Novel $|V_{cb}|$ extraction via Lorentz-boosted *bc*-tagging at the LHC

(for poster presentation)

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- Expect to achieve ~10% level uncertainty on $|V_{cb}|$ based on Run 2+3, and ~5% uncertainty at HL-LHC

uncertainties via an *in-situ* calibration

2.A Boosted bc tagging

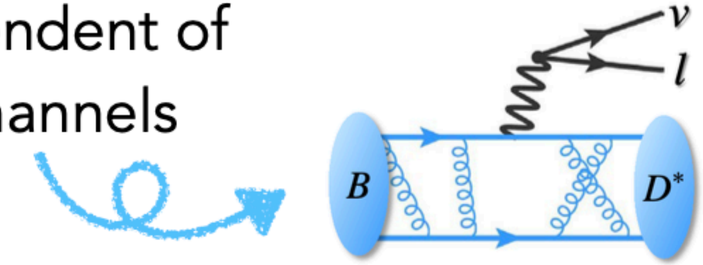
3. Results

$\frac{\Delta|V_{cb}|}{|V_{cb}|}$ vs Luminosity

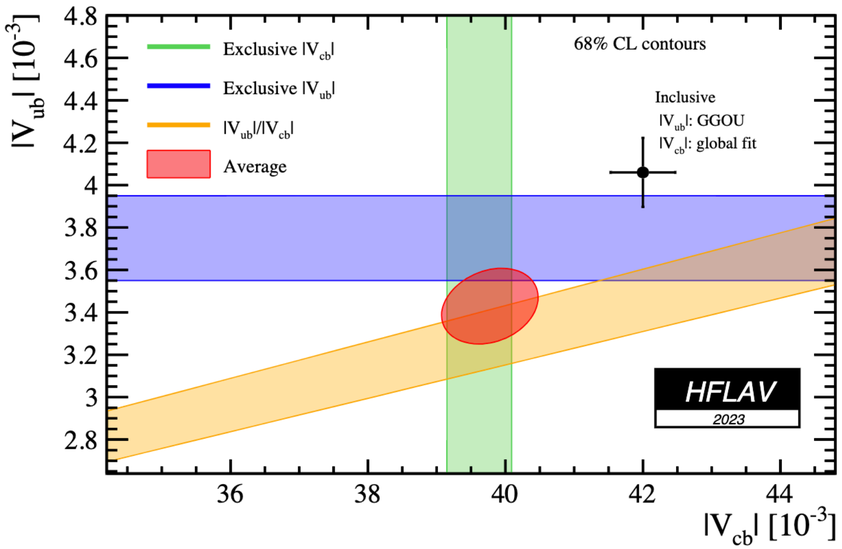
0.30

Introduction

- **The decay of $W \to cb$** offers a clean, complementary handle on $|V_{cb}|$, independent of traditional B-physics channels



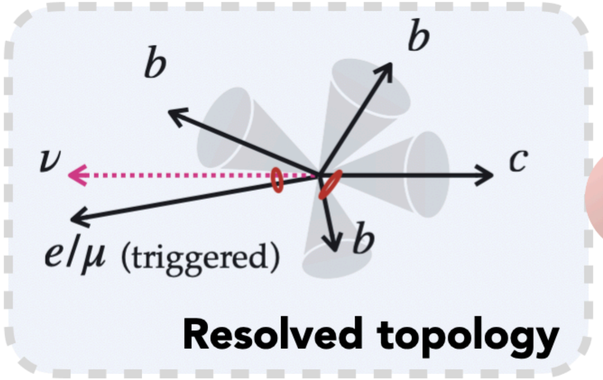
  - May help address the discrepancy between inclusive and exclusive $|V_{cb}|$ measurements



Our method

1. Method

- Conventional LHC method:
  measuring $W \to cb$ decay from $t\bar{t}$ semi-leptonic (1ℓ) phase space



Resolved topology

VS.

