AIDA 2020

Advanced European Infrastructures for Detectors at Accelerators

The future version of AIDA-2020 and the roadmap to Horizon Europe

Paolo Giacomelli
INFN Bologna

CSN1
Roma, May 28, 2019

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654168.

History

- FP6: EUDET: 2006-2010
  - Detector development for linear collider
- FP7: AIDA: 2011-2014
  - Detector development for LHC upgrades and linear colliders
  - Project-specific work packages
- FP8: AIDA-2020 started in May 2015
  - Common LC and LHC work packages
  - New communities: large cryogenic neutrino experiments, new topics
  - New innovation measures, with industry
- **All projects have a strong leverage on matching funds**

Increasing level of integration

AIDA

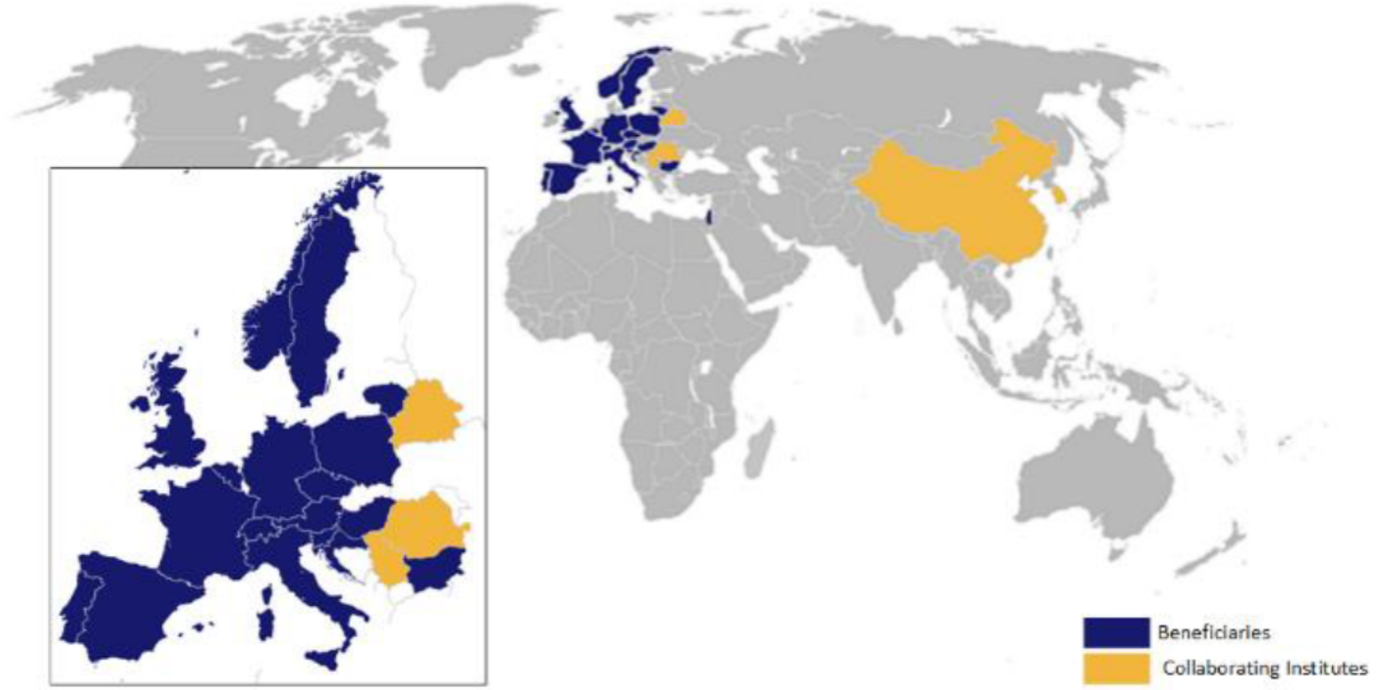
AIDA 2020

AIDA 2020

Advanced European infrastructure for Detectors at Accelerators

- Collaborative framework
- Infrastructure: common interest

https://aida2020.web.cern.ch



- 19 countries
- 39 beneficiaries
  - + 20 collaborating institutes
- Coordinated by CERN

- Total budget 29.8 M€
- EC contribution 10.0 M€

- Activities:
  - Mainly: Joint Research & Networks (85%)
  - Transnational Access (13%)

