BCAMs study and $y_{CP} - y_{CP}^{K\pi}$ measurement at LHCb

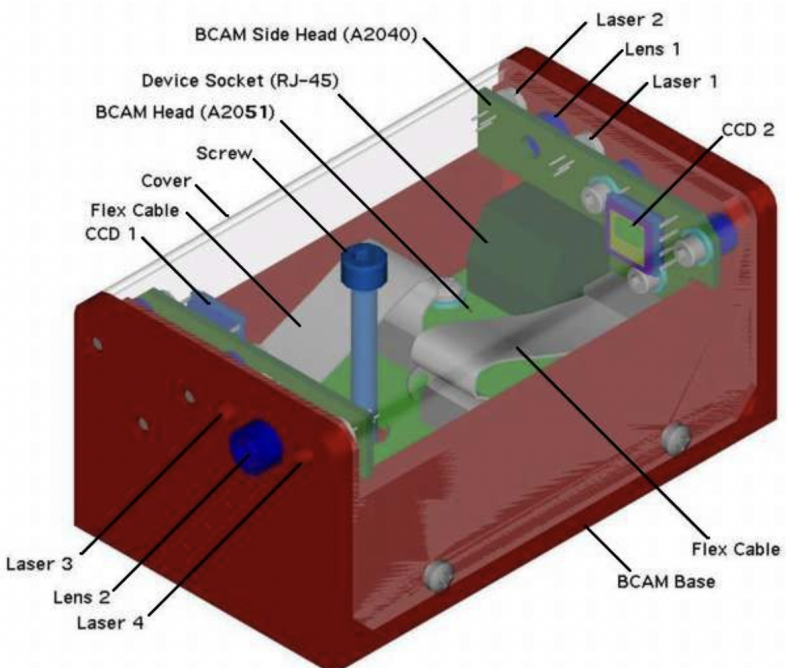
Kaminaris Dimitrios

Supervisor: Frédéric Blanc

École Polytechnique Fédérale de Lausanne

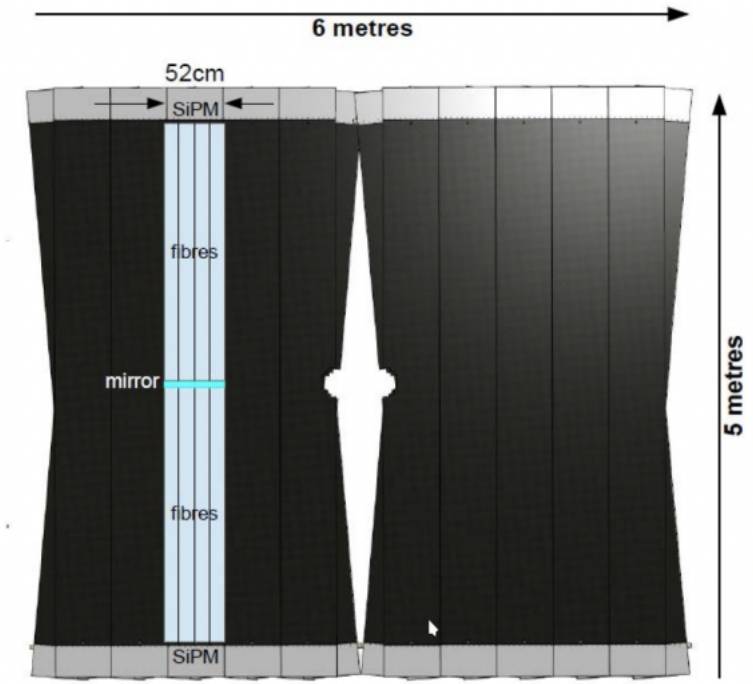
BCAM - Brandeis CCD Angle Monitor

- Optical instrument designed to monitor the geometry of large structures
- Consists of one or two electronic cameras and one or two pairs of light sources
- The cameras use CCD image sensors and measure the bearing of light sources
- A BCAM is analyzing the relative position of the center of a light spot that is projected onto the CCD