- **New method:**
  measuring highly Lorentz-boosted $W \to cb$ decay from $t\bar{t}$ (1ℓ)

Boosted topology

- **Benefits of boosted channel:**
  - ✓ Significant background veto powered by "boosted bc-tagging"
  - ✓ Better control of systematic uncertainties via an *in-situ* calibration

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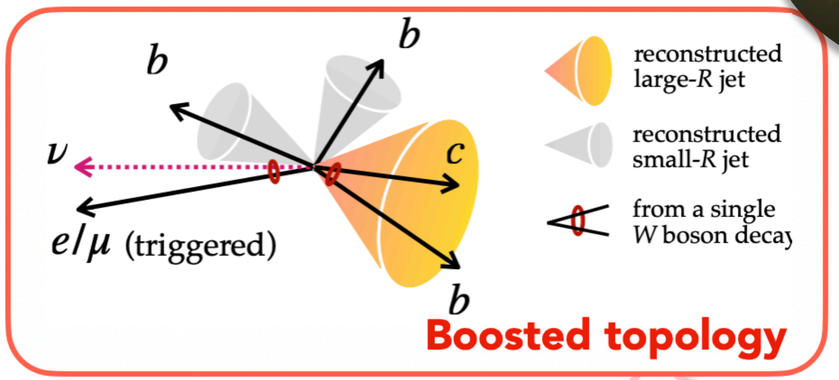
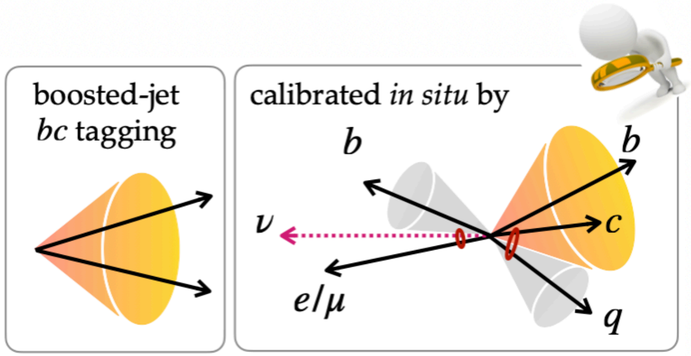


Boosted topology



- **Benefits of boosted channel:**
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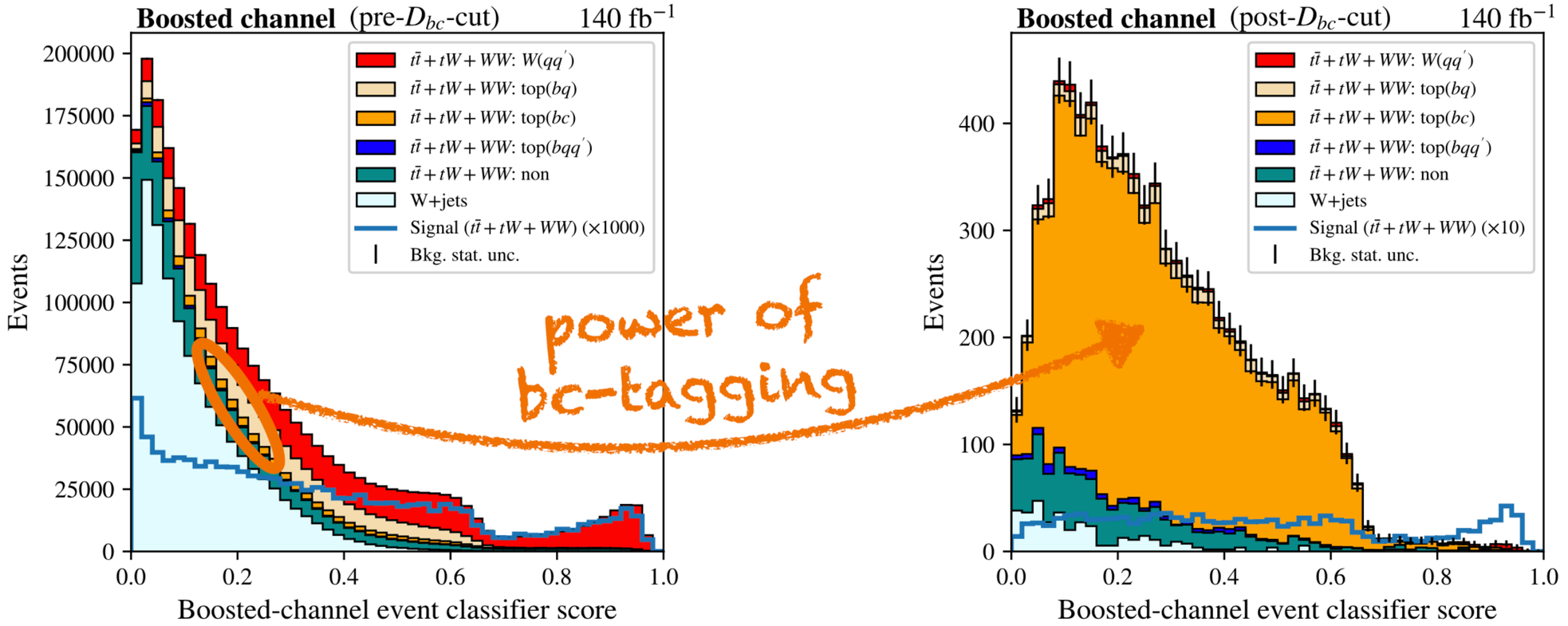
Boosted *bc*-tagging

