

# Summary of WP14

## Infrastructure for advanced calorimeters

Frank Simon, MPI for Physics

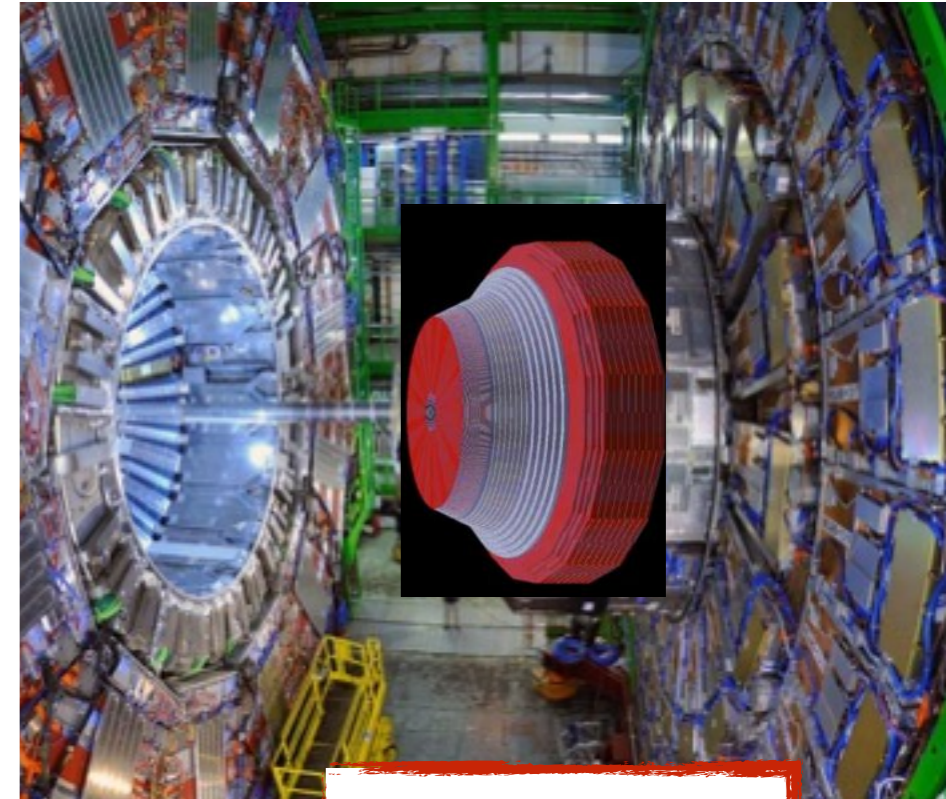
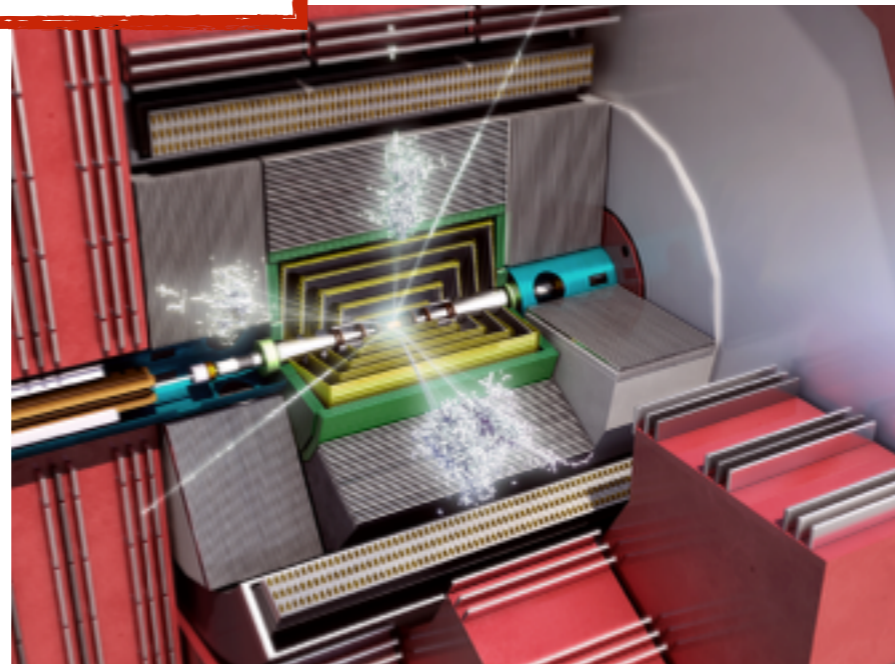
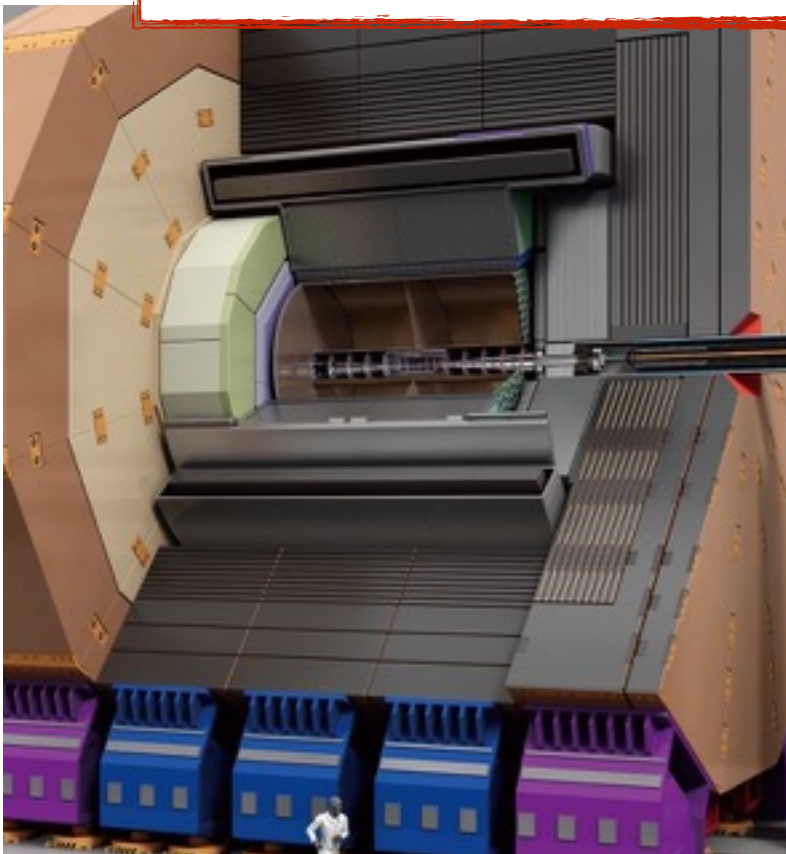
AIDA2020 Kickoff Meeting, CERN, June 2015



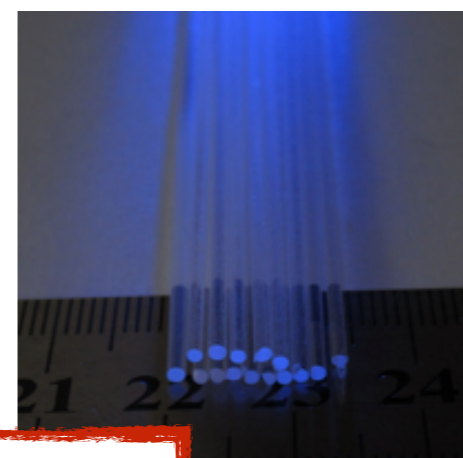
# The Context: Calorimetry in High Energy Physics

- Calorimeters are key components in all HEP detectors
  - Active development for LHC upgrades and future Facilities, generic R&D for novel materials

Linear  $e^+e^-$  colliders ILC & CLIC



CMS Upgrade



New Materials

# The Motivation for WP14

---

- The goal of WP14:  
To provide tools to facilitate the development, construction and evaluation of modern calorimeter technologies and calorimeter systems for HEP experiments

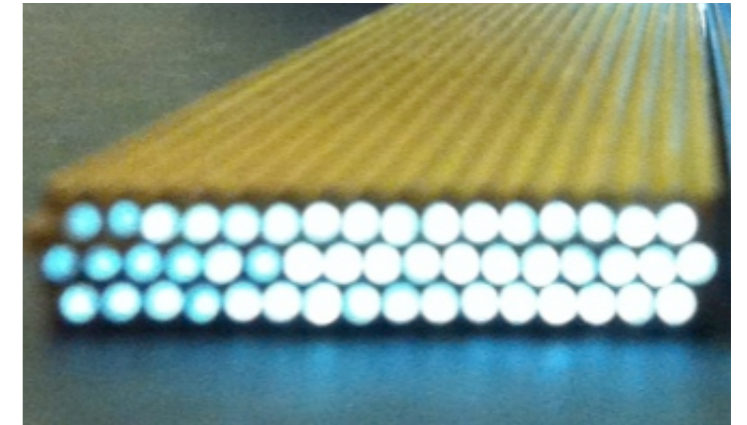
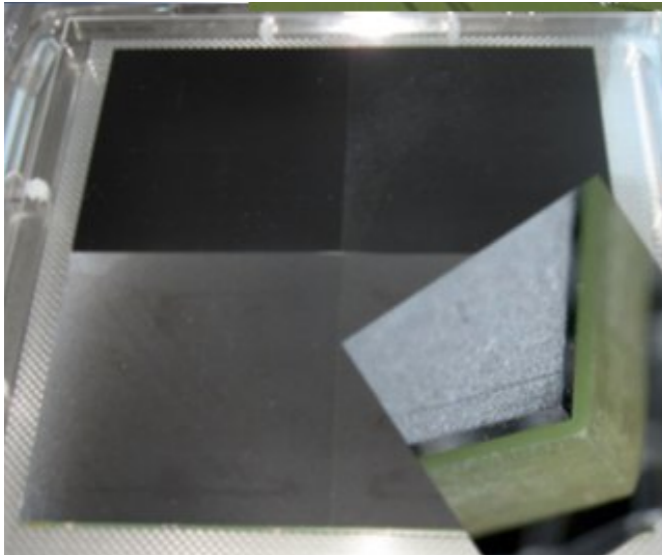
# The Motivation for WP14

