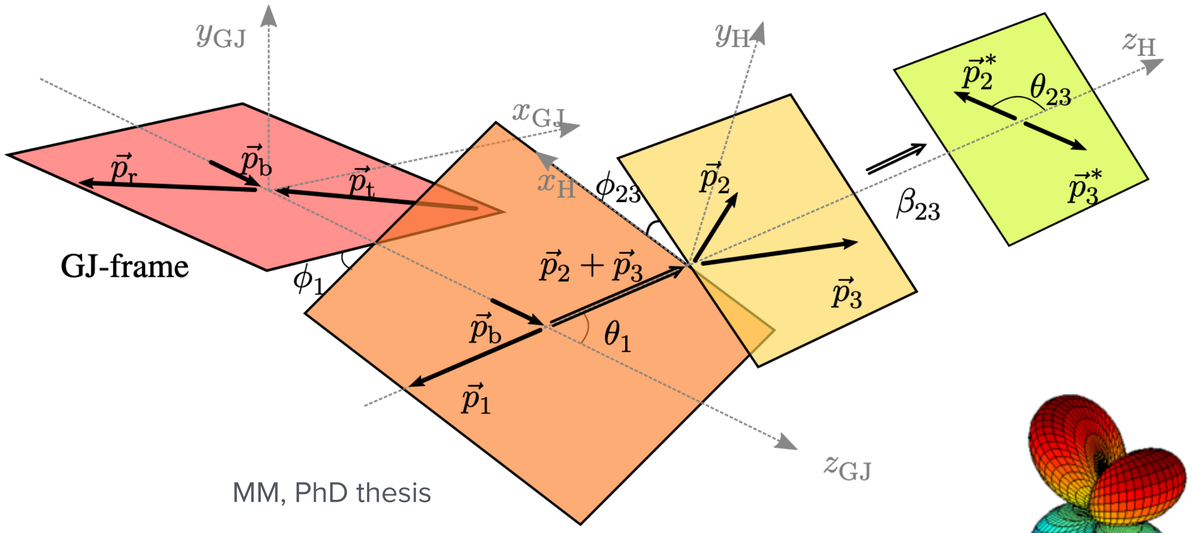
KAI HABERMANN, SEBASTIAN NEUBERT, MIKHAIL MIKHASENKO

VA: PARTIAL WAVE ANALYSIS

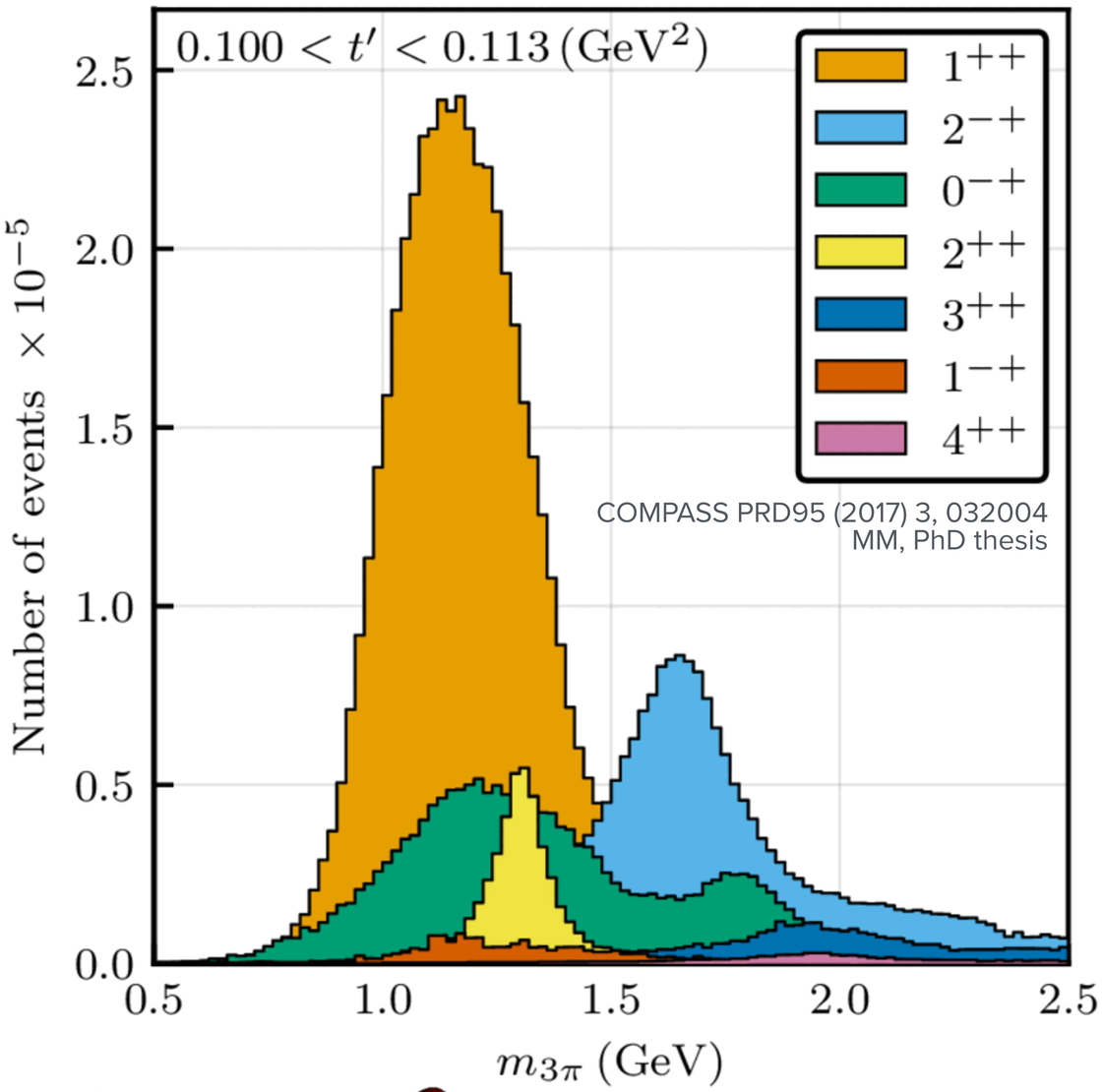
PWA is essential but hard to access.
VA-PWA makes it intuitive and available

