Snowmass 2021 Instrumentation Frontier
IF06 - Calorimetry - Conveners

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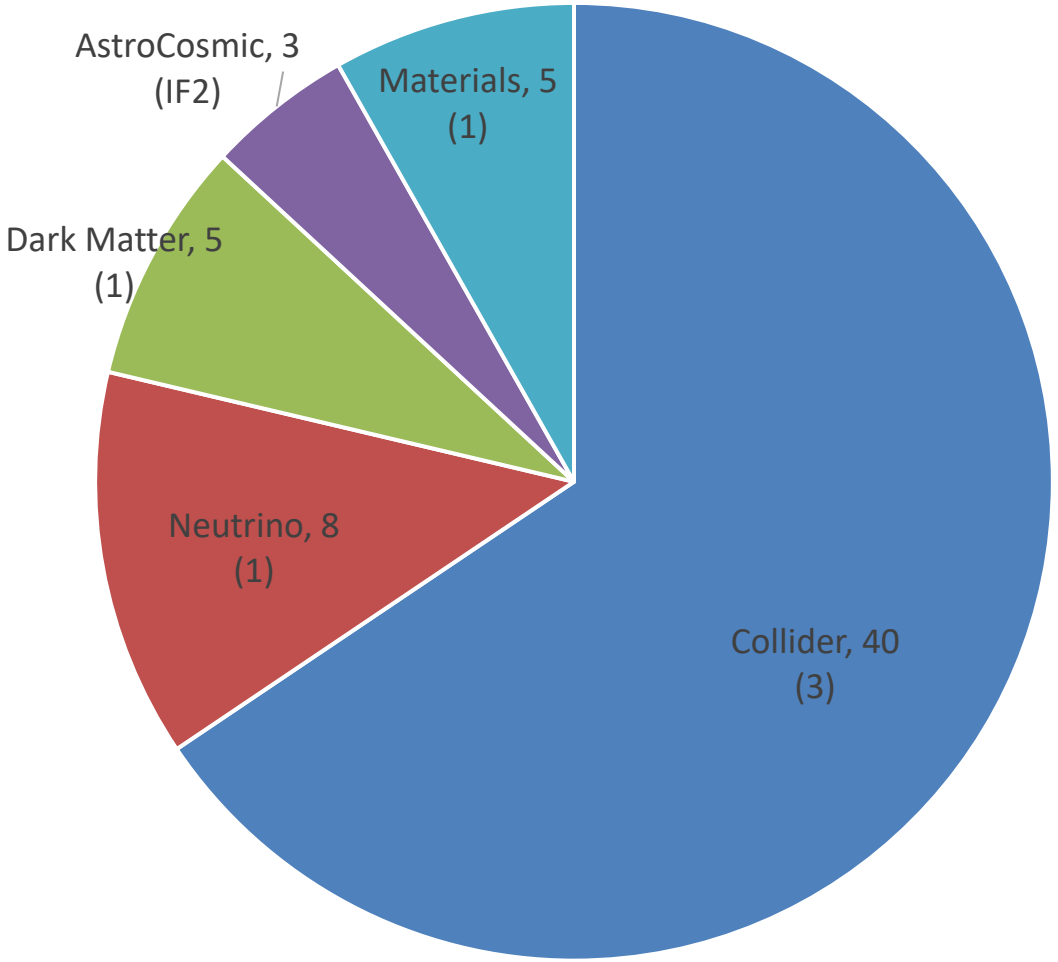
IF6 Calorimetry Updates

- 61 LOIs
- Five topics divided in six whitepapers for calorimetric instrumentation (AstroCosmic to be included in IF2)
  - All lead authors identified and agreed to serve
  - Outlines/feedbacks from lead authors received (except one)
  - Seek contributions from LOIs and invitations
- Comments/Issues from lead authors
- Next Steps



Instrumentation Frontier IF06 – Calorimetry

White Papers Lead Authors

1) Collider:

- Particle Flow Calorimetry for Future Colliders
  - Katja Kruger (DESY)
  - Randi Ruchti (Notre Dame)

- Dual Readout Calorimetry for Future Colliders
  - Sarah Eno (Maryland)
  - Franco Bedeschi (INFIN-Pisa)

- Precision Timing for Collider Experiment based Calorimetry
  - Frank Simon (MPP Munich)
  - Sergei Chekanov (ANL)

2) Neutrino

- Calorimeter Techniques and Materials for Neutrino Experiments
  - Milind Diwan (BNL)
  - Jae Yu (UTA)

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White Papers Lead Authors (cont'd)

3) Dark Matter

- New Calorimeter Techniques and Materials for Dark Matter Detection
  - David Winn (Fairfield)
  - Rick Gaitskell (Brown)

4) Materials

- Materials for Future Calorimeters
  - Ren-Yuan Zhu (Caltech)
  - Minfang Yeh (BNL)

5) Astro/Cosmic - possible White Paper - maybe include these LOIs in an IF02 paper?

