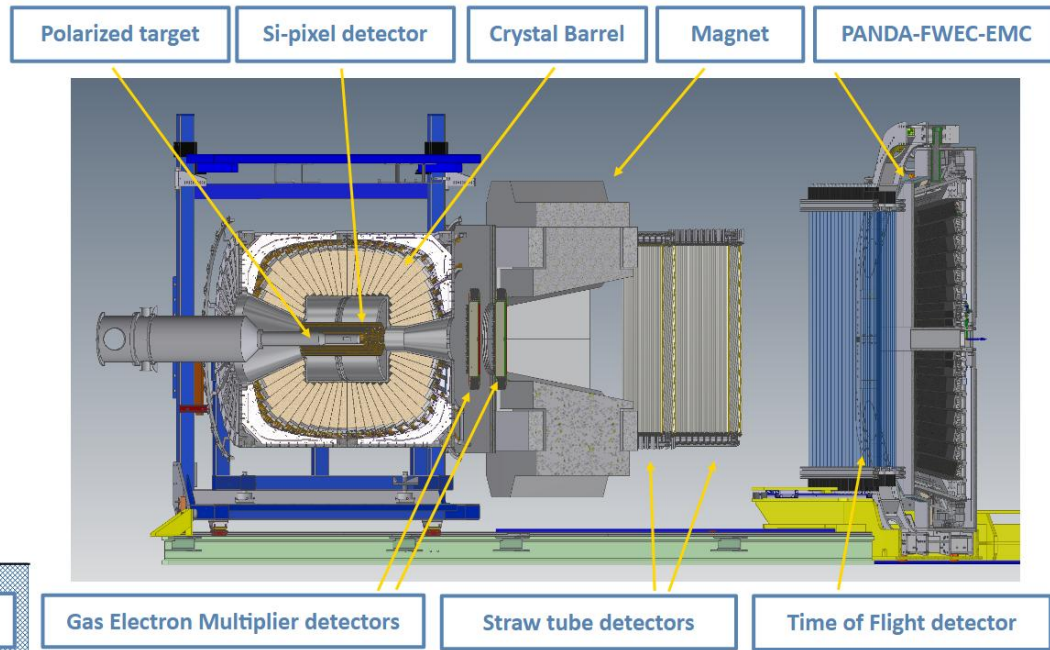
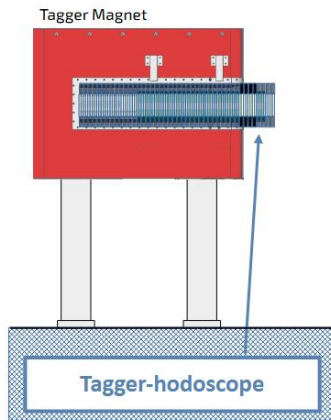


In future:



BnGa-PWA



JüBo coupled channel analysis

meets LHCb

For now: use existing data ← project (BnGa-PWA) started already

Combination of existing **KN** – scattering data with LHCb $\Lambda_b \rightarrow \gamma p K$

Λ^* -states

do contribute

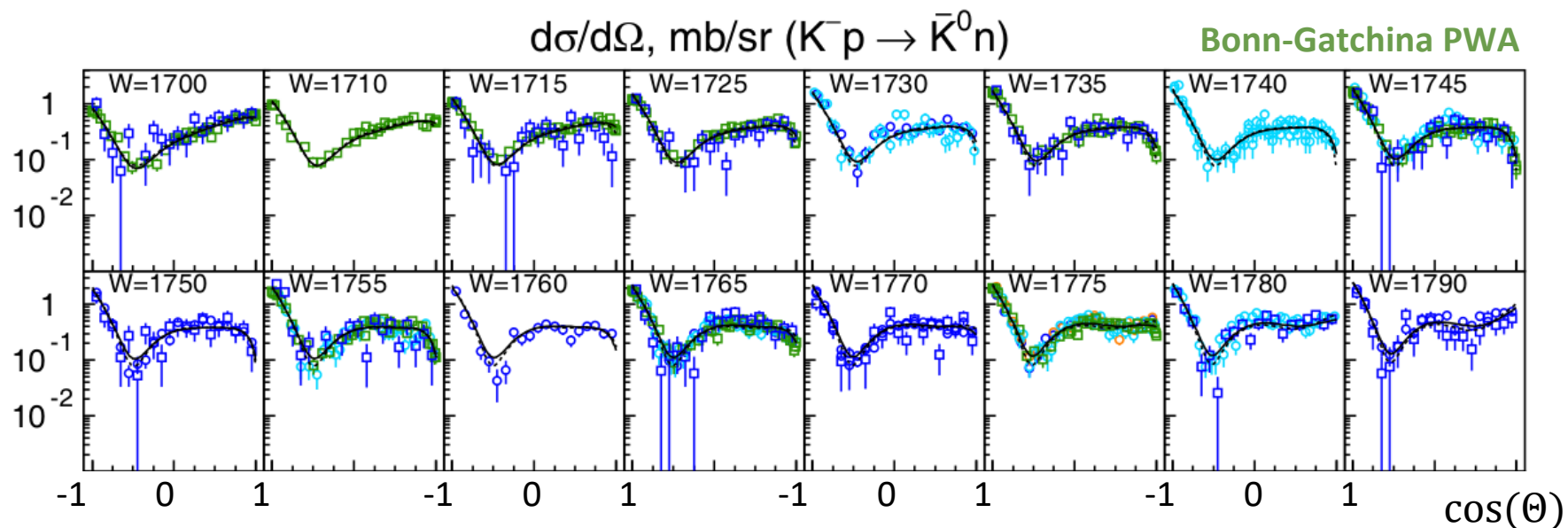
Table 1. List of reactions used in the partial-wave analysis. Δ denotes the $\Delta(1232)3/2^+$, Λ^* the $\Lambda(1520)3/2^-$, Σ^* the $\Sigma(1385)3/2^+$.