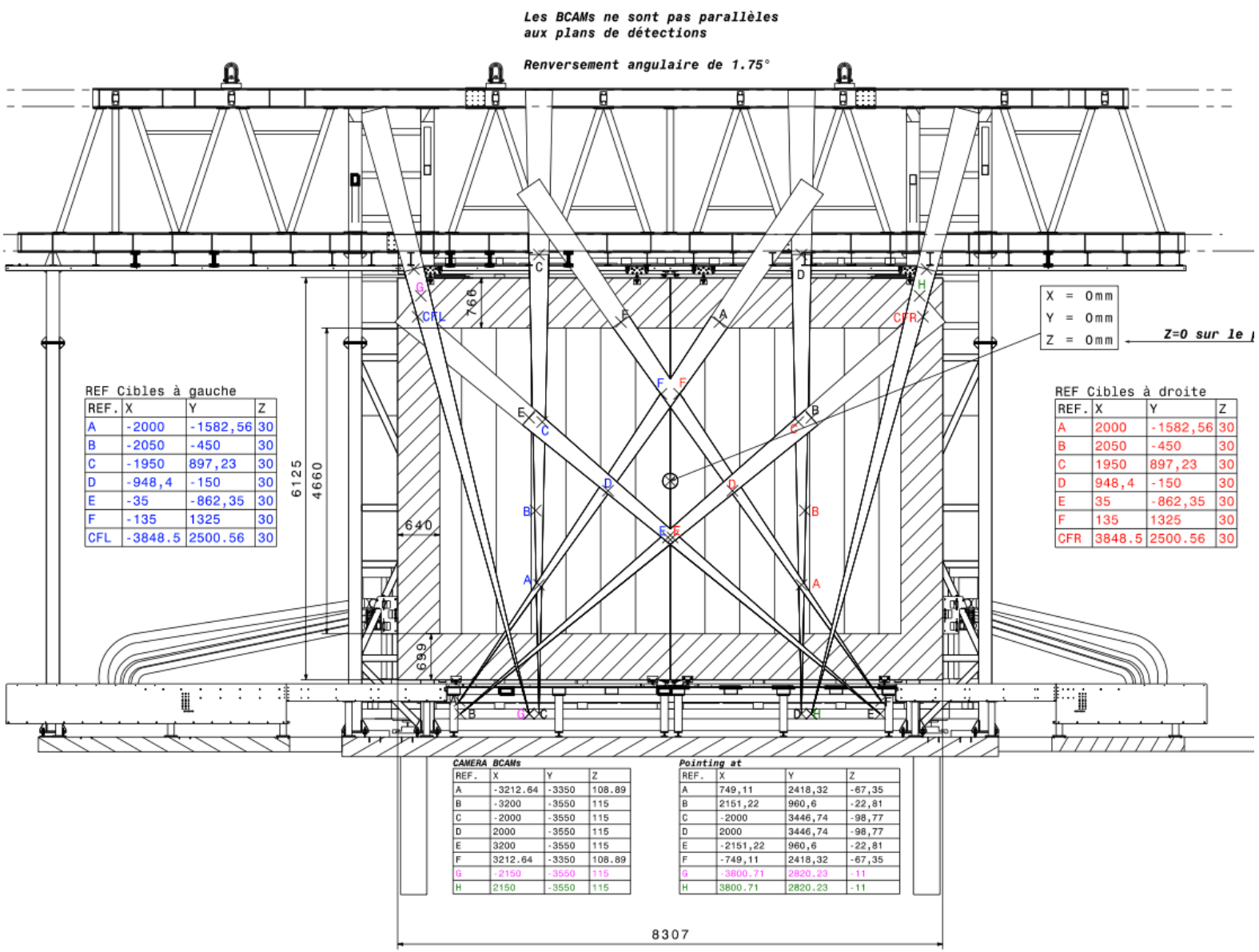


BCAMs on SciFi at LHCb

- We need constant monitoring of the SciFi surface geometry
- BCAMs and high index glass balls are placed on the SciFi
- Does the detector move depending on the behavior of magnet,temperature,...?
- We have 14 targets in 3 stations (T1,T2,T3) and 8 cameras per station
- The aim is to obtain 3D positions of targets with high precision