---

- The goal of WP14:  
To provide tools to facilitate the development, construction and evaluation of modern calorimeter technologies and calorimeter systems for HEP experiments
- Our hope for WP14:  
Develop a platform for calorimeter R&D in Europe, which
  - brings the different communities closer together around common tools and challenges
  - exploits synergies beyond those already envisioned in the proposal
  - may provide the seed for more intense collaboration

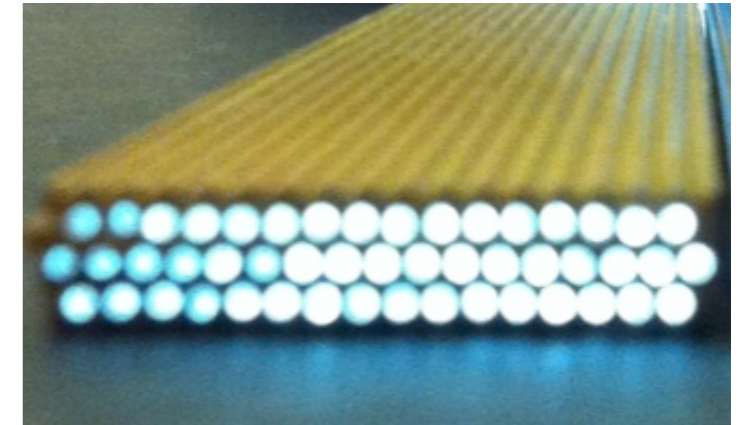
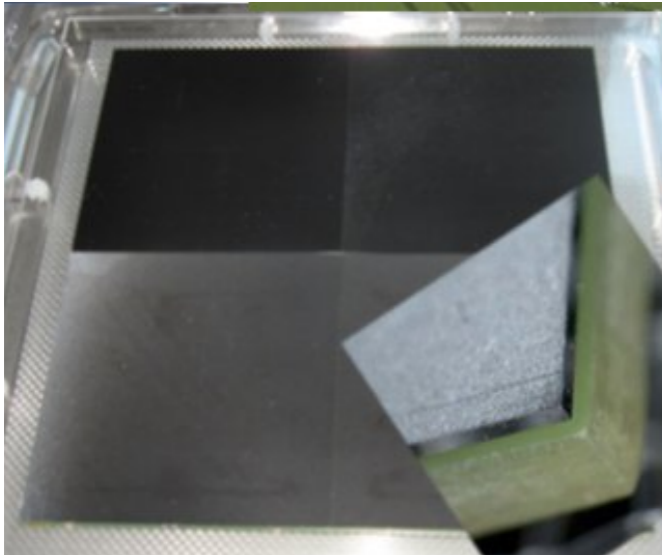
# WP14: Infrastructure for all Calorimeter Components

- Active elements - Silicon, Scintillator (Crystals, Plastic; tiles & fibers), photon sensors

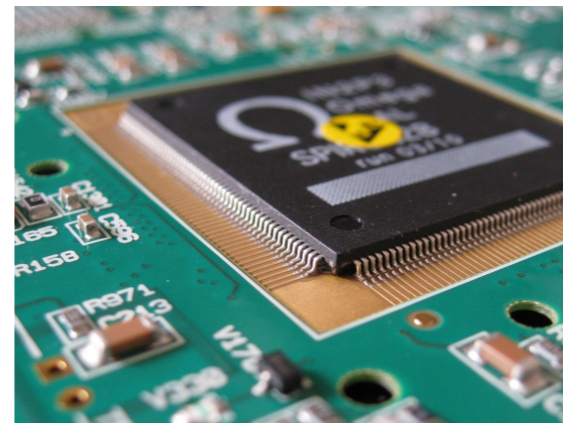


# WP14: Infrastructure for all Calorimeter Components

- Active elements - Silicon, Scintillator (Crystals, Plastic; tiles & fibers), photon sensors

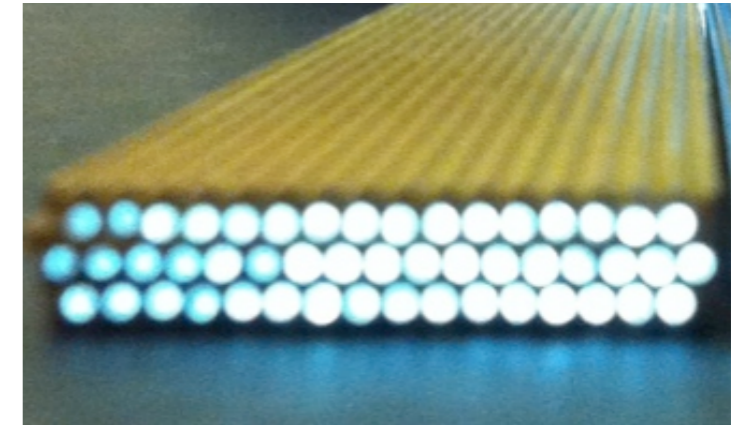
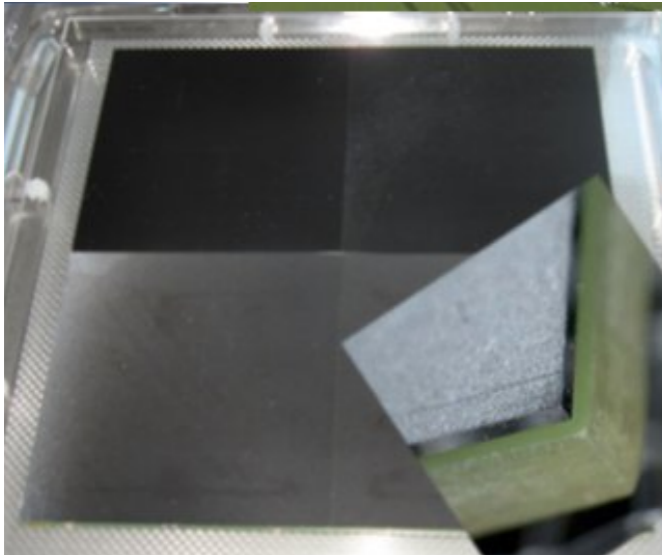


- Readout and DAQ
  - Close connection to WPs 4 & 5

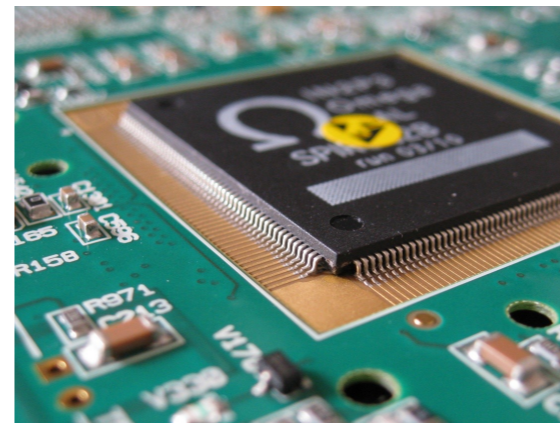


# WP14: Infrastructure for all Calorimeter Components

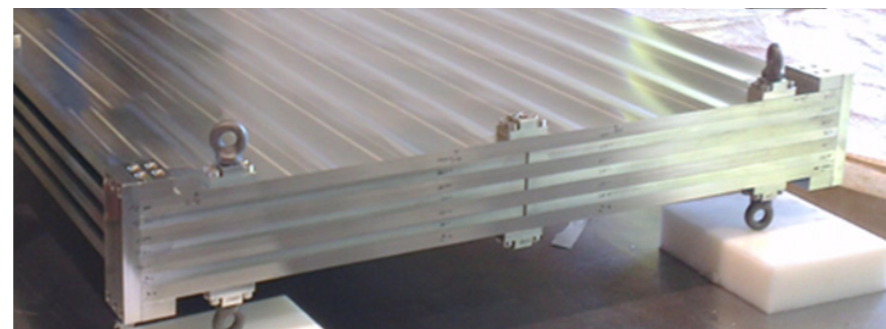
- Active elements - Silicon, Scintillator (Crystals, Plastic; tiles & fibers), photon sensors



- Readout and DAQ
  - Close connection to WPs 4 & 5



- Mechanics & Cooling



# WP14 Participants

- Beneficiaries
  - AGH-UST
  - CERN
  - CIEMAT
  - CNRS - IPNL, LAL, LLR, LPNHE, LPSC
  - DESY
  - ETHZ
  - INFN - MI, RTV, TO
  - IPASCR
  - JGU
  - MPG-MPP
  - TAU
  - UiB
  - VU