$K^- p \rightarrow K^- p$	$K^- p \rightarrow \bar{K}^0 n$	$K^- p \rightarrow \pi^0 \Lambda$
$K^- p \rightarrow \omega \Lambda$	$K^- p \rightarrow \eta \Lambda$	$K^- p \rightarrow \pi^0 \Sigma^0, \eta \Sigma^0$
$K^- p \rightarrow \pi^\mp \Sigma^\pm$	$K^- p \rightarrow K^{+/-} \Xi^{-/+}$	$K^- p \rightarrow K^{-/+} \Delta^{+/-}$
$K^- p \rightarrow \pi^\pm \Sigma^{*\mp}$	$K^- p \rightarrow \pi^0 \Lambda^*$	$K^- p \rightarrow K^{*-} p$
$K^- p \rightarrow K^{*0} n$	$K^- p \rightarrow \pi^0 \pi^0 \Lambda$	$K^- p \rightarrow \pi^0 \pi^0 \Sigma$

Similar reactions (existing data) were fitted by different groups including the Bonn-Gatchina PWA

Example for the fit quality

(and data consistency – many different data sets)



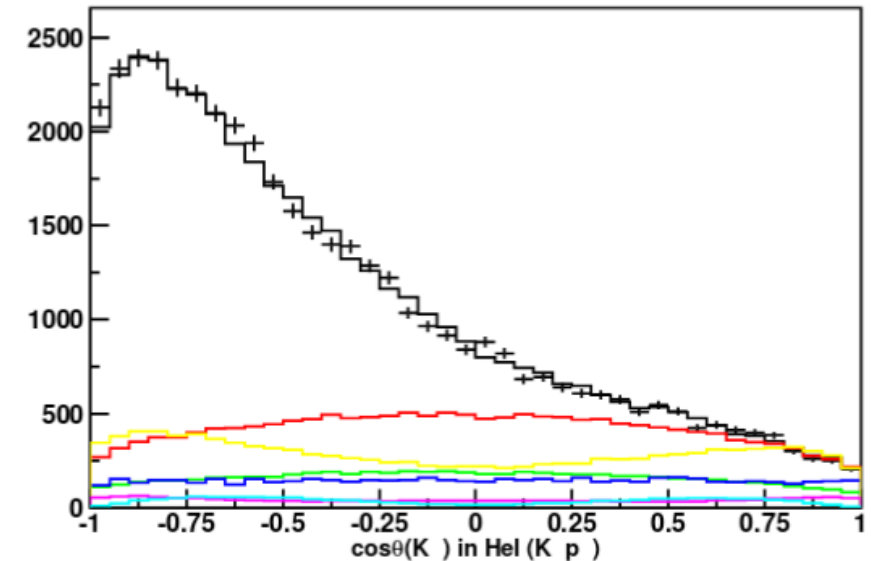
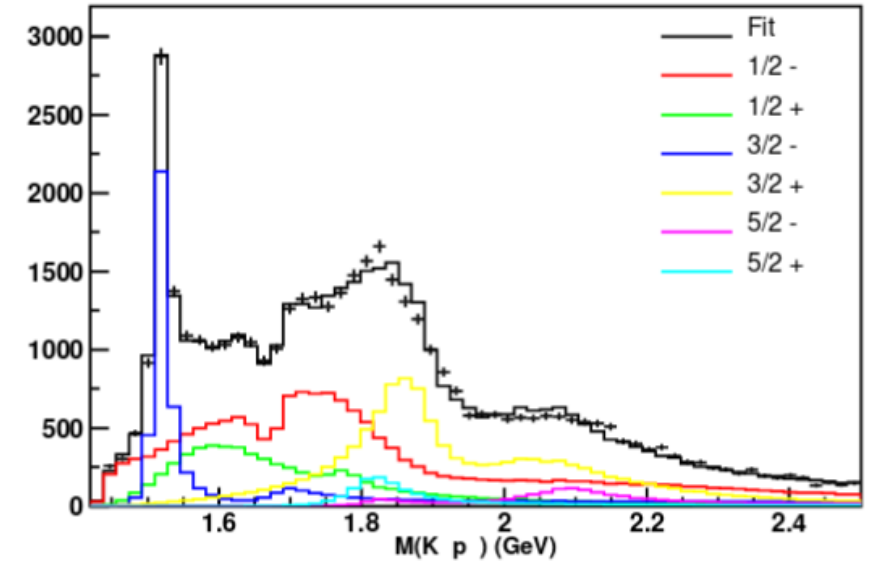
KN – scattering data → Λ^* - states → used for fit to LHCb-data

Results:

Sarantsev et al., “Hyperon II: Properties of excited hyperons”,
Eur.Phys.J.A 55 (2019) 10, 180

Resonance	Pole position (Re, 2 · Im)
$\Lambda(1405)1/2^-$	(1432±10, 42±7)
$\Lambda(1670)1/2^-$	(1676±2, 33±4)
$\Lambda(1800)1/2^-$	(1809±9, 205±16)
$\Lambda(1600)1/2^+$	(1562±8, 232±15)
$\Lambda(1810)1/2^+$	(1773±7, 38±14)
$\Lambda(1890)3/2^+$	(1872±5, 101±10)
$\Lambda(2070)3/2^+$	(2044±20, 360±45)
$\Lambda(1520)3/2^-$	(1517.5±0.4, 15.3±0.9)
$\Lambda(1690)3/2^-$	(1683±3, 72±5)
$\Lambda(1830)5/2^-$	(1819.5±3, 62±5)
$\Lambda(2080)5/2^-$	(2070±15, 172±28)
$\Lambda(1820)5/2^+$	(1813±3, 78±7)
$\Lambda(2110)5/2^+$	(2048±10, 255±20)
$\Lambda(2100)7/2^-$	(2040±14, 215±29)