WHY PWA MATTERS

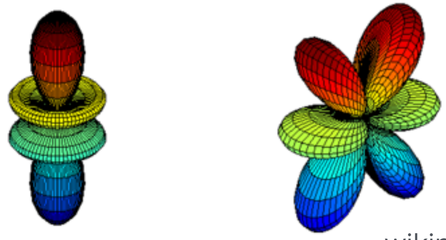
- Angular distributions are determined by quantum numbers, spin and parities
- PWA is the only tool to resolve overlapping resonances.



MM, PhD thesis



COMPASS PRD95 (2017) 3, 032004
MM, PhD thesis



wikipedia

THE PROBLEM

- Complex problem, steep learning curve
- No common standard

- Exclusively CLI, no visual tools

AMPGEN

MP

OOLS

ComPWA

MC

Helicity Amplitude Module
for Matrix Element Reweighting

PRWIAN

NumPy

Project	Collaboration
AmpGen	CLEO / LHCb
AmpTools	BESIII / GlueX
BruFit	CLAS12
ComPWA (C++)	
ComPWA project • QRules • AmpForm • TensorWaves	
cFit	
FDC-PWA	BESIII
GPUPWA	BESIII
HAMMER	
Ipanema	
Laura++	LHCb
Mint2	
Pawian	BESIII / PANDA
PyPWA	JLab
Rio++	LHCb
ROOTPWA	COMPASS
TARA	Crystal Barrel
TensorFlowAnalysis • AmpliTF • TFA2	LHCb
TF-PWA	BESIII / LHCb
ThreeBodyDecays.jl	LHCb

