

## 1. Motivation

The scattering parameters of D mesons with light hadrons were never measured, however they are important for:

- searches of exotic charm states<sup>[1]</sup>  
Are there multi-quark or molecular states of D mesons with light hadrons?
- lattice QCD calculations  
Benchmark the available predictions for the scattering parameters
- understanding the B meson decay<sup>[2]</sup>  
Current measurements are incompatible with the standard model
- D mesons in heavy-ion collisions<sup>[3]</sup>  
Study the influence of the hadronic phase in the production of charm hadrons in heavy-ion collisions

## 3. Selection of D<sup>±</sup> mesons

Reconstructed via the D<sup>±</sup> → K<sup>-</sup>π<sup>+</sup>π<sup>+</sup> decay + c.c.  
Different origins for D<sup>±</sup> mesons:

- prompt  
From the hadronisation of the charm quark or decay of excited charm states
- non-prompt  
From beauty hadron decay
- combinatorial background  
From the combination of uncorrelated pion and kaon tracks

Selection based on the decay-vertex topology, employing a machine-learning multi-class classification algorithm

## 2. Femtoscopy method

The interaction between the particles results in momentum correlations → correlation function (CF)

$$C(k^*) = \underbrace{\xi(k^*)}_{\text{experiment}} \frac{N_{\text{same}}(k^*)}{N_{\text{mixed}}(k^*)} = \underbrace{\int d^3r^* S(r^*) |\psi(k^*, r^*)|^2}_{\text{theory}}$$

source wave function

$r^* \sim 0.8 \text{ fm}^{[4]}$

CFs of D<sup>±</sup> mesons with light hadrons:  
high-multiplicity proton-proton collisions at  $\sqrt{s} = 13 \text{ TeV}$

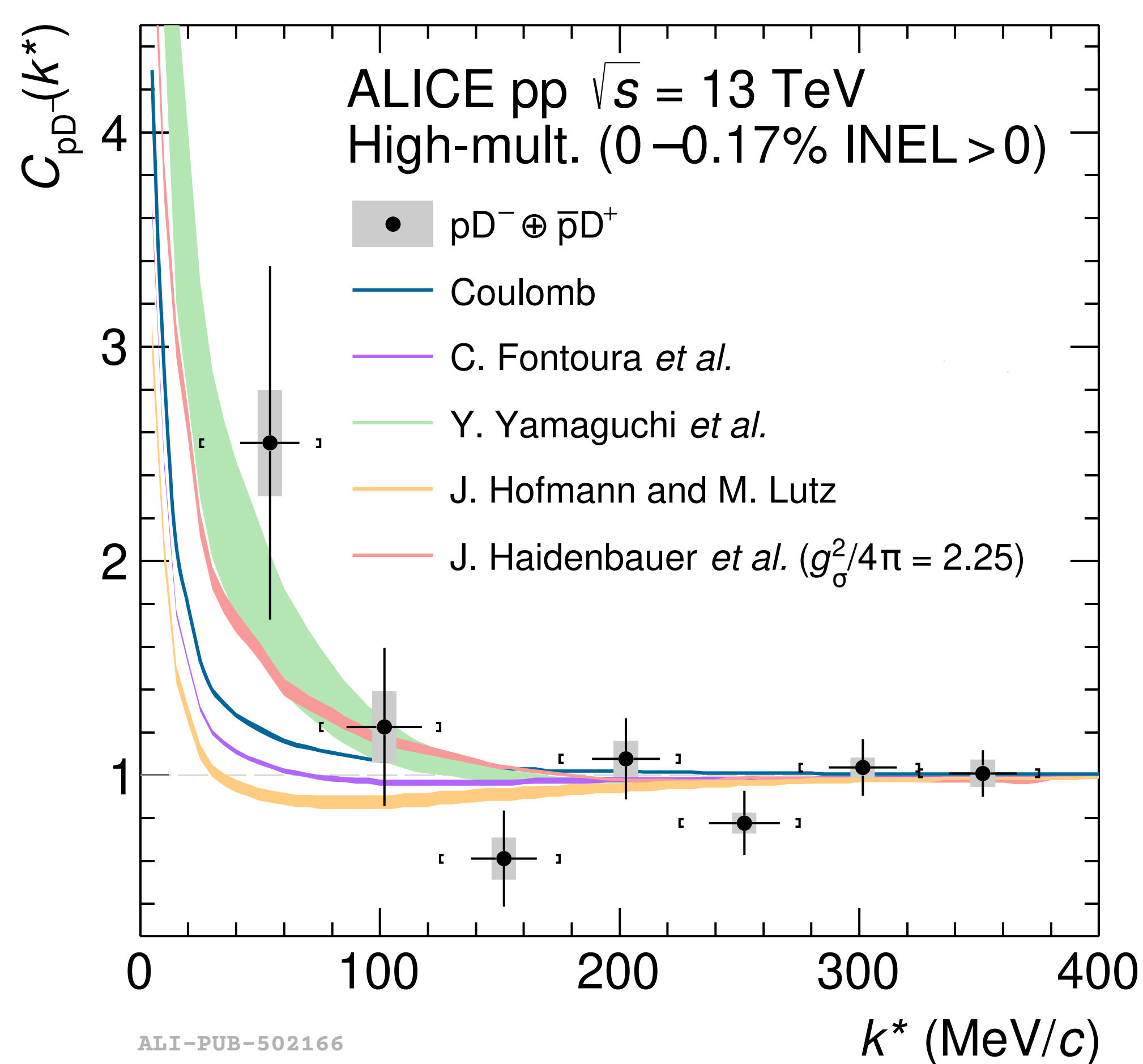
## 4. Background corrections

CF corrected for several sources of background:

- jet-like correlations
- weak decays
- combinatorial background
- strong decays

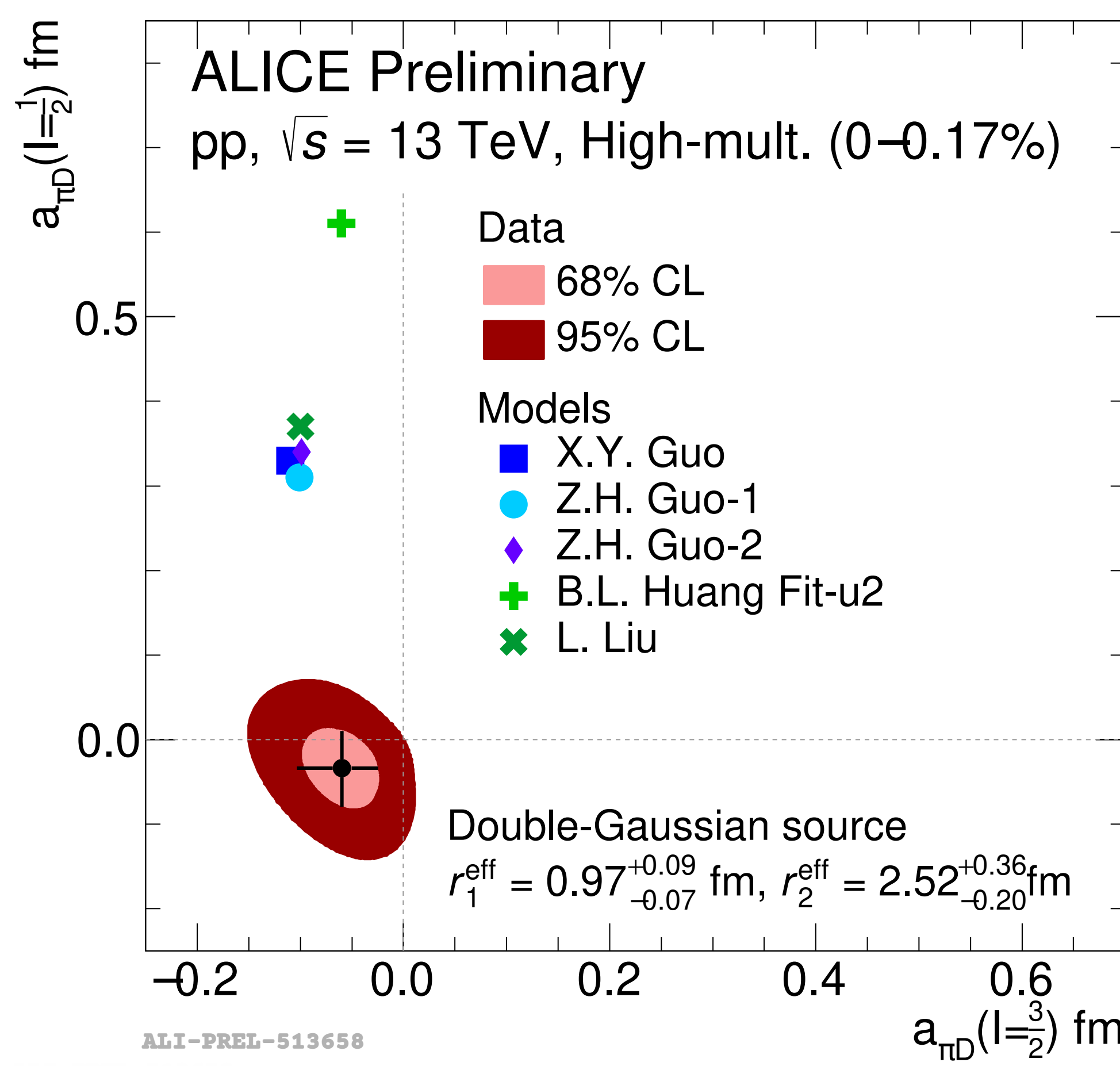
## 5. D<sup>-</sup>-proton, D-pion and D-kaon interactions

