

PHASE – Panel on Hadronic Amplitudes

Proposal

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PWA 9 / ATHOS 4
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Open Issues in Amplitude Analysis

- State of the Art amplitude models (isobar model) may **violate unitarity** and have **wrong analytic structure**. Breit-Wigner amplitudes are only a good approximation for narrow resonances far from thresholds
- Extracted resonance parameters depend on specific decay, can't easily be compared across processes
- Associated **systematic uncertainty not quantifiable** without further input
- **Coupled channel** dynamics taken into account in few analyses



Recent Advances in Phenomenology (Selection)

■ Dispersion theory

Example: $B_{(s)}^0 \rightarrow J/\psi \pi \pi$ [PRD90(2014)012003]

reinterpreted in [JHEP1602(2016)009]

needs less parameters

better consistency across channels

Idea came up at the LHCb AmAn Workshop

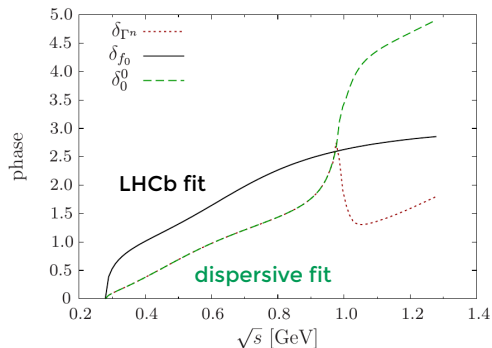
Rio 2015

■ Dynamical coupled-channel methods

Example: Baryon spectroscopy, Pentaquarks?

■ Regge theory, duality, finite-energy sum rules

Example: sparsely populated parts of large phase-space Dalitz Plots



... see this week's PWA 9 / ATHOS 4 workshop program!



Collaboration on Hadronic Amplitudes

The **need and desire** to improve collaboration between phenomenologists and experiments has been documented previously. For example:

- **ATHOS Whitepaper:**
Analysis Tools for Next-Generation Hadron Spectroscopy Experiments
[Acta Phys. Polon. B46,2(2015)257]
- **INT Whitepaper: Issues and Opportunities in Exotic Hadrons**
↪ arXiv:1511.06779
- **EMMI Rapid Reaction Task Force: Resonances in QCD**
[Nucl. Phys. A948(2016)93]



PHASE – Panel on Hadronic Amplitudes

- Initiated at MIAPP Workshop (November 2016)
Flavour Physics with High-Luminosity Experiments
→ diverse drafting group
- ↪ PROPOSAL Document <https://goo.gl/5o36g5>
- Has been communicated on February 10th to a wide range of experimental collaborations and theory groups.

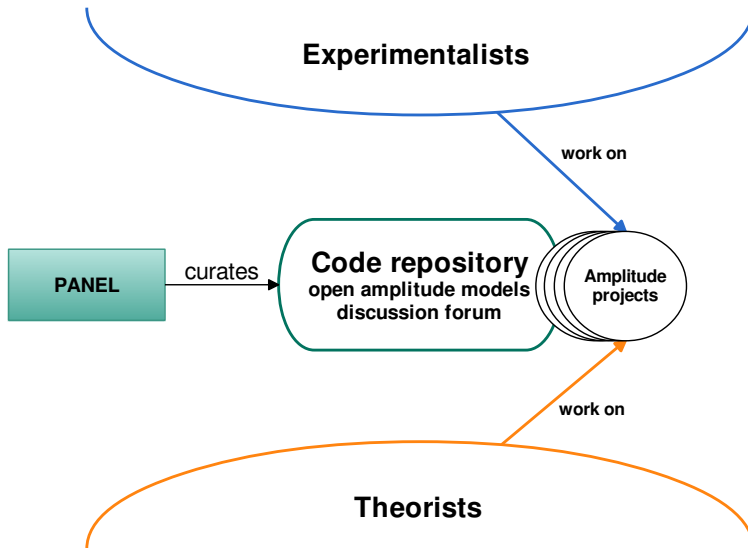


Goal of the Initiative

- Create **better amplitude models**
- Facilitate **collaboration** between phenomenologists and experiments
- Provide **specific code/tools** which can be used by the experiments to analyse their data

