

# The state-of-the-art quantum technology

*The Transformer & its Applications to High Energy Physics Problems*

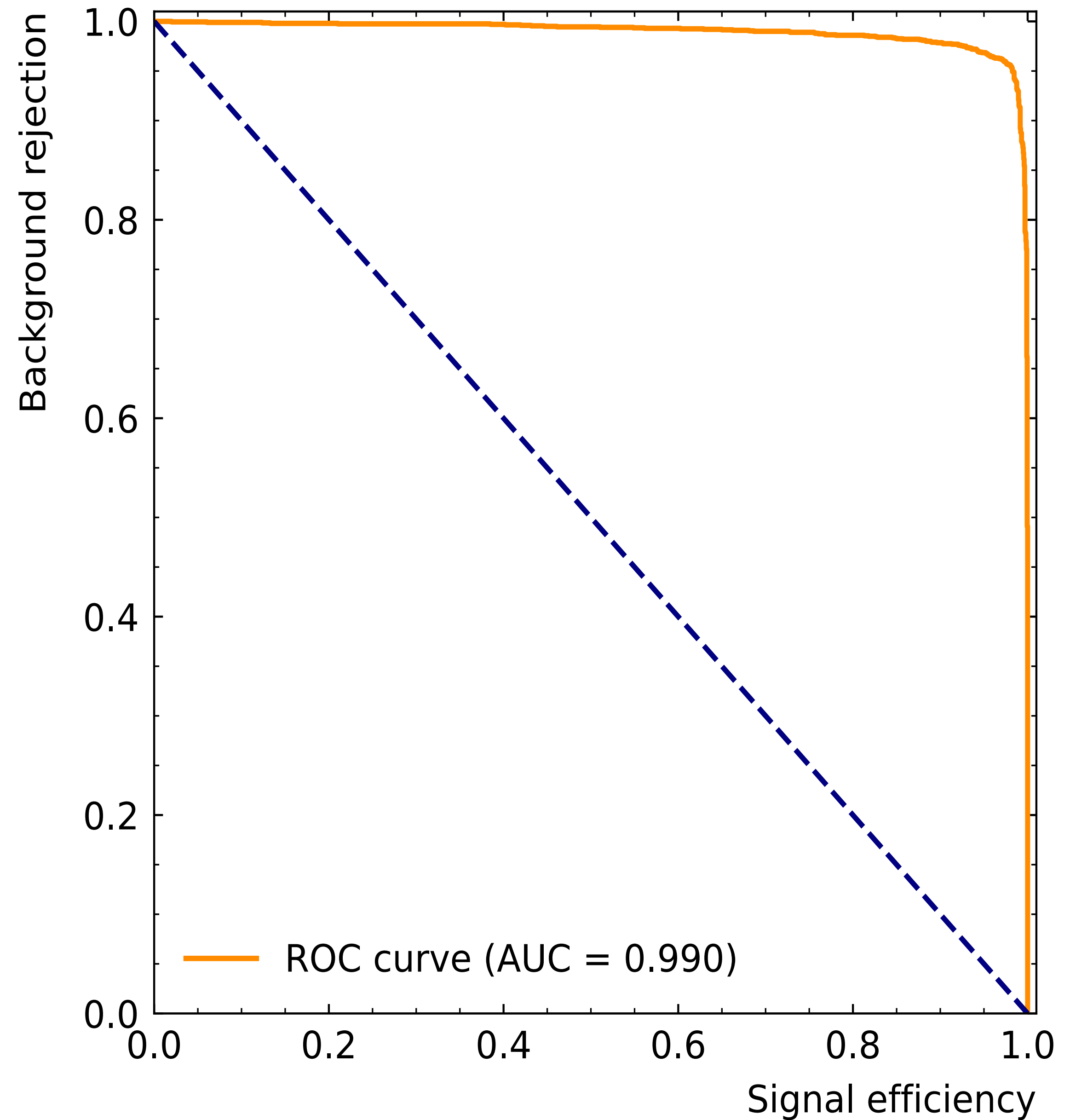
