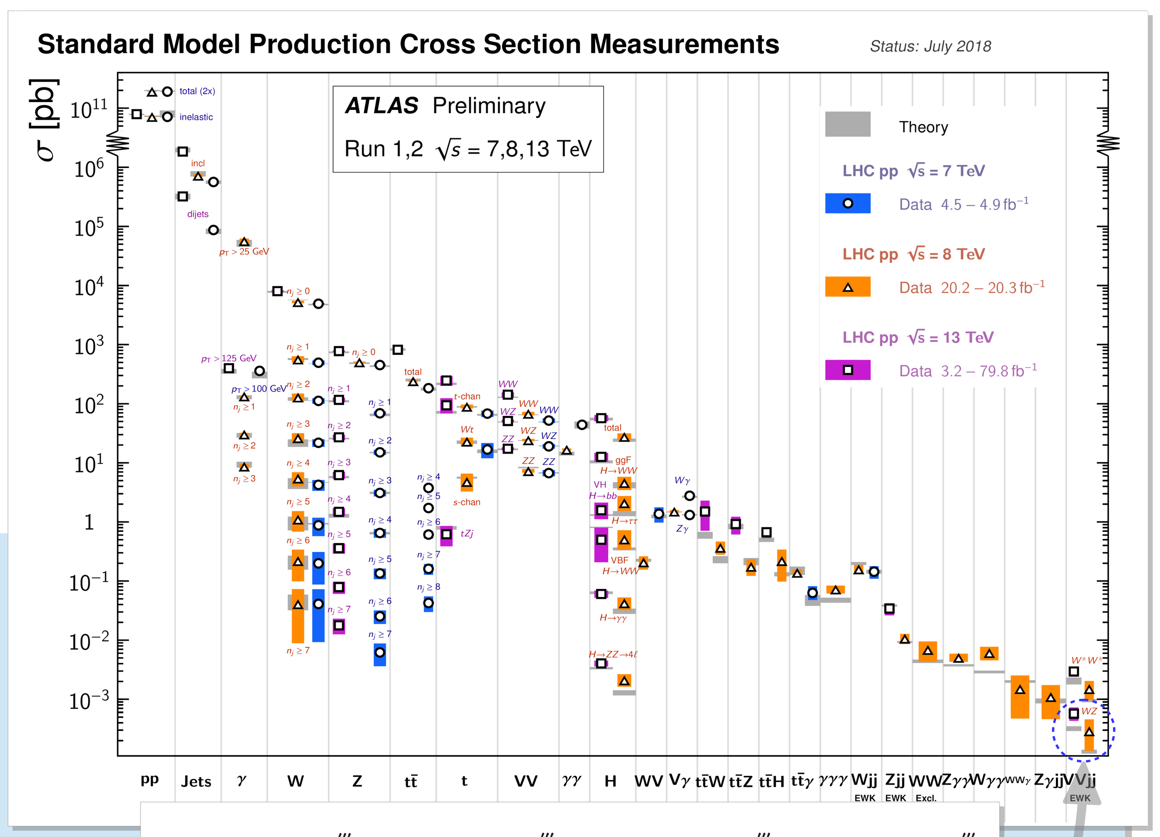
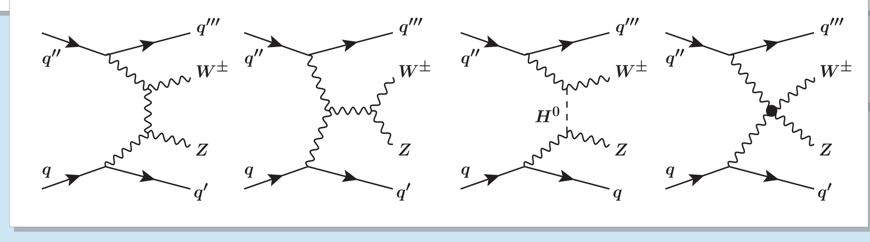
LHCC Poster Session – CERN, 27 February 2019

Observation of electroweak $W^{\pm}Zjj$ production at $\sqrt{s}$ = 13 TeV with the ATLAS detector