2.A Boosted bc tagging



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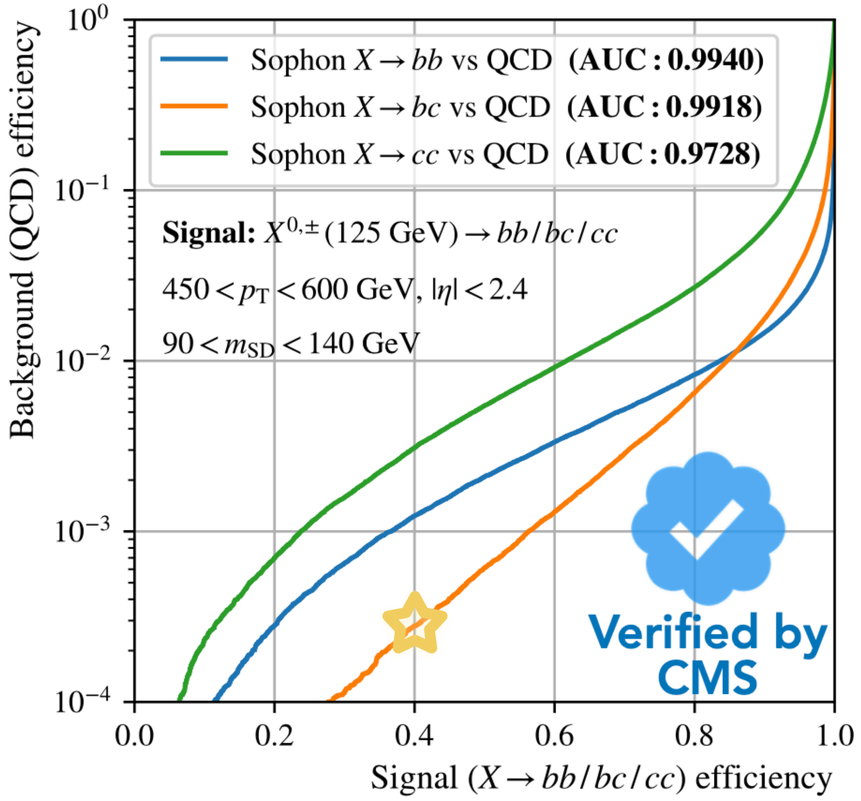
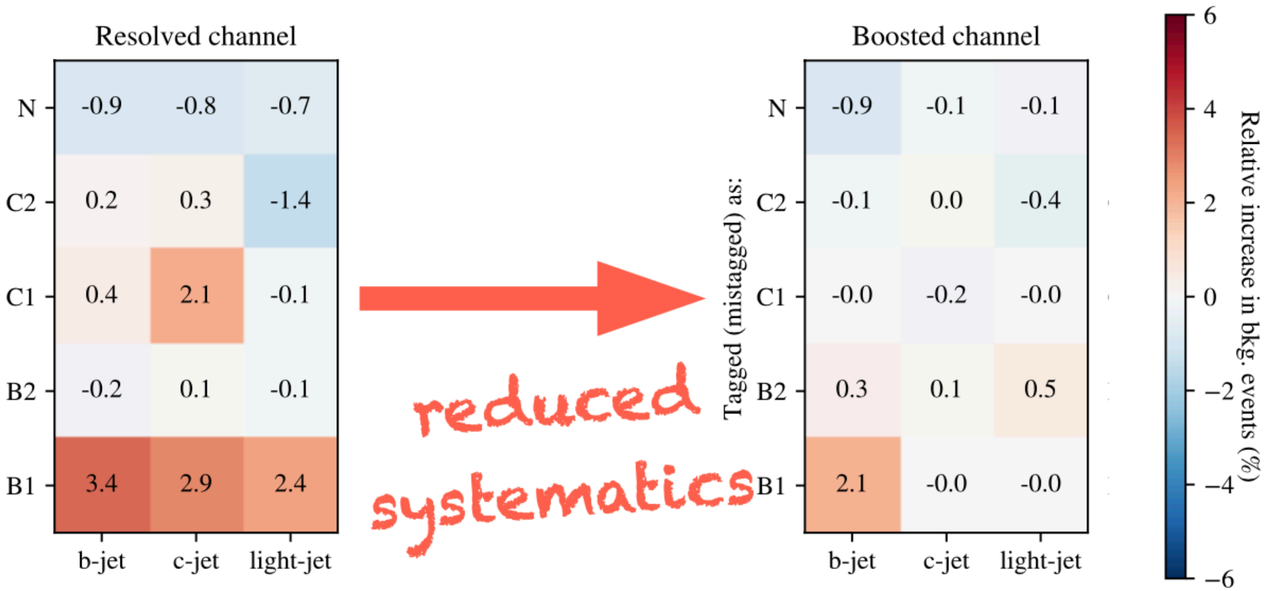