BCAMs on SciFi at LHCb



REF Cibles à gauche

REF.	X	Y	Z
A	-2000	-1582,56	30
B	-2050	-450	30
C	-1950	897,23	30
D	-948,4	-150	30
E	-35	-862,35	30
F	-135	1325	30
CFL	-3848.5	2500.56	30

REF Cibles à droite

REF.	X	Y	Z
A	2000	-1582,56	30
B	2050	-450	30
C	1950	897,23	30
D	948,4	-150	30
E	35	-862,35	30
F	135	1325	30
CFR	3848.5	2500.56	30

CAMERA BCAMs

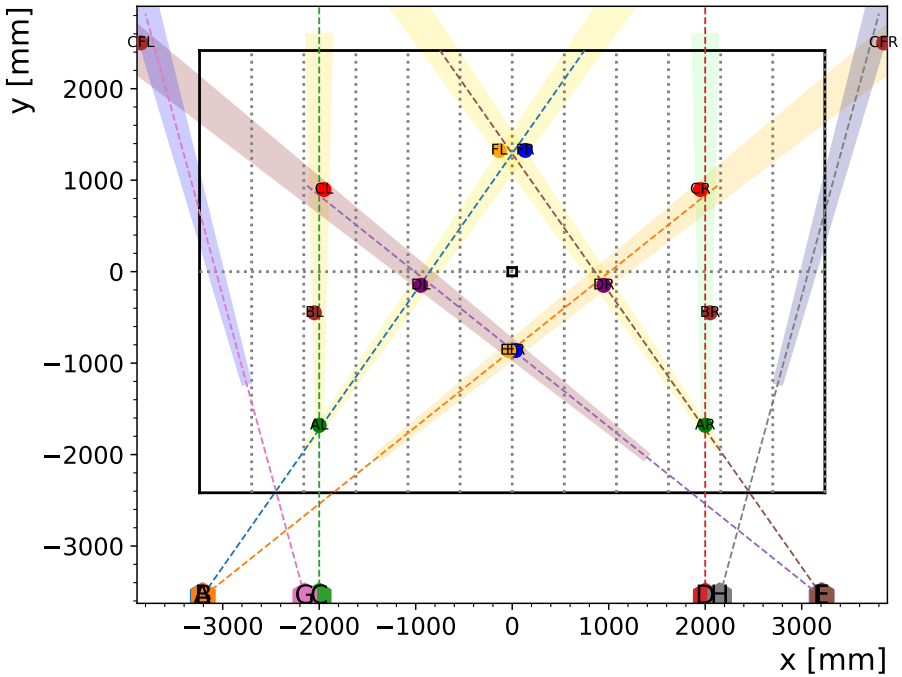
REF.	X	Y	Z
A	-3212.64	-3350	108.89
B	-3200	-3550	115
C	-2000	-3550	115
D	2000	-3550	115
E	3200	-3550	115
F	3212.64	-3350	108.89
G	-2150	-3550	115
H	2150	-3550	115

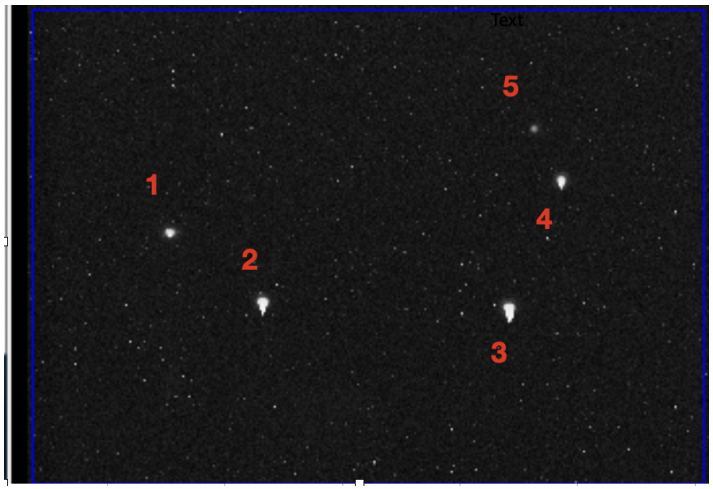
Pointing at

REF.	X	Y	Z
A	749,11	2418,32	-67,35
B	2151,22	960,6	-22,81
C	-2000	3446,74	-98,77
D	2000	3446,74	-98,77
E	-2151,22	960,6	-22,81
F	-749,11	2418,32	-67,35
G	-3800.71	2820.23	-11
H	3800.71	2820.23	-11