- Associated Partners - receive funding through beneficiaries
  - CERN: Brunel, Imperial, Minsk
  - DESY: U HD, U W
  - INFN: UniMIB
  - TAU: IFJPAN

- External partners
  - Vinca Institute, Serbia
  - Gangneung-Wonju National University, Korea



# The Team of WP14

---

- Two task leaders for each task - to provide expertise in all topics within a task and to represent the full breadth of the WP14 community
- Work package leaders (and Task 14.1):  
Roman Pöschl (CNRS-LAL), Frank Simon (MPG-MPP)
- Task 14.2: Entiennette Auffray (CERN), Lucia Masetti (JGU)
- Task 14.3: Vincent Boudry (CNRS-LLR), Marek Idzik (AGH-UST)
- Task 14.4: Katja Krüger (DESY), Dirk Zerwas (CNRS-LAL)
- Task 14.5: MaryCruz Fouz (CIEMAT), Denis Grondin (CNRS-LPSC)

# WP14 Tasks: 14.2

---

- *Test infrastructure for innovative calorimeters with optical readout*

## **14.2.1** *Test benches for characterisation of organic and inorganic scintillator material*

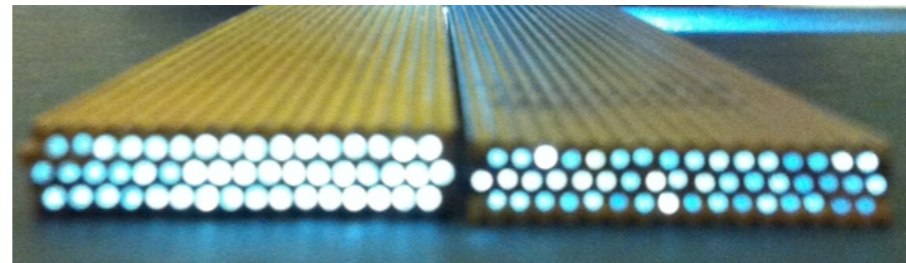
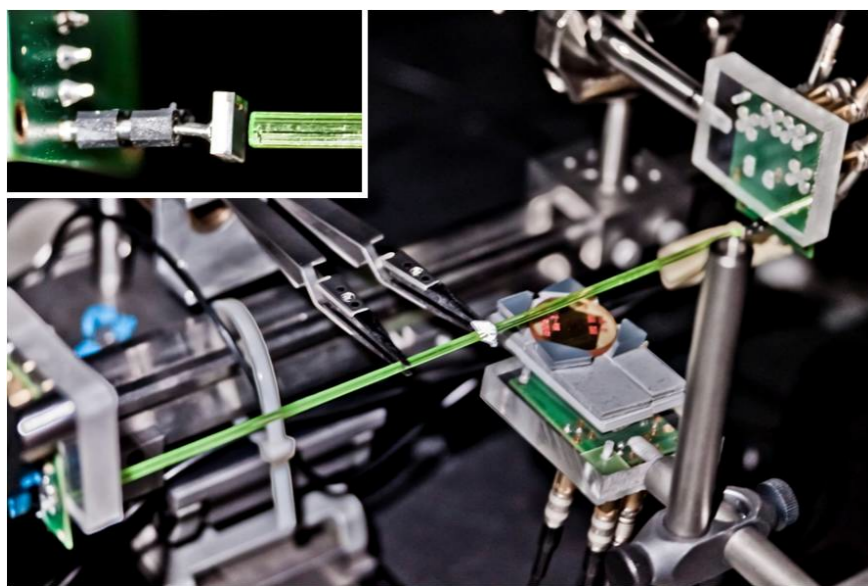
(CERN [CERN, RINP, Brunel], INFN [Torino, Roma, MiB, UNIMiB], VU, ETHZ)

## **14.2.2** *Test benches for the characterisation of highly granular calorimeter elements with scintillator and SiPM readout* (JGU, DESY [Uni Heidelberg], MPG-MPP, UiB, IPASCR)

# WP14 Tasks: 14.2

- *Test infrastructure for innovative calorimeters with optical readout*
  - 14.2.1** *Test benches for characterisation of organic and inorganic scintillator material* (CERN [CERN, RINP, Brunel], INFN [Torino, Roma, MiB, UNIMiB], VU, ETHZ)
  - 14.2.2** *Test benches for the characterisation of highly granular calorimeter elements with scintillator and SiPM readout* (JGU, DESY [Uni Heidelberg], MPG-MPP, UiB, IPASCR)

## Tests and characterisation of scintillators



Beam test infrastructure,  
infrastructure for radiation  
hardness tests

# WP14 Tasks: 14.2

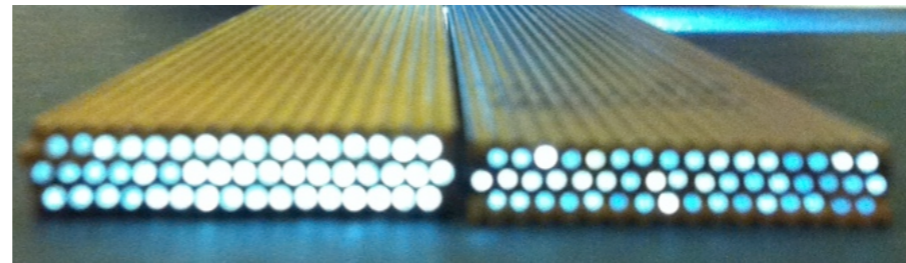
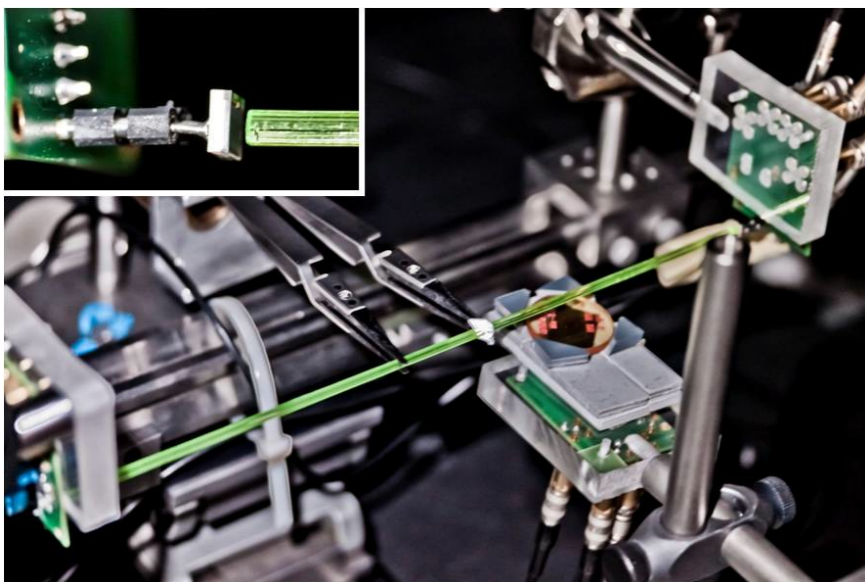
- *Test infrastructure for innovative calorimeters with optical readout*

## **14.2.1** *Test benches for characterisation of organic and inorganic scintillator material*

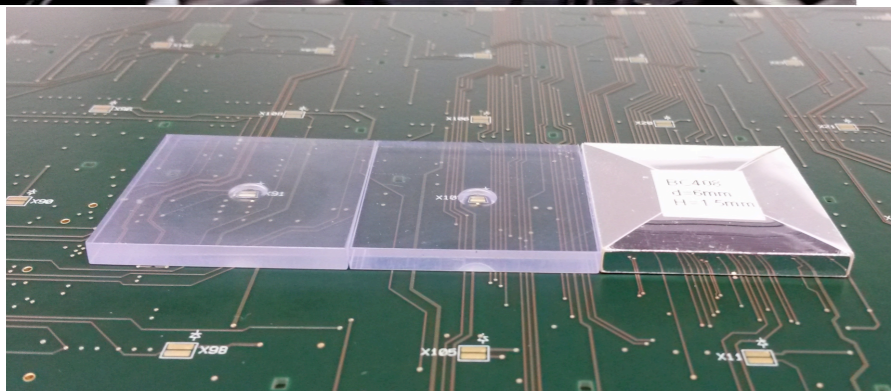
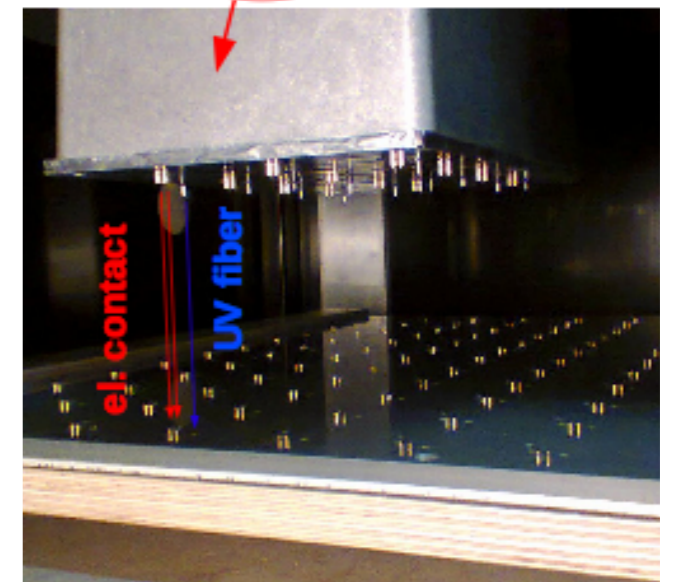
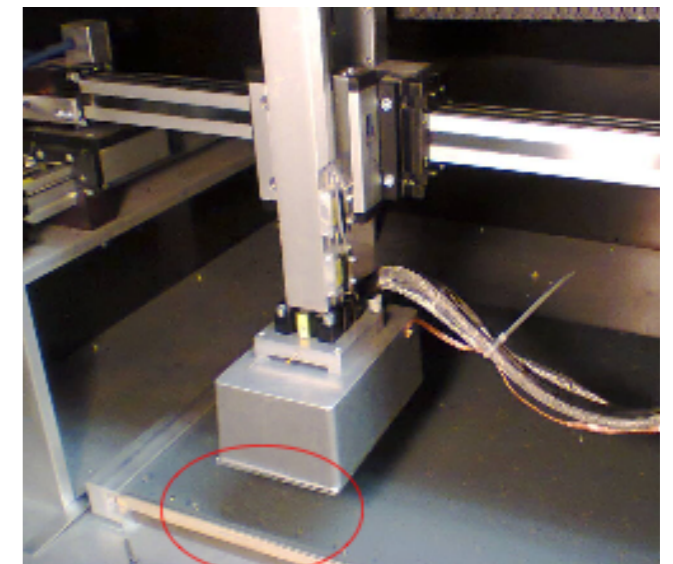
(CERN [CERN, RINP, Brunel], INFN [Torino, Roma, MiB, UNIMiB], VU, ETHZ)