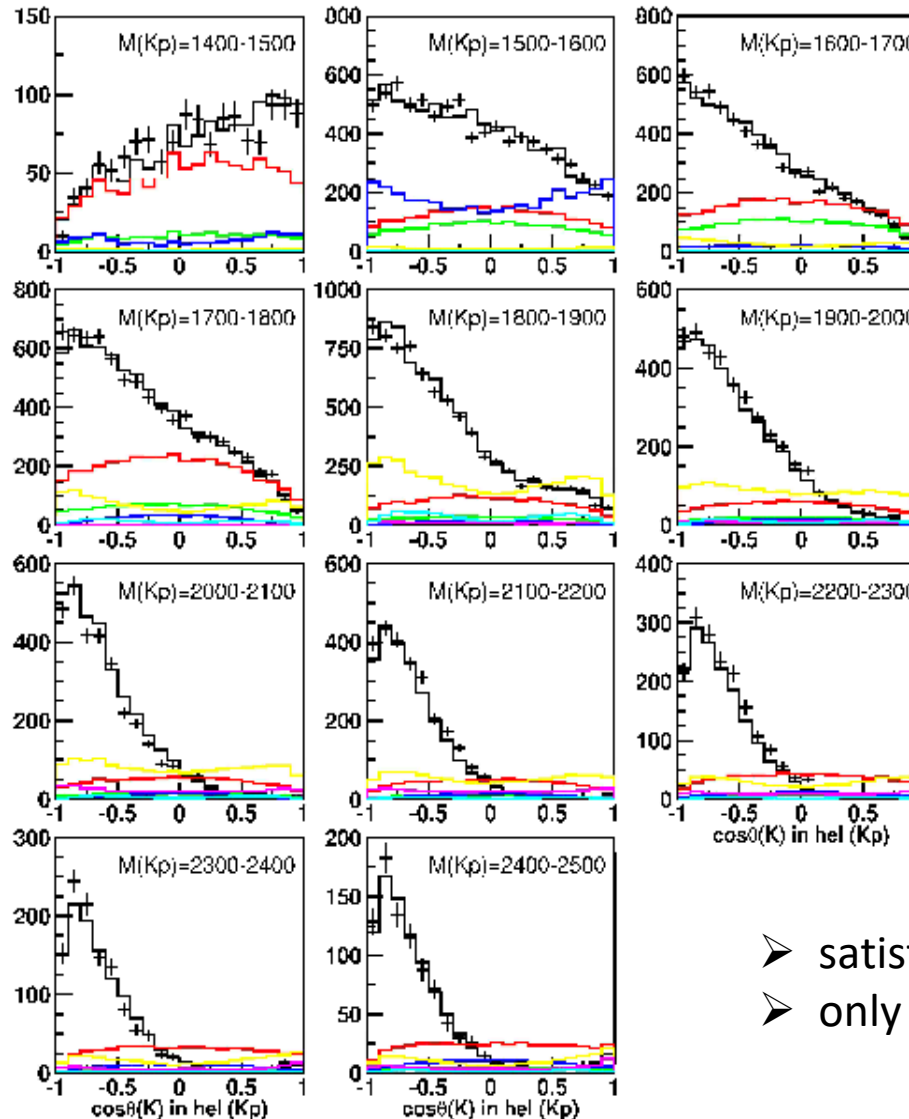
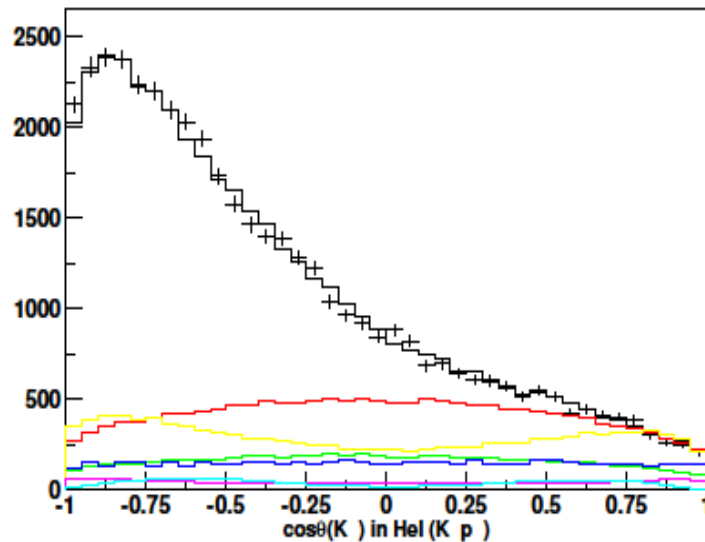
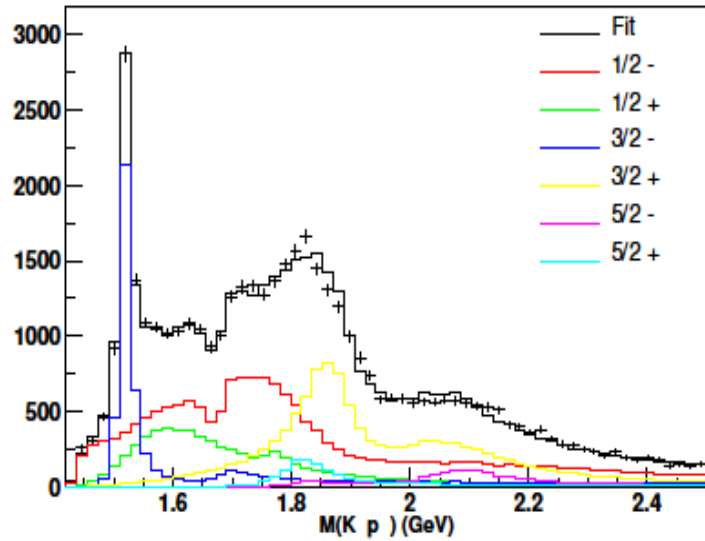
used



=> good description of the LHCb-data reached

KN – scattering data \rightarrow Λ^* - states \rightarrow used for fit to LHCb-data

Partial wave analysis of the $\Lambda_b \rightarrow \gamma K p$ data with **fixed** K-matrix parameters



