

International Collaborations on beam instrumentation ...with whom?, why?, how?

Hermann Schmickler (CERN), IBIC2016
special thanks for slides to Manfred Wendt, Jean-Jacques Gras, Peter Forck

THE BRIEF COLLABORATION BETWEEN
ALFRED NOBEL AND THOMAS EDISON



COLLECTION

Topics

- My very first collaboration
- Use-Cases for collaborations
- What do people collaborate on?
- Essentials for collaborative success
 - getting to know each other
 - sharing information
 - sealing the deal
 - staying friends
- One example of collaborations in beam instrumentation
- Conclusion

Disclaimer: Almost all my information is from European Events



My very first collaboration: PLL tune tracking

- 1987: Developments at CERN for LEP and at DESY for HERA
→ independent first preparations
- 1988: H.Schmickler meets S.Paetzold (group leader of J. Klute @ DESY) at the US-CERN Joint Accelerator School in Anacapri
→ good understanding, invitation for a visit at DESY follows
- 1988- 1990: Collaboration with J.Klute on “Phase-Locked-Loop” tune tracking and online feedback to the quadrupoles
→ fully digital implementation, code sharing, development on different platforms (integration into control system was a full SAGA at this time...at LEP through a telephone line between two access points...)
- Big Success in both machines...also first steps on protons at DESY;
Jens did most of the work, but was very lazy in publications
I published it and got known for it...

[PDF] Design and Functionality of the LEP Q-Meter - CERN
https://accelconf.web.cern.ch/accelconf/e90/PDF/EPAC1990_0774.PDF ▾