## **14.2.2** *Test benches for the characterisation of highly granular calorimeter elements with scintillator and SiPM readout* (JGU, DESY [Uni Heidelberg], MPG-MPP, UiB, IPASCR)

### Tests and characterisation of scintillators



Beam test infrastructure,  
infrastructure for radiation  
hardness tests



Test facilities for scintillator  
tiles with SiPM readout and  
mass SiPM tests

# WP14 Tasks: 14.3

---

- *Test infrastructure for innovative calorimeters with semiconductor readout*

## **14.3.1** *Assembly and QA Chain for silicon-based ECALs*

(CNRS [LLR, LAL, LPNHE], CERN [CERN, Imperial])

## **14.3.2** *Infrastructure for very compact Tungsten based calorimetry*

(DESY [Zeuthen], AGH-UST, TAU [Tel Aviv, IFJPAN], Vinca)

# WP14 Tasks: 14.3

- *Test infrastructure for innovative calorimeters with semiconductor readout*

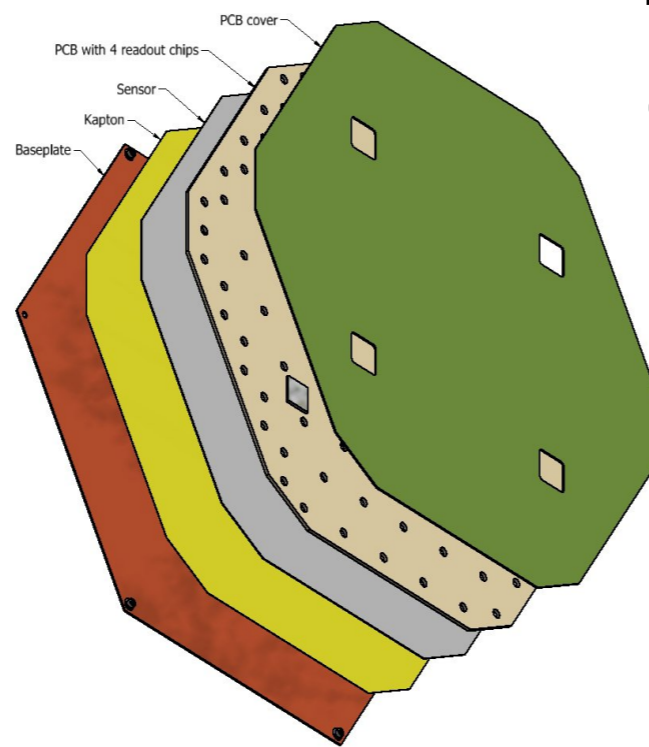
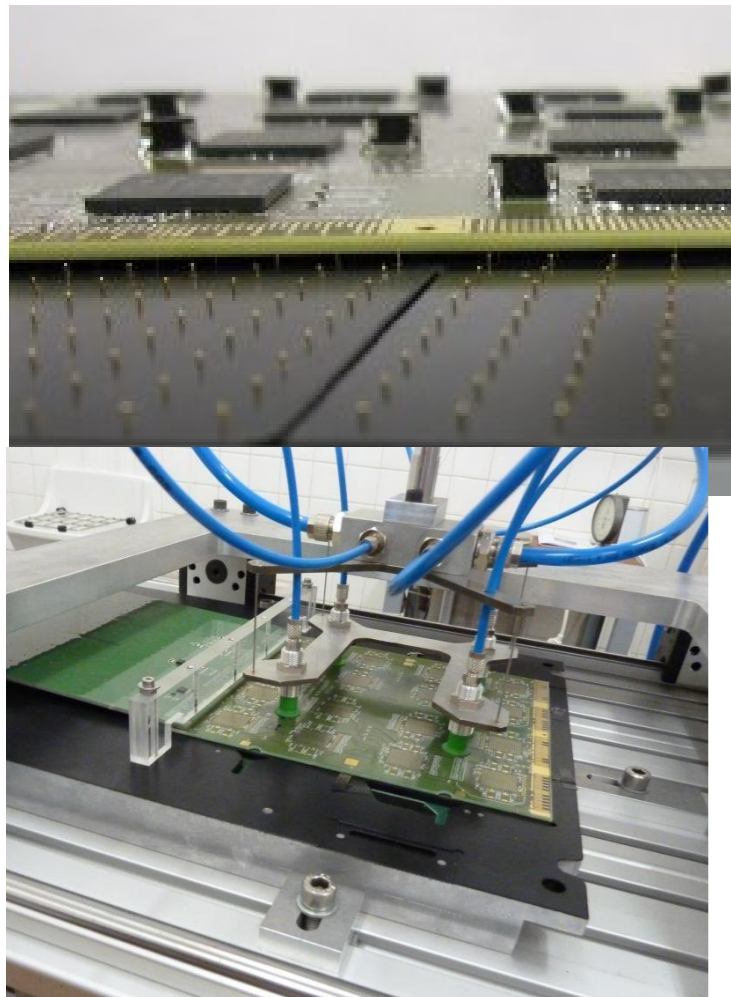
## **14.3.1** *Assembly and QA Chain for silicon-based ECALs*

(CNRS [LLR, LAL, LPNHE], CERN [CERN, Imperial])

## **14.3.2** *Infrastructure for very compact Tungsten based calorimetry*

(DESY [Zeuthen], AGH-UST, TAU [Tel Aviv, IFJPAN], Vinca)

Flexible FE test bench



Test beam infrastructure for CMS HGCAL

Assembly infrastructure, exploring industrialisation

# WP14 Tasks: 14.3

- *Test infrastructure for innovative calorimeters with semiconductor readout*

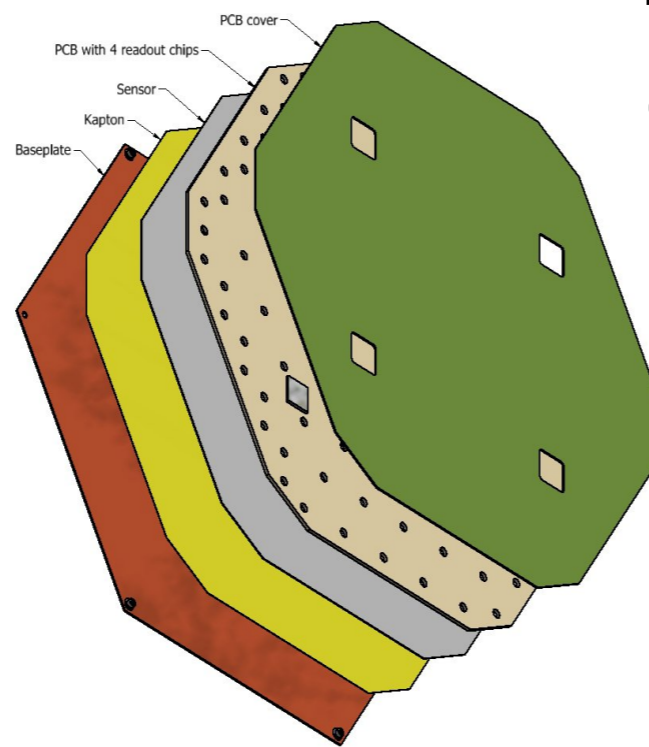
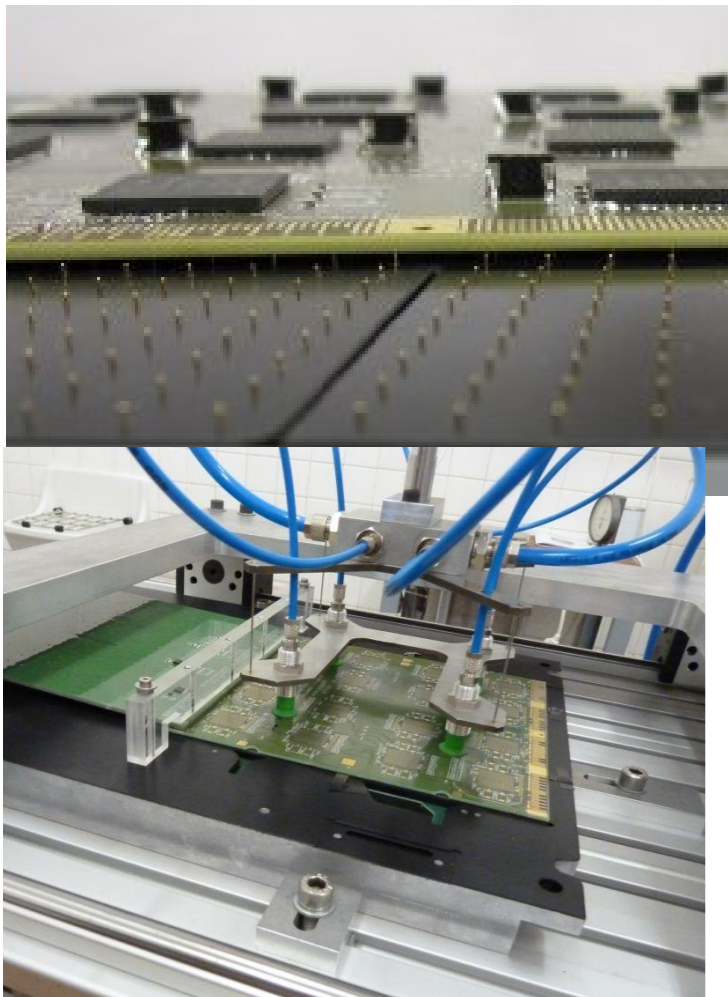
## 14.3.1 Assembly and QA Chain for silicon-based ECALs