Instrumentation Frontier
IF06 – Calorimetry – White Papers – Approach

- White Paper lead authors provide outlines
- White Paper lead authors contact LOI writers for contributions
- Let LOI writers know in which White Paper their inputs will be processed
- IF6 Conveners – Calorimetry – meetings on monthly basis
- Additional opportunities for talks/new ideas
- Consider convergence of IF6 issues with DoE/BRN
- Study input from e.g. ECFA Detector R&D Roadmap, LCWS2021, CPAD, TIPP,…

Particle Flow Calorimetry

White Paper Leaders: Katja Kruger, DESY and Randy Ruchti, Notre Dame

Abstract: Original motivation for PF calorimetry is to experimentally provide excellent jet energy resolution. Typically - jet energy resolution is relatively poor in conventional hadron calorimeters, but in particle flow calorimeters $\sigma/E < 5\%$ should be possible for a range of jet energies from ~50 GeV to ~250 GeV, important particularly for experiments at electron-positron colliders (ILC, CLIC, FCCee, CEPC). The high granularity, which is essential for PF calorimetry, can also be very beneficial for removal of background from pile-up on an event-by-event basis. This makes these calorimeters an attractive option also for hadron collider experiments, for example the HGCAL under construction for CMS for HL-LHC operations.

1. Introduction
2. Motivation for Particle Flow Calorimetry
    a. Scientific Objectives
        i. Measuring the energy of jets which includes understanding neutrals.
        ii. Vector Boson Reconstruction
        iii. Higgs Reconstruction
        iv. Tau Reconstruction
        v. Long lived particles (?)
    b. Resolution Concerns

Dual Readout Calorimetry for Future Colliders

F. Bedeschi[b], S. Eno[a], add more names[c]

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[b] *Istituto Nazionale di Fisica Nucleare, Sezione di Pisa: Pisa, Toscana, IT*
[c] *other departments*

Abstract

In this white paper for the 2022 Snowmass process, we detail the status of and future prospects for dual-readout calorimetry, and its potential impact on the goals for fundamental physics. While all calorimeters allow estimation of energy depositions in their active material, dual-readout calorimeters provide additional information, such as the wavelength or polarization of light produced in sensitive media and a precision measurement of the time of the energy deposit, that allow estimation of the shower-by-shower particle content of the showers. Knowledge of the shower particle content allows unprecedented hadronic particle and jet energy resolutions. We also discuss the impact continued development of this kind of calorimetry could have on the precision on Higgs property measurements at future colliders.

Keywords: calorimeters

Precision Timing for Collider Experiment based Calorimetry

S.Chekanov, F.Simon, etc.

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ABSTRACT

I describe the classification of whales in terms perhaps more familiar to the reader.

Submitted to the Proceedings of the US Community Study
on the Future of Particle Physics (Snowmass 2021)

Materials for Future Calorimeters

Ren-yuan Zhu and Minfang Yeh

Current and Planned Projects

- Calorimetry concept and design
- What are the current calorimetry usages and requirements?
  - Review DOE Basic Research Needs (BRN) for HEP instrumentation, December 2019 [1]
  - Current ongoing experiments
- What materials are available with pros/cons
  - engineering analysis on performance vs cost & availability

Key Issues and Onwards

- Review CPAD HEP instrumentation frontier workshop in March 2021 [2]
- Preferable materials with high density, better optical property, high light-yield and fast/short light pulse (and low cost)
  - high density → increased stopping power
  - high light-yield → energy and spatial resolution → improved reconstruction
  - high optical transmission → enhanced signal efficacy
- Novel calorimeter concepts with new materials.
  - A Radical consortium proposed to develop a ultracompact, radiation hard and fast-timing