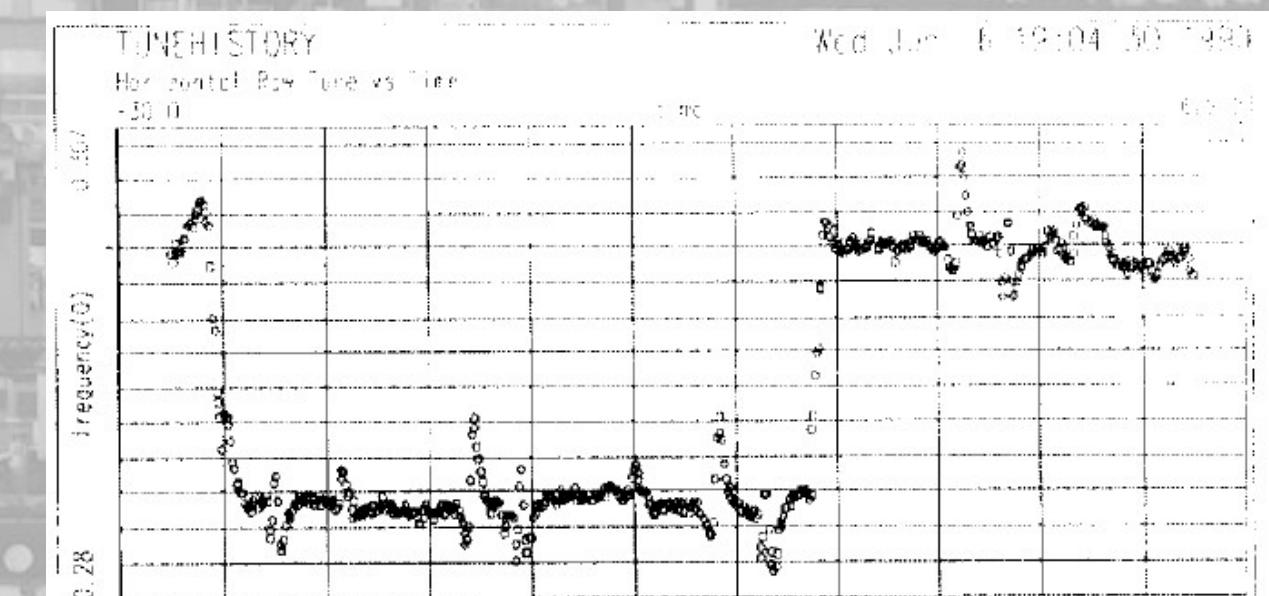
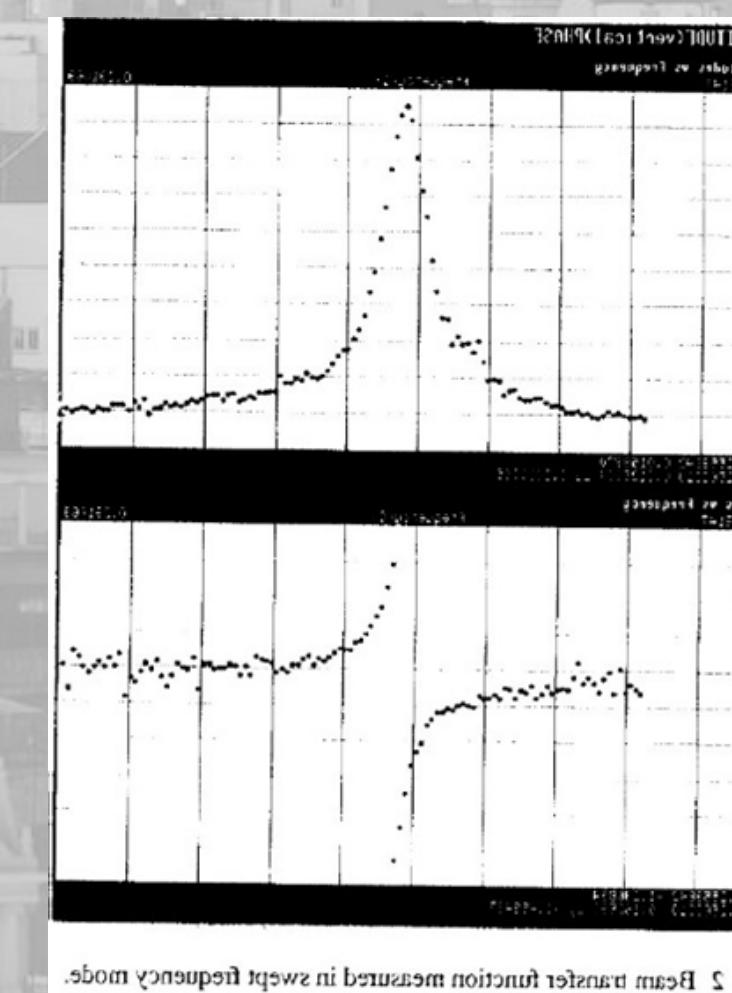
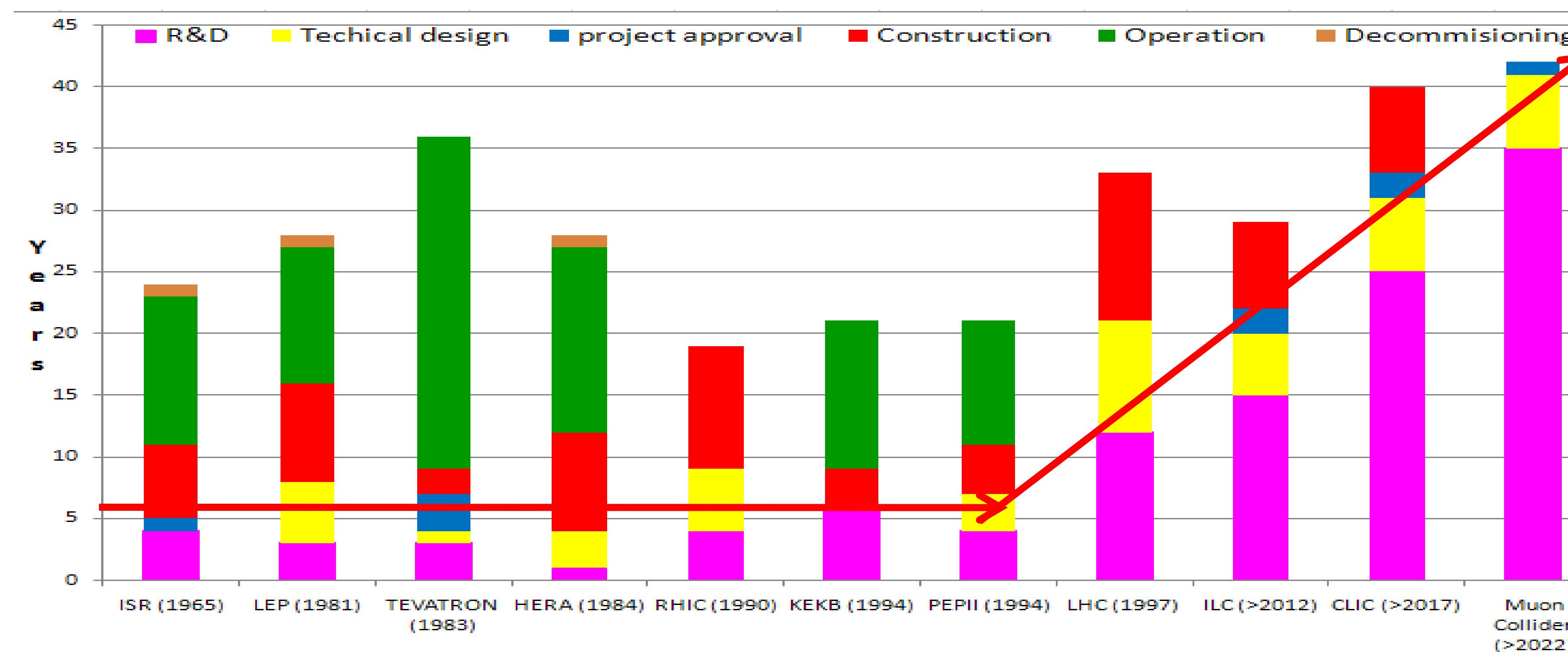
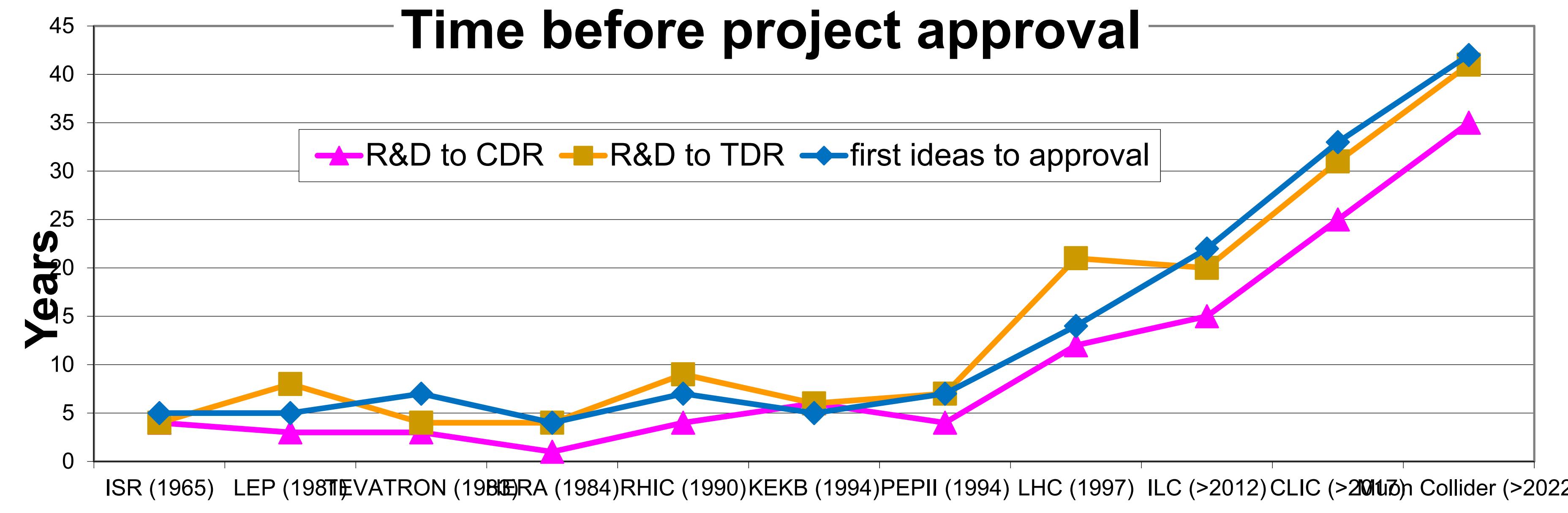


Fig. 4 Tune history record (tune versus time) measured in PLL mode

Some Use-Cases for well motivated collaboration

- Different laboratories having to solve the same problems
→ ex: Light sources, medical accelerators, colliders, FELs
- Contribution to a joint international effort
→ present and future high energy colliders and their testing facilities, next generation light sources, European co-funded projects
- Use of beam time at an external laboratory
→ “I have an idea/instrument to test...You have a beam”
- Optimized Usage of human resources
→ Give an interesting job to people temporary unemployed
→ help building up a team in a new laboratory
- Collaboration with industry
→ develop an idea further from a prototype to a product:
ex: libera proton; well known BPM electronics for beams with varying revolution frequency



What do people collaborate on?

1. Common R&D: Probably the most frequent subject of collaboration...
more on the scientific side or engineering side...
biggest fun...runs normally without major headaches
2. Develop and build something for a common project...
Here it gets more serious: obligation for result, timelines, commissioning, documentation, maintenance...
3. Develop and build something for a foreign project...
King's discipline of collaboration: budget questions and follow-up, obligation for result, timelines, commissioning, documentation, maintenance...
4. Lend people's workforce to another project

Why this list?

