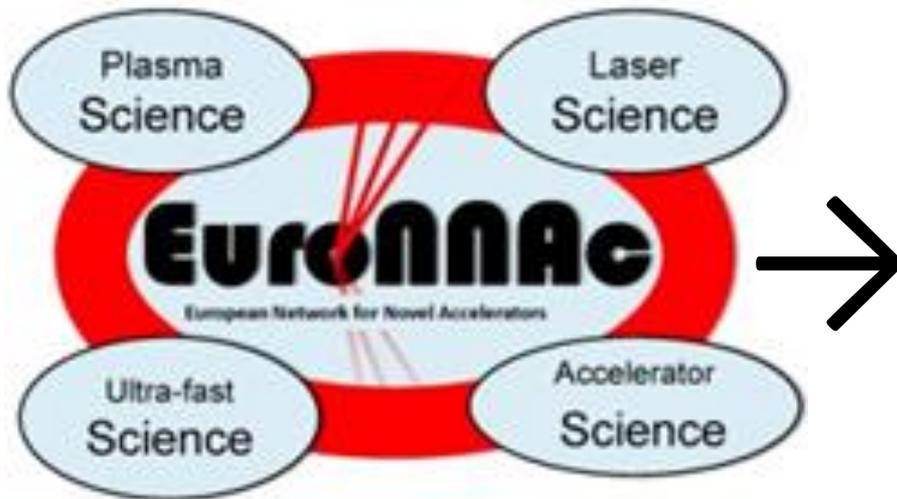
published as
EuCARD
monograph!



RFTech Co-ordinator W. Weingarten

retired 29.11.2011







EuroNNAc – main themes

EU-wide (global?) coordination of adv. accelerators

- table of facilities, excel files, ...

input statement to European HEP strategy process

- *"On the Prospect and Vision of Ultra-High Gradient Plasma Accelerators for High Energy Physics"*

vision into more realistic accelerator proposals

- preparation of AWAKE experiment at CERN (PDPWA)

negotiations on EuroNNAC2 as part of EuCARD2

- *funded!*

EuroNNAc related events

- | | |
|----------------|--|
| 17.-18.12.2009 | <u>Working meeting on proton driven plasma acceleration PPA09</u> , CERN |
| 11.-12.10.2010 | <u>Workshop on Proton Driven Plasma Wake Field Acceleration</u> , CERN |
| 03.-06.05.2011 | <u>1st general AccNet EuroNNAc workshop</u> , CERN |
| 02.-04.05.2012 | <u>EuroNNAc 2012 Meeting</u> , CERN |
| 02-07.06.2013 | <u>EuroNNAc EAAC2013 Conference</u> , La Biodola, Elba |



AccNet workshop on *proton driven plasma acceleration* “PPA09”