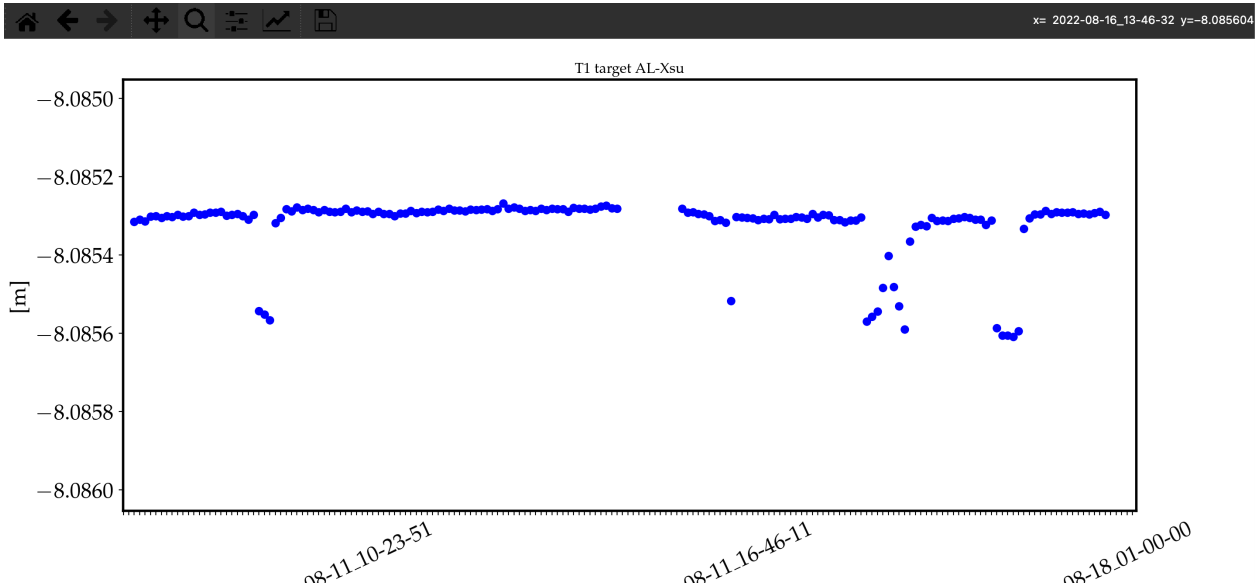
Calibration of Cameras

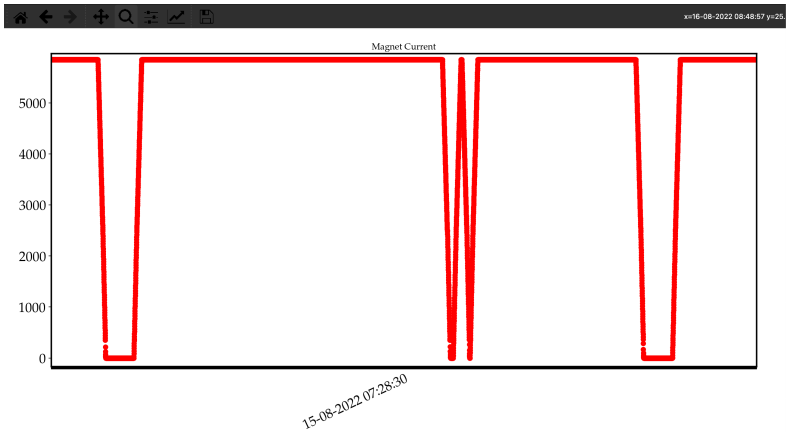
- Allows to build a common reference system and combine measurements of the same target by different cameras
- Dedicated data taking for each camera
- Targets measured with one BCAM at a time + the laser tracker
- Obtain orientation of each camera in the global system