Paper content

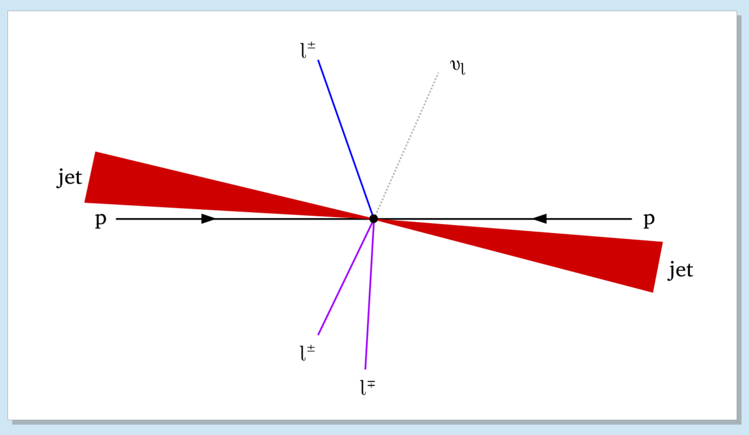
- Study of the WZjj-EW production in the **fully-leptonic** (e,μ) boson decay channels using 36.1 fb^{-1} of data recorded in 2015-2016 with the ATLAS detector
- **Cross-sections** are measured in a signal-rich phase-space for **WZjj-EW and WZjj**
- **Unfolded differential cross-section** are also derived for **WZjj**