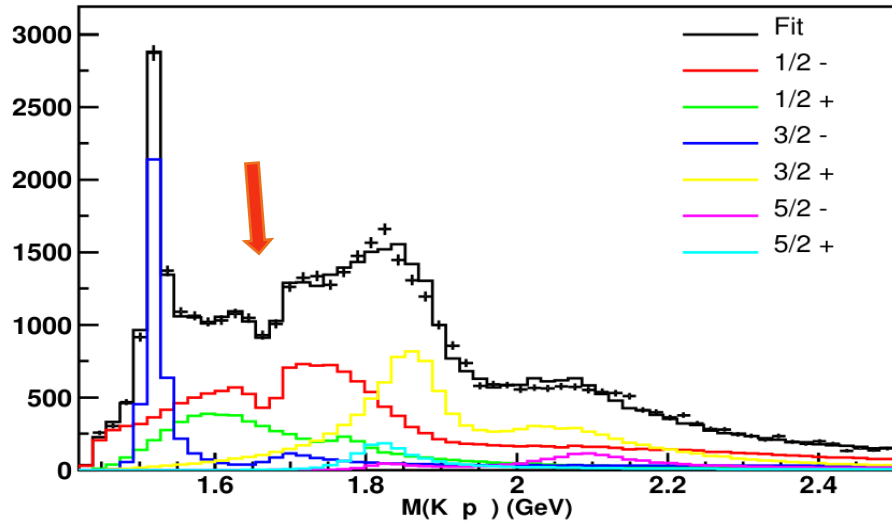
-log L=-25933

- satisfactory description
- only minor deviations

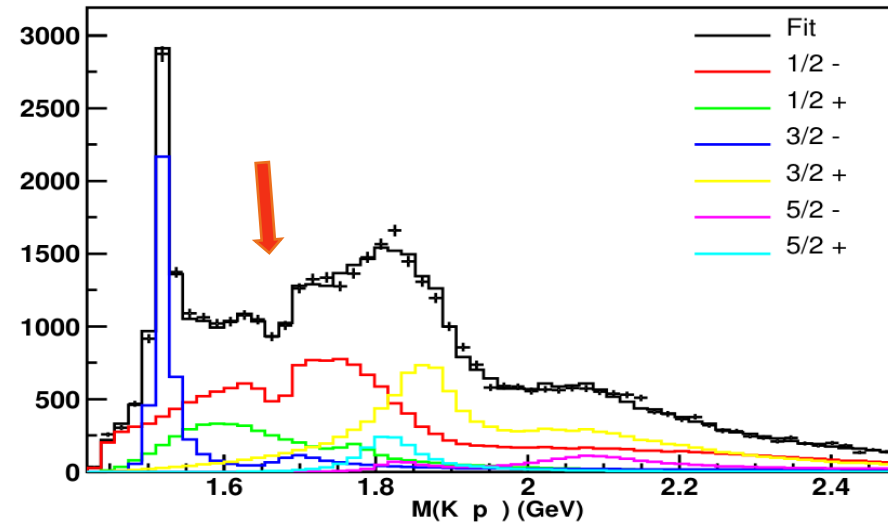
KN – scattering data \rightarrow Λ^* - states \rightarrow used for fit to LHCb-data

Combined fit of the data:

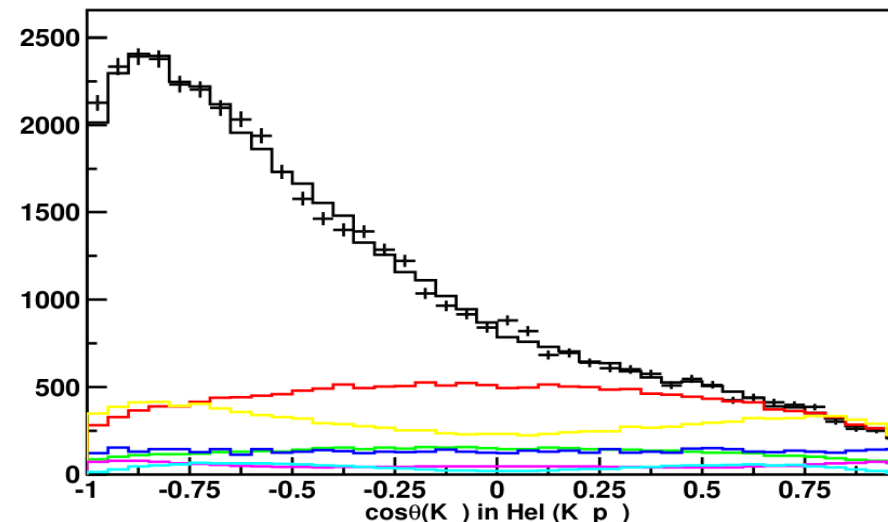
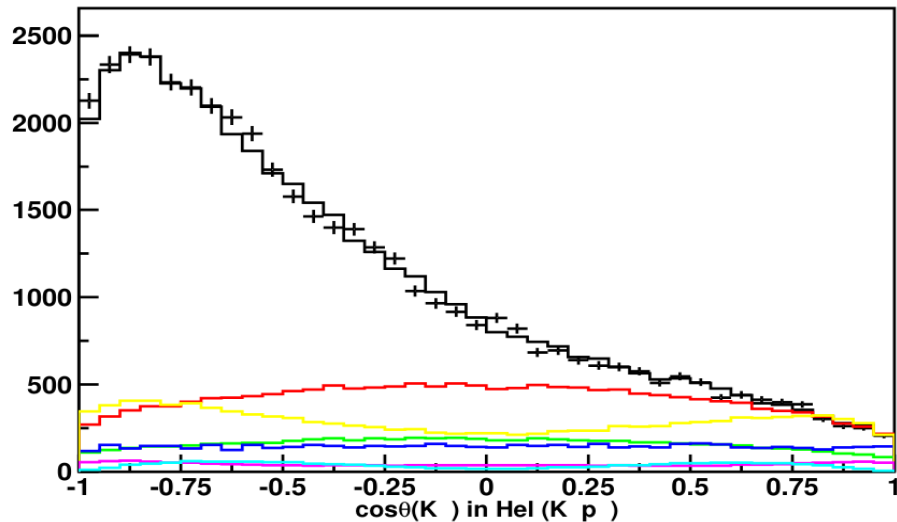
$-\log L = -25933$



