Report from the CP(t)&UT angles group

HFLAV All-Hands Meeting

Jordy Butter, Tim Gershon, Matt Kenzie,
Kenkichi Miyabayashi, Michele Veronesi

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New developments: software modernisation

- Main goals:
  - New combination framework for our HFLAV subgroup
  - New webpage for the results
  - Publicly available code
- Gitlab repo: [ut-combo]
- See also: [report by Tim]

Current combination frameworks

Three different software packages used:

1. **COMBOS**
   - sin(2β) from B0➜J/ψKS, etc.
   - Handles correlations of systematics between different experiments (common nuisance parameters)
   - Old (FORTRAN) code
2. **PhiThreeAverager**
   - Most results
   - Old (C++) code
3. GammaCombo (https://gammacombo.github.io/)
   - Combination of results for α and γ
   - Modern, well-maintained C++
   - No need to replace

New combination framework

- Replace PhiThreeAverager and COMBOS
- Starting point: Combination Code (CoCo)
  - Repository [GitLab], documentation [link]
  - Results are stored in *ResultSets*: json files with one or multiple measurements
  - Can handle correlations between measurements and change of parametrisation
- Plan:
  - Python-based
  - Minimisation: iminuit
  - Inputs: json files (ie *ResultSets*)
  - Matplotlib plots
  - Open-source
- Points of attention:
  - Asymmetric errors
  - Rescaling experimental results to common set of input parameters

Current status

- Minimising a χ^2 with iminuit (ie CoCo)
- Combination results -> json file
- Reproduced symmetric combinations
- For example:
  - $B^0 \to \pi^+\pi^-$ ✅
  - $B^0 \to \rho^+\rho^-$ ✅
  - $B^0 \to a_1^{\pm}\pi^{\mp}$ ✅
- Gitlab page in place: [ut-combo]
  - Gitlab issues to keep track of to-dos


```
{
"ResultSet": [
{
    "ResultSetLabel": "Comb",
    "Description": [ "Comb" ],
    "Parameter": [
    {
    "Name": "C_CP",
    "Value":  -0.311263,
    "Error":  0.030145
    },
    {
    "Name": "S_CP",
    "Value":  -0.666426,
    "Error":  0.029359
    }
    ],
    "StatisticalCorrelationMatrix": [
    [  1.00, 0.29 ],
    [  0.29, 1.00 ]
    ]
}
]
}
```

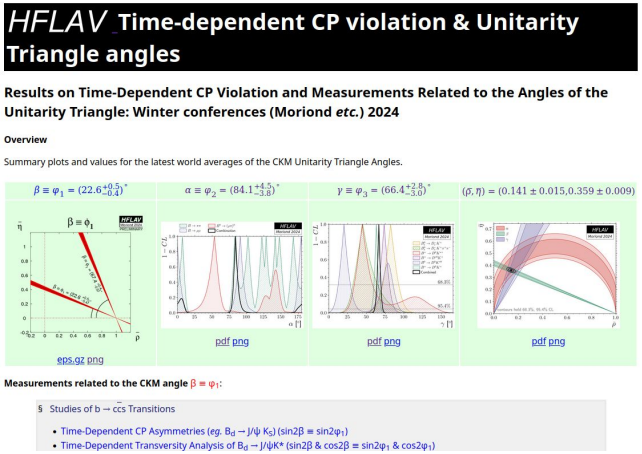

new combination $B^0 \to \pi^+\pi^-$

Experiment	S_{CP} ($\pi^+\pi^-$)	C_{CP} ($\pi^+\pi^-$)	Correlation
BaBar N(BB)=467M	−0.68 ± 0.10 ± 0.03	−0.25 ± 0.08 ± 0.02	−0.06 (stat)
Belle N(BB)=772M	−0.64 ± 0.08 ± 0.03	−0.33 ± 0.06 ± 0.03	−0.10 (stat)
LHCb Run 1 $\int L dt$=3.0 fb^{-1}	−0.63 ± 0.05 ± 0.01	−0.34 ± 0.06 ± 0.01	0.45 (stat)
LHCb Run 2 $\int L dt$=1.9 fb^{-1}	−0.706 ± 0.042 ± 0.013	−0.311 ± 0.045 ± 0.015	0.394 (stat) 0.306 (syst)
LHCb Average	−0.672 ± 0.034	−0.320 ± 0.038	0.405 (stat)
Average	−0.666 ± 0.029	−0.311 ± 0.030	0.288

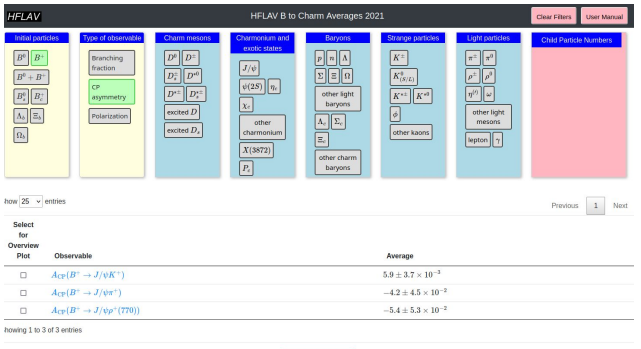
HFLAV combination $B^0 \to \pi^+\pi^-$

Modernisation of webpage

- Webpage [link]
  - Static html
- Plan: create a more dynamic page
  - Most important results easy to find
  - Detailed information folded
  - Very much open to suggestions
- Example:
  - HFLAV B to Charm Averages webpage: [link]



Current/old webpage



HFLAV B2Charm webpage