RECENT DEVELOPMENT

PWA = **ANGULAR PART** * **DYNAMICS**

Model independent,
completely clear

State of the art,
Subject to reaction theory

Nailed Down

Left for exploration

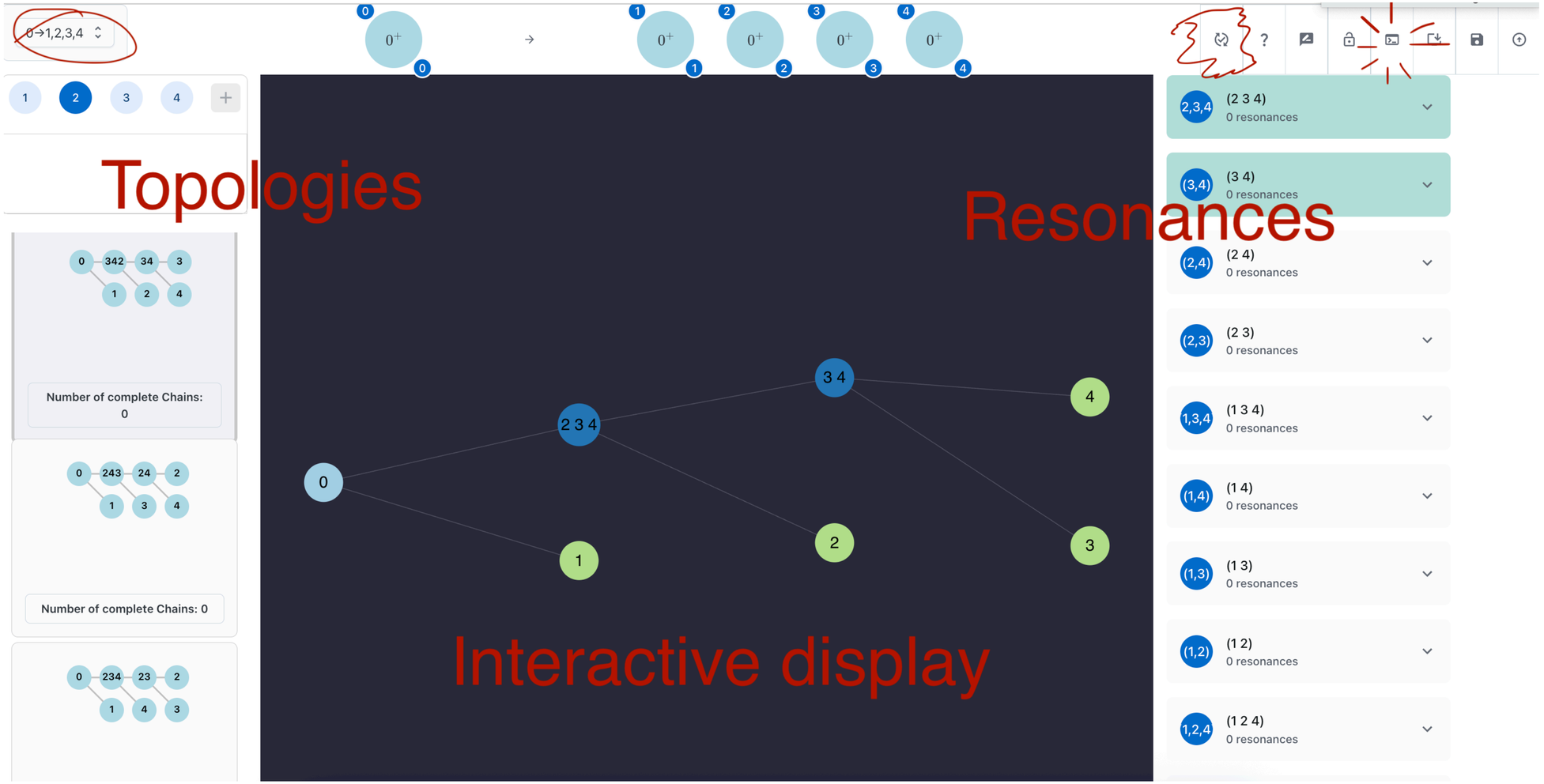