$-\log L = -26029$



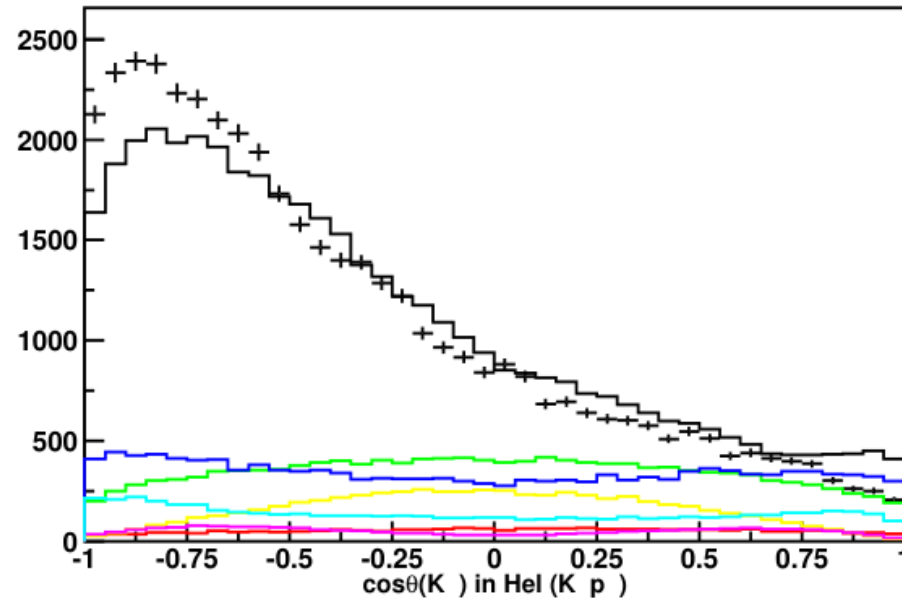
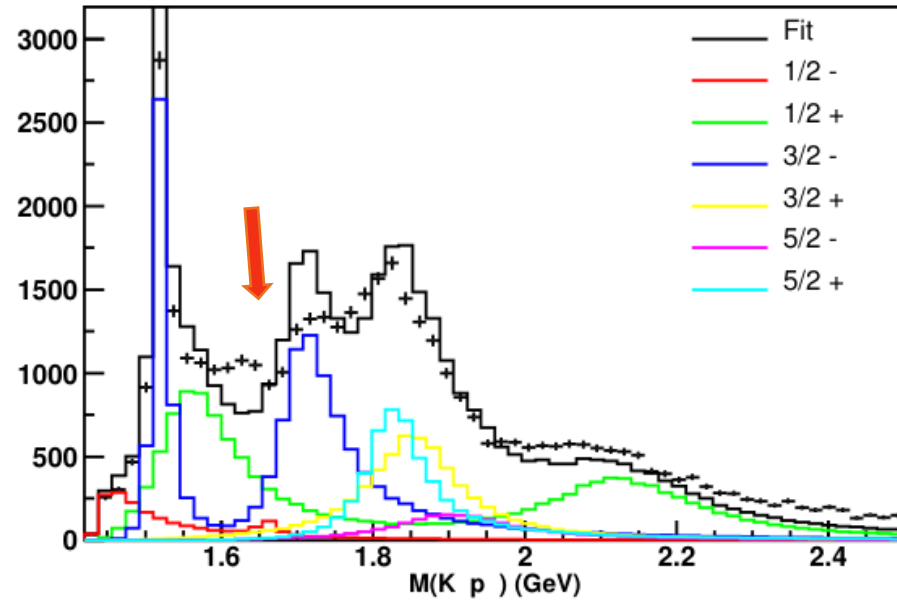
Quite interesting
interference
pattern in $\frac{1}{2}^-$ -wave:
 $\Lambda(1670)$, $\Lambda(1800)$



KN – scattering data $\rightarrow \Lambda^*$ - states -- Results from different PWA-groups

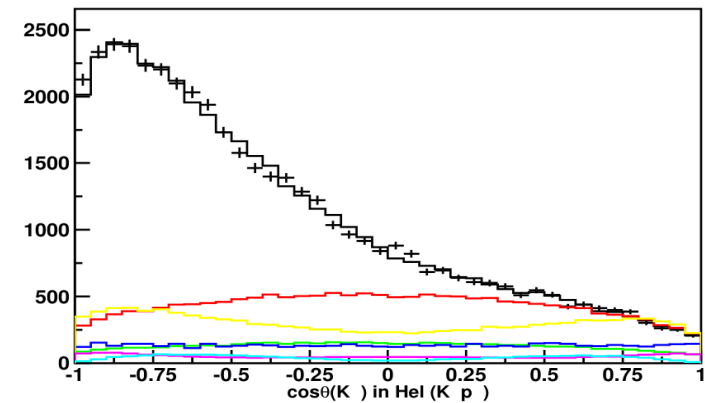
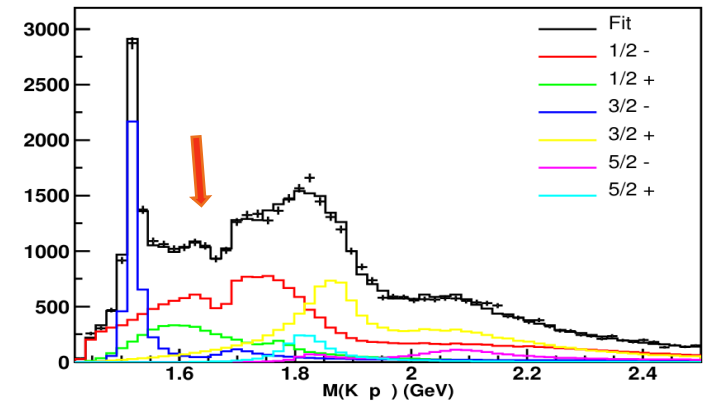
Fit with
ANL-Osaka-A states:

