Summary of Jan 12 Calorimetry Community meeting

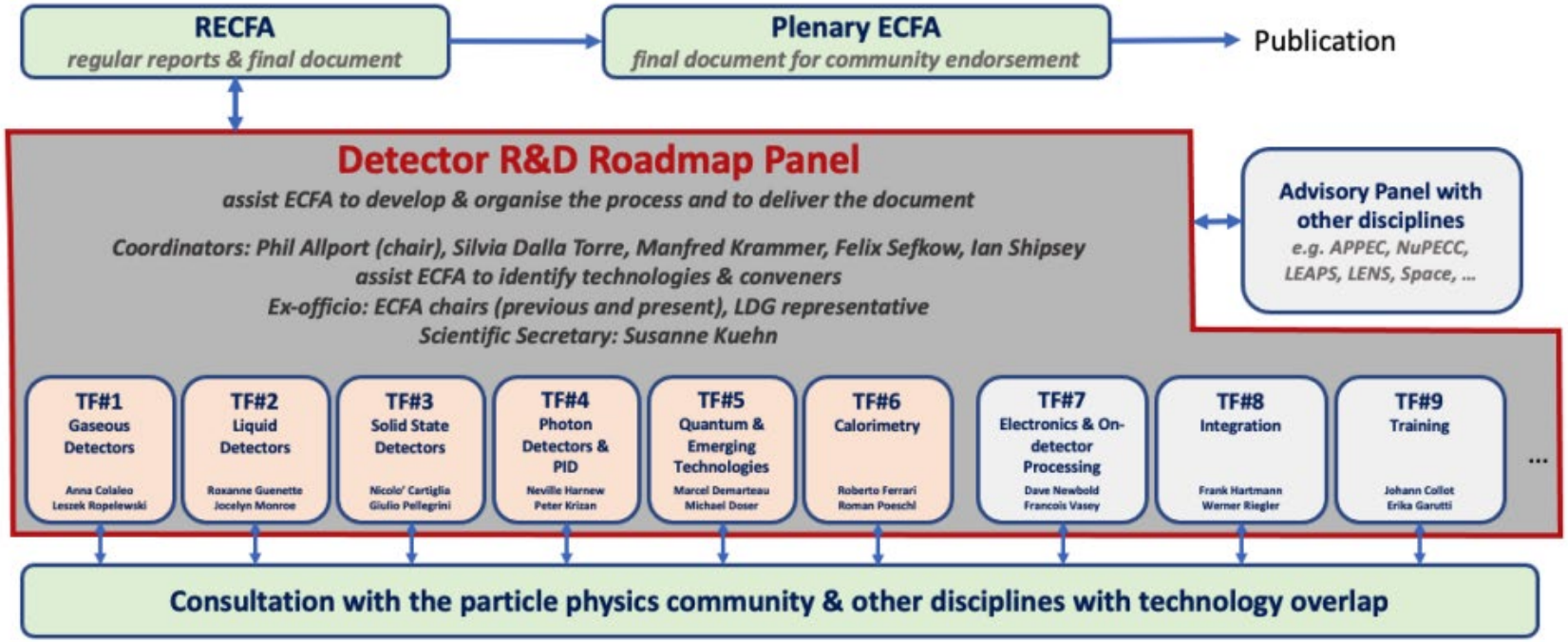
Junjie Zhu

University of Michigan

Community meeting agenda: https://indico.cern.ch/event/1212696/

Introduction

- Long processes that led to Detector R&D (DRD) roadmap document (https://cds.cern.ch/record/2784893, 264 pages) circulated for approval to ECFA in Nov 2021 and presentation to the Council in Dec 2021
  - "*organised by ECFA, a roadmap should be developed by the community to balance the detector R&D efforts in Europe, taking into account progress with emerging technologies in adjacent fields*" (recommendation from the European Strategy of Particle Physics in 2020)
  - The roadmap needs to "*identify and describe a diversified detector R&D portfolio that has the largest potential to enhance the performance of the particle physics programme in the near and long term*"