Abdualazem Fadol Mohammed

December 23, 2024

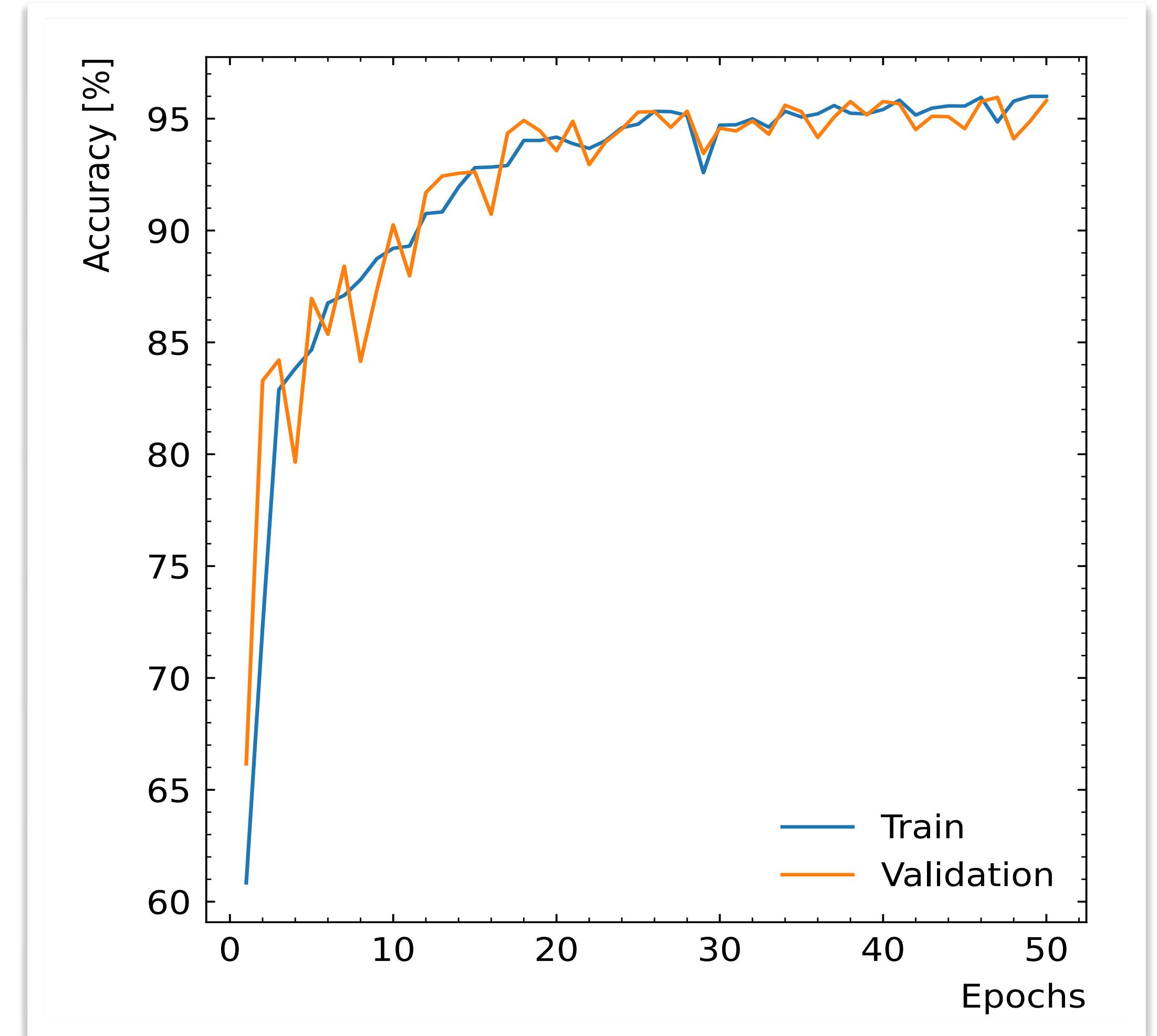
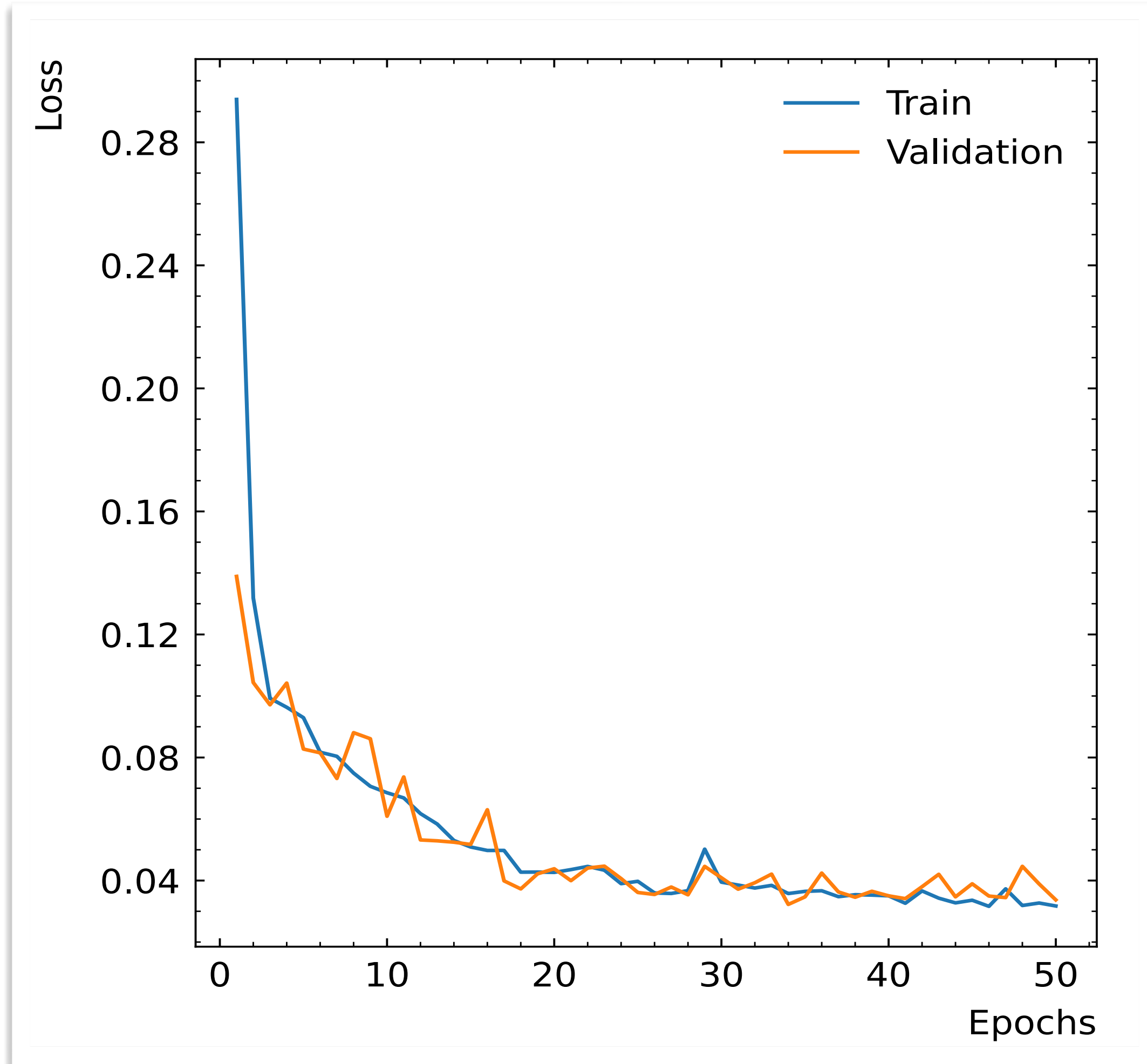