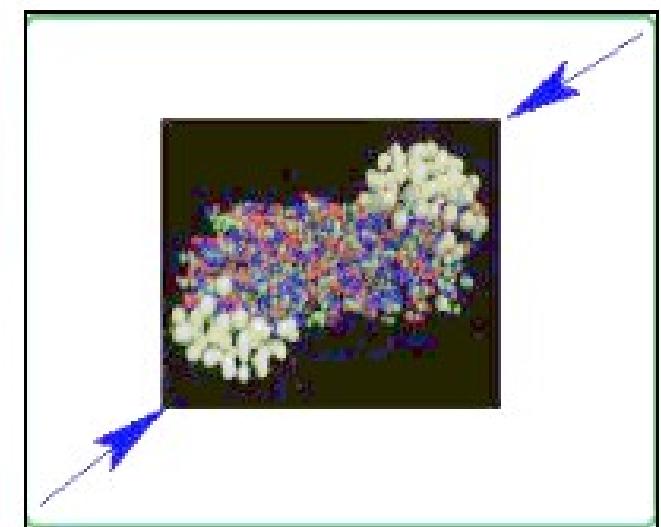
Depending on the collaboration subject different effort of contractual agreements.
Item 3 und 4 need specific attention (employment contracts, IP rights)

Essentials for Collaborative Success - Overview

- Getting to know each other:
→ conferences, workshops, schools, fellowships, scholarships
- Sharing information:
→ proceedings, e-publishing
→ Important effort of Jean-Jacques Gras from 2012:
BIGNET: A Common web portal for Beam instrumentalists
→ Open Hardware
Common hardware repository for reuse of developed electronic modules
(J.Serrano (CERN-BE-CO) et al.)
- Sealing the deal:
→ IP rights, NDAs, (personal) protection of individuals, safety rules, customs declarations
for radioactive material etc:
Do not even try to produce the documents yourself: find the right experts for this in your lab...plan for extra delays of 6 months and more...
- Staying friends:
 - Before you start: understand what the other wants to provide/what he can do.
 - Fix objectives with deadlines in writing.
 - Plan for regular information exchange.
 - Remember the big difference: You do not have hierarchical power over your collaboration partner; the collaboration must stay all along a mutual benefit situation!!

Getting to know each other... as a person and for work experience

- BIW, DIPAC, IBIC ... when do we meet in Brazil?
- European co-funded topical workshops
 - CARE-HHH-ABI (around 2005); K.Wittenburg & H.Schmickler
 - ARIES-ADA (2017-2021): P.Forck et al.
- Carsten Welsh Initiatives: Since 2008 about 40 fellows in various fields of beam instrumentation educated for 36 months. 100% EU funded
 - www.liv.ac.uk/DITANET; www.opac-project.eu; www.la3net.eu
 - yet to come: www.oma-project.eu (medical accelerators)
- Schools: Topical CERN Accelerator School on Beam Instrumentation
Planned for spring 2018



High Energy High Intensity Hadron Beams

Coordinated by [W. Scandale](#)
and [F. Zimmermann](#)

HHH is a Networking Activity (N3) in the framework of [CARE](#)
(Coordinated Accelerator R&D in Europe)

Main Objectives	Network structure	Activity Reports	Job Opportunities	Workshops	Literature and Presentations	Links
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New! [Future CARE-HHH workshops](#)

New! CERN Bulletin Issue 31, Article 3, July 2007 – [‘Collimation: A Silicon Solution’](#)

New! CERN Courier Article vol. 47, no. 5, June 2007 – [‘Bent Silicon Crystal Deflects 400 GeV Proton Beam at the Super Proton Synchrotron’](#)

CERN Courier Article vol. 47, no. 2, March 2007 – [‘LUMI'06 Takes Strides Towards LHC Upgrade’](#)

CERN Courier Article vol. 47, no. 2, March 2007 – [‘Obituary for Francesco Ruggiero, 1957-2007’](#)

CERN Courier Article vol. 45, no. 3, April 2005 – [‘LHC Upgrade Taking Shape with CARE and Attention’](#)

[Main Objectives](#)

[CARE-HHH Network structure](#)

Work Package 1: Advancements in Accelerator Magnet Technologies ([AMT](#))

Work Package 2: Novel Methods for Accelerator Beam Instrumentation ([ABI](#))

Work Package 3: Accelerator Physics and synchrotron Design ([APD](#))

[Participating institutes and linkmen](#)

[CARE Publications, Deliverables, and HHH Activity Reports](#)

LHC upgrade paths – [parameter scenarios \(pdf\)](#), [upgrade IR layouts](#), [tentative milestones](#)

[Job Opportunities](#)

[Workshops](#)

[Literature and Presentations](#)

<http://care-hhh.web.cern.ch/CARE-HHH/>



ARIES – ADA



European Union funded Topical Workshops on actual Beam Diagnostics Issues

ARIES: Accelerator Research and Innovation for European Science and Society

- Covering many innovative topics within the entire accelerator science
- Funding duration May 2017 to 2021
- Managed by Maurizio Vretenar CERN and Roy Aleksan CEA

ADA: Advanced Diagnostics at Accelerators

- **Network** related to innovative diagnostics and **actual** developments of common interest
- **Activity:** Organization of topical workshops on actual issues,
→ duration of about 2 days with typically 20 to 40 participants
- **Tasks** and task leaders for

Beam diagnostics at *hadron LINACs*: Peter Forck GSI

hadron synchrotrons : Rhodri Jones CERN

synchrotron based light sources: Francis Perez ALBA

LINAC based light sources: Kay Wittenburg DESY

⇒ You are warmly welcome to propose important subjects, to contribute to the workshops,
strengthen the collaboration and enlarge the knowledge within our community

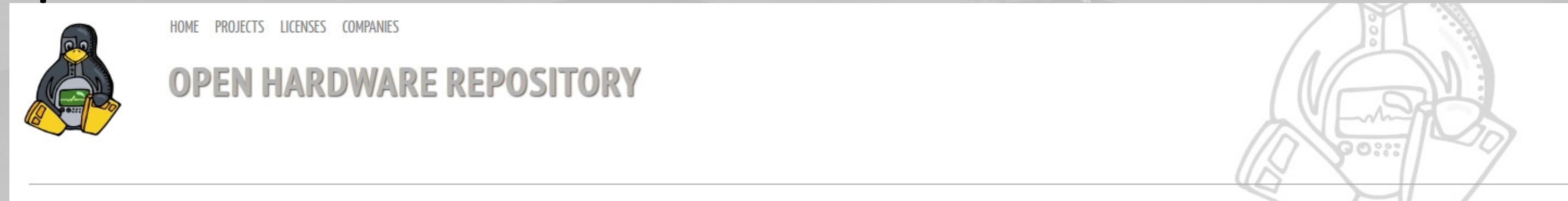
Sharing information

- Open Hardware Platform: J.Serrano et al.
- BIGNET: J.J.Gras



"Of course this website is safe. As an extra measure of security, they make you sign in with your Social Security number, mother's name, your bank account, home address, phone number and date of birth."

Open Hardware Platform: J.Serrano et al.