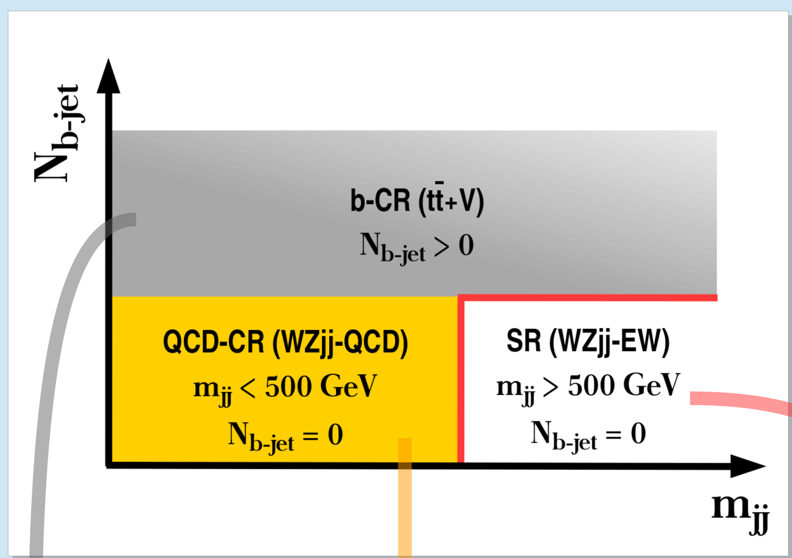


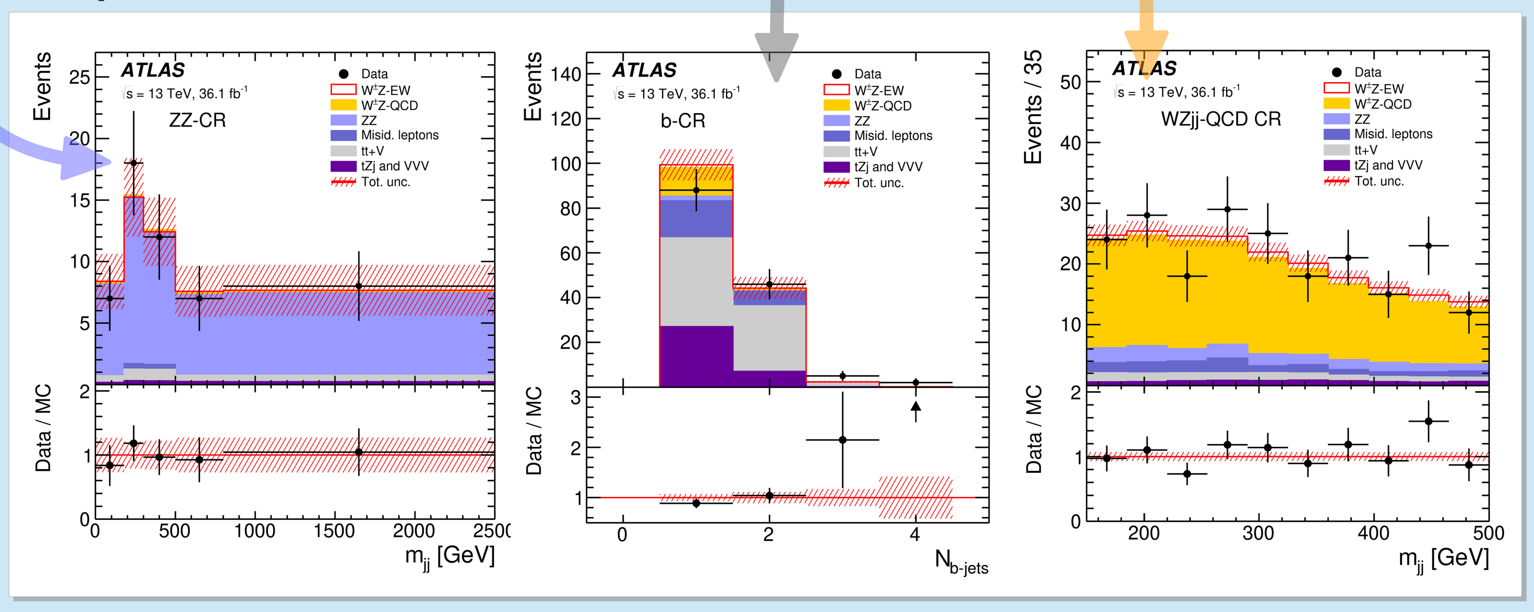


Event selection

- **Leptons** (exactly 3):
  - $|\eta| < 2.5$
  - $p_T^{\ell,Z} > 15$ GeV, $p_T^{\ell,W} > 20$ GeV
  - $|M_Z - M_Z^{PDG}| < 10$ GeV
  - $m_T^W > 30$ GeV
- **Jets** (at least 2):
  - $|\eta| < 4.5$, $\eta_{j1}\eta_{j2} < 0$
  - $p_T^{j1/j2} > 40$ GeV
  - $m_{jj} > 150$ GeV
- The selection is split in **3 regions**
- An **additional CR** is defined for the **ZZ-QCD background** by **requiring 4 leptons instead of 3**