# Transformer for the Zc(3900)

- Total number of events: 20k.
- Training, validation, and testing: 11.2k, 4.8k, and 4k
- Number of variables: 26
- L rate & batch: 0.0036 & 128
- Architecture:**
  - $d_{FF} = 500$
  - Dropout = 0.0066
  - $iL = 6$
  - $h = 4$
  - Embedded dimension: 64
- Total time for the training and validation: 0h:3m:32s

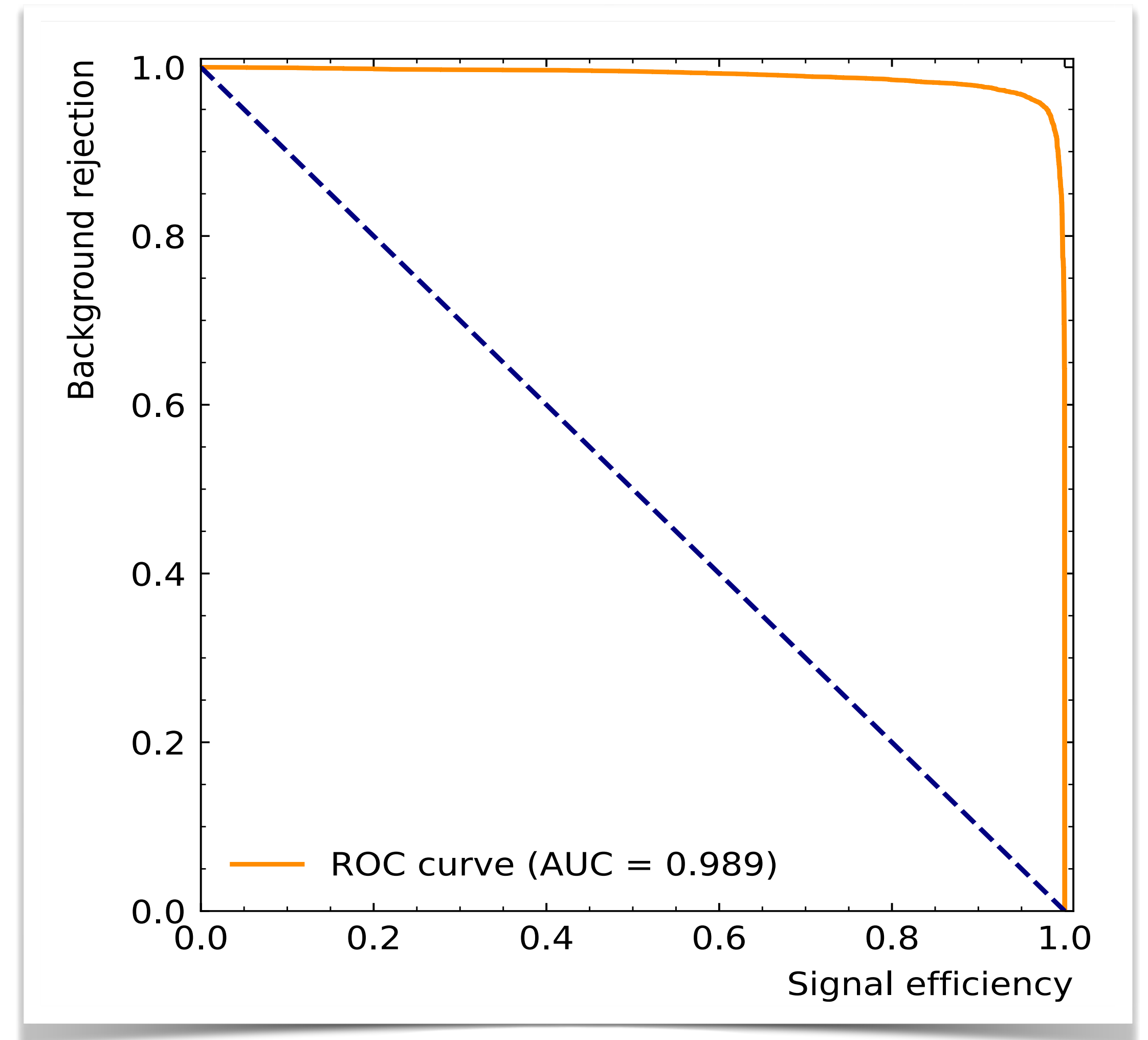
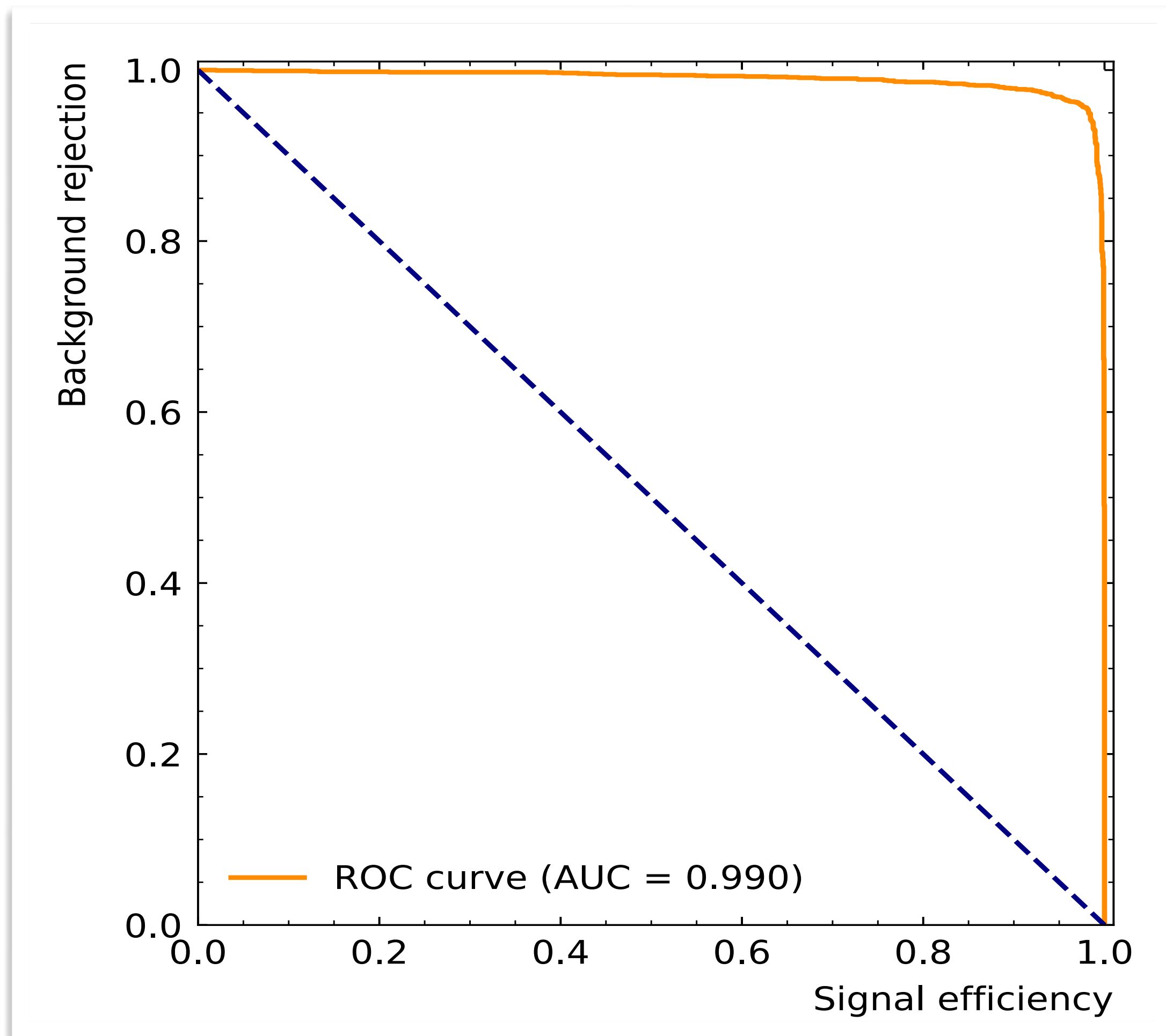


