US-FCC Calorimetry

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Calorimetry FY27 Requests

General considerations [ratings +1,0,-1 w/ 1 = highest]

A. US-FCC strengths/opportunities
B. Facilitating and and growing community engagement
C. Timing, eg early start advantages, short term opportunities

Focus areas for FY27

1. Test beam studies following up on initial commissioning and testing from 2026 by DR groups
2. Engineering design for LAr
3. Simulation for Si-W performance and sensor design requirements
4. DR Simulations workshop/tutorials

Calorimetry FY27 Requests

Test beam studies following up on initial commissioning and testing from 2026 by DR groups

- US groups are leading efforts in both EM and HAD R&D efforts
- US groups have a unique opportunity in 2027 for domestic R&D with SLAC test beam facility coming on line. Both the precision timing structure of the beam and the pure electron beam at moderate energy (8GeV) will give unique data to guide ongoing design efforts for the IDEA detector.
    a. 8 GeV is low enough to avoid saturation effects on prototype readout systems (no groups have prototypes with large dynamic range at present), while providing enough energy to reach 1% energy resolution to directly test ECAL performance
    b. Precision timing studies allowed by the SLAC beam (beam structure and trigger sync) will provide direct testing of timing capabilities for Fiber Calo readout (shower/jet structue, PID studies) and for ECAL timing (eg to infer photon timing)

Groups: [ECAL: CUA, FNAL, UMI, UMD, ...] [HCAL: TTU, Baylor]

Calorimetry FY27 Requests

Test beam studies following up on initial commissioning and testing from 2026 by DR groups

- US
- US

fa
ele
eff
a
b

m
e
sign
(no
enough
r sync)
/jet

ECAL: ($40k)
$15k FNAL for Sergey Los (~2weeks effort for readout devel)
$25k Personnel Travel for test beam*
Rating [range -3--3] : 3=1,1,1

HCAL: ($45k)
$15k M&S for module/trigger prep and shipping
$25k Travel for test beam*
Rating[range -3--3]: 2=1,0,1 [second s]

*Based on teams of 6 for 10 day run including: commissioning/data taking/breakdown

Groups: [ECAL: CUA, FNAL, UMI, UMD, ...] [HCAL: TTU, Baylor]

Calorimetry FY27 Requests

Engineering design for LAr

BNL:

- Simulation studies of thermal management of cold electronics
- Collaborate with CERN cryo lab to validate the thermal simulation and cooling interface to the cryogenic system.

Funding request: $30k=$25k (0.1 FTE mechanical engineer), $5k (1-week trip to CERN)
Rating[range -3--3]: 2=1,0,1

Arizona:

- Accelerate test-beam preparations

Funding request: $200k=$120k (1.0 FTE mechanical engineer), $50k (0.4 FTE electrical engineer), $30k (parts for prototype)
Rating[range -3--3]: 0=0,-1,1 (downrated b/c of long delay to LAr test beams options)

Calorimetry FY27 Requests

Simulation for Si-W performance and sensor design requirements

Reimagining Si-W based e+e- collider precision luminosity measurements

Working on a **new approach** to the design of the **luminosity calorimetry** for future e+e- colliders. Emphasis on simulation and design studies.
The detector technology is likely to be **Si-W**.
Exploring an analog approach and plan to look at digital.
Simulations achieve 3.7%/sqrt(E) using **thick silicon layers (750 um) with high sampling frequency**, and expect significantly better than 100 um resolution in radius and and r dphi for modest cell sizes (the much better sampling also improves position resolution - it is not all about Moliere radius).

This started from the premise of trying to evaluate how feasible it is to extend the acceptance for the e+e- -> gamma gamma process into the LumiCal acceptance, where one will need excellent Bhabha rejection.
The ultra-high granularity opens up new directions in shower reconstruction but also in being able to resolve individual showers that will aid in a more exclusive measurement that can probe the details of the process modeling (for both Bhabhas and gamma gamma).

Resource request:
- o Some travel support.
- o Some GS support (even just summer).
- o Some M&S funds for detector components for effective positron lifetime measurements.

Digital ECal based on MAPS

Builds on and complements the sensor development for tracking
- Sensor needs to first satisfy the requirement for Higgs factory tracking, then adaptation for calorimetry will be implemented
- Prototyping steps achieved in collaboration w/ CERN (@SLAC) along with detailed Higgs factory shower reconstruction simulation studies

Design and prototyping needed to optimize Higgs factory performance
- power consumption (10 mW/cm2 / lower?)
- cooling design/power dissipation
- potential for multiple thresholds
- bit depth requirement for calorimetry
- stitching to make 2000 m^2 feasible
- basic mechanical design
  - absorber with minimized sampling gaps - maintain Moilere radius
  - passive cooling / power pulsing

Simulation studies demonstrate needed Higgs factory performance
- for electromagnetic shower resolution
- for shower containment
- for separation of showers within jets
- for particle flow reconstruction

Simulations continue optimization
- sampling frequency
- pixel sizes
- other choices

Common interests/coordination with DRD6 collaborators
Utrecht University (T. Peitzmann)
University of Birmingham (N. Watson)
others (FOCAL for ALICE)

Other collaborators interested:
Brown(Gouskos), Stony Brook(Dao, Piacquadio)

SUPPORT NEEDED URGENTLY
Partial grad student research assistant
Travel to collaborative meetings and workshops

Calorimetry FY27 Requests

Simulation for Si-W performance and sensor design requirements

Kansas:

- Simulation studies for Si-W luminomitor

Funding request: $20k=$15k (summer student), $5k (workshop travel)
Rating[range -3--3]: 0=0,0,0 (interesting project, potentially new ideas)

Oregon, Brown, Stony Brook:

- Digital ECAL with MAPS

Funding request: $35k=$30k (0.5FTE student for simulation efforts), $5k (workshop travel)
Rating[range -3--3]: 0=0,0,0

Calorimetry FY27 Requests

DR Simulations workshop/tutorials

Interested groups: Baylor, CUA, Princeton, Rutgers, TTU, UMD, UVa

- US groups have build a strong code base for simulations for all DR-related calorimetry
- Over the next couple years, simulation studies will be a strong part of the international R&D and influence on future design efforts
- Too fully compete, it is vital that we train a critical mass of early career researchers to use and develop simulation tools.

Funding request: $35k = Travel support for 4 day training workshop to support approximately 10 junior participants and 3-4 instructors/mentors, snacks/ammeneties.

Rating[range -3--3]: 3=1,1,1

Calorimetry FY27 Requests ($305k)

Summary, curated priorities

1) DR Simulations workshop/tutorials [Managing institute TBD] $35k
   a) Quick build up of community expertise
   b) Community building and deliverables
2) Simulation of thermal management of cold electronics [BNL] $30k
   a) good/cost benefit ratio
3) 2027 DR test beams $40k+$45k
   [FNAL for ECAL, TTU for HCAL]
   a) Opportunity to take lead in results on timing performance and resolution with pure e- beam w/ US DR prototypes
4) Simulation studies for Si-W luminomitor $20k
   a) good/cost benefit ratio - potentially new idea
5) LAr turbine [UAZ] $100k
   a) large , single group request. Interesting R&D, but argument for LAr test beam readiness not compelling given facility schedules (reduced from original request)
6) Digital ECAL with MAPS $35k
   a) Interesting concept, but unclear if US impact can be significantly improved w/ 0.5 students