(CNRS [LLR, LAL, LPNHE], CERN [CERN, Imperial])

## 14.3.2 Infrastructure for very compact Tungsten based calorimetry

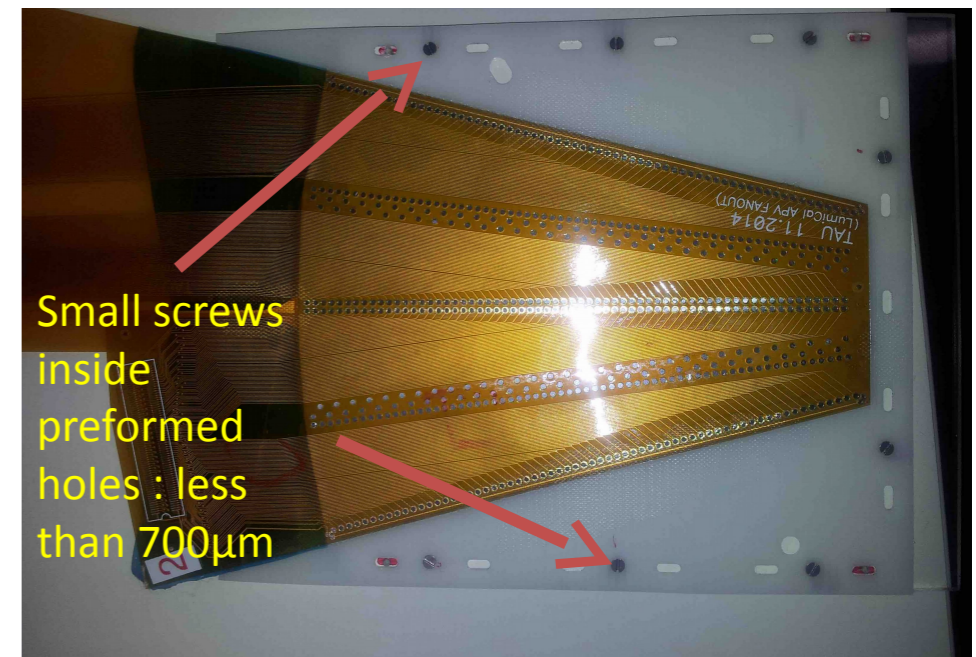
(DESY [Zeuthen], AGH-UST, TAU [Tel Aviv, IFJPAN], Vinca)

### Flexible FE test bench



Assembly infrastructure,  
exploring industrialisation

### Test beam infrastructure for CMS HGCAL



Units to test very compact  
forward calorimeters

# WP14 Tasks: 14.4

---

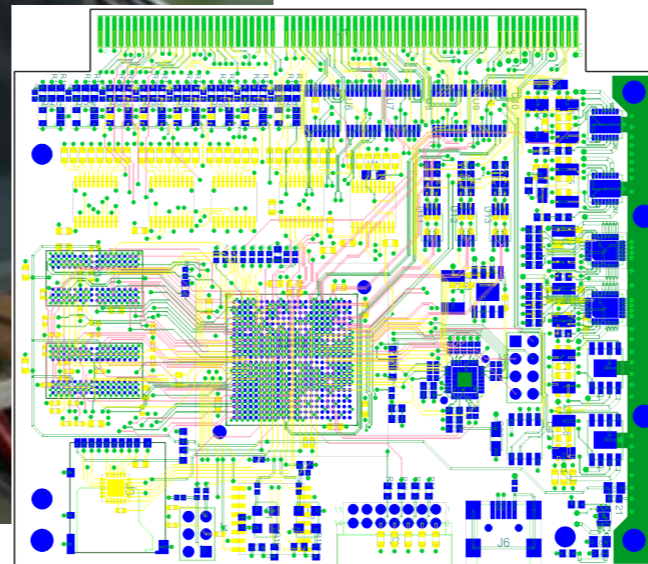
- *Readout systems for innovative calorimeters*
    - 14.4.1 LC Calorimetry specific DAQ interfaces** (IPASCR, CNRS [IPNL, LLR], DESY [Hamburg])
    - 14.4.2 Low Power Readout & Monitoring systems**  
(CNRS [LAL, IPNL], DESY [Hamburg, Uni Wuppertal])
- ⇒ Directly interfaces with WP5 on LC-specific DAQ



# WP14 Tasks: 14.4

- *Readout systems for innovative calorimeters*
    - 14.4.1 LC Calorimetry specific DAQ interfaces** (IPASCR, CNRS [IPNL, LLR], DESY [Hamburg])
    - 14.4.2 Low Power Readout & Monitoring systems** (CNRS [LAL, IPNL], DESY [Hamburg, Uni Wuppertal])
- ⇒ Directly interfaces with WP5 on LC-specific DAQ

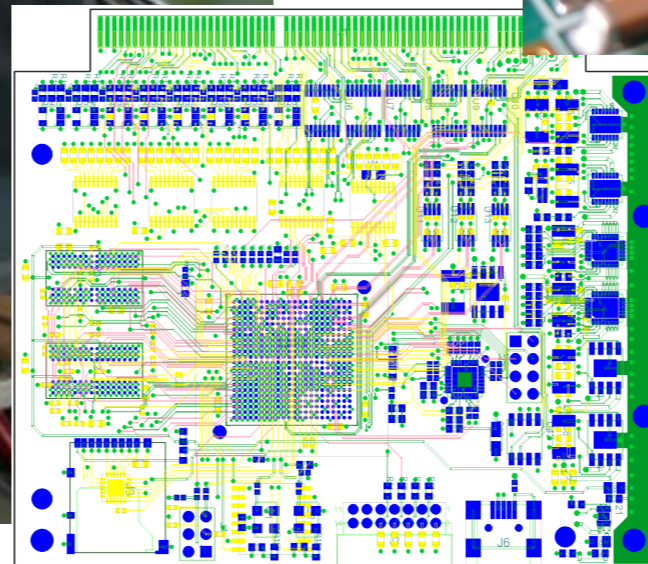
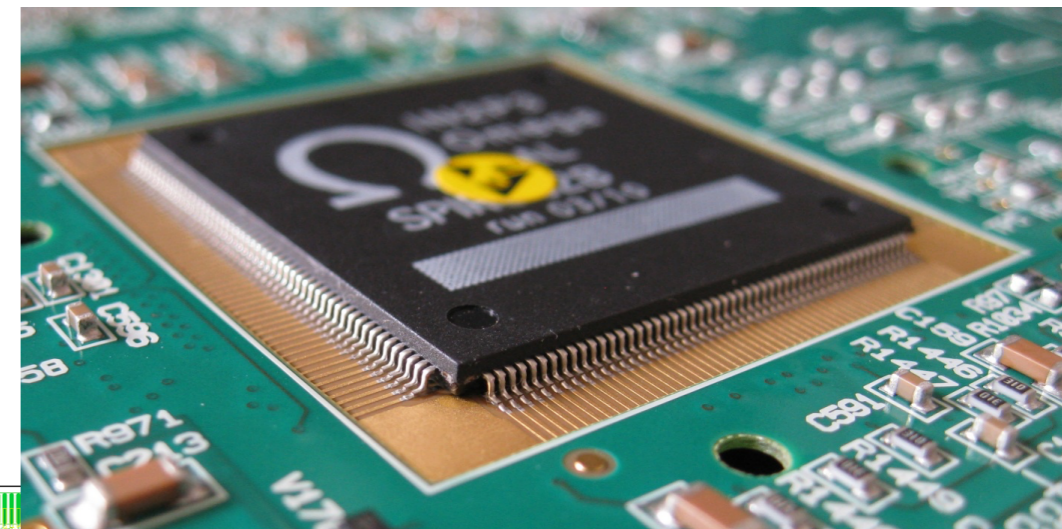
Detector interface cards (DIF) for SiW ECALs,  
RPC and SiPM / scintillator HCALs