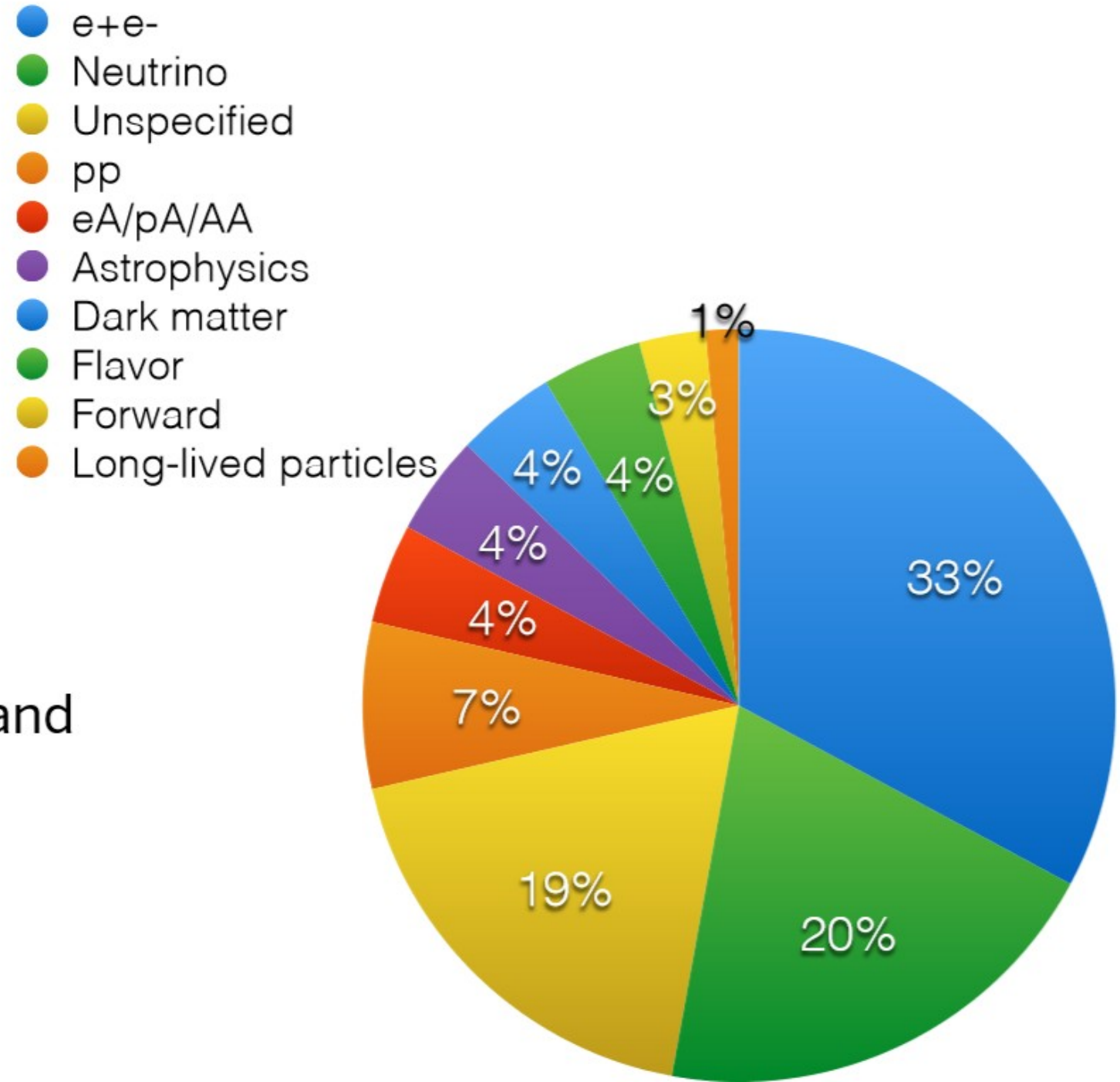
Neutrino-related Calorimetric Detector WP

- IF6 has 8 LOIs related to neutrinos, which also appear to be listed in NF10 (94 LOIs): Neutrino Detectors convened by Josh Klein, Ana Machado, Dave Schmitz, Raimond Strauss.
  - Identified that the 94 LOIs in NF10 are quite comprehensive for calorimetric instrumentation including noble liquids, water, scintillator, emulsion, and radio detection.
- Recommendation
  - white paper for the Instrumentation Frontier “IF6/neutrinos” to be coordinated with NF10 to produce a common document for neutrino detectors (with a section on calorimetric techniques).
- Consensus?