Wigner rotations for cascade reactions

Kai Habermann *

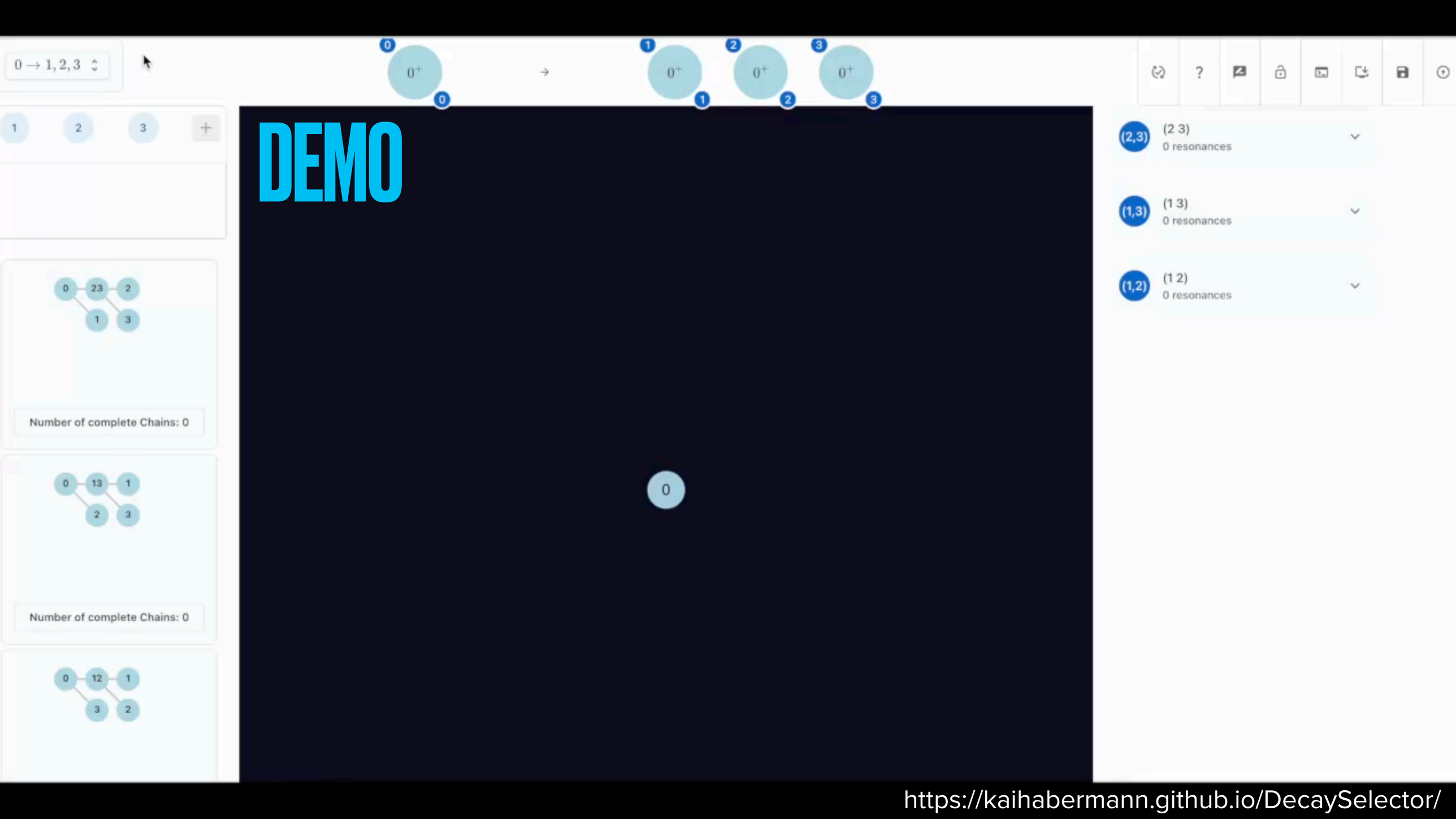
Mikhail Mikhasenko †

OUR PLATFORM

- No install. No expert knowledge.
- Clickable configuration
- Based on the recent generalization of helicity formalism