17-18 December '09, 24 participants

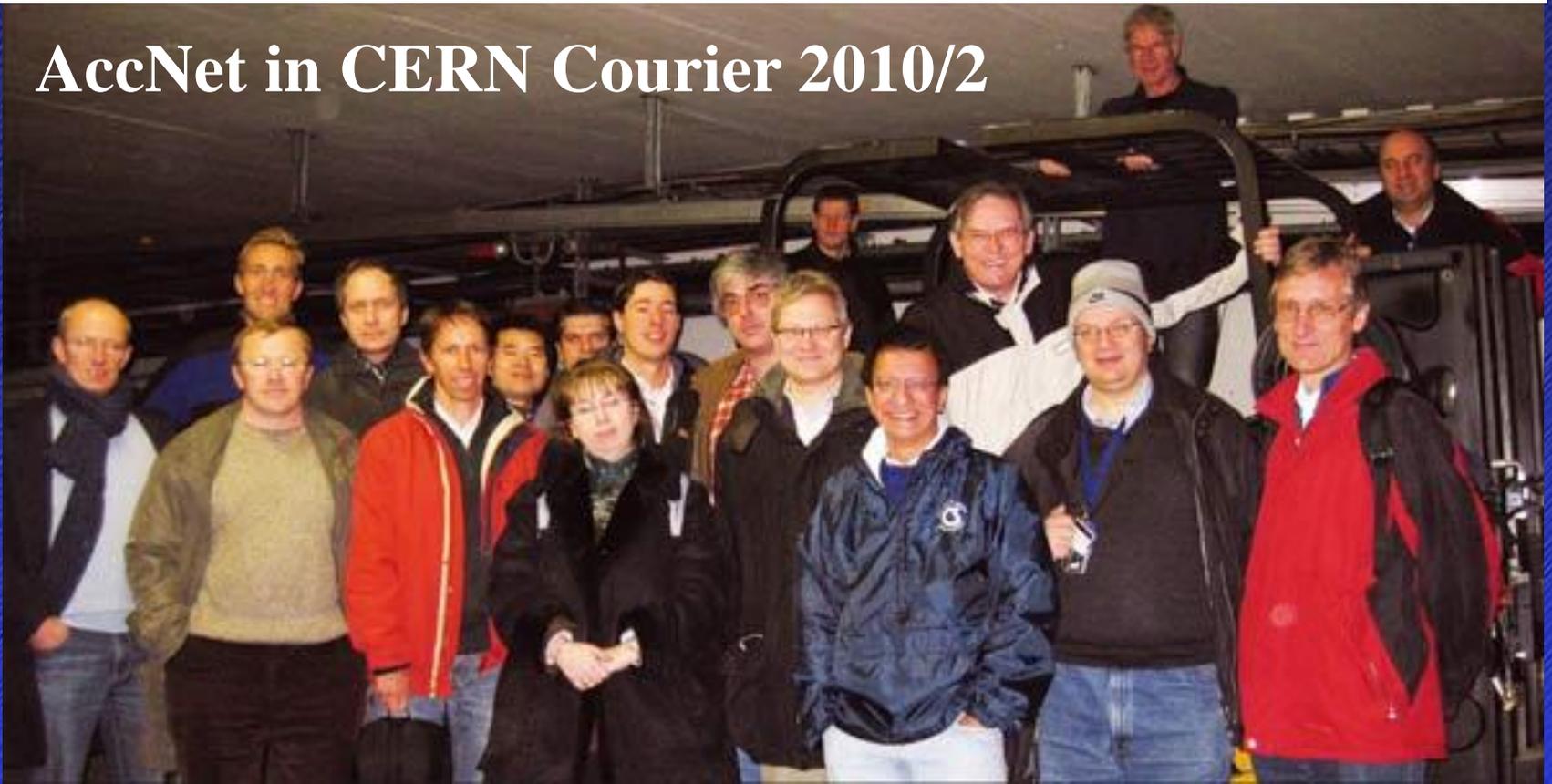
CERN COURIER

<http://indico.cern.ch/conferenceDisplay.py?confId=74552>

Feb 24, 2010

Workshop pushes proton-driven plasma wakefield acceleration

AccNet in CERN Courier 2010/2



EuroNNAc

European Network for Novel Accelerators

EINDHOVEN University of Technology

University of Oxford
University of Strathclyde
Manchester University
Lancaster University
Cockcroft Institute
STFC Daresbury Laboratory
John Adams Institute
ASTeC
STFC Central Laser Facility
Liverpool University
University College London
Imperial College

Instituto Superior
Tecnico de Lisboa

LULI
Soleil
LPGP
LOA
IRAMIS/CEA
Laboratoire Leprince-Ringuet
(Ecole polytechnique - CNRS/IN2P3)
LAL

European Organization for
Nuclear Research (CERN)
PSI

University Düsseldorf
LMU University Munich
DESY
GSI
Max-Planck-Institute for Quantum Optics
Max-Planck-Institute for Physics
Helmholtz Institute Jena
Helmholtz-Zentrum Dresden-Rossendorf
University Hamburg

Lund University

Budker INP
Institute of Applied Physics RAS

Extreme Light Infrastructures (ELI)