6 technology facing Task Forces + 3 cross-cutting Task Forces

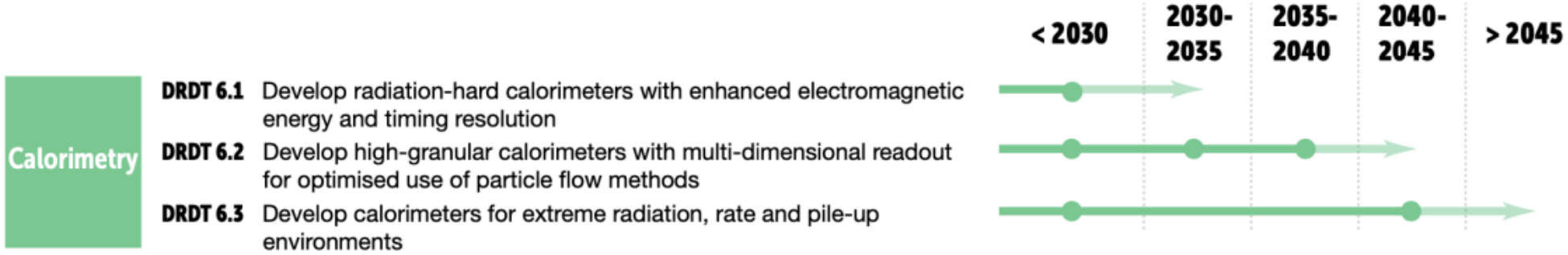
Chapter 6 “Calorimetry” (DRD roadmap)

- 6.1 Introduction
- 6.2 Main drivers from the facilities
  - Near- and mid-term R&D programs to meet the needs of the HL-LHC experiments and future e^+e^- Higgs-EW-top factories and EIC (DRDT 6.1, 6.2)
  - Longer term: strategic R&D to address requirements of muon and hadron colliders (DRDT 6.3)
- Key technologies
  - Silicon-based, liquified Noble gases, gaseous detector, light-based calorimeters, precision timing, readout
    - Challenges and requirements for future projects
    - Main R&D directions
- Observations
- Recommendations
  - Implementations of DRDT 6.1, 6.2, and 6.3
  - Understand how calorimeters can benefit from progress in terms of precision timing for single particles and showers, including within showers
  - Changes in readout architectures need to be followed up and integrated into the planning
  - The uncertain landscape and the size of demonstrators emphasize the role of R&D Collaborations.
  - Long-tem projects and it is important that calorimeters can be upgraded with state-of-the-art technology during the lifetime of a project

Main drivers from the facilities

- Timescale of projects as approved by European Lab Director Group (LDG)
  - Guiding principle: Project realization must not be delayed by detectors

- Detector R&D Themes (DRDT)