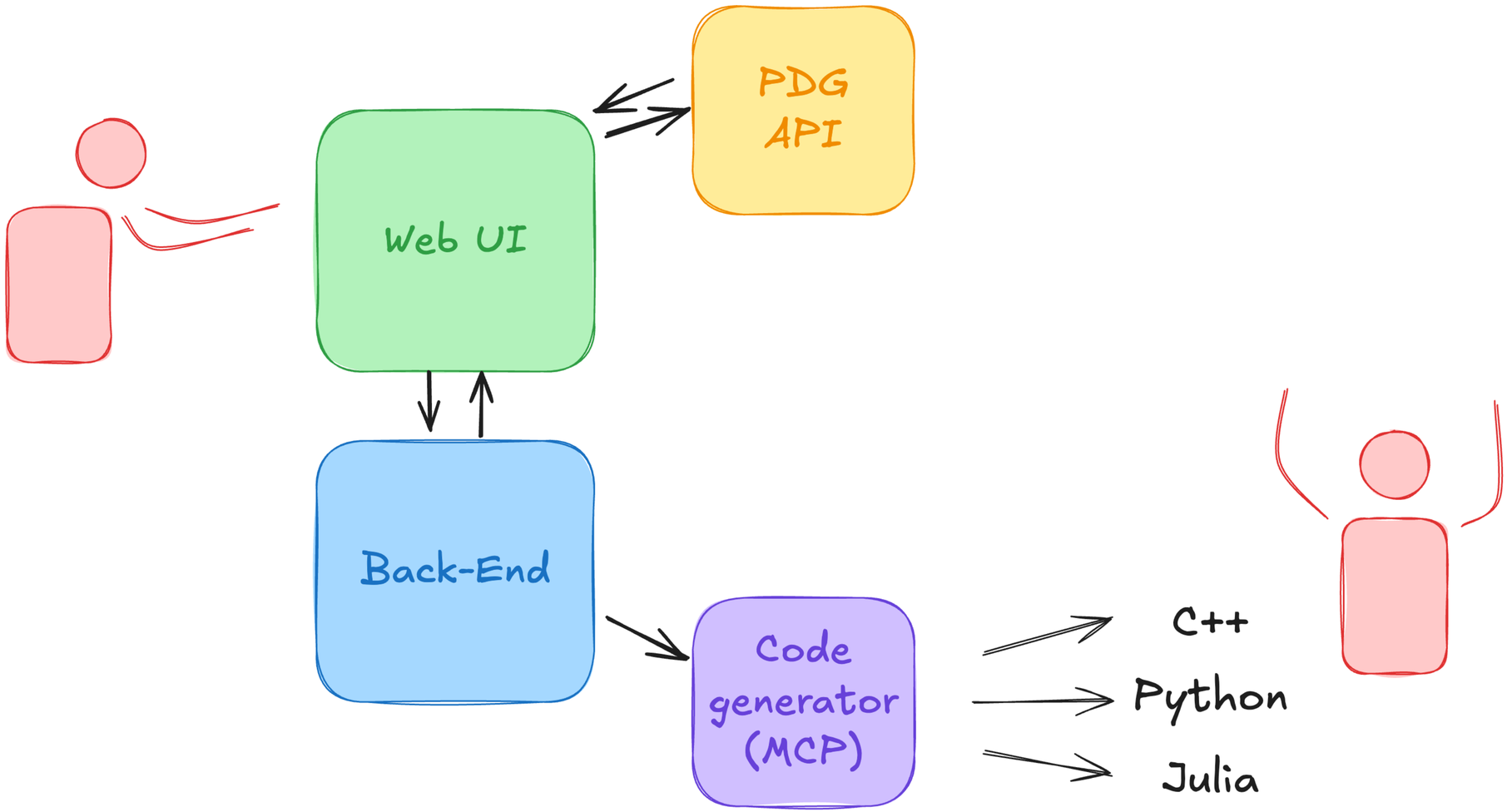


https://kaihabermann.github.io/DecaySelector/



https://kaihabermann.github.io/DecaySelector/

FRONT-END + BACK-END

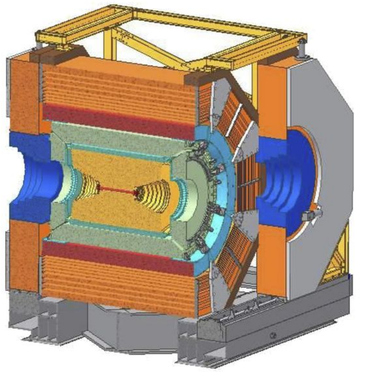


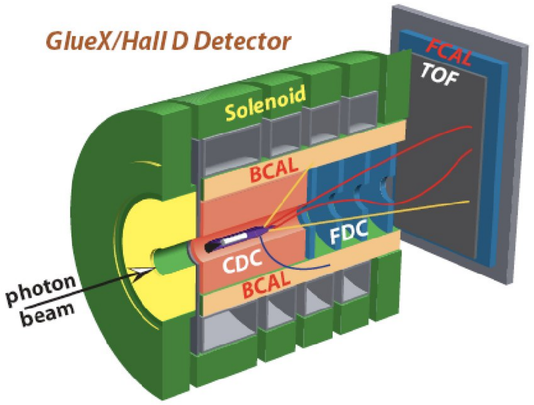
ENABLING THE LARGE COMMUNITY

- **Who Needs It?**
  - LHCb (CERN), COMPASS/AMBER (CERN), Belle II (Japan), BESIII (China), GlueX (JLab, USA), A2 (MAMI, Germany), CB (ELSA, Germany), QCD@FAIR (FAIR, Germany)