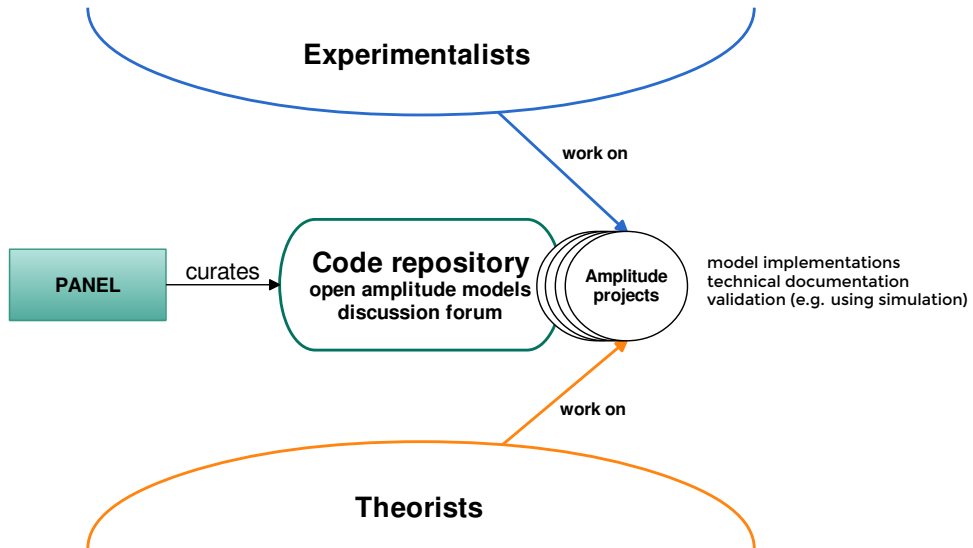


PHASE - Open Source Infrastructure





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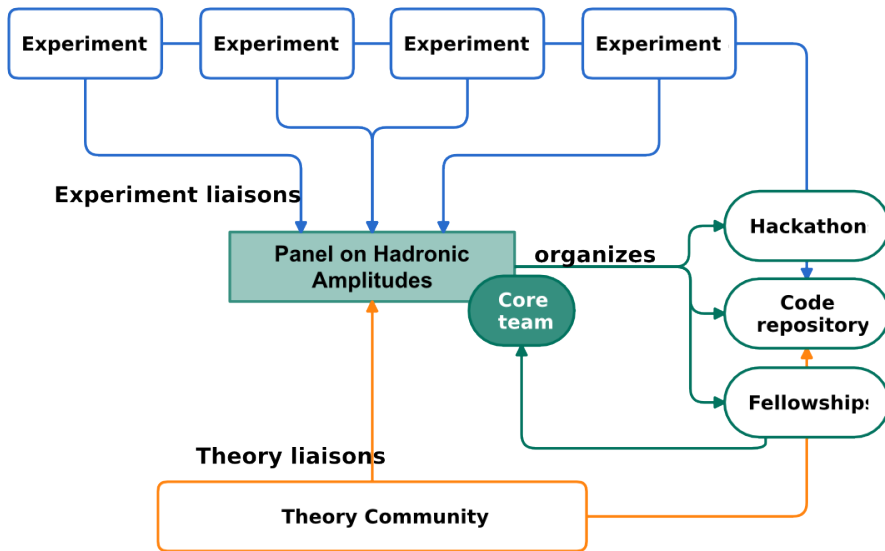


Code-Repository as Center-Piece

- Focus on **advanced models** that need a community effort to realize
- Need a **platform to share and discuss** amplitudes between experimentalists and theorists
- **GITLAB/GITHUB** repository and collaboration platform
 - Low barrier of entry
 - Services: Wiki, webpages, issue-tracker, easy merging of work ...
 - Inspect, compare, comment, propose changes to code
 - Github Examples:
 - <https://github.com/lhcb/first-analysis-steps>
 - <https://github.com/PHASE-network>
 - <https://github.com/PHASE-network/rootpwa>



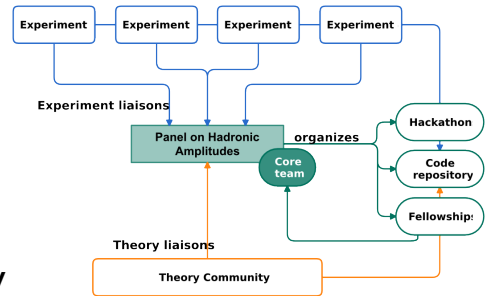
PHASE - Organisation





Role of the Panel

- Ensure the **flow of information**
- **Curate** the PHASE repository
- Ensure **open access** to the repository
- Facilitating a fair scrutiny of the contributed models
- Regular **review article** on the state of art of amplitude analyses.
- Draft joint funding applications for the PHASE project.





