

The GS-HCAL Paper

A Publication Strategy Discussion

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The paper at a glance

• **Title:** The design and performance of the glass-scintillator hadronic calorimeter for the CEPC reference detector.

• **Target journal:** Nuclear Science and Techniques (NST). A Q1 journal in the CAS system, focused on instrumentation and methods.

• **Why publish:** The first standalone, peer-reviewed paper dedicated to the GS-HCAL. The CEPC TDR is a comprehensive technical report — not a peer-reviewed journal article. No focused, physics-motivated GS-HCAL synthesis exists in the literature.

• **This talk:** The publication challenge, what we have done, and what we plan to add.

Latest draft: <https://www.overleaf.com/read/tjsxyqrbhqq#87fb74>

Updated version also posted on today's indico agenda

The design and performance of the glass-scintillator hadronic calorimeter for the CEPC reference detector

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The CEPC reference detector requires a particle-flow-oriented hadronic calorimeter with high three-dimensional granularity, sufficient depth, and robust neutral-hadron performance. Such a calorimeter is essential for the precision reconstruction of hadronic W , Z , and Higgs final states. The glass-scintillator hadronic calorimeter (GS-HCAL) is adopted as the baseline HCAL of the CEPC reference detector. It uses $40 \times 40 \times 10$ mm³ gadolinium fluoro-oxide glass-scintillator cells read out by 3×3 mm² silicon photomultipliers, arranged in a barrel and two endcaps. The full detector comprises 5.22 million channels with a total depth of 6.3λ and a sampling fraction of about 30%. Experimental studies of the baseline active unit show a light yield of ~ 1500 ph/MeV and an attenuation length of about 6 cm. The glass scintillator retains more than 70% of its light yield after irradiation below 100 Gy, and practical single-cell signals have been measured with ¹³⁷Cs, cosmic-ray muon, and 5 GeV electron-beam sources. Geant4 simulation of the design predicts a standalone single-hadron energy resolution of $29.8\%/\sqrt{E} \oplus 6.5\%$ with non-linearity within 2%. Combined with particle-flow reconstruction, a boson mass resolution of 3.88% is achieved for the $H \rightarrow gg$ benchmark. Full prototype beam validation remains necessary to close the optical model. Birks quenching, intrinsic ϵ/λ , calibration, and system-level response. This study establishes the technical and performance basis of the GS-HCAL baseline design.

Keywords: glass scintillator; hadronic calorimeter; CEPC; silicon photomultiplier; particle-flow algorithm; highly granular calorimeter

I. INTRODUCTION

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§ The Circular Electron-Positron Collider (CEPC) [1] is designed to measure Higgs boson couplings to sub-percent precision. It will also enable sensitive electroweak and flavour studies at centre-of-mass energies around the Z pole, the

The core problem: publishing a detector paper after the TDR

The expected sequence: subsystem papers published before the TDR

The TDR references them as authoritative sources — the normal, easier order.

What happened: the CEPC TDR moved faster than the subsystem papers

The TDR is complete and released. Several detector papers — including the GS-HCAL — are still in preparation.

Consequence: any detector paper not yet published, **overlaps heavily with the already-released TDR**

Not unique to HCAL. **The ECAL paper received a referee comment flagging the TDR overlap — a direct warning that this is a real, general issue.**

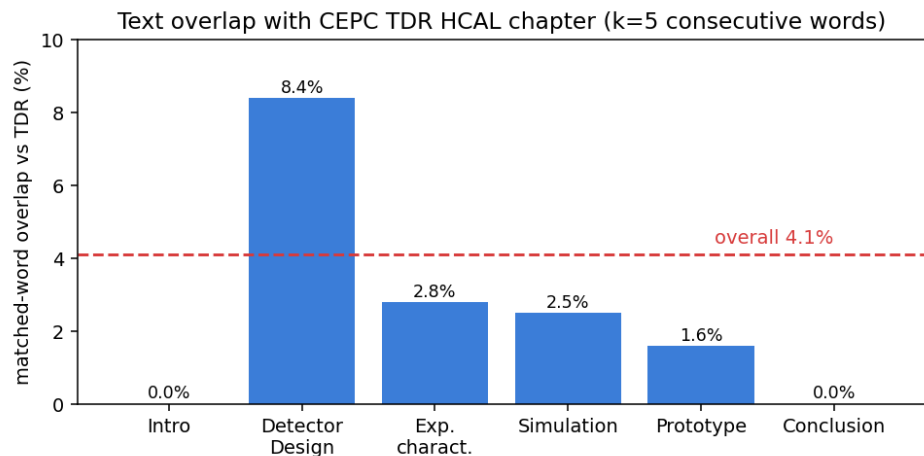
What we have done

Text de-duplication — only 4.1% word overlap with the TDR chapter

Introduction & Conclusion: 0%. The residual is entirely shared data tables and physics numbers — unavoidable.

Repositioning — the first standalone, peer-reviewed GS-HCAL paper

A "Relation to the CEPC TDR" paragraph has been added at the end of the Introduction. A cover letter will proactively explain the TDR relationship to the editor. The paper is presented as a focused, physics-motivated synthesis — not an engineering manual.



46 chanical feasibility, calibration strategy, and the prototype
47 validation programme, and Section VI summarises the find-
48 ings.

49 The CEPC Reference TDR documents the entire refer-
50 ence detector, including all HCAL engineering, mechani-
51 cal design, and alternative technology options, in exhaus-
52 tive detail [2]. This paper is the first standalone, peer-
53 reviewed account dedicated to the glass-scintillator HCAL
54 (GS-HCAL). It presents a focused, physics-motivated syn-
55 thesis that links GFO glass material properties, single-cell
56 measurements, full-detector simulation, and the $H \rightarrow gg$
57 boson-mass-resolution benchmark into one coherent argu-
58 ment. Readers are referred to the TDR for the complete en-
59 gineering, mechanical, and alternative-option detail not re-
60 peated here. [NEW-ANALYSES PLACEHOLDER: quanti-
61 tative results added beyond the TDR, to be finalized]

What we plan to add

Cross-experiment comparison

Overlay GS-HCAL resolution ($29.8\%/VE \oplus 6.5\%$) with AHCAL, SDHCAL, and conventional HCAL in one figure. Numbers already verified — straightforward to produce.

Depth scan with ECAL included

Re-run the energy resolution simulation at $> 6 \lambda_I$, including the ECAL in front, to test whether the constant term decreases.

[Tao Lin \(software group\) has been contacted — the simulation chain is operational.](#)

Intrinsic e/h from electromagnetic shower fraction

Extract the intrinsic e/h using truth-level information from existing Geant4 simulation. The TDR reports e/h ratios but has never extracted this quantity — filling a gap the TDR itself identifies.

Summary and Your input

- **The problem:**
 - **TDR came first → detector papers lag behind → overlap risk (not just HCAL).**
- **What we have done:**
 - **text de-duplication (4.1%), repositioning as the first standalone GS-HCAL paper.**
- **What we plan to add:**
 - **cross-experiment comparison, depth scan with ECAL, intrinsic e/h extraction.**
- **We welcome your comments and suggestions.**