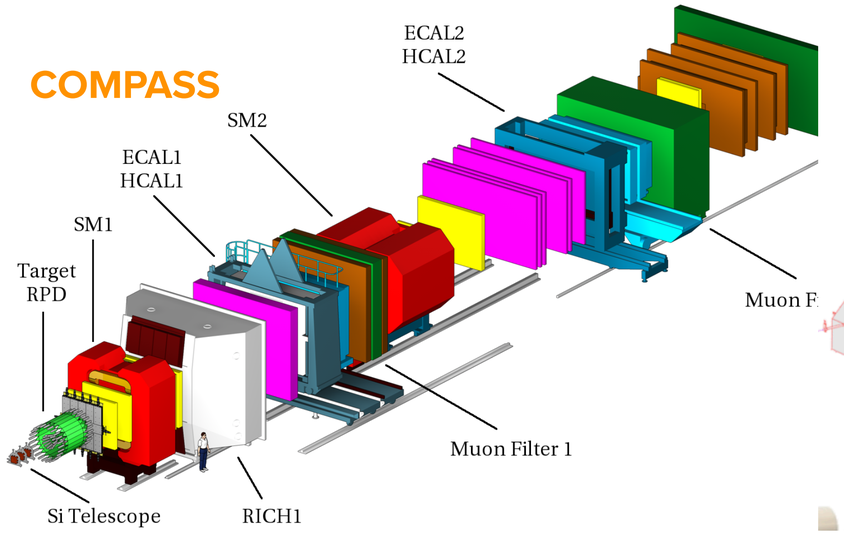
- **How they use it?**
  - Data Analysts
  - Developers
  - Cross-validation