- **Superior background suppression power in the boosted regime!**
  - Retain **40% of signal** while **pushing QCD background to 0.02% level!**
  - Why so powerful? —thanks to the state-of-the-art DNN-based boosted-jet taggers in CMS/ATLAS
  - Already demonstrated in recent bb or cc-tagging analyses

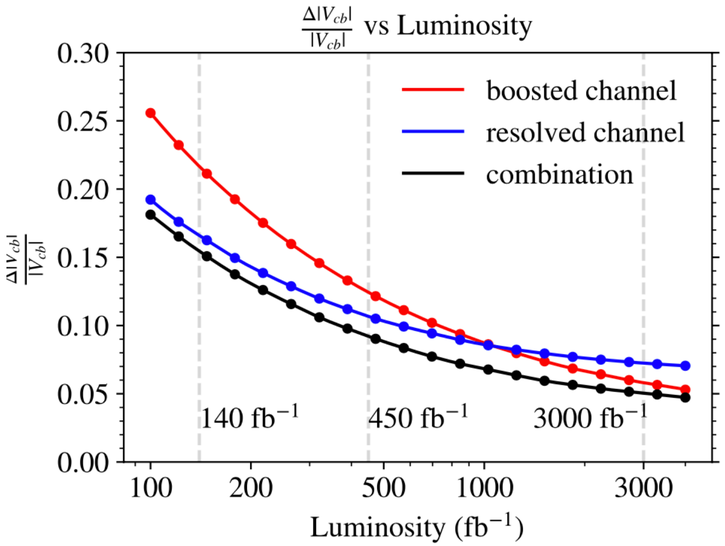
Boosted *bc*-tagging & uncertainties

2.B Flavour tagging uncertainties



- Improved flavour tagging uncertainties (traditionally the key challenge) thanks to *in-situ* calibration