# WP14 Tasks: 14.4

- *Readout systems for innovative calorimeters*
    - 14.4.1 LC Calorimetry specific DAQ interfaces** (IPASCR, CNRS [IPNL, LLR], DESY [Hamburg])
    - 14.4.2 Low Power Readout & Monitoring systems** (CNRS [LAL, IPNL], DESY [Hamburg, Uni Wuppertal])
- ⇒ Directly interfaces with WP5 on LC-specific DAQ

Detector interface cards (DIF) for SiW ECALs, RPC and SiPM / scintillator HCALs



Test bench for high volume ASIC tests (full detector requires ~ 200k ASICs)

# WP14 Tasks: 14.5

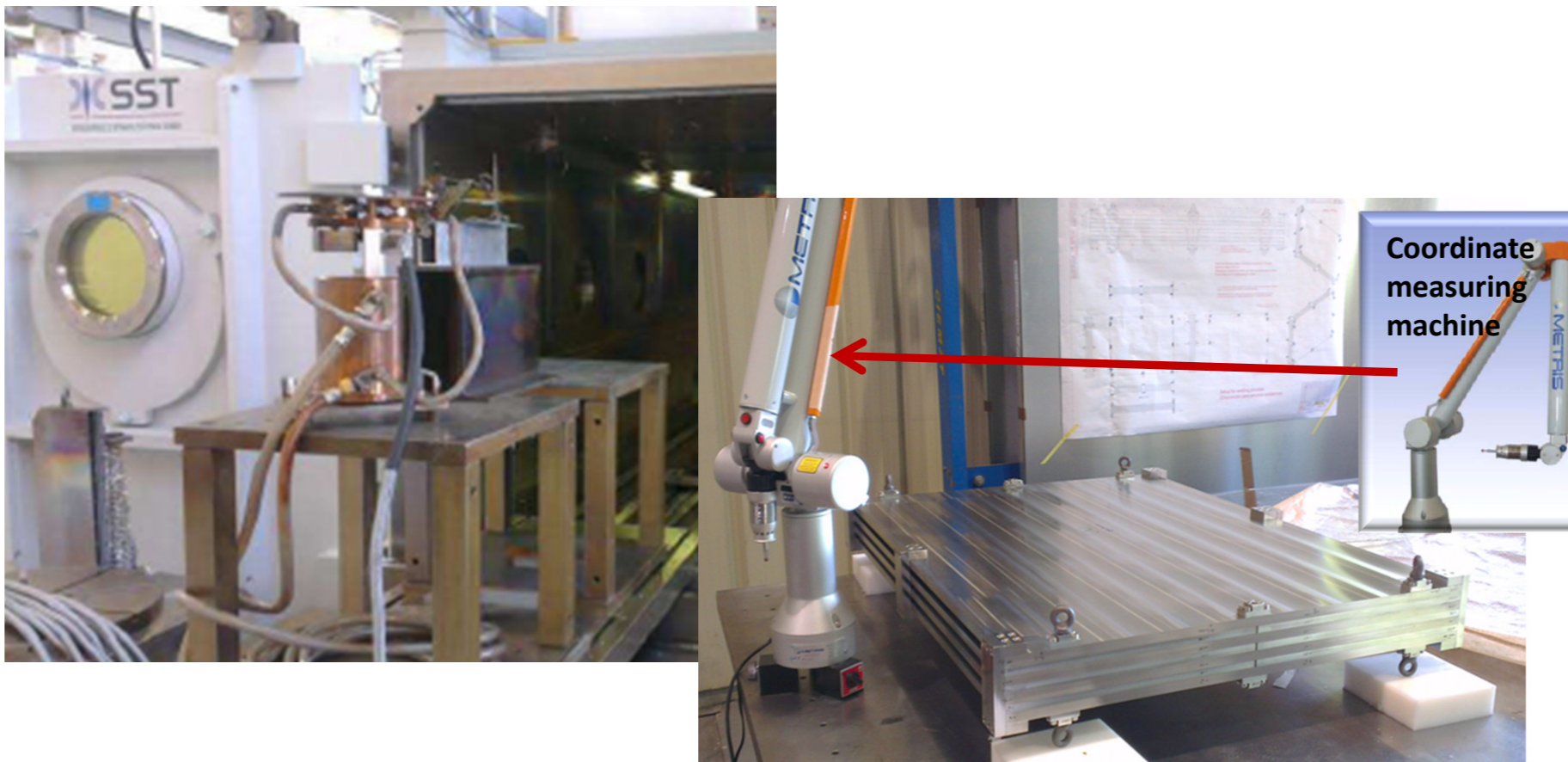
---

- *Mechanical and thermal tools for innovative calorimeters*
  - 14.5.1** *Precision mechanics for calorimeter structures* (CIEMAT [Madrid])
  - 14.5.2** *Infrastructure to evaluate thermal properties of calorimeter structures* (CNRS [LPSC], DESY [Hamburg])

# WP14 Tasks: 14.5

- *Mechanical and thermal tools for innovative calorimeters*
  - 14.5.1** *Precision mechanics for calorimeter structures* (CIEMAT [Madrid])
  - 14.5.2** *Infrastructure to evaluate thermal properties of calorimeter structures* (CNRS [LPSC], DESY [Hamburg])

Demonstrator to study beam welding for high-precision calorimeter absorber structures

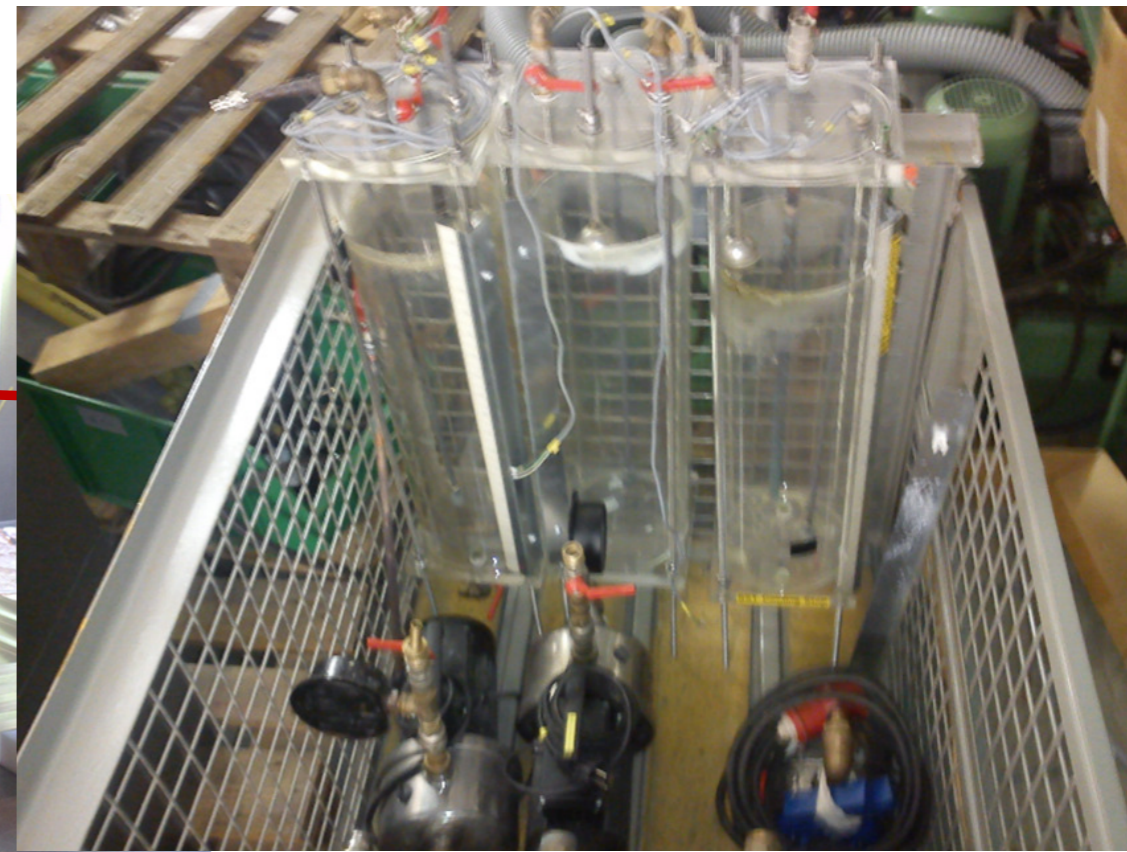
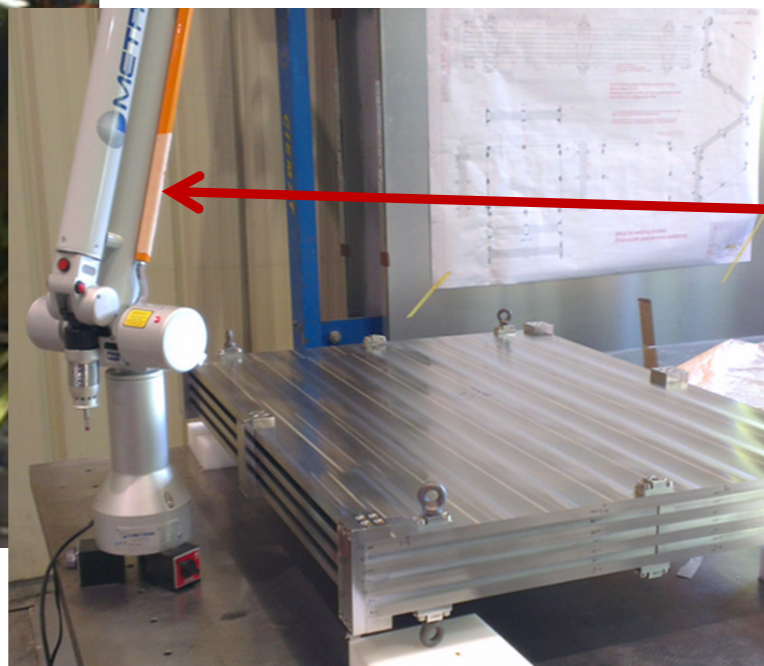
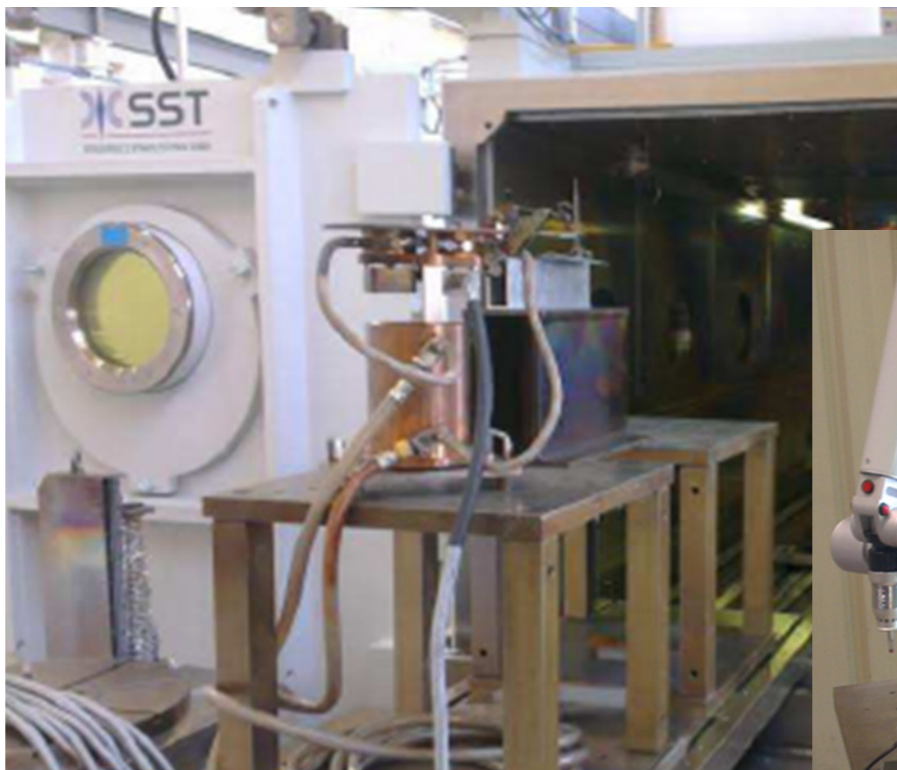