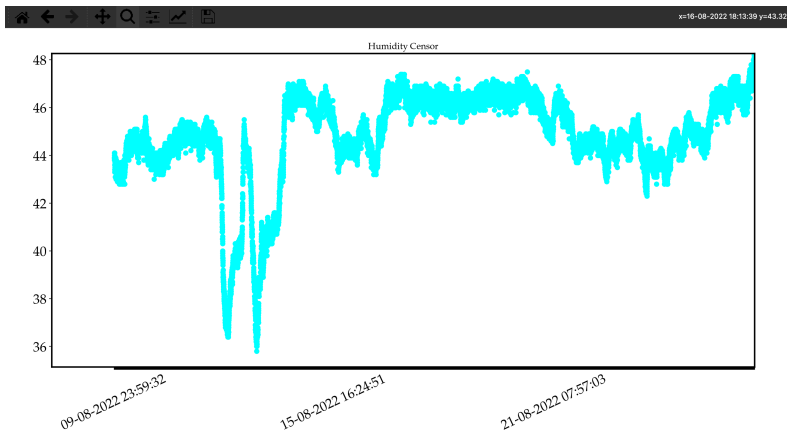




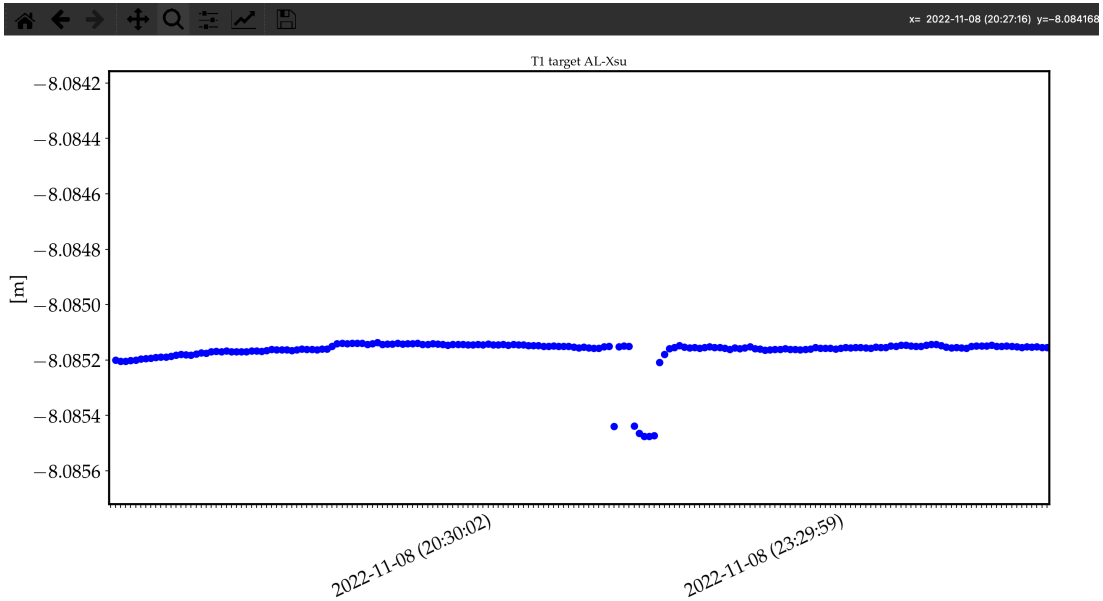
Correlations between target movement and magnet state/humidity censor