Things PHASE will do:

- Organize amplitude analysis **hackathons**
- Provide validation of amplitude models
(compare predictions of different models)
- Community building
- Technical support for **Open-Data** initiatives
- PHASE fellowships



Next Steps

- Collect feedback on the proposal (this session)
- Reformulate/clarify where necessary (this week)
↳ PROPOSAL Document <https://goo.gl/5o36g5>
- Find volunteers to serve as Liaisons on the first Panel
- Setup repository, organize 1st hackathon

Backup



- **How is this going to impact experiment independence?**
 - Experimental collaborations stay in full control of their data and analyses processes. Sharing through PHASE will always be subject to the rules of those collaborations. Since PHASE operates on a strictly Open model of collaboration, no privileged access will be created.
- **Who will work on the amplitude models?**
 - It's a community effort. The repository will be open to everyone to start a project.
- **What funding programs are being targeted?**
 - Has not started yet. First ideas: Horizon 2020 Network. Will be EU-based.
- **What is the relation to JPAC, BRAG, etc?**
 - We aim for lively exchange and collaboration (facilitated by distributed code repositories (git))



- Is this not recreating already existent structures?
 - PHASE focus is the collaborative platform and the code. It fills an open niche, which should add value to the various existing and successful Workshop series. The idea of a collaborative platform was conceptualized over years by this community. PHASE will not organize classic workshops.
- A review on amplitude analysis seems overkill
 - The idea was brought up to give the (young!?) volunteers working on PHASE an opportunity for an interesting publication, as a reward for their service to the community. The review should be a pedagogical document (similar to mini-reviews in the PDG, but with more details). A concise source like this is missing.
- What does you mean by "validation" of a model?
 - The devil is in the detail. We want to provide infrastructure to easily compare amplitude implementations. E.g. to check if two implementations actually represent the same physical amplitude.



Vision of the Initiative

- Enable joint analyses of hadronic processes across multiple experiments and multiple data sets
- Provide a forum and infrastructure for joint developments within the hadron physics community
- Define best practices
- Provide researchers with useful tools for data analysis



Curation (wiktionary)

- The act of curating, of **organizing and maintaining** a collection of artworks or artifacts.
- (archaic) The act of curing or healing.
- (databases) The manual updating of information in a database.



Tools which could live in the PHASE repo

Adapted from [Acta Phys. Polon. B46,2(2015)257]

- **Amplitude code**
- MC generators
- Data readers
- Minimizers
- Integrators
- Plotters
- Parallelization libraries
- Exchange ideas (code snippets)
- **Ecosystem of coexisting, independent code**



A Reference Implementation

- The purpose of the library is to implement the **physics functions** needed for amplitude analysis.
- While we will try to make it fast, optimization towards certain technologies is not the main focus of the effort.
- It will become a **reference implementation**
 - Analysers can use the library directly in their fitters
 - Comes with a **test-suite** to compare custom implementations against
- Working groups and reviewers will be able to request **consistency checks** against the reference library.
- Goal: a **consistent, tested and documented set of functions** for all amplitude analyses in LHCb
- Can be used to communicate our models to theorists



Making Contributions to the PHASE repository

- The repository will be open
- **Everybody** can contribute
- In practice: Any people developing models or doing analysis
- Contributions are handled through a **standard process** such as the
↳ C4 Collective Code Construction Contract
- PHASE panel members can contribute but their main job is to curate, i.e. set up and maintain the process



Amplitude Analysis Hackathons

- Get a group of experts together for 3 weeks
- Concrete task to implement e.g. a certain amplitude model that is needed
- Pay for accommodation during workshop
- Results will be made public through PHASE servers



Independent bodies have been established for specific topics already

- ↪ HFAG - Heavy Flavour Averaging Group
- ↪ JPAC - Joint Physics Analysis Center
- ↪ BRAG - Baryon Resonance Analysis Group

- ↪ INS Data Analysis Center
- ↪ CKM fitter / ↪ Ufit

For amplitude analysis such an institution is missing in Europe