The screenshot shows the Open Hardware Repository (OHWR) website. At the top, there's a navigation bar with links to HOME, PROJECTS, LICENSES, and COMPANIES. Below the navigation is a logo of a penguin holding a circuit board and a wrench. The main title "OPEN HARDWARE REPOSITORY" is displayed in large, bold, grey letters. On the right side of the page, there's a large, faint watermark-style illustration of a person wearing a hard hat and safety glasses, looking at a computer screen. The user profile for "JAVIER SERRANO" is shown, with a small profile picture of a penguin. Below the profile, it says "Registered on: 2010-02-15" and "Last connection: 2016-09-13". A section titled "Projects" lists numerous projects managed by Javier Serrano, including ADC Testing, CERN BE-CO-HT contribution to KiCad, CernFIP, CERN LINGS Time Transfer, CERN Open Hardware Licence, Conv. TTL Blocking - Gateware, Conv. TTL Blocking - Hardware, Conv. TTL Blocking - Testing, FMC ADC 100M 14b 4cha, FMC ADC 100M 14b 4cha - Gateware, FMC ADC 100M 14b 4cha - Hardware, FMC ADC 100M 14b 4cha - Software, FMC ADC 100M 14b 4cha - Testing, FMC DEL 1ns 4cha, FMC DIO 5ch TTL a, FMC PCIe Carrier (PFC), FMC TDC 1ns 5cha, fwatch, Getting Started with the SPEC, HDL Core Lib, Low-level RF Servo control, Miscellaneous Projects - non-HW, Mock Turtle, Mock Turtle - Gateware, Mock Turtle - Software, Multi-channel Time Interval Counter and fine delay generator, nanoFIP, OHR Meta Project, OHR Support, Platform-independent core collection, Simple PCIe FMC carrier (SPEC), TDC core, urv-core, VME64x core, VME FMC Carrier (VFC), and White Rabbit. The "Activity" section shows a timeline of events from July 2016, including contributions to KiCad, edits to the CERN Open Hardware Licence Wiki, and bug fixes for FMC ADC 100M 14b 4cha software. A large watermark for "http://www.ohwr.org/users" is overlaid across the center of the page.

JAVIER SERRANO

- Registered on: 2010-02-15
- Last connection: 2016-09-13

Projects

- ADC Testing (Developer, 2010-10-20)
- CERN BE-CO-HT contribution to KiCad (Manager, 2013-02-01)
- CernFIP (Manager, 2010-02-17)
- CERN LINGS Time Transfer (Manager, 2011-09-26)
- CERN Open Hardware Licence (Manager, 2011-07-11)
- Conv. TTL Blocking - Gateware (Developer, 2013-11-31)
- Conv. TTL Blocking - Hardware (Developer, 2014-01-23)
- Conv. TTL Blocking - Testing (Developer, 2014-07-23)
- FMC ADC 100M 14b 4cha (Manager, 2010-04-26)
- FMC ADC 100M 14b 4cha - Gateware (Manager, 2014-05-07)
- FMC ADC 100M 14b 4cha - Hardware (Manager, 2014-05-07)
- FMC ADC 100M 14b 4cha - Software (Manager, 2016-05-13)
- FMC ADC 100M 14b 4cha - Testing (Manager, 2014-05-07)
- FMC DEL 1ns 4cha (Manager, 2010-04-23)
- FMC DIO 5ch TTL a (Manager, 2011-05-27)
- FMC PCIe Carrier (PFC) (Developer, 2010-02-19)
- FMC TDC 1ns 5cha (Manager, 2010-12-06)
- fwatch (Manager, 2014-05-11)
- Getting Started with the SPEC (Manager, Reporter, 2014-02-06)
- HDL Core Lib (Manager, 2010-09-14)
- Low-level RF Servo control (Manager, 2010-11-12)
- Miscellaneous Projects - non-HW (Manager, 2010-09-01)
- Mock Turtle (Manager, 2015-10-01)
- Mock Turtle - Gateware (Manager, 2015-10-01)
- Mock Turtle - Software (Manager, 2015-10-01)
- Multi-channel Time Interval Counter and fine delay generator (Manager, 2016-02-19)
- nanoFIP (Manager, 2015-03-24)
- OHR Meta Project (Manager, 2010-06-16)
- OHR Support (Manager, 2010-02-17)
- Platform-independent core collection (Manager, 2011-04-18)
- Simple PCIe FMC carrier (SPEC) (Manager, 2010-06-22)
- TDC core (Manager, 2011-08-29)
- urv-core (Manager, 2015-10-01)
- VME64x core (Manager, 2012-11-02)
- VME FMC Carrier (VFC) (Developer, 2010-02-19)
- White Rabbit (Manager, 2010-02-15)

Activity

Reported issues: 36

2016-07-25

- 10:13 CERN BE-CO-HT contribution to KiCad - CERN devs demo SPICE integration in KiCad
- 10:12 CERN BE-CO-HT contribution to KiCad - CERN devs demo SPICE integration in KiCad
- 10:12 CERN BE-CO-HT contribution to KiCad - CERN devs demo SPICE integration in KiCad
- 10:08 CERN BE-CO-HT contribution to KiCad - Wiki edit: Wiki (#72)
KiCad SPICE video

2016-07-14

- 13:35 CERN Open Hardware Licence - Wiki edit: CernOhlProjects (#96)
ExpEYES added.
- 10:39 CERN Open Hardware Licence - Wiki edit: CernOhlProjects (#95)
Robot telescope and pop-up solar generator.

2016-05-13

- 13:28 FMC ADC 100M 14b 4cha - Software - Bug #998 (Resolved): can not access dummy image
The FAQ page now links to the correct file: http://www.ohwr.org/attachments/4460/fmc-adc_dummy_eeprom
- 12:35 FMC ADC 100M 14b 4cha - Software - Wiki edit: Release-v2014-04 (#4)
Update links to gateware
- 12:32 FMC ADC 100M 14b 4cha - Software - Wiki edit: Release-v2014-05 (#9)
Updated pointers to gateware releases

2016-05-07

- 17:26 CERN Open Hardware Licence - Wiki edit: CernOhlProjects (#01)

BIGNET: J.J.Gras

Welcome to the Beam Instrumentation Global Network

The purpose of this site is to provide an easy and efficient way to share design, issues, questions and progress on particle accelerators beam instrumentation between experts from the different laboratories.

This site should allow beam instrumentation experts to:

- find the laboratories with machines producing beam with similar characteristics (particle type, total beam intensity, bunch intensity, frequency, energy...)
- find who is the colleague working there on the beam observable concerned (i.e. beam position, loss, intensity, transverse or longitudinal profile, tune...) and how to contact them
- find documents describing their system designs and performance assessments

You will find below the list of Laboratories participating to this initiative.

You will find on your right a summary of the coming related events and latest ongoing discussions if any.