Results



3. Results

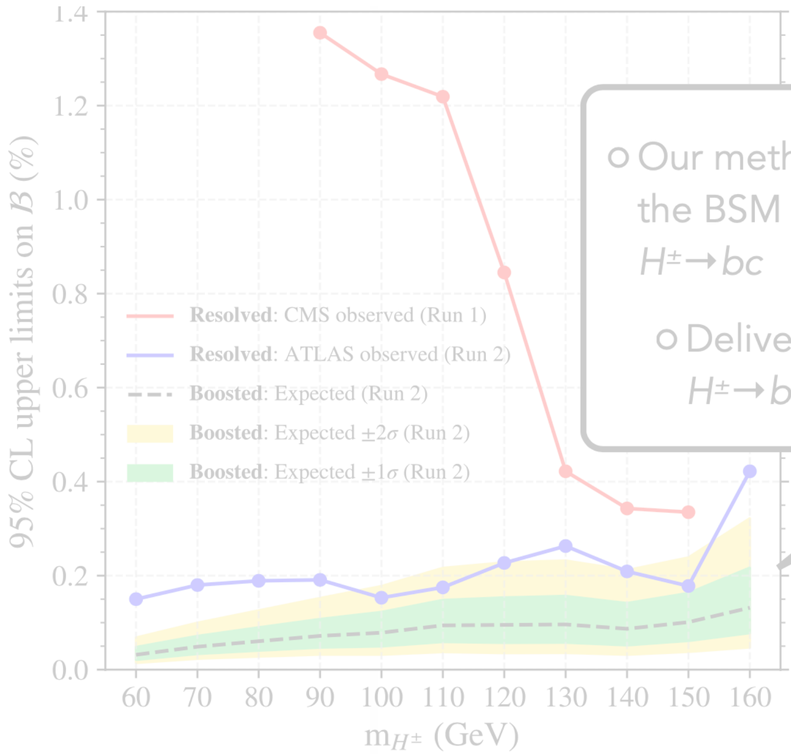
- Under Run-2 data, the conventional approach yields:

$\Delta|V_{cb}|/|V_{cb}| =$
0.065 (flavor tag. syst.)
$\oplus$ 0.154 (stat.)

cross-checked with ATLAS preliminary results

- HL-LHC (3 ab^{-1}) reaches 0.05 relative uncertainty on $|V_{cb}|$
  - ATLAS–CMS combination: **0.036 relative uncertainty**. Enable to offer critical insights to $|V_{cb}|$ puzzle

30% improved sensitivity!



- Our method also constrains the BSM charged Higgs decay $H^\pm \to bc$
  - Delivers the most stringent $H^\pm \to bc$ limit to date!

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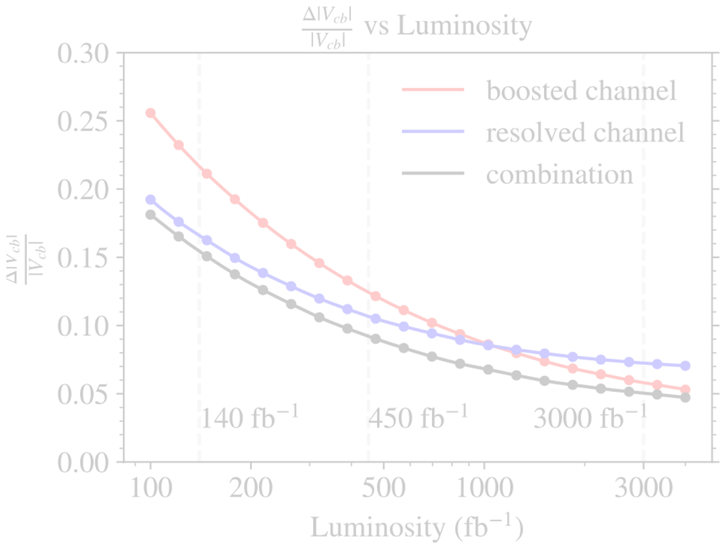