log L= -22432



BnGa

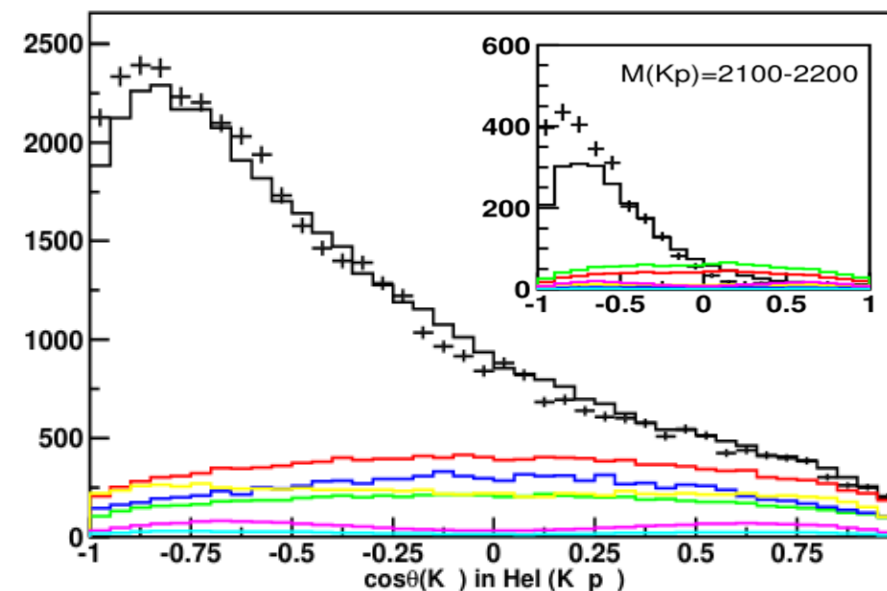
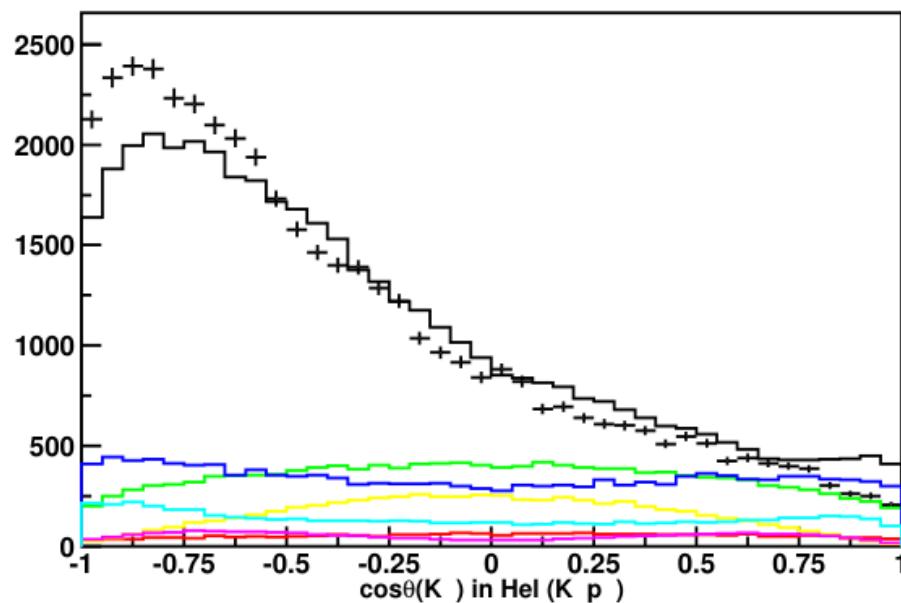
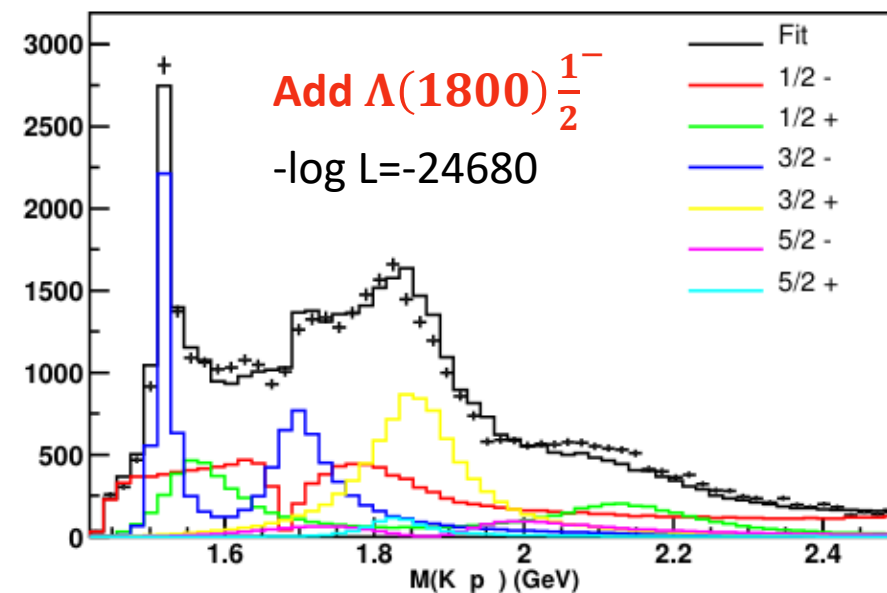
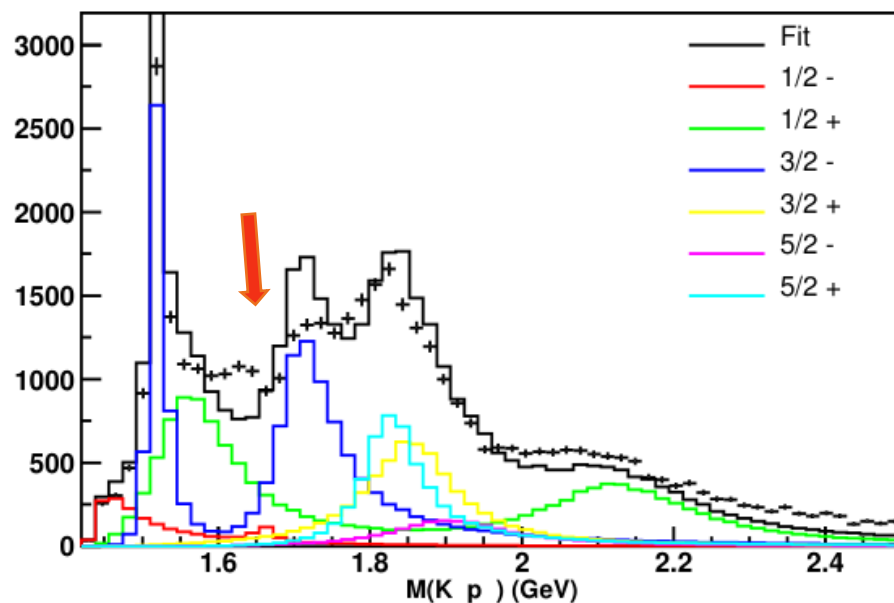
-log L=-26029



KN – scattering data $\rightarrow \Lambda^*$ - states -- Results from different PWA-groups

Fit with
ANL-Osaka-A states:

$\log L = -22432$



- LHCb-data nicely compatible with the Bonn-Gatchina solution but not with ANL-Osaka
- Interesting structure in the LHCb data: **Destructive interference of $\Lambda(1670)1/2^-$ and $\Lambda(1800)1/2^-$!**
Successful data description not possible in the absence of $\Lambda(1800)1/2^-$.
- $\Lambda(2070)3/2^+$ needed to describe the data in the region of 2100 MeV.