You will find on your left, under BI Portal chapter, access to:

- the list of Laboratories participating to this web site
- the relevant Beam and Machine Parameters for the different machines (*Machine Overview*)
- a list and some litterature for the different monitor technologies used in Beam Instrumentation (*under Instrument Technology*)
- a list of the beam instrumentation experts in the different laboratories with their domains of expertise.
- a library for relevant *Documentation* on these instruments
- You also have access to the *Discussion* pages where you should be able to launch a new one if you fill the need.
- the *Machine Types*, *Beam Observables* and *Particle Types* lists will eventually be hidden. They are used as input for the other lists and exposed here for the purpose of discussion.

<http://ibic12.kek.jp/prepress/papers/tuca01.pdf>

Jean Jacques has started this effort in 2012 and since 2013 he had to stop the support of this activity for health reasons.

Somebody would need to take up this activity...

If a new candidate will not be found (likely) the maintenance of this site could become the rotational task of the program committee of each IBIC???

accepted by CERN on the last day of such a three-month period.

Article 7

Intellectual property

- 7.1 The term "intellectual property" shall mean all intellectual property including know-how in forms such as drawings, designs, inventions, software programs, reports, processes and protocols and protected by means such as secrecy, patents, copyrights and trademarks.
- 7.2 The disclosure of existing intellectual property (IP) by either Party to the other shall not create any right in respect of that intellectual property, other than a licence to use the intellectual property in so far as necessary for the performance of the obligations under the Agreement.

4

KE1789/TE

- 7.3 The disclosure of existing intellectual property by one Party to the other is without any warranty, express or implied, by either Party and neither Party accepts any liability in relation thereto..
- 7.4 IP generated in the execution of this Agreement shall be vested in CERN. So far as the Contractor is aware there are no third party IP rights issues (including but not limited to ownership disputes, allegations or notice of potential patent infringement issues and patent or patent application validity determinations) relating to the Contractor's IP required for use in the Supply provided always that this undertaking shall not be deemed to impose or imply any obligation to undertake any searches of IP or undertake any general due diligence enquires of any third party not directly engaged in the Supply.
- 7.5 If CERN commercially exploits the IP generated pursuant to this Agreement CERN agrees to pay to the Contractor a fair and reasonable royalty to reflect the effort and contribution to the intellectual property arising from the Supply. If CERN requires access to use any of the Contractors existing IP for the purposes of exploiting any IP generated under this Agreement, the Contractor will not unreasonably refuse to grant to CERN a licence to the relevant IP for such purpose to be negotiated on fair and

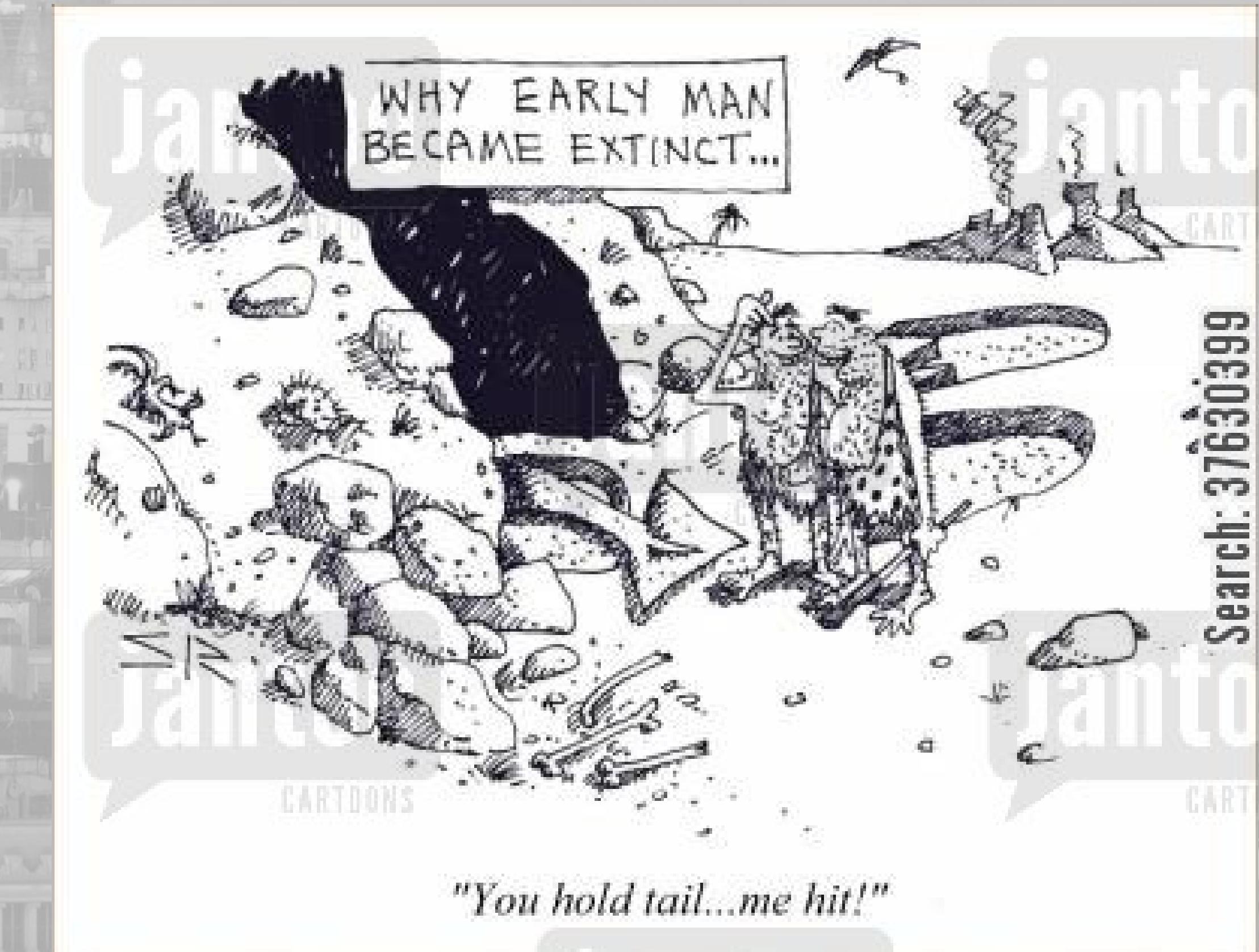
 mwwssnc3
Is CERN ownership acceptable?

 mwwssnc3
I have inserted this clause as we do not want to be, in effect, giving away any background IP for free as that is potentially a breach of our charity law obligations.

Last not least:

- A closing example of a positive past collaboration:
- Taken out of the infinite number of past good collaborations

ATF Damping Ring BPM Collaboration



"You hold tail...me hit!"