# Transformer for the Zc(3900)



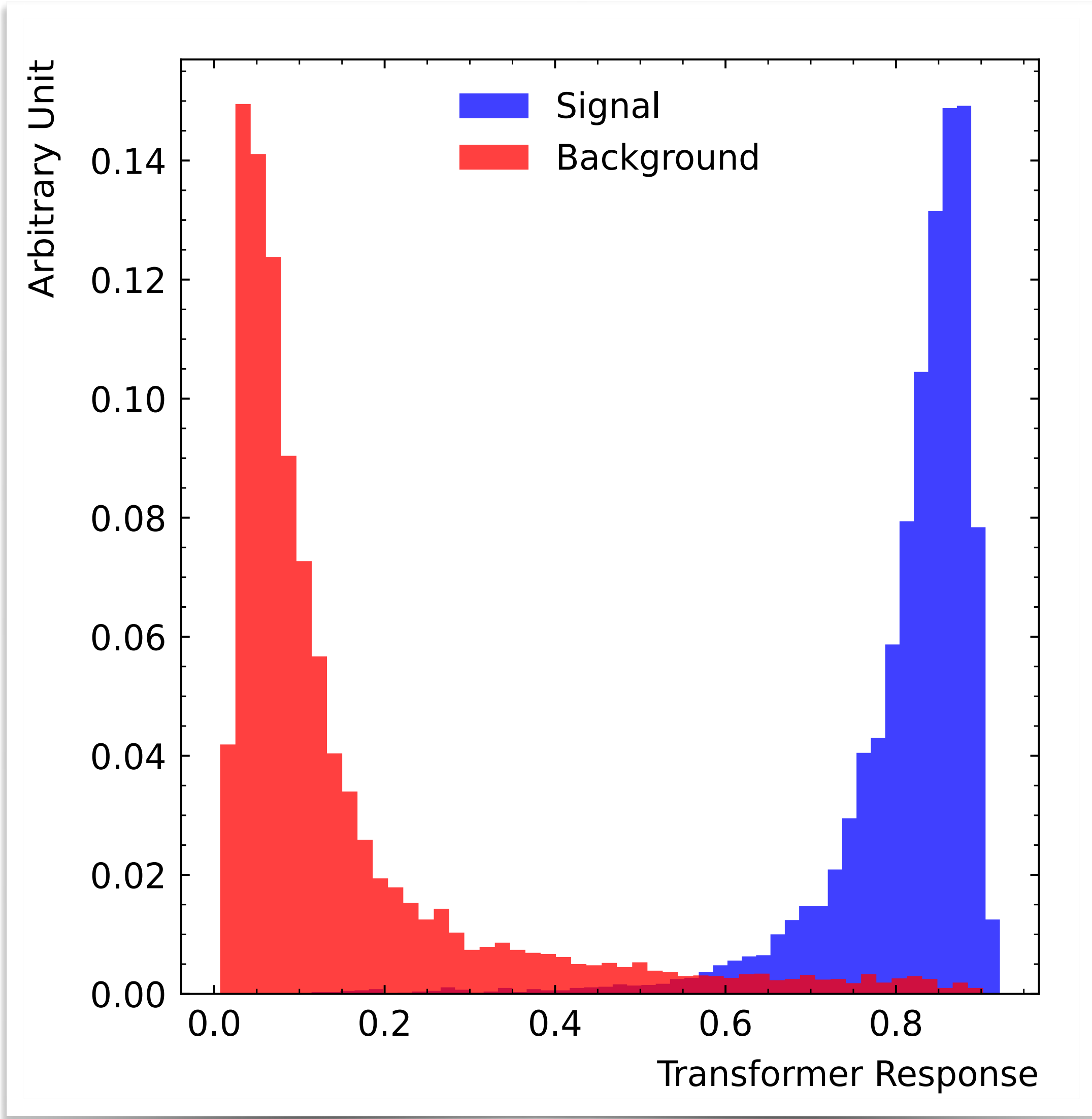
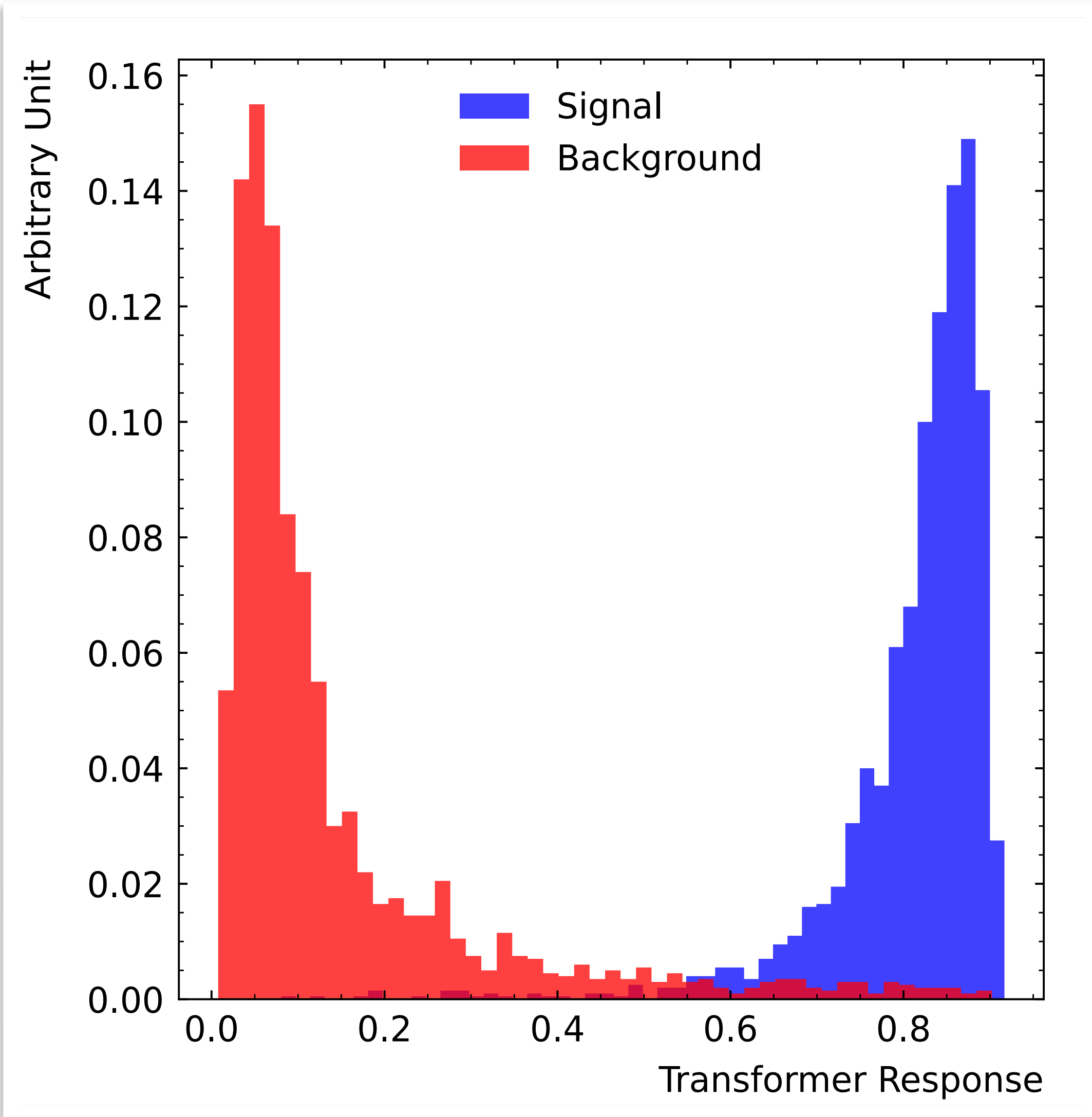
- Total number of events: 20k for 26 variables.
- Training, validation, and testing: 11.2k, 4.8k, and 4k