Along those lines: **Cross functional research team:**

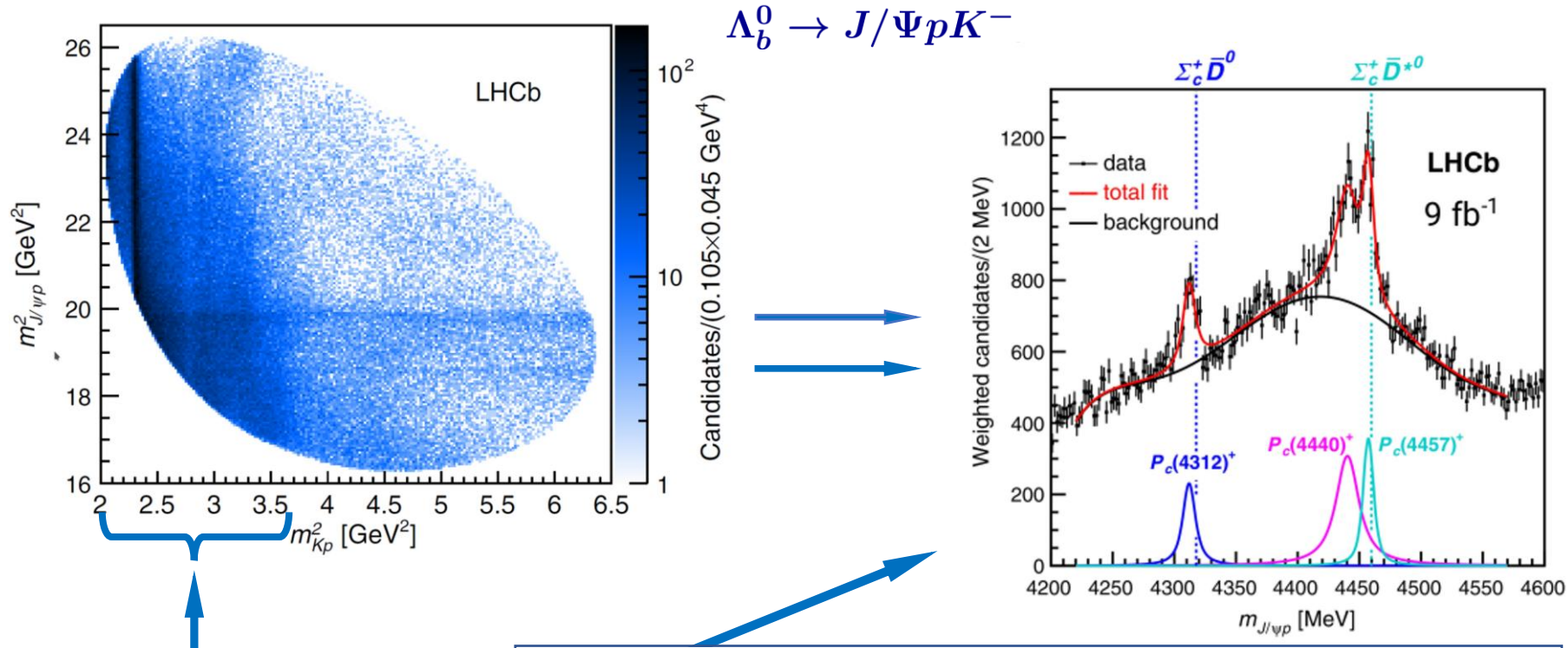
**Johannes, Sebastian, Ulrike + Andrey, Deborah + ... + further support from theory
Christoph, Bastian...**

+ flavor theory

⇔ 3 quick examples

Λ^* - states in the LHCb – data \rightarrow pentaquark properties

- Spectrum and properties of Λ^* , Σ^* \Leftrightarrow not even all states of the first excitation band known



Contribution of strange baryon resonances

= badly known

... interferences ...

For determination of pentaquark properties:

\Leftrightarrow Strange baryon resonances and their properties needed!

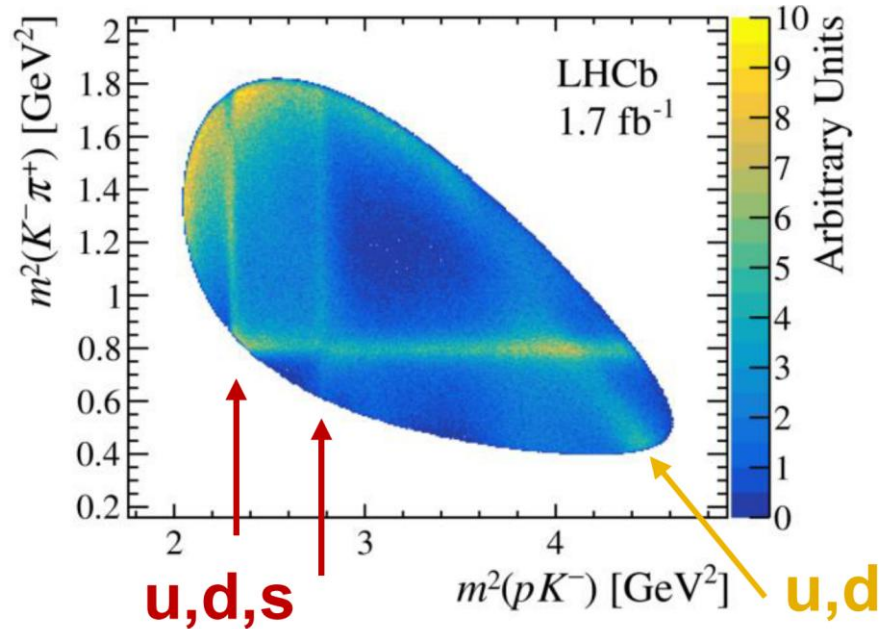
\Leftrightarrow ELSA!

Polarisation experiments to avoid ambiguities !

\Leftrightarrow Common analysis of ELSA- and LHCb-data

To understand the LHCb – data ↔ Better understanding of the **strange-** and **non-strange** baryons needed!