Search: 37630399



KEK

- Nobuhiro Teranuma
 - Junji Urakawa
- SLAC**
- Doug McCormick
 - Joe Fisch
 - Justin May
 - Janice Nelson
 - Andrei Seryi
 - Tonee Smith
 - Mark Woodley



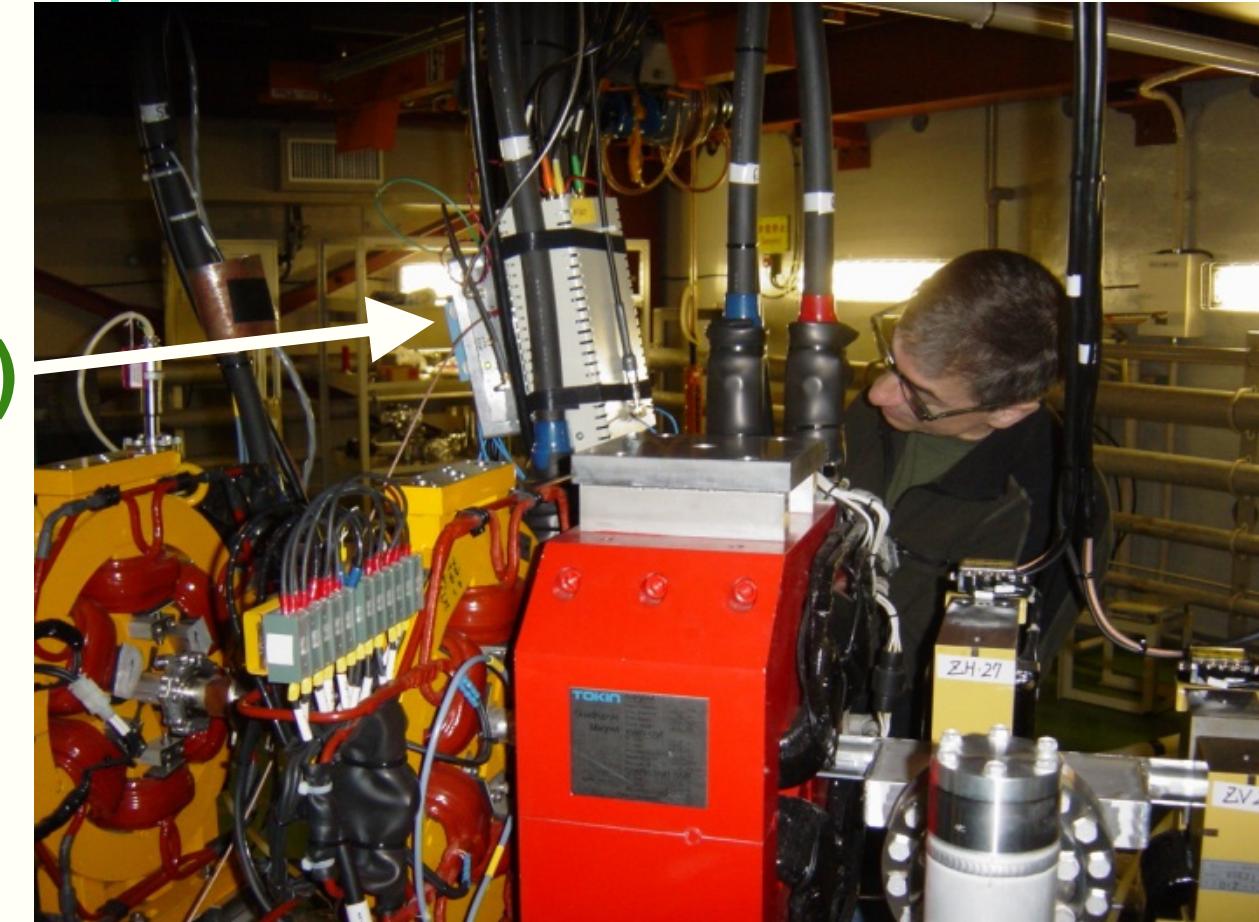
Fermilab

- Charlie Briegel
- Nathan Eddy
- Eliana Gianfelice
- Bill Haynes
- Peter Prieto
- Dennis Nicklaus
- Ron Rechenmacher
- Duane Voy
- Manfred Wendt

...and many others!