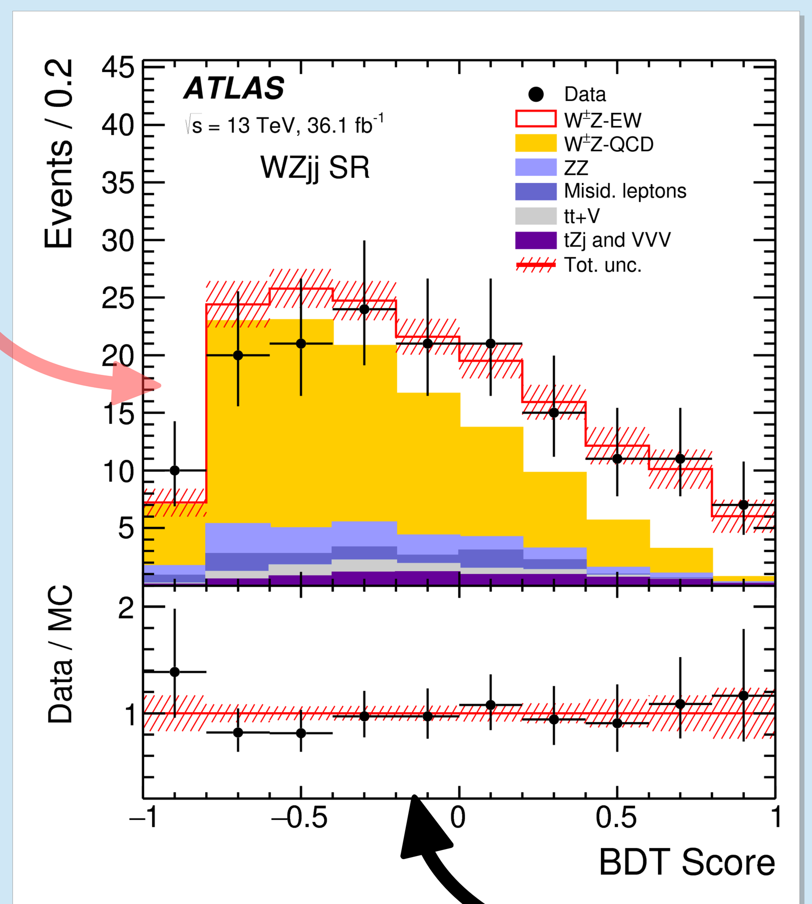


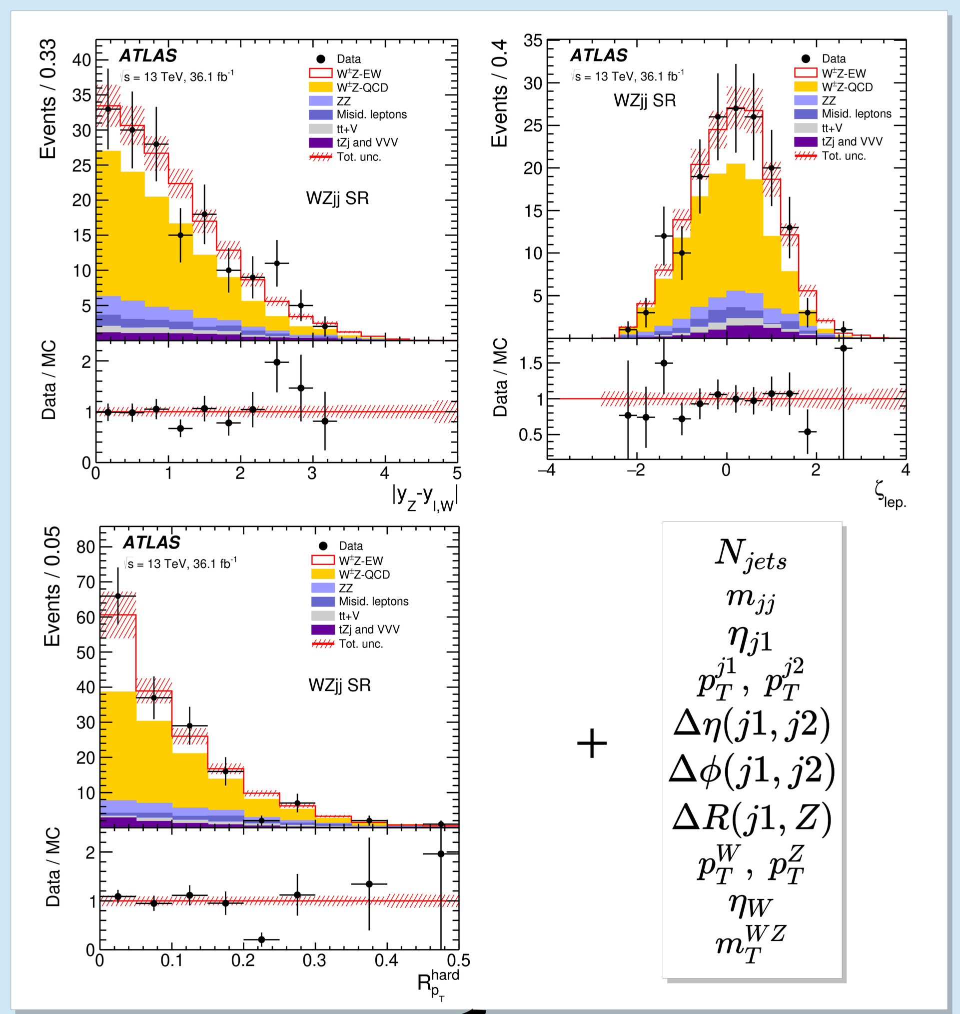




Multivariate approach

- A **BDT** is trained in the signal region
- It uses **15 variables selected for their discrimination potential,** mostly between the **main background (WZjj-QCD)** and the WZjj-EW signal.
- It is trained on Monte Carlo to separate **WZjj-EW signal** from **all backgrounds**
- The input variables Data/MC agreement has been extensively checked throughout the analysis
- The trained BDT allows an **excellent signal purity in the high BDT score region**