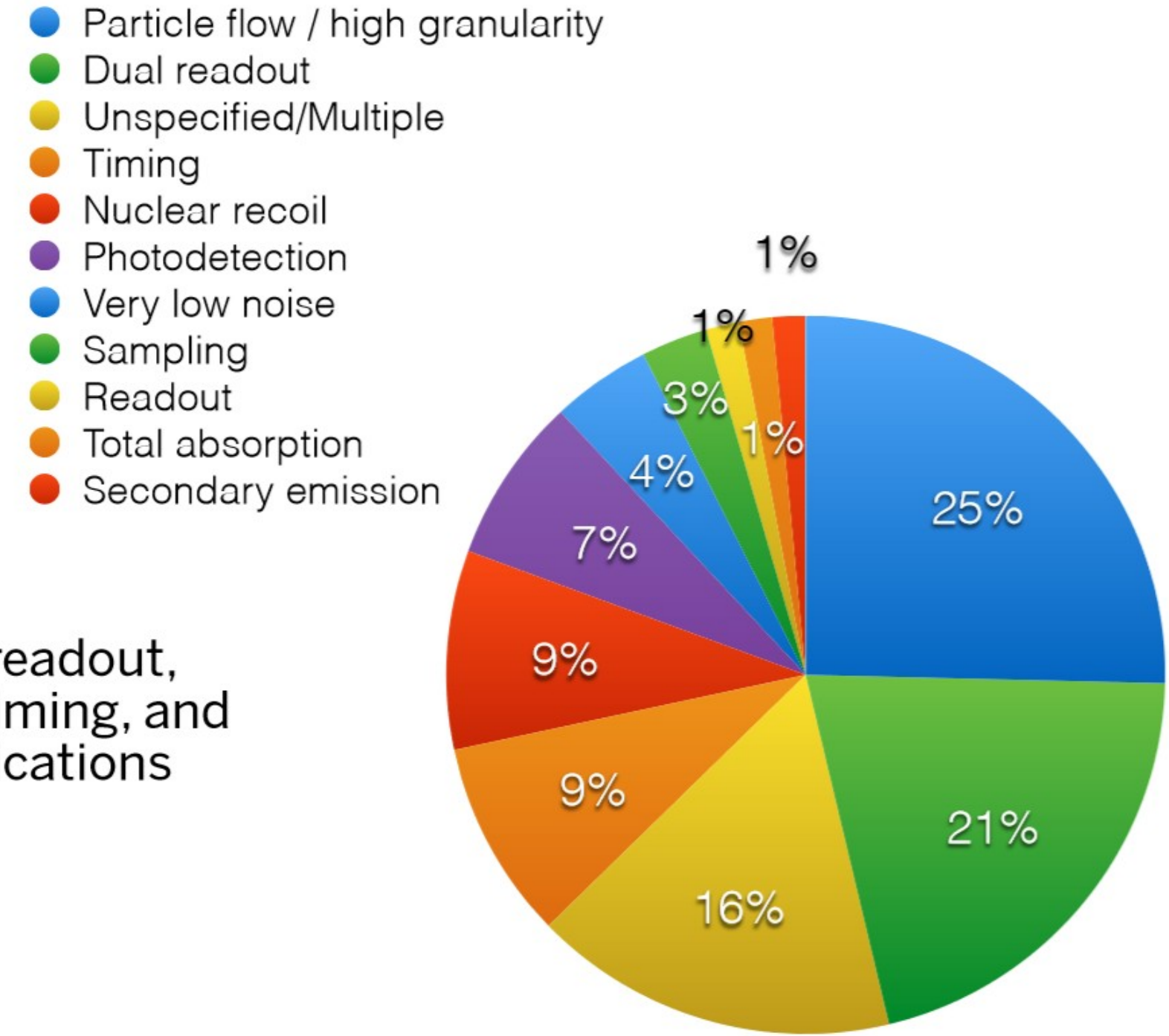
Instrumentation Frontier
IF06 – Calorimetry – White Papers – timeline

- 10/2021 -
  - (IF6 Conveners) Follow-up WP discussions with lead authors
- 12/15/2021: 1st draft WP
  - (IF6 Conveners) Review draft and iterate with lead authors
- 01/22/2022: 2nd draft WP
  - Share with IF
- 2/15/2022: 3rd draft WP
- 2/25/2022: final request for comments
- 3/1/2022: final draft ready for arXiv

EXTRA



- e^+e^-, generalized R&D, and neutrino applications dominate



- Particle flow, dual readout, generalized R&D, timing, and nuclear recoil applications dominate