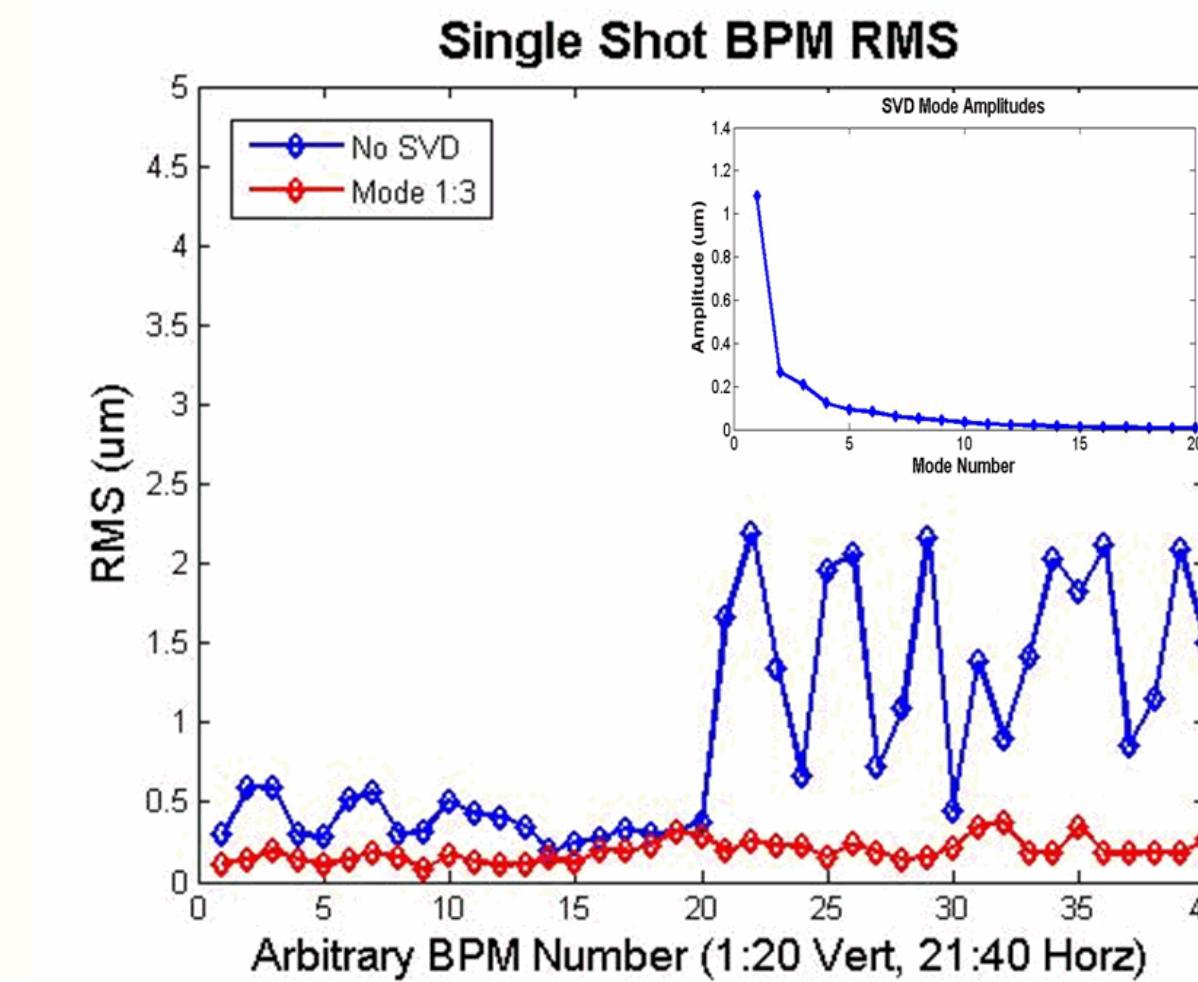
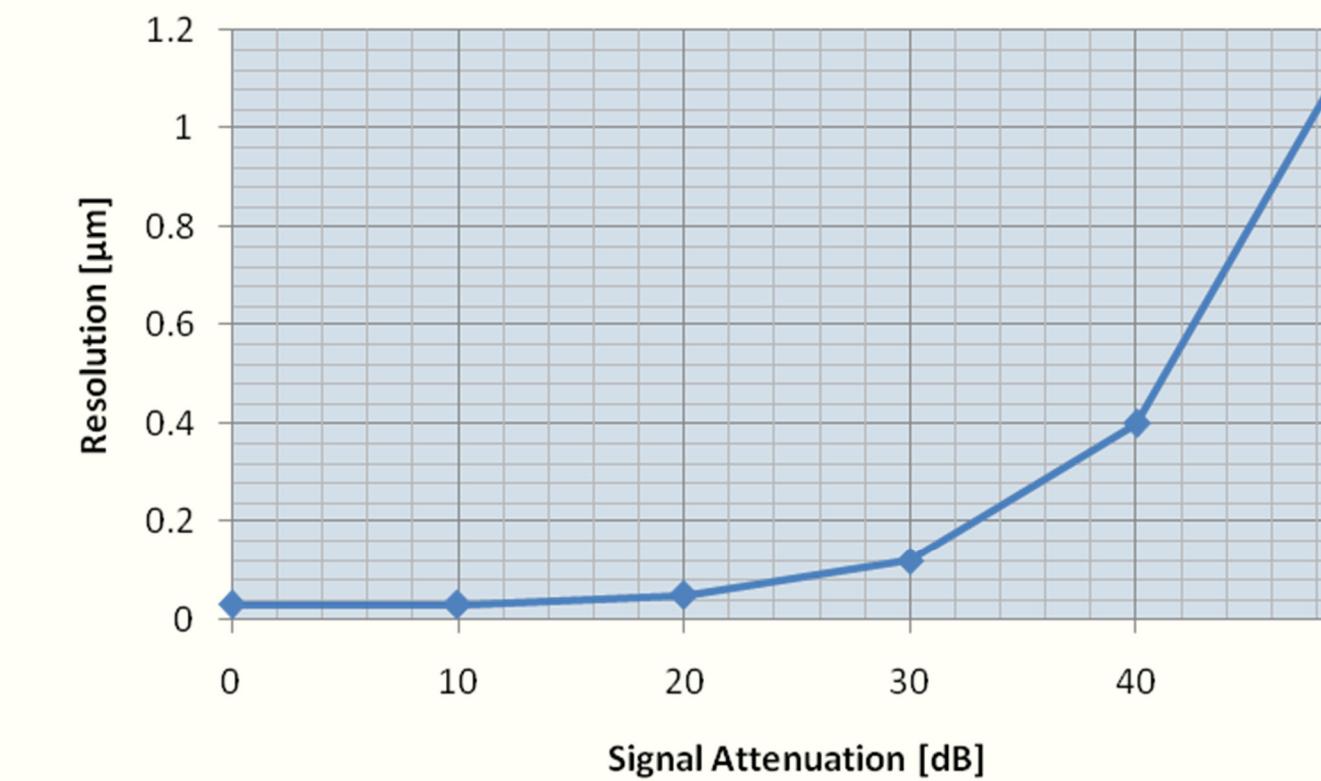
- ILC damping ring R&D at KEK's Accelerator Test Facility (ATF):
 - Investigation of the beam damping process (damping wiggler, minimization of the damping time, etc.)
 - Goal: generation and extraction of a low emittance beam ($\epsilon_{\text{vert}} < 2 \text{ pm}$) at the nominal ILC bunch charge
- A major tool for low emittance corrections:
a high resolution BPM system!
 - Optimization of the closed-orbit, beam-based alignment (BBA) studies to investigate BPM offsets and calibration.
 - Correction of non-linear field effects, i.e. coupling, chromaticity,...
 - Fast global orbit feedback(?)
 - Necessary: a state-of-the-art BPM system, utilizing
 - a broadband turn-by-turn mode ($< 10 \mu\text{m}$ resolution)
 - a narrowband mode with high resolution ($\sim 100 \text{ nm}$ range)

- Upgraded 20 (of 96) ATF damping ring BPMs
 - Initiative started by Marc Ross in 2006
 - SLAC:
 - Analog downmix electronics (tunnel hardware)
 - LO signal distribution and DC power supplies
 - beam-based alignment studies (also remote!)
 - Fermilab:
 - Digital signal processing (*Echotek* hardware)
 - VME timing and RF signal hardware
 - Calibration and remote control
 - Software and EPICS control interface
 - SVD analysis and turn-by-turn kicked beam studies (also remote!)
- Features of the upgraded BPMs:
 - High resolution narrowband mode
 - Wideband turn-by-turn (TBT) mode
 - Automatic calibration (gain error correction)



