ABP Computing in 2021

G. Iadarola
• The development of numerical tools for accelerator physics is **at the core of the ABP group mission** (as explicitly stated in the ABP group mandate):
  o It is the backbone of our applied studies
  o It represents an important contribution of CERN to the worldwide accelerator community → our codes are used all over the world

• Today ABP has a **huge capital of software and know-how** in different areas of computational accelerator physics, which was built over decades
  o This has played a key role in the successful design, construction, exploitation and upgrade of CERN Accelerator Complex
Important **challenges** are ahead of us:

- Studies for the present accelerators and upgrade programs are becoming more and more complex and advanced, requiring more sophisticated and flexible modeling software
  - possibility of effectively combining different tools in the same environment is key
- Design studies to prepare CERN’s long-term future require the capability of covering a broad variety of effects (FCC design, plasma acceleration, muon collider, Physics Beyond Colliders)
- “New” technologies in the fields of hardware and software offer important opportunities that we must be able to catch

...while optimizing the use of our **limited resources**
• Traditionally codes owned and managed **within individual sections and teams**
  o ABP Computing Working Group established in 2017 as a common forum

• **Room for improvement** especially with respect to:
  o Identifying synergies and avoid fragmentation and duplication of efforts
  o Better coordination of interlinked projects
  o Definition of a clear strategy for evolution/replacement of obsolescent tools
  o Establishing professional development workflows for all core tools (versioning, issue tracing, testing, documentation)
  o Easing the learning curve for users and enabling them to tackle more advanced studies
To tackle challenges and improve where needed, the **2021 ABP reorganization** foresees the creation of an **ABP Computing Panel** in order to:

1. Coordinating the software development activities in the group
2. Defining the medium- and long-term strategy for the evolution of our software tools
3. Identifying the needs for hardware resources and services
4. Liaising with the IT department, the controls groups and external computing centers concerning hardware resources and services

*(full mandate can be found [here](#))*

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Discussions took place at the end of 2020 with all of proposed panel members, with Yannis and with the section leaders in order to identify needs and objectives for the near future:

→ Extremely interesting! Thanks a lot for the very precious time and input!

Main objectives and ongoing software-development activities (with milestones and timelines, where possible) are collected in this webpage

→ Feedback is very welcome!

Main items on our plate will be summarized in the following slides.
We should aim at establishing a **professional development workflow**, starting from the codes that are strategic for ABP’s daily work

→ A list of core codes is available in [this page](#).

**Minimal requirements:**
- Source code uploaded and tracked in an online git repository (e.g. GitHub or GitLab)
- One or more "ready-to-run" examples should be provided.
- A simple "Getting started guide" should be available, illustrating how to install the code and run an example.
- Specifically for python tools, standard practices for python packages should be followed.
- Proper versioning and automatic testing are strongly encouraged.

**Survey to be made in the coming weeks** of what we have and what is missing

→ to be discussed in a coming meeting
Key objectives for 2021

**MAD-X**
*Involved persons: Tobias, Laurent*

- Support cpymad for python workflows
- Improve support for misaligned and overlapping elements
- Improve save/reload capabilities (full mad-x state)

**MAD-NG**
*Involved persons: Laurent*

- Focus will be on non-linear normal forms analysis and advanced tracking maps (building know ad develop tools).
  - The long-term goal is to match the capabilities and performance of PTC and possibly do better.
- Provide python interface for integration with other ABP and operation tools (LSA, PyHEADTAIL, sixtracklib, pymask)
**Key objectives for 2021**

**Tracking library**

*Involved people: Riccardo, Martin, Kostas, Tobias, Gianni, Roderik*

Build a modular library to be used as single-particle tracking engine in a broad range of applications.

Requirements:

- Compatible with CPUs and GPUs
- Interfaced with other tools for collective effects studies (instabilities, space-charge)
- Run efficiently with HTCondor and BOINC
- Adopt design choices that facilitate future maintenance, development, and adaptation to new technologies → keep the code slim
- Allow the integration of advanced collimation capabilities (advanced aperture models, scattering, coupling with FLUKA, tracking of fragments)
- Be extendable to model lepton rings

Prerequisite for this work is the preparation of a set of examples (with legacy tools) representative of the different use-cases
**SixDesk**
*Involved persons: Guido, Frederik (t.b.c.)*

- Restructure the tool to ease maintenance and further development (re-use as much as possible pysixdesk).
- Integrate new developments (pymask, Xtrack)
- Improve usage flexibility
- Explore the usage of containers (singularity or docker) on BOINC for more flexible simulations (e.g. including python)

**Xpart**
*Involved persons: Guido, Foteini, Kostas*

- Concentrate in a single library tools for the generation of particle ensembles
- Capabilities are presently scattered over several codes (SixDesk, pysixdesk, sixtrack, PyHEADTAIL)
Key objectives for 2021

**COMBI**
*Involved persons: Xavier, Sondre*
- Port to python the top-level layer that manages the interaction schedule, in order to interface with other libraries having a python interface

**PyHEADTAIL**
*Involved persons: Lotta*
- Build a solid set of examples and tests covering the entire library
- Improve documentation, introduce a simple “Getting started guide”
- Finalize merge into master of the coupled-bunch branch
- Integrate with Xtrack library for advanced non-linear tracking.
- Introduce multithread CPU parallelization (numba, or cython), required for performance in COMBI-like simulations
- Review, document and update GPU features

**PyPIC**
*Involved persons: Gianni*
- Restructure library to better integrate CPU-based FD solvers and GPU-based FFT solvers.
- Foresee combined usage with new tracking library for space-charge simulations.
**FCC-ee developments**

Involved persons (from ABP): Riccardo, Xavier, Gianni, Tobias, Frank Schmidt, Daniel, Frank Zimmermann

- Synergy with code development project led by EPFL
- ABP involved on two main fronts:
  - Development of optics and tracking tools
  - Modeling of interaction regions (e.g. beam-beam, beamstrahlung)
  - Collimation studies

**AWAKE simulation activities**

- ABP hosts important simulation activities for the AWAKE experiments
- Interesting and challenging plasma and beam dynamics simulations
- Several potential synergies to be identified and exploited (e.g. plasma simulations for beam sources, Particle In Cell exploitation)
- Very demanding in terms of HPC resources (presently running outside CERN)
To work efficiently we need to establish a **fluid exchange of information**

**Regular meetings to:**
- Update on development work
- Share findings, issues, ideas
- Ask for feedback and help from the others

**Meetings style**
- Round table
- Headlines only (details can be discussed offline in smaller groups)
- Slides only when needed
- Frequent (~weekly) but brief (30-45 minutes!)

**Invitation:** ABP-CP members + anybody interested in joining (you can self-subscribe [here](#))

**Computing seminars:** occasionally meetings with an enlarged audience to discuss special topics of general interest (also from IT, CO etc.), in the style of the ABP-CWG meetings.
http://cern.ch/abpcomputing

Contents:
- Inventory of ABP software tools
- List of available computing resources and services (e.g. batch, cluster) with instructions for access and usage
- Guidelines, instructions and how-tos
- List of objectives and ongoing activities → to be used to keep track

MkDocs site, hosted on GitLab:
- Very simple markdown language
- You are very very very welcome to contribute! (just ask for access rights)