# WP14 Tasks: 14.5

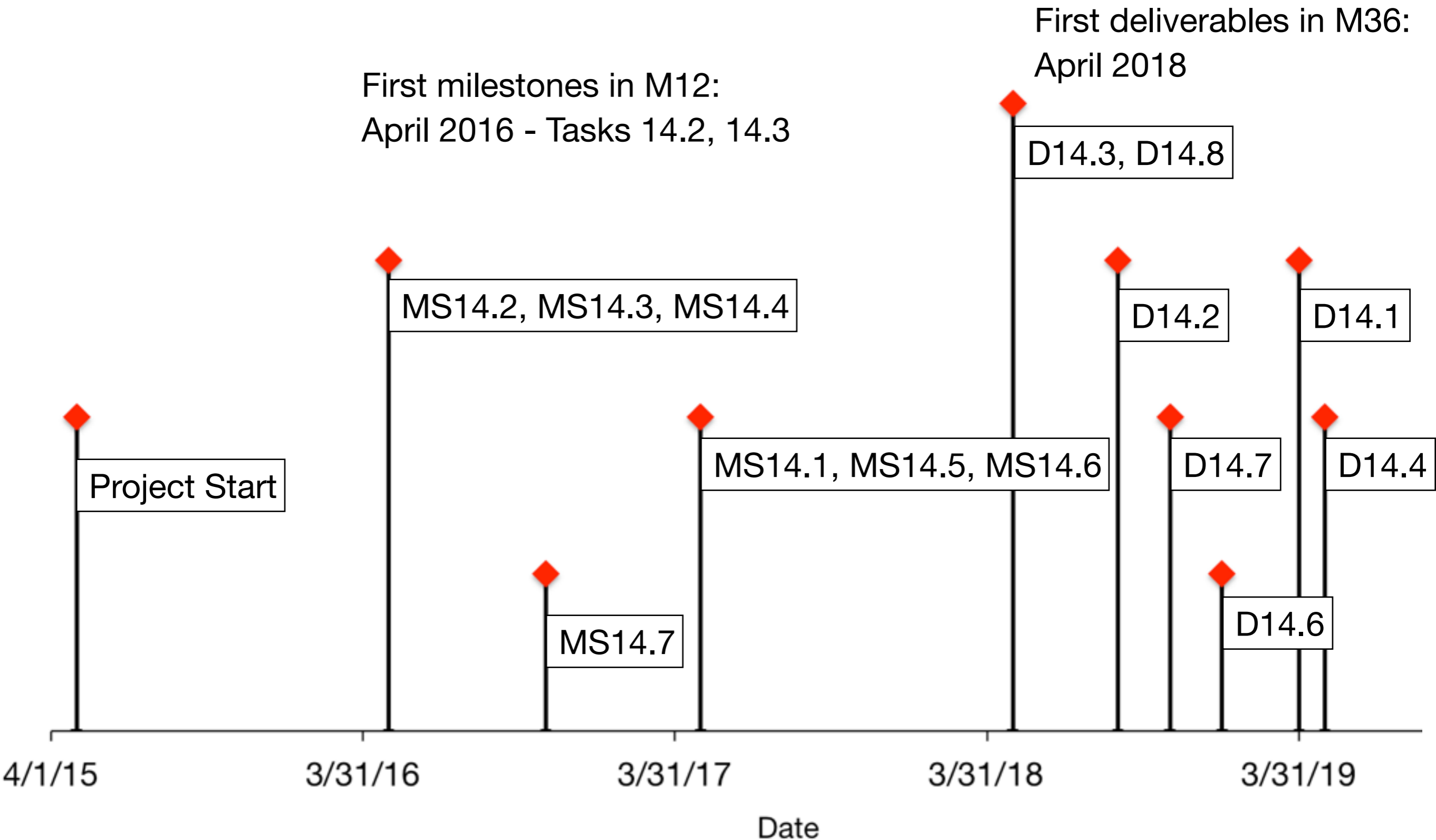
- *Mechanical and thermal tools for innovative calorimeters*
  - 14.5.1** *Precision mechanics for calorimeter structures* (CIEMAT [Madrid])
  - 14.5.2** *Infrastructure to evaluate thermal properties of calorimeter structures* (CNRS [LPSC], DESY [Hamburg])

Demonstrator to study beam welding for high-precision calorimeter absorber structures

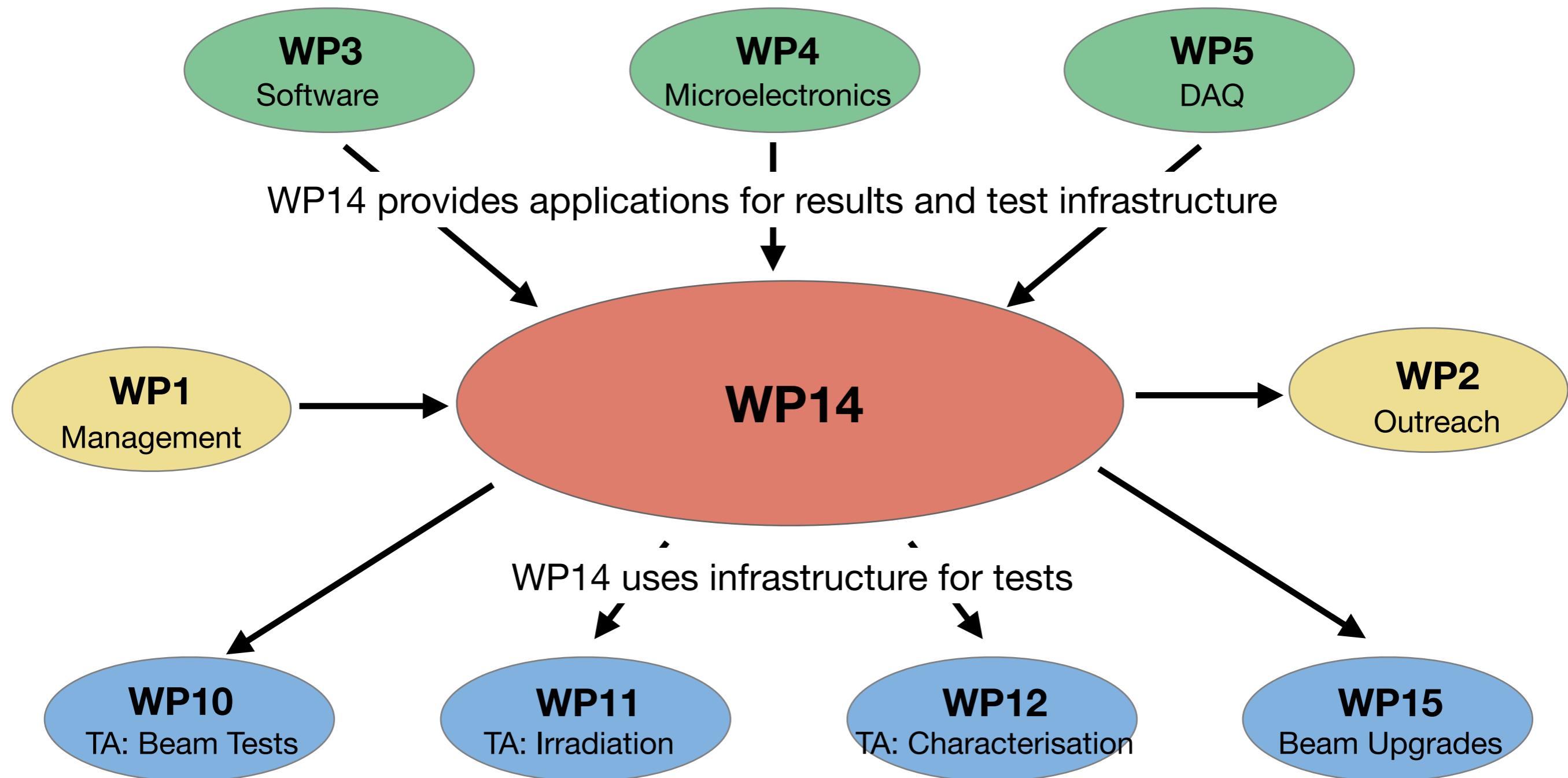
Leak-less cooling systems for test beams as demonstrators for full detector systems