### D<sup>-</sup>-proton



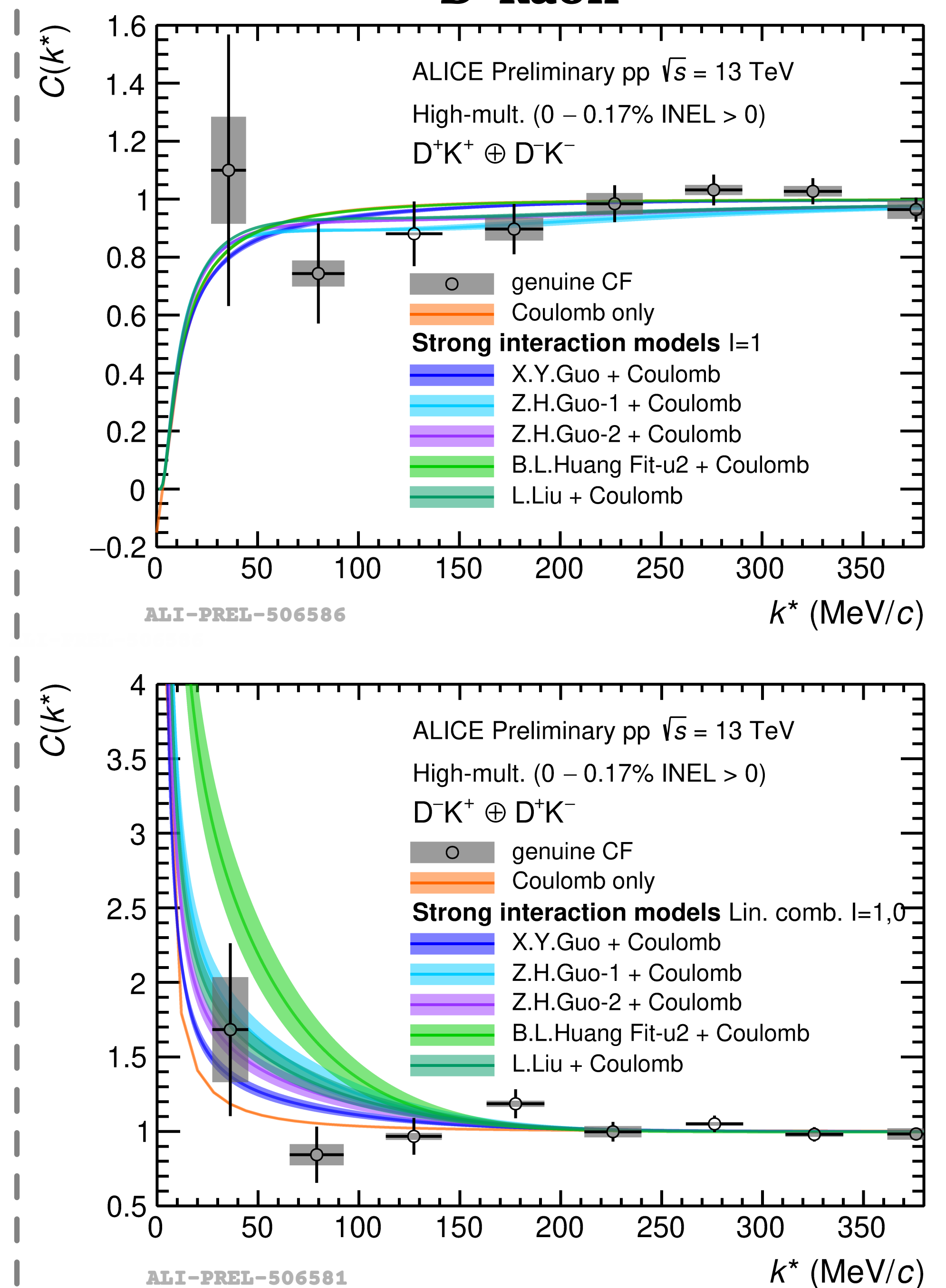
- CF compatible with Coulomb only<sup>[5]</sup>
- scattering parameters determined with the Lednický-Lyuboshitz<sup>[6]</sup> (LL) model  
 $f_{0,I=0}^{-1} \in [-0.4, 0.9] \text{ fm}^{-1}$
- compatible with attractive interaction and  $N\bar{D}$  bound state

### D-pion



- very shallow interaction
- scattering parameters → LL model, via simultaneous fit of the two charge states  
 $a_{\pi D}^{I=3/2} = -0.06 \pm 0.03(\text{stat}) \pm 0.02(\text{syst})_{-0.03}^{+0.01}(\text{source syst}) \text{ fm}$   
 $a_{\pi D}^{I=1/2} = -0.03 \pm 0.04(\text{stat}) \pm 0.02(\text{syst})_{-0.01}^{+0.01}(\text{source syst}) \text{ fm}$
- comparison with theory:  
mixed isospin: strong deviation  
pure isospin: agreement

### D-kaon



- very shallow interaction
- CFs compatible with Coulomb only

## References

- [1] PRC 84 (2011) 064910 [3] PLB 701 (2011) 445–450 [5] arXiv:2201.05352  
[2] PRL 126 (2021) 192001 [4] PLB 811 (2020) 135849 [6] SJNP 35 (1982) 770

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