$\Lambda_c \rightarrow p K^- \pi^+$



	RPP 2010	BnGa- PWA	RPP'25 (2018-25)
N(1710)1/2 ⁺	***	*****	*****
N(1860)5/2⁺		*	**
N(1875)3/2⁻		***	***
N(1880)1/2⁺		***	***
N(1895)1/2⁻		*****	*****
N(1900)3/2⁺	**	*****	*****
N(2060)5/2⁻		***	***
N(2100)1/2 ⁺	*	***	***
N(2120)3/2⁻		***	***
$\Delta(1600)3/2+$	***	***	*****
$\Delta(1900)1/2-$	*	***	***
$\Delta(1940)3/2-$	*	**	**
$\Delta(2200)7/2-$	*	***	***

New particles (resonances) found

↔ new high precision photoproduction data

↔ Bonn-Gatchina PWA

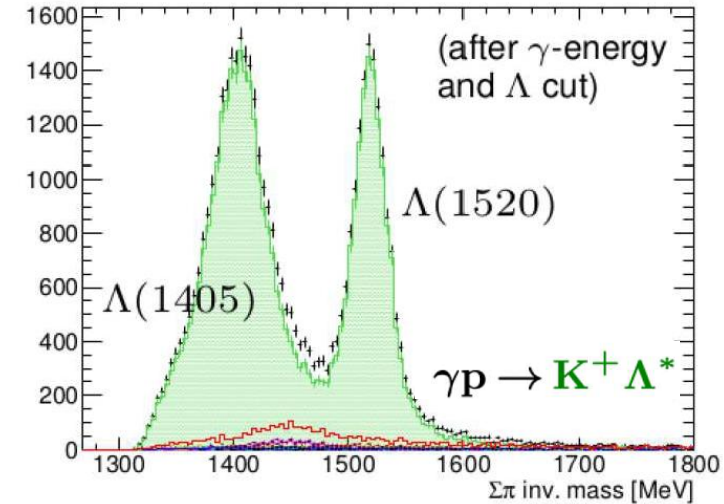
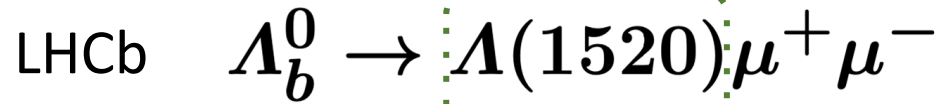
Further states?

Photoprod. off the neutron !

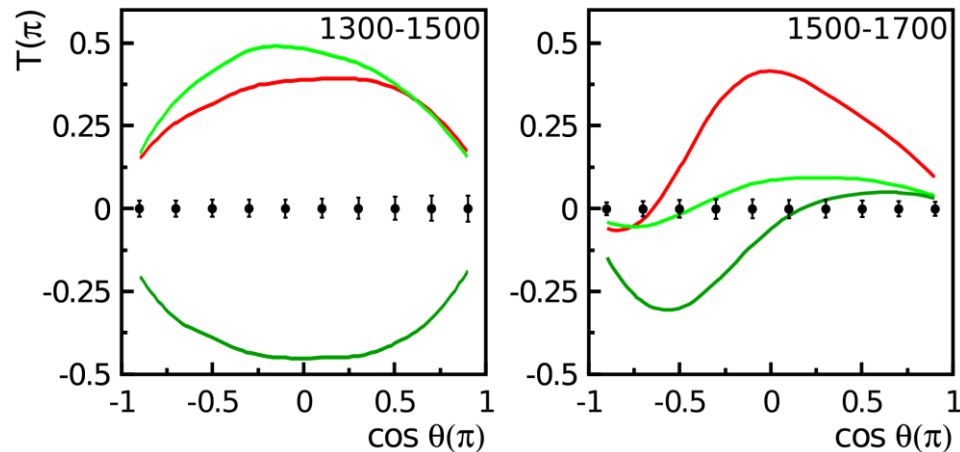
only examples shown

+ JüBo-solution as alternative option

Example: Rare baryon decay \rightarrow search for new phenomena



Polarization measurements \rightarrow unambiguous partial wave analysis



\Rightarrow High sensitivity

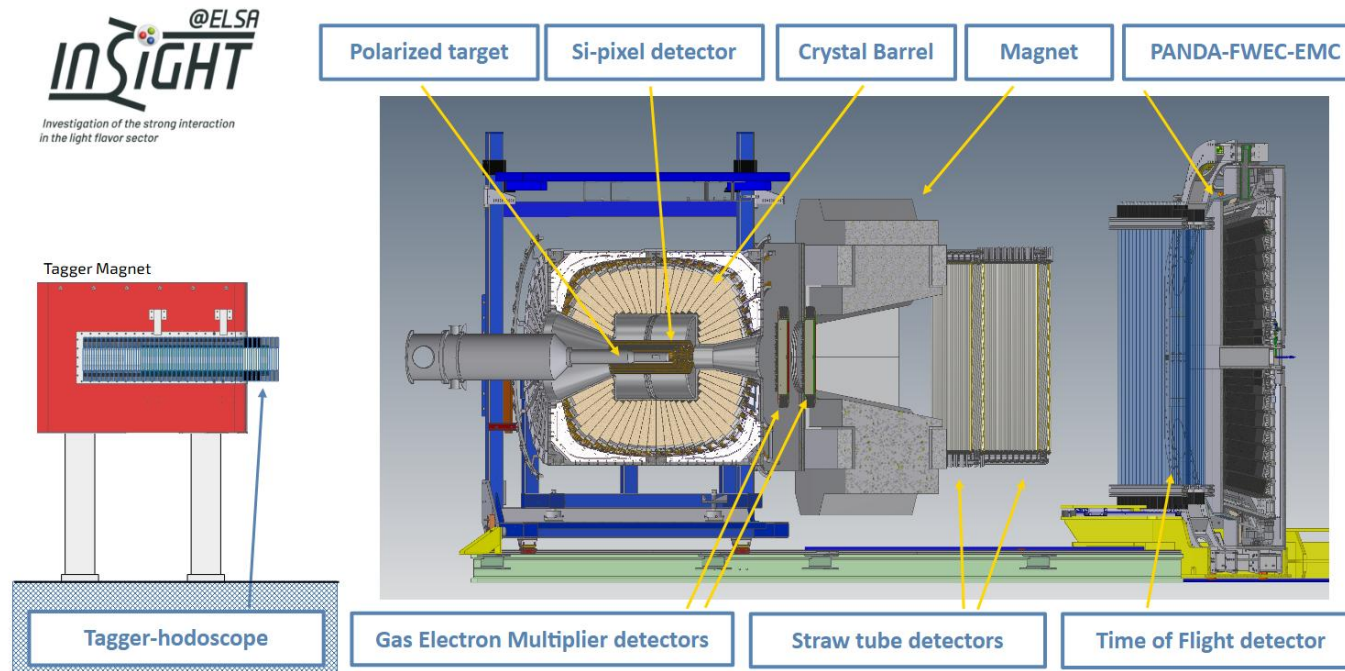
Along those lines: Cross functional research team:

Johannes, Sebastian, Ulrike + Andrey, Deborah + + further support from theory

Christoph, Bastian...

+ flavor theory + ...

+



RA1, TA1 \leftrightarrow RA2