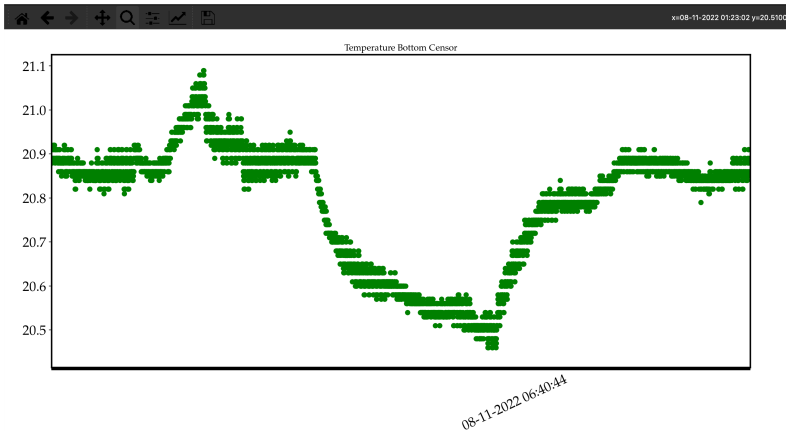


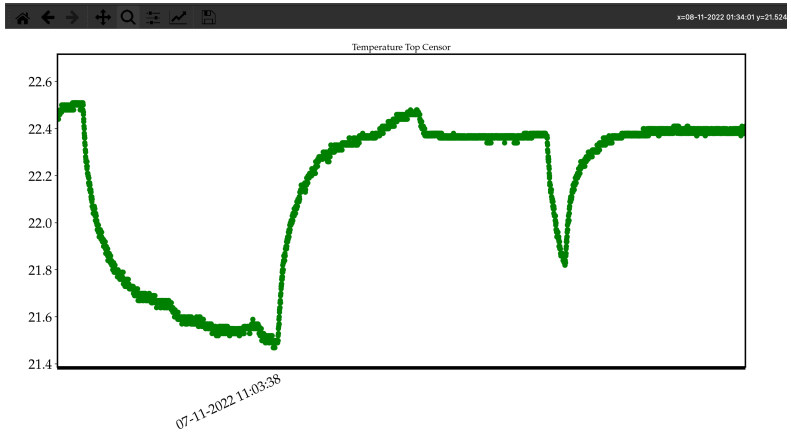




Correlations between target movement and temperature censors







Measurement of charm mixing parameter $y_{CP} - y_{CP}^{K\pi}$ using two-body D^0 meson decays

- Neutral charm mesons change their flavour and turn into their antimeson counterpart ($D^0 - \bar{D}^0$ mixing)
- $D^0 - \bar{D}^0$ oscillations described by the two parameters

$$x_{12} = 2[M_{12}/\Gamma] \qquad\qquad y_{12} = [\Gamma_{12}/\Gamma]$$

- The non-zero value of y_{12} implies that the time-dependent decay rate of Cabibbo suppressed $D^0 \longrightarrow f$ decays is described by an exponential function with an effective decay width $\hat{\Gamma}$ that differs from Γ
- The departure from unity of the ratio of the effective decay widths of $D^0 \longrightarrow \pi^-\pi^+$ and $D^0 \longrightarrow K^-K^+$ decays over that of $D^0 \longrightarrow K^-\pi^+$ decays is measured via

$$y_{CP}^{f} = \frac{\hat{\Gamma}(D^0 \longrightarrow f) + \hat{\Gamma}(\bar{D}^0 \longrightarrow f)}{2\Gamma} - 1$$

Measurement of charm mixing parameter $y_{CP} - y_{CP}^{K\pi}$ using two-body D^0 meson decays

- The above can be approximated as

$$y_{CP}^{f} = y_{12} cos\phi_{f}^{\Gamma}$$

  where ϕ_{f}^{Γ} is the CP-violating phase difference of the interference between decay amplitudes with and without absorptive mixing
- Any deviation of y_{CP}^{f} from y_{12} would be a sign of CP violation
- The measurement will be performed on Run3 data
- Current work: Improve the $D^0 \longrightarrow hh$ trigger lines
- Goal is to incorporate the kinematic matching procedure, performed in the previous measurement[1], directly to the trigger line

[1] https://arxiv.org/abs/2202.09106

Thank you for your time and attention!