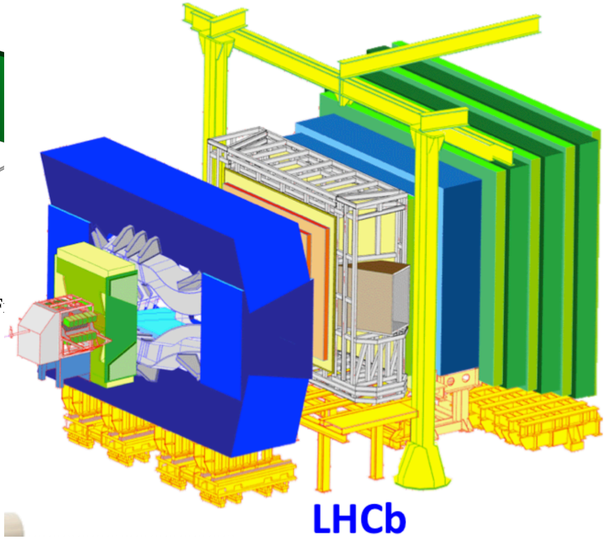
BESIII





COMPASS





LHCb

VIRTUAL ACCESS, REAL IMPACT

TRAINING

1/YEAR

PHYSICISTS

HACKATHONS

1/YEAR

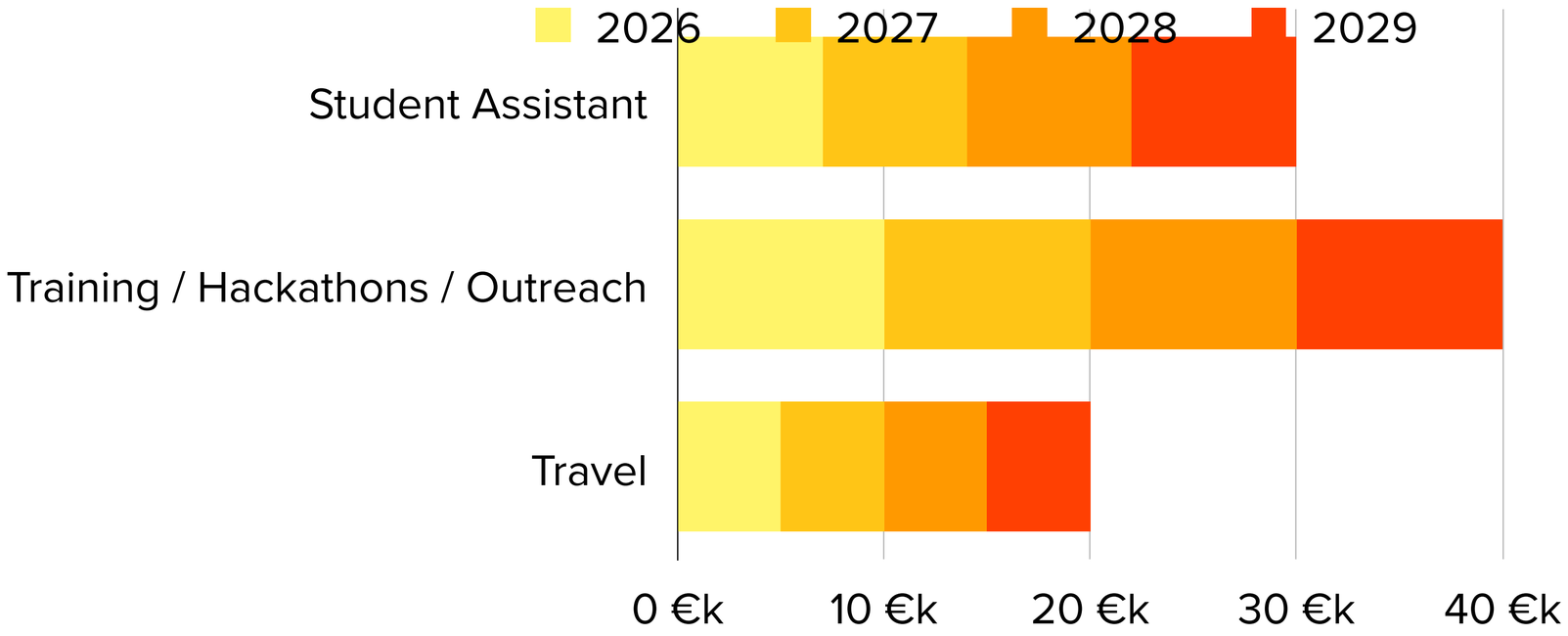
EXPERTS

ALL

TUTORIALS

READY TO SCALE

- **Functional prototype exists.**
- **Needs great polish, hosting, and outreach.**



- **Budget total: 90k**

VA-PWA IN 3 POINTS

ENABLES EVERYONE TO USE PWA

BRIDGES EXPERIMENTS AND TOOLS

WORKING IDEA — NOW NEEDS SCALING

BACKUP

EXAMPLES OF CONFIGS

AMPGEN

Code | Blame | 199 lines (186 loc) · 19.8 KB

```
# Description of CF amplitude D0 -> K-,pi+,pi+,pi-
EventType D0 K- pi+ pi+ pi-
Import $AMPGENROOT/options/kMatrix.opt

a(1)(1260)-::Spline      40         0.18412         1.9
a(1)(1260)+::Spline      40         0.18412         1.9
K(1460)+::Spline         40         0.6             3.0
K(1460)bar-::Spline      40         0.6             3.0
K(1)(1270)+::Spline      40         0.6             3.0
K(1)(1270)bar-::Spline   40         0.6             3.0


CouplingConstant::Coordinates  polar
CouplingConstant::AngularUnits deg
CoherentSum::Verbosity         0

D0{K*(892)bar0{K-,pi+},rho(770)0{pi+,pi-}}                  0          0.196        0.001
D0[P]{K*(892)bar0{K-,pi+},rho(770)0{pi+,pi-}}               0          0.362        0.002
D0[D]{K*(892)bar0{K-,pi+},rho(770)0{pi+,pi-}}               2          1.000        0.000
D0{rho(1450)0{pi+,pi-},K*(892)bar0{K-,pi+}}                 0          0.162        0.005
D0[P]{rho(1450)0{pi+,pi-},K*(892)bar0{K-,pi+}}              0          0.643        0.006
D0[D]{rho(1450)0{pi+,pi-},K*(892)bar0{K-,pi+}}              0          0.649        0.021
```

TFPWA

```
config_str = """

decay:
    A:
       - [R1, B]
       - [R2, C]
       - [R3, D]
    R1: [C, D]
    R2: [B, D]
    R3: [B, C]

particle:
    $top:
       A: { mass: 1.86, J: 0, P: -1}
    $finals:
       B: { mass: 0.494, J: 0, P: -1}
       C: { mass: 0.139, J: 0, P: -1}
       D: { mass: 0.139, J: 0, P: -1}
    R1: [ R1_a, R1_b ]
    R1_a: { mass: 0.7, width: 0.05, J: 1, P: -1}
    R1_b: { mass: 0.5, width: 0.05, J: 0, P: +1}
    R2: { mass: 0.824, width: 0.05, J: 0, P: +1}
    R3: { mass: 0.824, width: 0.05, J: 0, P: +1}

"""
```