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
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
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

• 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

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

<table>
<thead>
<tr>
<th>Main Objectives</th>
<th>Network structure</th>
<th>Activity Reports</th>
<th>Job Opportunities</th>
<th>Workshops</th>
<th>Literature and Presentations</th>
<th>Links</th>
</tr>
</thead>
</table>

**New! Future CARE-HHH workshops**

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. 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.

http://www.ohwr.org/users
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???
Sealing the deal: Contracts

• Many different contract types cover international collaborations: MoU, collaboration agreement, contracts...

• Please respect:
  - Technical documentation to be made by BI experts
  - Legal details to be made by appropriate experts
  - Account for significant delays in contract signature if specific legal questions need to be addressed

...paying a beer to your legal officer normally does not help… it rather irritates them…

- try to reuse previous agreements between same or similar institutes

Typical stumble stones: IP rights, NDA, safety and (social) security of employees in foreign institutes, customs…

---

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 as so far as necessary for the performance of the obligations under the Agreement.

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 requires 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
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
ATF DR BPM Collaboration

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!
Motivation for High Res BPMs

- **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 ($\varepsilon_{\text{vert}} < 2$ 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-or-the-art BPM system, utilizing**
    - a broadband turn-by-turn mode (< 10 µm resolution)
    - a narrowband mode with high resolution (~ 100 nm range)
ATF DR BPM Upgrade Activities

- 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)
ATF DR BPMs: Achievements

- **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 x 10 kHz harmonics (EMI through main power supply bus)
Achievements (cont.)

• 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