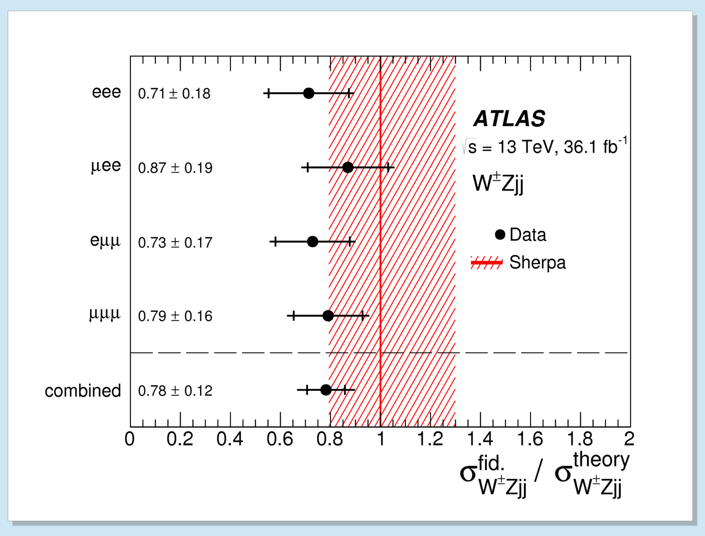


WZjj cross-section

- The WZjj (EW + QCD) fiducial cross-section is computed, for **each decay channels**, as:

$$\sigma^{fid}_{WZjj} = \frac{N_{data} - N_{bkg}}{\mathcal{L}.C_{WZjj}} \times \left(1 - \frac{N_\tau}{N_{all}}\right)$$

- A **good agreement** is observed with the prediction from **Sherpa**.

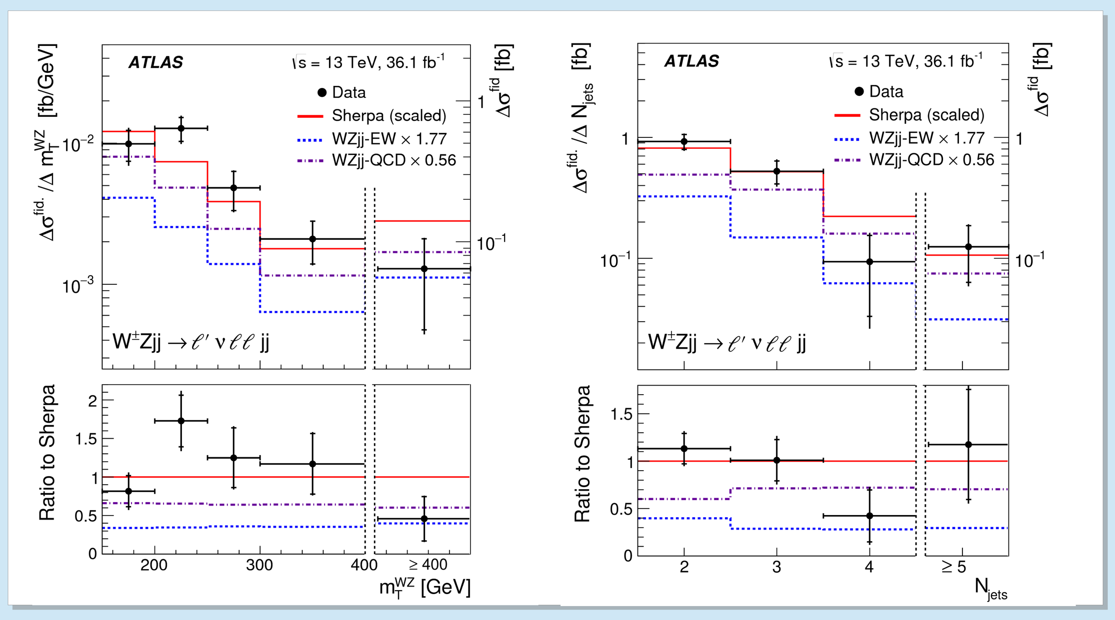


- The **total fiducial WZjj cross-section** in the VBS fiducial phase-space is:

$$\sigma^{fid.}_{WZjj} = 1.68 \pm 0.16(\text{stat.}) \pm 0.18(\text{syst.})\ \text{fb} = 1.68 \pm 0.25\ \text{fb}$$