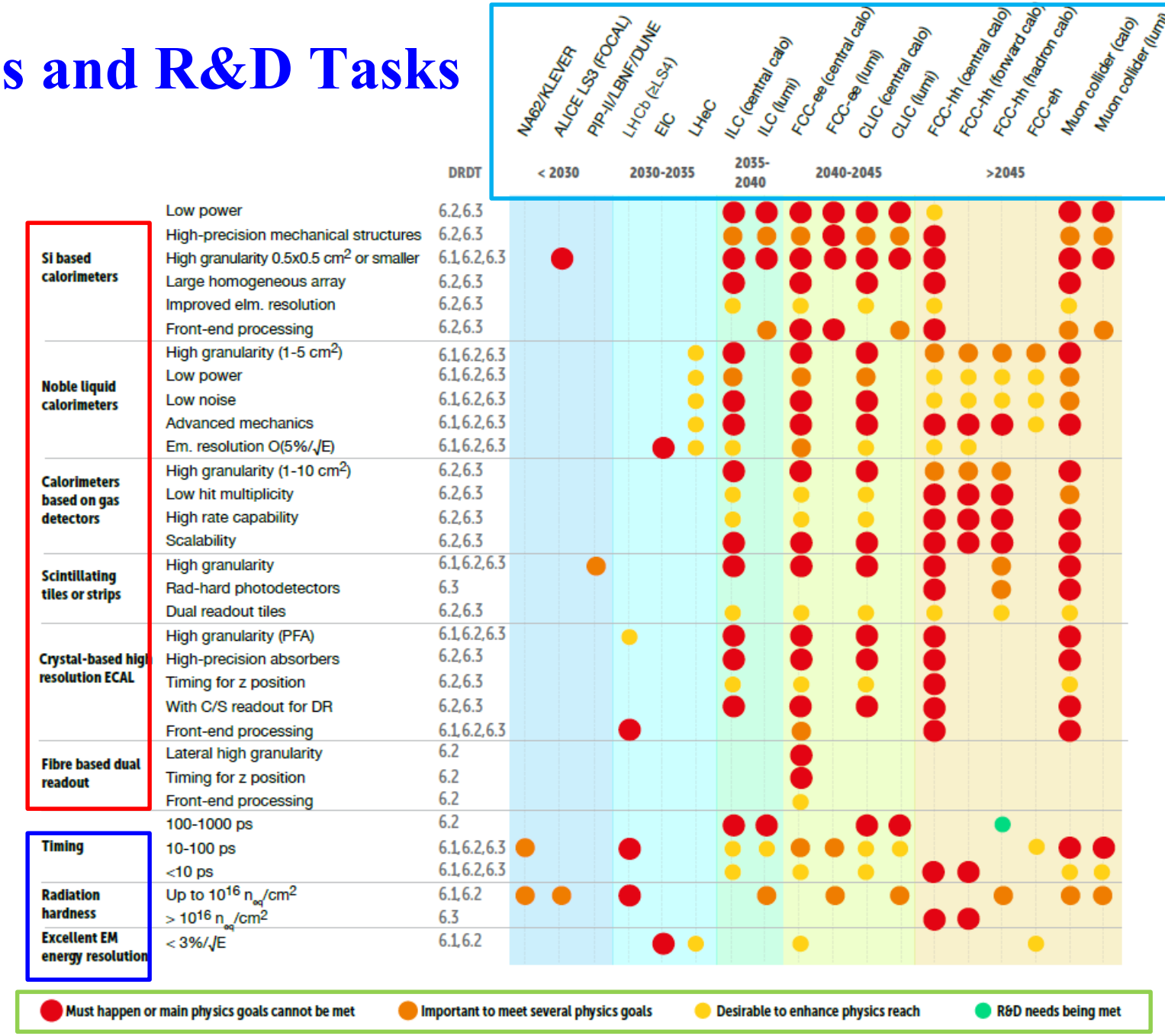


  - DRDT6.1: Completion of R&D programs for the HL-LHC upgrades (mainly for LHCb)
  - DRDT6.2: Address calorimeters at future Higgs-EW-TOP factories, and also a granular EMCAL for DUNE
  - DRDT6.3: start for calorimetry at a future hadron collider and a Muon collider

Identified Key Technologies and R&D Tasks

- Key technologies and requirements are identified in Roadmap

- R&D Tasks are grouped into:
  - **Must happen**
  - Important
  - Desirable
  - Already met



Future organization of DRD (in Europe)

- CERN Council has mandated EFCA to work out a detailed implementation plan (in close collaboration with the SPC, the funding agencies and the relevant research organizations in Europe and beyond)
  - ECFA Roadmap Coordination group has worked out a proposal and presented to SPC and Council in March and June 2022
  - Organize long-term R&D efforts into newly established DRD Collaborations based on detector technology areas (one for each of the six areas and an additional similar structure for the transversal topics)
  - DRD Collaborations should be anchored at CERN (CERN recognition but not CERN collaborations)
  - Taking full account of existing, well-managed and successful ongoing R&D collaborations and other existing activities
  - The formation of new DRD collaborations should adopt a community-driven approach:
    - Strategic R&D via DRD collaborations (long-term strategic R&D lines), experiment-specific R&D (with well defined detector specifications), Blue-sky R&D
  - The progress and the R&D will be overseen by a DRDC (Detector Research and Development Committee, to be set up by the CERN research director) that is assisted by ECFA
  - The funding will come from national resources

