



# Status of Detector R&D Yellow Report

CLICdp collaboration meeting  
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# Scope



- Review of current status and future plans for [CLIC detector technology R&D](#)
- Backup document for Input to [European Strategy Update](#) process
- [Review of results](#) achieved since CLIC CDR in 2012:
  - CLIC detector overview and experimental conditions
  - Vertex/tracker
  - Main calorimeters → CALICE
  - Forward calorimeters → FCAL
  - Readout electronics / DAQ
  - Appendices for major software and hardware tools developed within the CLIC detector R&D studies (Timepix3 beam telescope, Caribou DAQ, Allpix<sup>2</sup> simulation)
- Focus on [new results](#) + [CLIC-specific R&D](#) → emphasis on vertex/tracker
- [Review style](#), mostly citing already published material (notes, publications, proceedings, theses)
- Aim for [~100 pages](#) (no strict limitation, but need to keep balance btw. chapters)
- Publication as [CERN Yellow Report](#), reviewed within CLICdp

## 3. Vertex and tracking detector (40-50 p.)

- 3.1. Requirements . (\*) . . . . .
- 3.2. Detector concept (\*). . . . .
- 3.3. Hybrid readout ASICs . . . . .
  - 3.3.1. Timepix . . . . .
  - 3.3.2. Timepix3 . . . . .
  - 3.3.3. CLICpix .(\*) . . . . .
  - 3.3.4. CLICpix2 .(\*) . . . . .
- 3.4. Hybrid passive sensor assemblies . . . . .
  - 3.4.1. Fine-pitch bump bonding . . . . .
  - 3.4.2. Thin planar sensors . . . . .
    - 3.4.2.1. Timepix(3) study, thickness . . . . .
    - 3.4.2.2. CLICpix(2) resolution at 50um pitch, thickness . . . . .
  - 3.4.3. Active-edge sensors (\*) . . . . .
  - 3.4.4. Sensors with enhanced lateral drift (ELAD) . . . . .
- 3.5. CMOS sensors . . . . .
  - 3.5.1. Capacitively coupled active High-Voltage CMOS sensors . . . . .
  - 3.5.2. Monolithic High-Voltage CMOS sensors (\*). . . . .
  - 3.5.3. Monolithic High-Resistivity CMOS sensors . . . . .
  - 3.5.4. Monolithic SOI sensors . . . . .
- 3.6. Detector Integration . . . . .
  - 3.6.1. Backend processing (TSV) . . . . .
  - 3.6.2. Lightweight support structures . . . . .
  - 3.6.3. Assembly and cabling . . . . .
  - 3.6.4. Cooling . . . . .
- 3.7. Summary and outlook . . . . .

- Chapter editors: A. Nürnberg, DD
- Aim for ~40-50 pages + ~6p appendices
- Main sources:  
Publications, CLICdp notes, proceedings, AIDA-2020 report, theses Nilou, Matthew, Magdalena, Mateus, recent unpublished results
- Status:
  - chapter outline defined;
  - 10 pages of text and figures (\*)

Appendices (~6 pages):

- A. CaRIBOu scalable readout system**
- B. Beam telescope infrastructure (\*)**
- C. Simulation tools**

## 4. Calorimeters (10-12 p.)

- 4.1. Requirements for calorimetry at CLIC . . . . .
- 4.2. Detector concept . . . . .
  - 4.2.1. ECAL . . . . .
  - 4.2.2. HCAL . . . . .
- 4.3. Electromagnetic Calorimeter (ECAL) . . . . .
  - 4.3.1. Sensor + ASIC R&D . . . . .
  - 4.3.2. Assembly / mass-production . . . . .
  - 4.3.3. Mechanics, cooling, integration . . . . .
  - 4.3.4. Power pulsing . . . . .
  - 4.3.5. Test-beam results . . . . .
    - 4.3.5.1. Energy resolution . . . . .
    - 4.3.5.2. Particle separation . . . . .
    - 4.3.5.3. Software compensation . . . . .
- 4.4. Hadronic Calorimeter (HCAL) . . . . .
  - 4.4.1. Sensor and ASIC R&D . . . . .
  - 4.4.2. Assembly / mass production . . . . .
  - 4.4.3. Mechanics, cooling, integration . . . . .
  - 4.4.4. Power pulsing . . . . .
  - 4.4.5. Test-beam results . . . . .
    - 4.4.5.1. Energy resolution . . . . .
    - 4.4.5.2. Particle separation . . . . .
    - 4.4.5.3. Software compensation . . . . .
    - 4.4.5.4. Timing . . . . .
    - 4.4.5.5. Combined performance ECAL+HCAL . . . . .
- 4.5. Summary and Outlook . . . . .

- Chapter editor: K. Krüger
- Aim for ~10-12 pages
- Main sources: CLICdet note, CALICE publications + analysis notes, proceedings (overlap with other ESU documents)
- Status:
  - chapter outline defined
  - sources for material and contributors identified

# Forward Calorimeters



## 5. Very forward calorimeters (6-8 p.)

5.1. Requirements	
5.2. Detector concept	} From CLICdet note
5.2.1. Luminosity calorimeter (LumiCal)	
5.2.2. Beam calorimeter (BeamCal)	
5.3. Mechanics	
5.4. Sensor & ASIC R&D	
5.5. Test-beam results	
5.5.1. Performance of a fully instrumented detector plane	} published
5.5.2. Results from a multilayer stack	
5.5.3. Results from thin-sensor stack with tracking layers	→ publ.+thesis draft
5.6. Summary and outlook	

- Chapter editor: A. Levy
- Aim for ~6-8 pages
- Main sources: CLICdet note, 2015 JINST 10 P05009, Eur. Phys. J. C 78 (2018) 135, thesis draft Itamar, conference proceedings Sasha and Veta (overlap with other ESU documents)
- Status:
  - chapter outline defined
  - Sources for material and contributors identified

## 6. Readout electronics and data acquisition system (8-10 p.)

6.1. Detector readout requirements . . . . .	
6.2. Subdetector implementation schemes (*) . . . . .	
6.2.1. Example implementation for calorimeters . . . . .	
6.2.2. Estimation of CLIC detector rates (*) → Readout overview table . . . . .	
6.3. Power delivery and power pulsing . . . . .	
6.3.1. Implementation example: vertex detector (*) . . . . .	
6.3.2. Implementation example: calorimeters . → CALICE prototypes (from Katja) . . . . .	
6.4. Summary and Outlook . . . . .	

- Chapter editor: E. Sicking (with help from S. Kulis, X. Llopart and CERN CMS DAQ group)
- Aim for ~8-10 pages
- Main sources: Notes, proceedings, new estimates (cf. Eva's presentation for advisory board review)
- Status:
  - chapter outline draft
  - 5 pages of text and figures (\*), including first draft of r/o overview table

# Timeline



- **Mid September**: first draft including all chapters
- **Mid October**: submission of final version to PubCom, ~1 week for initial feedback + implementing it
- **End October**: start of collaboration review (~3 weeks?)
- **~End November**: deadline for review within CLICdp , ~10 days for implementing comments
- **December 1<sup>st</sup>: deadline for submission to CREB (CERN Reports Editorial Board)**
- **December 8<sup>th</sup>**: feedback from (formal) CREB review, assignment of CERN-2018-xxx number (→ reference for summary report), few days for implementing comments (final editing / publishing support from CERN library group t.b.c.)
- **Mid December**: submission to CDS, arXiv
- **December 18<sup>th</sup>: deadline for community input to ESU**