# The Time Structure of WP14



# WP14 in AIDA2020



# Summary

---

- WP14 is one of three Joint Research Activities in AIDA-2020 - with the goal to develop infrastructure for the development, construction and operation of HEP calorimeters and calorimeter technologies
- Four tasks (+ management):
  - Test infrastructure for innovative calorimeters with optical readout
  - Test infrastructure for innovative calorimeters with semiconductor readout
  - Readout systems for innovative calorimeters
  - Mechanical and thermal tools for innovative calorimeters
- Brings together LHC and Linear Collider community around common challenges and technologies



# Summary

---

- WP14 is one of three Joint Research Activities in AIDA-2020 - with the goal to develop infrastructure for the development, construction and operation of HEP calorimeters and calorimeter technologies
- Four tasks (+ management):
  - Test infrastructure for innovative calorimeters with optical readout
  - Test infrastructure for innovative calorimeters with semiconductor readout
  - Readout systems for innovative calorimeters
  - Mechanical and thermal tools for innovative calorimeters
- Brings together LHC and Linear Collider community around common challenges and technologies

If you want to stay informed about WP14 sign up to the mailing list:  
[AIDA-2020-WP14@cern.ch](mailto:AIDA-2020-WP14@cern.ch)

# Backup - WP Details

# The Anchors: Milestones

|             | Title   | Lead Ben. | Task   | Month |
|-------------|---|-----------|--------|-------|
| MS14.1 (56) | Commissioning of fibre test benches   | CERN      | 14.2.1 | 24    |
| MS14.2 (13) | Specification of systems for highly granular scintillator tests   | MPG-MPP   | 14.2.2 | 12    |
| MS14.3 (14) | Assembly and QA chain demonstration for highly granular silicon calorimeters                            | CNRS      | 14.3.1 | 12    |
| MS14.4 (15) | Design specifications of test stations for irradiated Si sensors and LHC oriented front-end electronics | CERN      | 14.3.1 | 12    |
| MS14.5 (57) | Design and test of ASICS and readout board prototype for test infrastructure                            | AGH-UST   | 14.3.2 | 24    |
| MS14.6 (58) | Definition of optical and electrical coupling of readout, interface functionality and DIF design        | CNRS      | 14.4.2 | 24    |
| MS14.7 (31) | Design of cooling system for tungsten / carbon-fibre and for HCAL structures                            | DESY      | 14.5.2 | 18    |

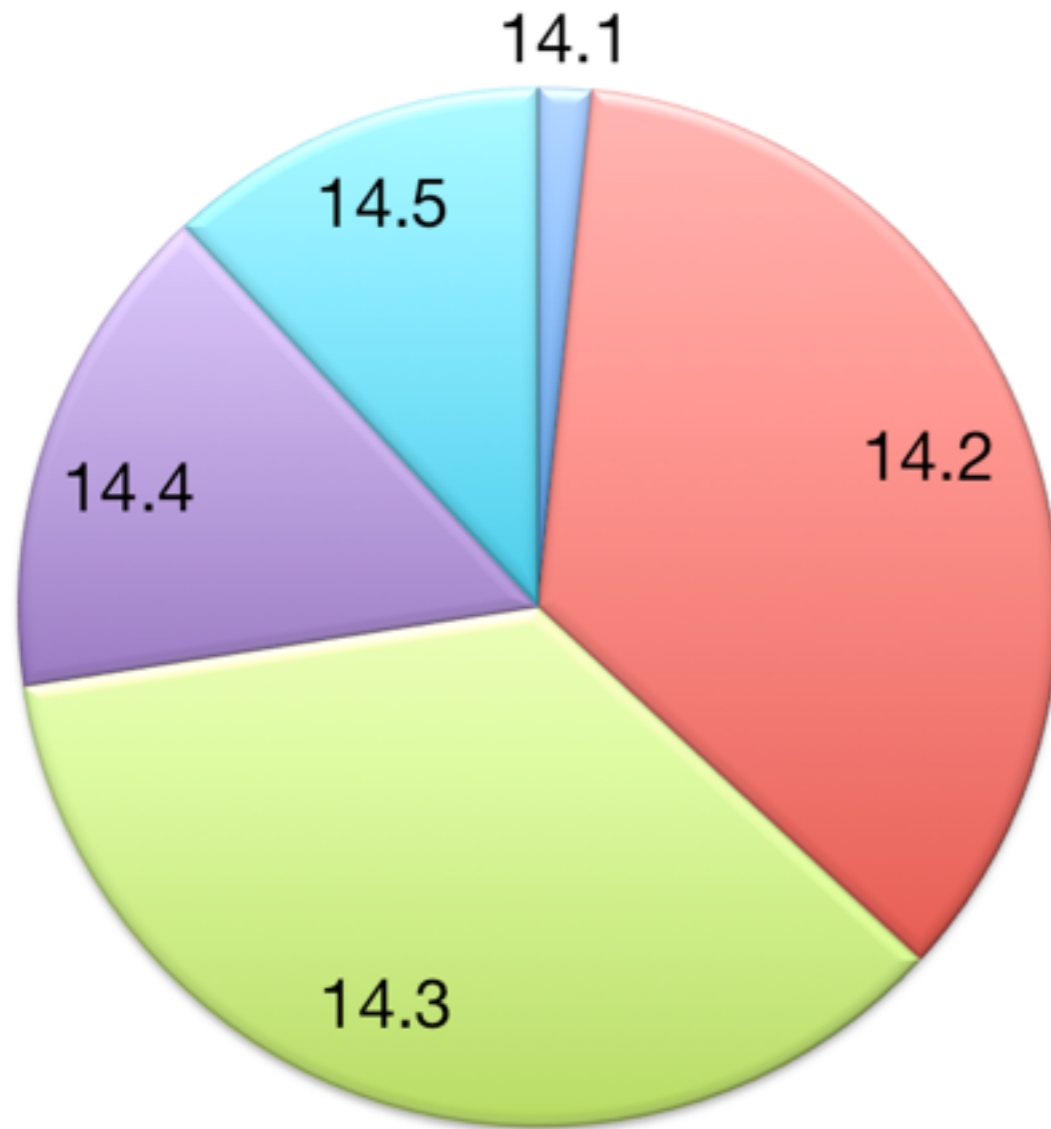
# The Anchors: Deliverables

|       | Title  | Lead Ben. | Task   | Month |
|-------|--|-----------|--------|-------|
| D14.1 | Fibre test benches   | CERN      | 14.2.1 | 47    |
| D14.2 | Performance of test infrastructure for highly granular optical readout | MPG-MPP   | 14.2.2 | 40    |
| D14.3 | Advanced assembly chain for Si calorimeters                            | CNRS      | 14.3.1 | 36    |
| D14.4 | Very compact calorimeters  | AGH-UST   | 14.3.2 | 48    |
| D14.5 | Common running of calorimeter prototypes                               | DESY      | 14.4.1 | 36    |
| D14.6 | Updated readout system   | CNRS      | 14.4.2 | 44    |
| D14.7 | Electron beam welding demonstrator                                     | CIEMAT    | 14.5.1 | 42    |
| D14.8 | Large leak-less system, thermal model                                  | DESY      | 14.5.2 | 36    |

One deliverable per sub-task

# WP14 - Finances

WP14 EC Funding - Total 966 kEUR



- EC Funding: 966 kEUR
- Total costs: 2.45 MEUR
  - 281 PM, 461 kEUR material direct cost

WP14 EC Funding Distribution