Suggested implementation timeline

Through 2023, mechanisms will need to be agreed with funding agencies in parallel to the process below for country specific DRD collaboration funding requests for Strategic R&D and for developing the associated MoUs.

Q4 2022	Outline structure and review mechanisms agreed by CERN Council. Detector R&D Roadmap Task Forces organise **community meetings** to establish the scope and scale of community wishing to participate in the corresponding new DRD activity. (Where the broad R&D topic area has one or more DRDTs already covered by existing CERN RDs or other international collaborations these need to be fully involved from the very beginning and may be best placed to help bring the community together around the proposed programmes.)
Q1 2023	**DRDC mandate formally defined** and agreed with CERN management; Core DRDC membership appointed; and EDP mandate plus membership updated to reflect additional roles.
Q1-Q2 2023	**Develop the new DRD proposals** based of the detector roadmap and community interest in participation, including light-weight organisational structures and resource-loaded work plan for R&D programme start in 2024 and ramp up to a steady state in 2026.
Q3 2023	**Review of proposals by DRDC** leading to recommendations for formal establishment of the DRD collaborations.
Q4 2023	DRD Collaborations receive formal **approval from CERN Research Board**.
Q1 2024	New structures operational for ongoing review of DRDs and R&D programmes underway.

Through 2024, collection of MoU signatures

K. Jakobs, ECFA Meeting November 2022

Towards implementation of DRD Calorimetry

- Entry point, "DRD Calo indico page": https://indico.cern.ch/category/12772/ Please register there
  - Information on important events and access to relevant documents
  - Note also the Q&A Doc
  - 184 people from four regions registered so far

- Organisation of 1st Community Meeting (today) Jan 12: https://indico.cern.ch/event/1212696/
  - Get impression on plans for different key technologies
  - Get feedback/input by community on roadmap process and the implementation
  - Conveners and speakers of today's sessions are also entry points for interested groups to join the DRD calorimetry