# Transformer for the Zc(3900)



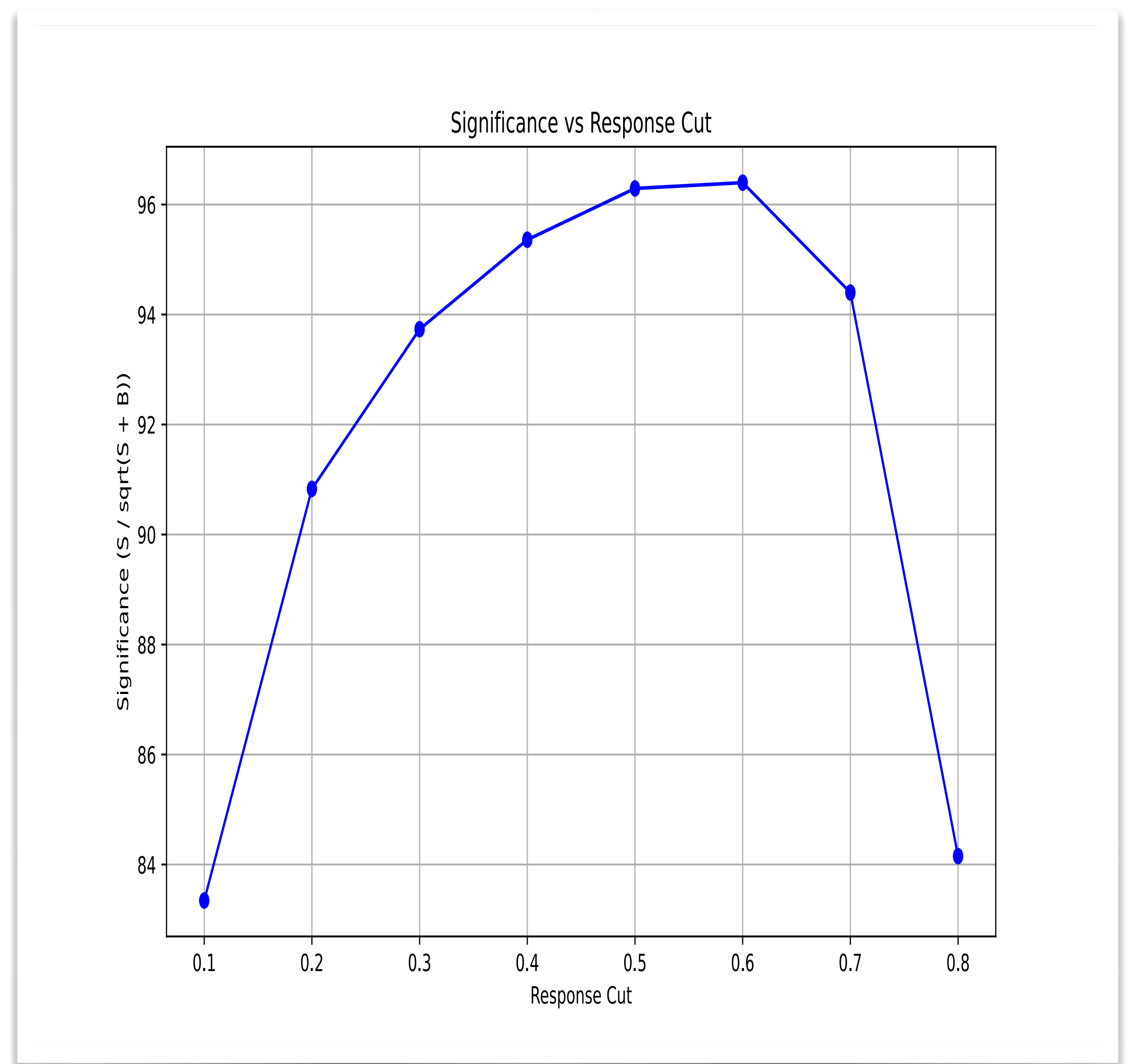
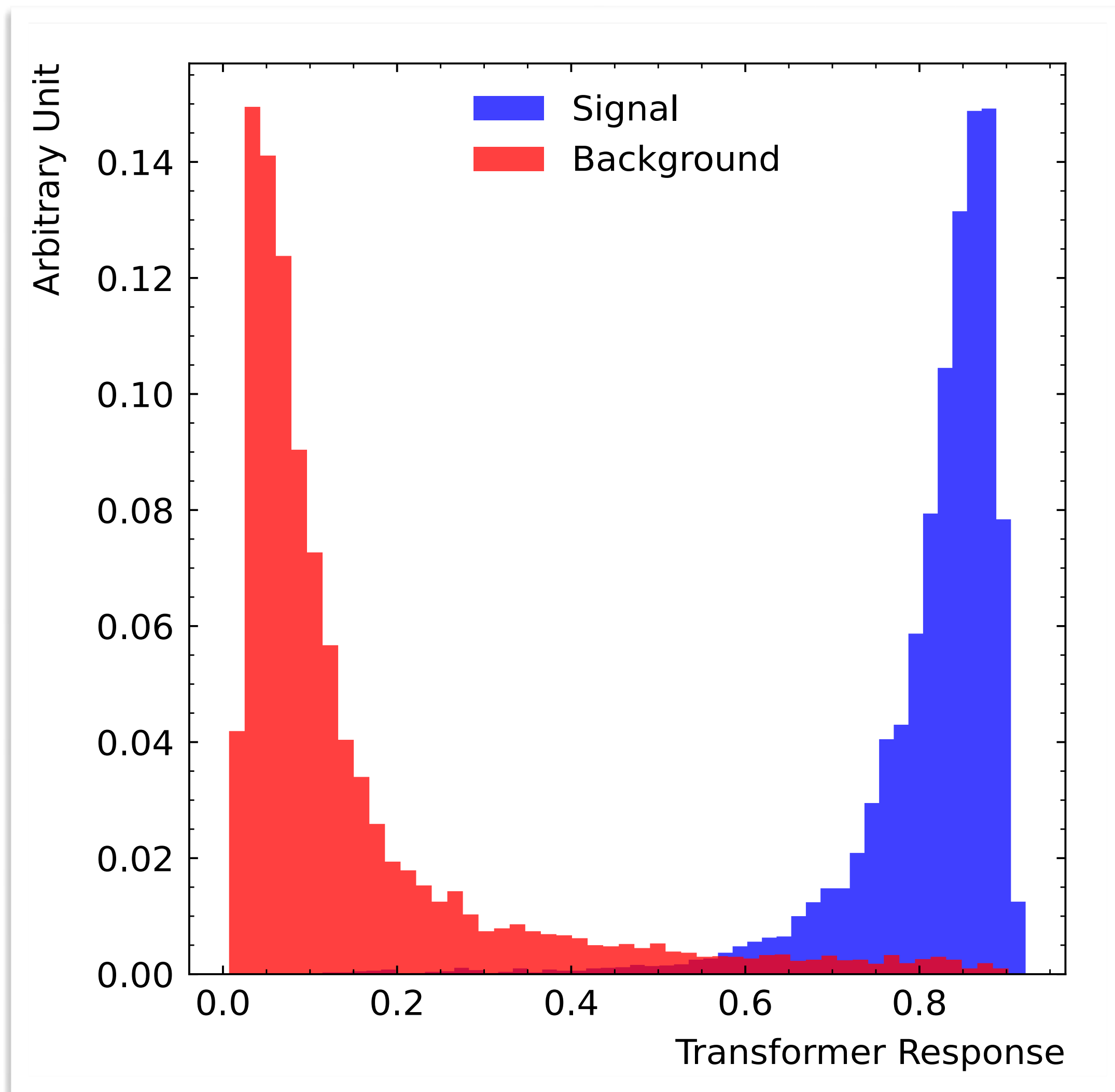
□ The model after training, validation, and testing (left) and after deploying the model (right).