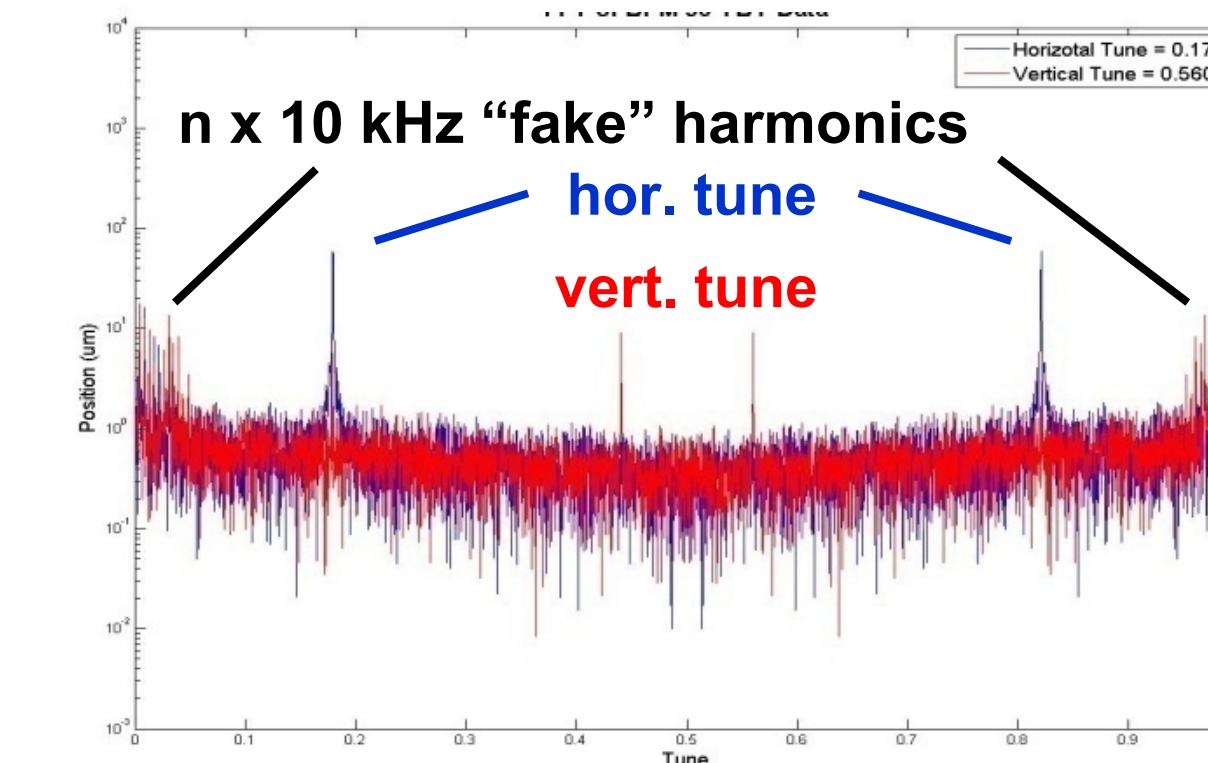
- **Narrowband Mode**

- Resolution < 200 nm (beam based measurement, 50 Hz 126-tap notch filter and excluding beam motion effects by SVD analyses, correlated modes 1-3)
- Resolution limit ~30 nm (signal generator)

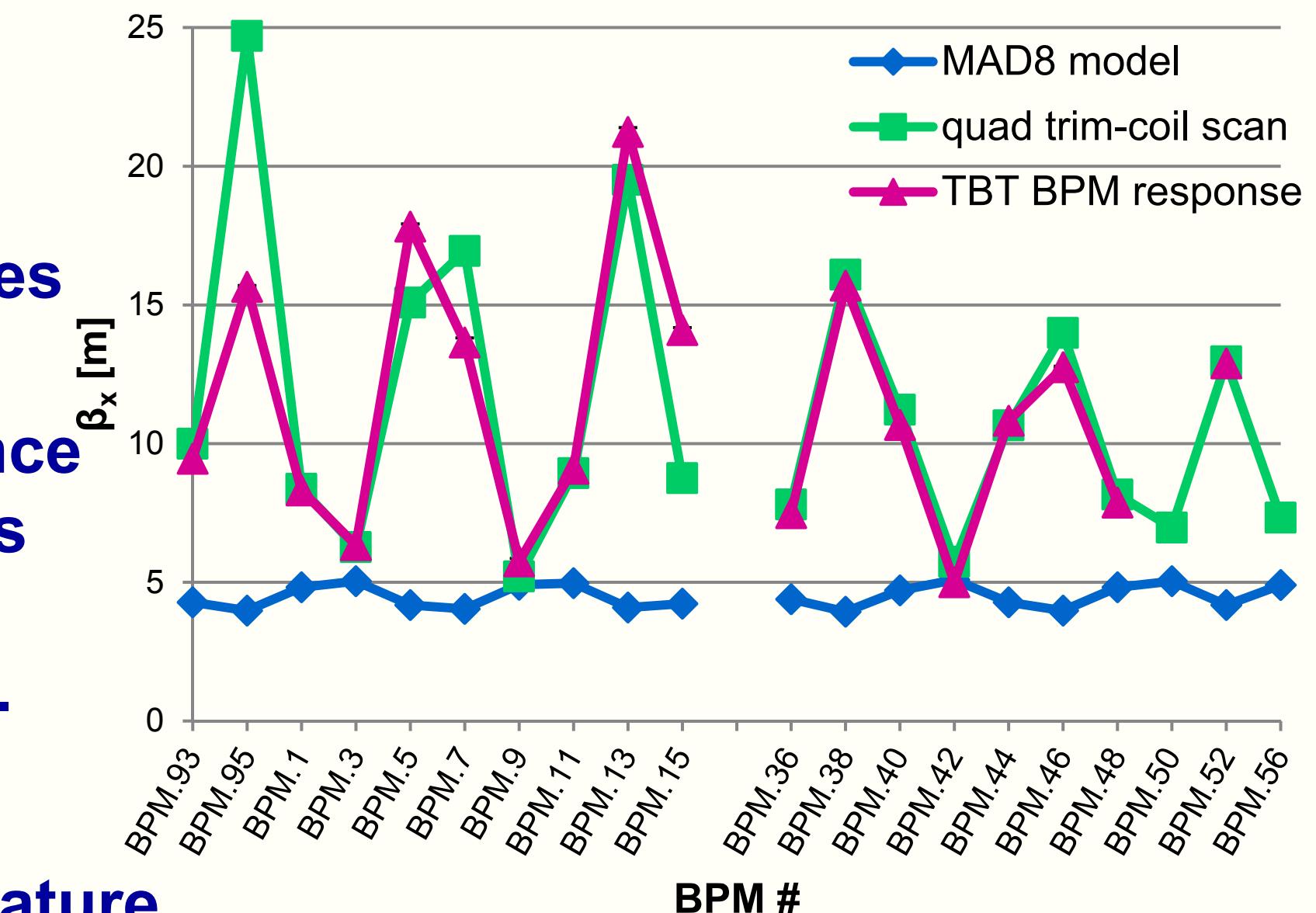


- **Wideband turn-by-turn (TBT) Mode**

- True turn-by turn measurement (~150 ns integration time)
- Few μm resolution
- Observed unwanted $n \times 10$ kHz harmonics (EMI through main power supply bus)



- **TBT Kicked Beam Studies**
 - Single shot optic measurements match very well with quad trim coil scans, and revealed large discrepancies to the theoretical model!
 - These promising results give confidence to apply the method for optics analysis and non-linear corrections (coupling, chromaticity), as done at the Tevatron.
- **Automatic calibration System**
 - Corrects for gain errors due to temperature and aging effects.
 - Beam and correction signals are processed simultaneously.
- **Beam Based Alignment Studies**
 - Reproducibility and stability of the reported BPM offsets are improved by ~10, compared to the present ATF damping ring BPMs.
- **Remote Shift Operations**
 - Beam study shifts were performed remotely from SLAC and Fermilab!



No Conclusions

- ...but:
 - "The strength of the team is each individual member. The strength of each member is the team." - *Phil Jackson*
 - "If you have an apple and I have an apple and we exchange these apples then you and I will still each have one apple. But if you have an idea and I have an idea and we exchange these ideas, then each of us will have two ideas." - *George Bernard Shaw*
 - "Coming together is a beginning, staying together is progress, and working together is success." - *Henry Ford*