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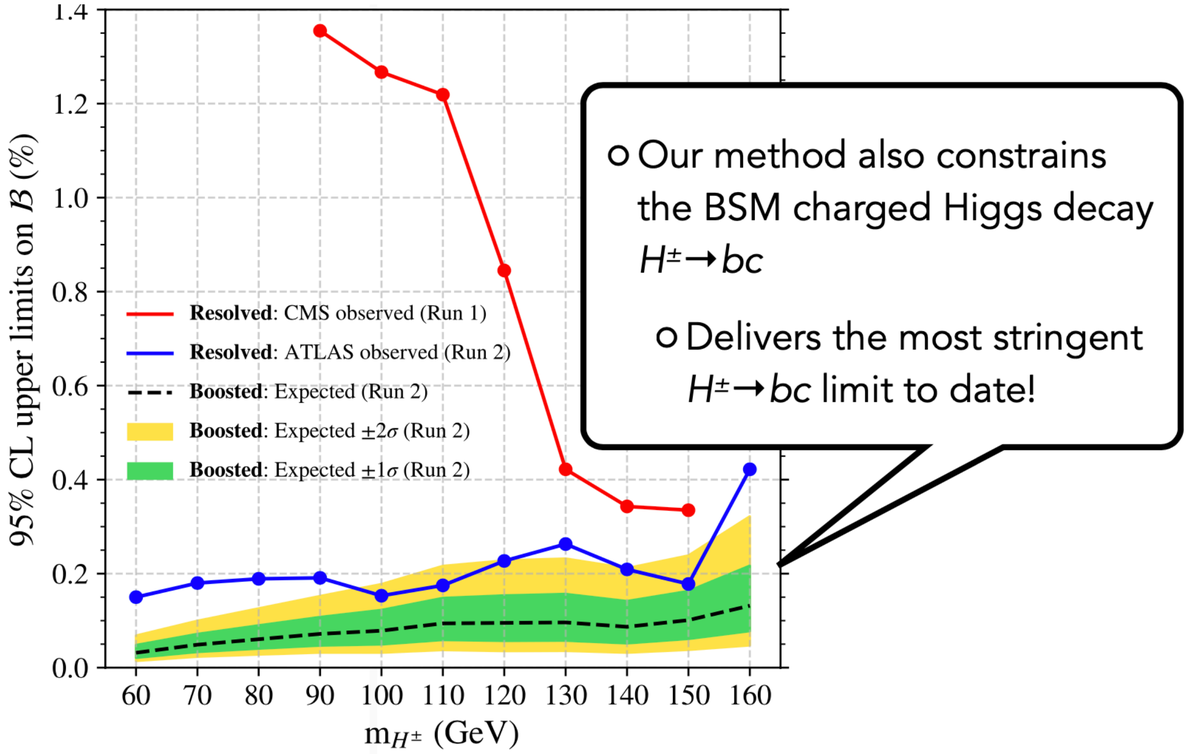

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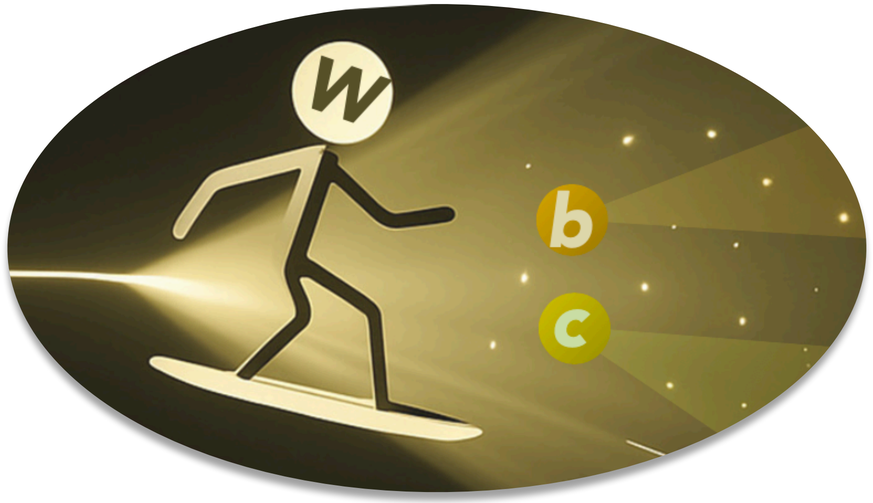

Thank you for your attention —see you at the poster session!