# Transformer for the Zc(3900)



□ The model after training, validation, and testing (left) and after deploying the model (right).

# Transformer for the Zc(3900)



I saved a ROOT file with the discriminant variable and the response.

One can apply a cut on the response  $> 0.6$  and then do the fit.

# Quantum computer hardware

## **IBM hardware:**

- Log in here: <https://quantum.ibm.com>
- Username: [Abdualazem.Fadol@gmail.com](mailto:Abdualazem.Fadol@gmail.com)
- Password: Ihep@2024-2025
- Three devices are available with 127 qubits.

Limitation on the number of jobs submitted to IBM.

## Open Plan instance

By default, users who sign up for an IBM Quantum account are assigned to the Open Plan and the Open Plan's instance, `ibm-q/open/main`. To guarantee that everyone can use the QPU allocated to the plan fairly, **an individual can have no more than three jobs running and/or in the queue (across all QPUs) at the same time.** Submitting more than three jobs at a time will return error [#3458](#), and additional jobs will be canceled.

Those using the Open Plan instance have up to 10 minutes total of quantum time per month, which resets at 00:00:00 UTC on the first of each calendar month. Open Plan users can track their usage on the [Platform dashboard](#), [↗ Workloads](#), [↗](#) and [Account ↗](#) pages.

# Summary

- The training, validation, testing and model deployment results are reasonable.**
- I already produce ROOT files with the response and the discriminant variable.**
- While I'm figuring out the IBM job submission, we can proceed with the analysis using the quantum simulator.**