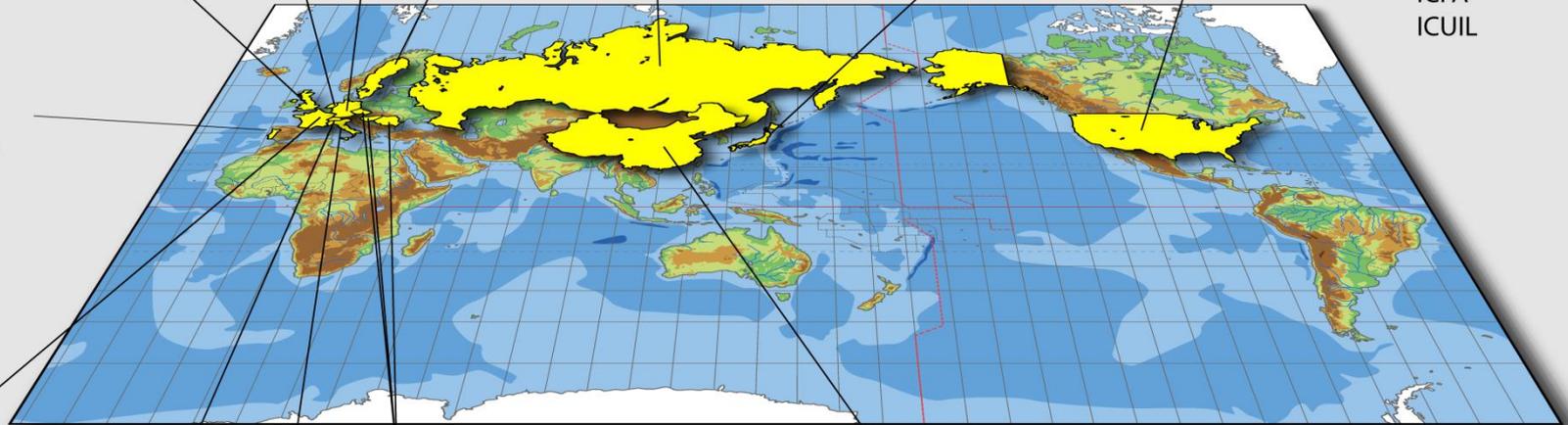
INFN-LNF
Pisa University and INFN
Consiglio Nazionale Delle Ricerche, INO
University of Rome LA SAPIENZA

KEK

Fermilab
SLAC
UCLA
LBNL
BNL

ICFA
ICUIL

Inst. of Physics, Chinese Academy of Sciences
Tsinghua University, Beijing
Shanghai Jiao Tong University



EAAC2013, 2-7 June 2013



© vinicio.tullio@Inf.infn.it



145 participants

Goal: distributed European test facility 312453

Conclusion: substantial extra funding needed

AccNet publications

EuCARD AccNet documents

- about **160 in total**
 - 2 CERN Yellow Reports
 - 4 journal articles
 - > 60 conference presentations
 - ~12 workshop summaries
 - 1 PhD thesis
 - 2 master theses
 - 2 EuCARD monographs

not all in the database

AccNet outreach & dissemination examples

E-CLOUD'12 article in **CERN Courier**, Sept. 2012

Article on EuCARD LEP3, TLEP, SAPPHiRE, VHE-LHC Days in **Accelerating News** Magazine, issues 3 & 5

presentations and seminars:

TU Darmstadt, MEPAS, Hiroshima, Kyoto, SLAC SSI, SLAC50, Oxford, KEK, CERN, Frascati, CEA Saclay, LAL Orsay, APS Denver, Sendai, ...

recent posters & papers at conferences:

≥7 contributions to IPAC'13 Shanghai,
10 to IPAC'12 New Orleans, 6 to RT2012 Berkeley,
6 contributions to ICAP'12 Warnemünde

AccNet deliverables

| Deliverables of tasks | Description/title | Nature | Delivery month | Status |
|-----------------------|---|--------|----------------|-----------------|
| 4.1.1 | Continually updated AccNet web site | O | M2 | DONE, OK |
| 4.1.2 | AccNet Strategy for future proton & electron facilities in Europe | R | M48 | to come soon !? |
| 4.2.1 | Continually updated EuroLumi web site | O | M2 | DONE, OK |
| 4.2.2 | EuroLumi Strategy and issues for LHC IR, LHC injector and beam-parameter upgrade path(s), with comment on longer-term prospects, and for FAIR | R | M48 | to come soon!? |
| 4.3.1 | Continually updated RFTECH web site | O | M2 | DONE, OK |
| 4.3.2 | Strategy/result for SRF test infrastructures | R | M24 | Published! |
| 4.3.3 | RFTEch strategy/result for cavity design, LLRF & HPRF systems and design integration, and costing tools | R | M48 | to come soon!? |

AccNet success indicators

excellent attendance to AccNet workshops
from many European labs, universities, US laboratories,
Japan, international organizations, industry

impact: - new collaborations (Mexico, ESA , Kyoto)

- crab-cavity program for LHC

- e-cloud modeling & mitigation

- advances on new concepts:

HE-LHC, VHE-LHC, LEP, TLEP,

SAPPHiRE, PDPWA,

cost efficient!; 43 topical workshops; ~160

documents; outreach articles & invited talks

AccNet summary

EuroLumi, RFTech & EuroNNAc extremely active;
helped launch & support many new initiatives

many *activities previously initiated or promoted by EuCARD-AccNet became real projects* + new ideas emerged; *EuroLumi activities refocused* in response

strong *dissemination efforts* in parallel

final deliverables being completed

(EuroLumi, RFTech, AccNet, EuroNNAc?)

Coming together is a beginning, staying together is progress, and working together is success.

Henry Ford