Differential cross-sections

- **Unfolded differential cross-sections** are computed for **WZjj (EW+QCD)**
- **Data in the SR** are unfolded through an iterative Bayesian unfolding method, in order to remove detector effects
- Unfolded distribution were selected for being **useful for future aQGC studies,** and/or for **future Monte Carlo modeling studies**



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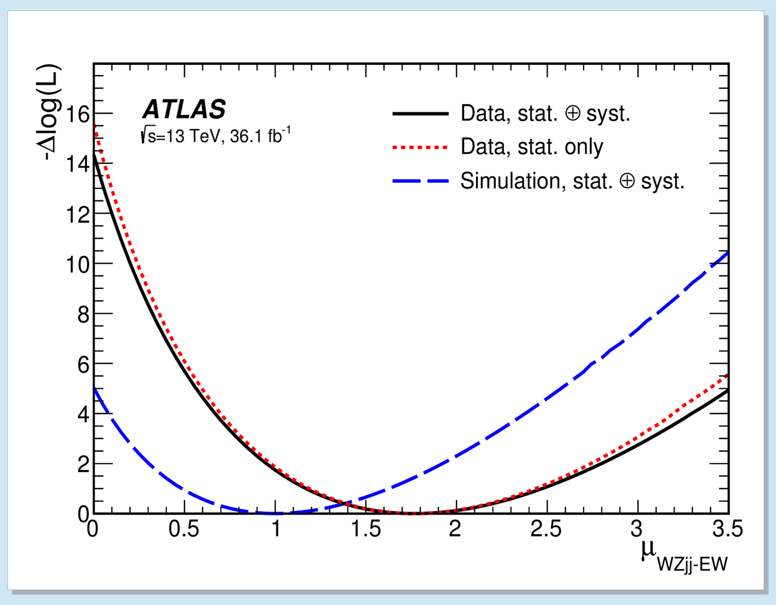
$\Sigma p_T^{lep.}$
$\Delta\phi(W,Z)$
$\Delta y(j1,j2)$
$\Delta\phi(j1,j2)$
m_{jj}
N_{jets}^{gap} (*)

(*) N_{jets} in the rapidity gap between the two tagging jets

WZjj-EW cross-section

- A **combined likelihood fit** is performed in the **SR** and the **3 CRs simultaneously.**
- **Systematic uncertainties** on the **objects reconstruction** and on the **signal and backgrounds modeling** are taken into account, and correlated between the 4 regions used in the fit.
- **Interference between WZjj-EW and WZjj-QCD** are taken into account as part of the signal.
- Its impact on the signal shape is evaluated in simulation and used as a systematic uncertainty.

Source	Uncertainty [%]
$WZjj$–EW theory modelling	4.8
$WZjj$–QCD theory modelling	5.2
$WZjj$–EW and $WZjj$–QCD interference	1.9
Jets	6.6
Pile-up	2.2
Electrons	1.4
Muons	0.4
b-tagging	0.1
MC statistics	1.9
Misid. lepton background	0.9
Other backgrounds	0.8
Luminosity	2.1
Total Systematics	10.7



- The **signal strength** ($\mu_{WZjj\text{-}EW}$) is measured in the SR only:

$$\mu_{WZjj-EW} = 1.77^{+0.44}_{-0.40}(\text{stat.})^{+0.22}_{-0.17}(\text{syst.}) = 1.77^{+0.49}_{-0.43}$$

(with respect to the prediction from Sherpa)

- With an associated significance of 5.3σ **(3.2σ expected)**

Data	161	
Total predicted	167	± 11
$WZjj$–EW (signal)	44	± 11
$WZjj$–QCD	91	± 10
Misid. leptons	7.8	± 3.2
$ZZjj$–QCD	11.1	± 2.8
tZj	6.2	± 1.1
$t\bar{t} + V$	4.7	± 1.0
$ZZjj$–EW	1.80	± 0.45
VVV	0.59	± 0.15

- **The fiducial cross-section** is derived from the signal strength value, **in a phase-space closely matching the SR definition (VBS fiducial phase-space)**:

$$\sigma^{fid.}_{WZjj-EW} = 0.57^{+0.14}_{-0.13}(\text{stat.})^{+0.07}_{-0.06}(\text{syst.})\ \text{fb} = 0.57^{+0.16}_{-0.14}\ \text{fb}$$

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ArXiv:1812.09740
Submitted to PLB

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