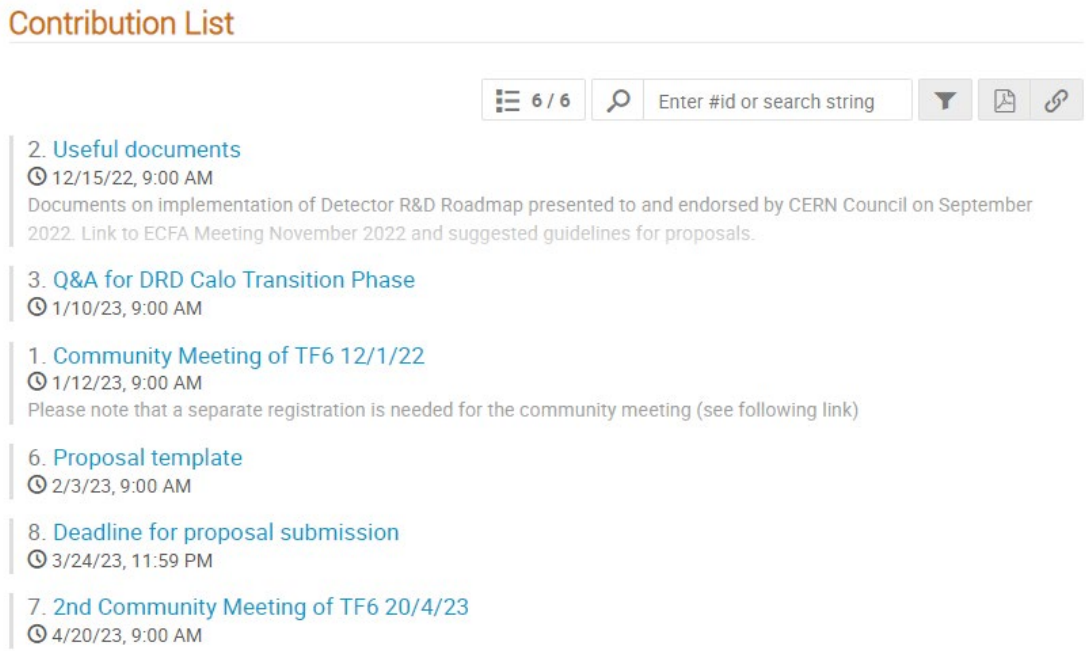
- Proposal phase until 1st of July 2023
  - Input-proposals (until 1st of April 2023) https://indico.cern.ch/event/1213733/contributions/
    - Proposal team will get in contact with stakeholders and ask for input-proposals
    - Contact persons will be assigned for the different topics
  - 2nd community meeting around middle of April April 20, https://indico.cern.ch/event/1246381/
    - Presentation of input-proposals (w/o disclosing confidential information)
    - Presentation of a WP Structure of DRD Calorimetry
      - Existing R&D collaborations may serve as guidance
  - Input-proposals will be condensed into a DRD Calorimetry proposal until (about) 1st of June 2023
    - Further iteration with stakeholders, community and higher level bodies

Towards implementation of DRD Calorimetry

- https://indico.cern.ch/event/1213733/contributions/

  Mainly ECFA Roadmap document, talks, Suggested DRD proposal guidance →

  A shared word document (no Q&As listed yet) →



Proposal template

- https://indico.cern.ch/event/1213733/contributions/

Author(s)
123 Votre rue
00000 Votre ville
(33) 00 00 00 00 00

Prototype of a kryptonite calorimeter

January 31st 2023

5 pages max. excluding institute description and table in appendix.

DESCRIPTION OF THE PROJECT AND POSITIONING W.R.T. THE ROADMAP

Kryptonite calorimetry has been identified as one of the most promising technologies for calorimeters at future colliders. Calorimeters of this type are still at the conceptual stage but can be expected to be mature at the time when the next big collider project will be approved. Kryptonite has an interaction length of 1um and can serve as an absorber medium and as pixelated sensitive material. Interacting particles create large and fast energy deposits, It can be readout w/o further amplification and signal shaping by future ultraflat and ultrafast ASICs (DRD 7). Its fast signal rise time enables time resolutions in the yoctosecond range. Both features allow for low power electronics without additional cooling. For all these reasons the proposal matches well the DRDT 6.x formulated in the ECFA Detector R&D Roadmap.

OBJECTIVES

1. Milestone: Construct a few prototype layers based on kryptonite
2. Deliverable: Build large scale kryptonite prototype using ultraflat ASICs and carry out beam tests in high energy particle beams to study energy and position resolution, particle separation and time resolution.

The following is not mandatory but useful supplementary information

LIST OF PARTICIPATING INSTITUTES/LABS WITH SHORT DESCRIPTION

INSTITUTE 1

The contact person of institute 1 is XXX YYY (xxx.yyy@institute.zz)

Institute 1 has xxx members. It has a large track record in experimental particle physics with leading contributions to LEP and LHC experiments and has competences in … .

INSTITUTE 2

APPENDIX: PARTICIPATING INSTITUTES AND THEIR RESOURCES

In the following we ask for succinct information about your project. This information will be used in the final proposal of the DRD Calorimetry. However, most of the information (i.e. Everything below "Confidential Information") will be kept confidential. This information will only be known to the author team, the proposal team and to a small set of reviewers that will be determined by the future DRDC.

input to DRD Calo	
Description/Timeline	**Technology Deliverable 1**
Description of Technology	Kryptonite Calorimeter
Targeted DRDT	6.x
Strategic program(s) target	Track: Sandwich calorimeters with fully embedded Electronics – Main and forward calorimeters
Performance target	Excellent hadronic energy resolution and particle separation.
Planned date	20xx: up to five kryptonite layers (M) 20xx: Large scale kryptonite prototype, 30 layers (D)
Resources - Confidential Information	
Existing R&D Framework and/or list of contributors	CALICE/AIDAinnova Institute 1, Institute 2, …
Description of contribution to technological deliverable	Institute 1: Kryptonite housing Institute 2: Kryptonite layers Institute 3: ASICs Institute 4: DAQ and online Institute 5: Coffee and cookies …
FTE Contributions already covered or expected to continue (Phys., Eng./Dev. and Techn.)	Institute 1: 1 Phys., 2 Eng., 1 Tech. Institute 2: 1 Phys., 2 Eng., 1 Tech. Institute 3: … Institute 4: … Institute 5: …
Proposed new FTE request (Phys., Eng./Dev. and Techn.)	Institute 1: 1 Phys., 2 Eng., 1 Tech. Institute 2: 1 Phys., 2 Eng., 1 Tech. Institute 3: … Institute 4: … Institute 5: …
"Materials" funding already covered or expected to continue	Institute 1: 10 kg kryptonite Institute 2: 2 ASICs available Institute 3: Simple DAQ system Institute 4: … Institute 5: …
Proposed "materials" funding to be requested	Institute 1: 100 BEUR for mining kryptonite on Vulcan Institute 2: 1 MEUR for 10000 ASICs Institute 3: 100 kEUR for performant DAQ Institute 4: … Institute 5: …

ECFA

Final remarks

European Strategy Update

- This year will see the implementation of the ECFA Detector R&D Roadmap
- Formation of DRDs that conduct the strategic R&D formulated in the roadmap
  - DRD are expected to be in place in one year from now!!
- The Implementation process builds upon confirmed panels and established detector R&D Communities
  - However, there is no real blueprint for what we are doing (at least what concerns Detector R&D)
  - Each DRD will decide on its own structure, likely starting from the experience of existing collaborations and working groups
  - It is important that we will formulate an attractive R&D programme that motivates to join the DRD Calo
  - For all this the continuous communication with the community is essential
- Today is an important milestone in the process!!!
  - How existing collaborations incorporated into the new structure
  - Collaborations between different DRD groups
- Communication:
  - News will be spread though the mailing function of the DRD Calo indico page
  - Discussions will (hopefully) happen among colleagues, at institute and national levels, within existing communities
  - Set up of a dedicated DRD-Calo work environment, stay tuned

Other talks

- Status, R&D challenges, and plans on various detector technologies:
  - Sandwich calorimeters:
    - CALICE ECAL (silicon/scintillator tiles) and HCAL (scintillator tiles/RPC/MM/GEM, analog/semi-digital/digital readout)
    - CALICE digital pixel calorimeter based on MAPS
    - Liquid noble gas calorimeters with high granularity electrodes
  - Optical calorimeters:
    - Homogeneous calorimetry (GRAiNITA, SCEPC from CalVision, HGCC for CEPC, CRILIN for longitudinal information, HHC)
    - Picosecond scintillating sampling ECAL: SpaCal (W/lead absorber and garnet crystal/scintillator fibers), 3D printing for absorbers
    - Tile hadronic calorimeter (Tile+WLS fiber+SiPM)
    - DRO Fiber calorimeter
    - Scintillator development (improving timing performance and radiation hardness, new production methods)

Main discussions

- ASICs, PCB, warm/cold electronics
- Mechanics, scalability, cooling, services
- Radiation tests, test beam infrastructure and coordination
- Timing requirements
- Simulation tools/particle flow algorithms/detector concept full simulation models
- Korea/China/US participation, funding continuation
- Synergies with other DRDs