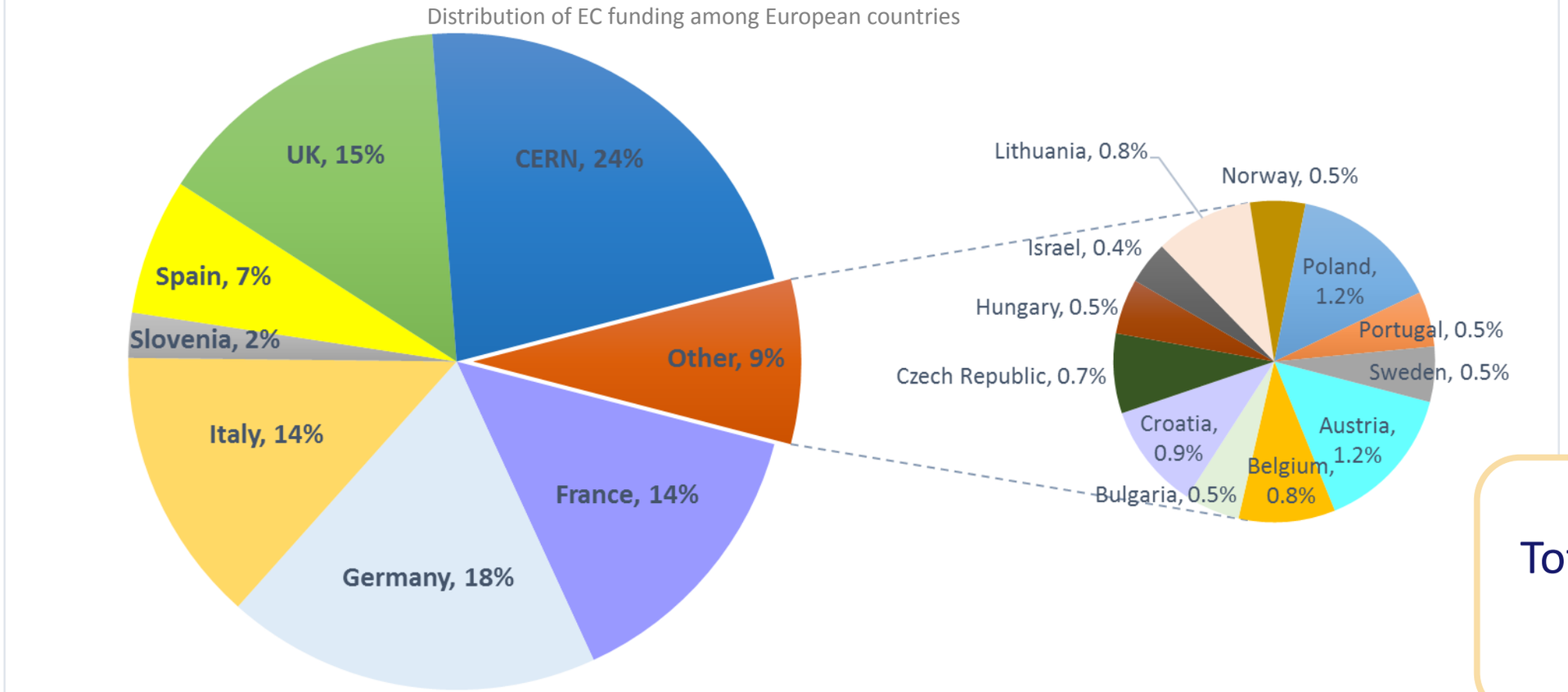
Participants bring in complementary competences and a balanced coverage of projects.

Resources

Full costs budget AIDA-2020 = **~ 29 M€**

EC contribution = **10 M€**

→ all partners contribute with a certain amount of matching funds and the funding rate for the beneficiaries varies between 29% (JRA) and 95% (TA)



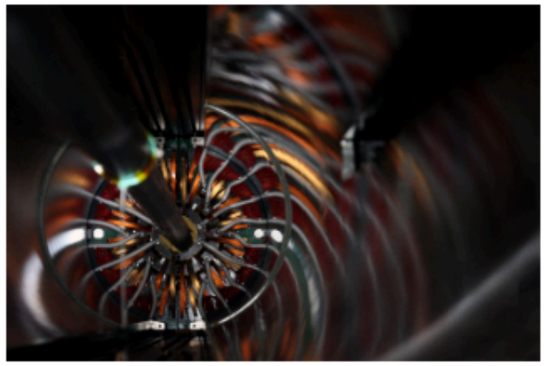
Key for involving small countries

Total Person-Months = **2,525.5 PM**

Activities

Activities

AIDA-2020 is divided into 15 Work Packages. A Work Package (WP) is a unit of work within the project. The WPs are theoretically independent but they were defined in order to foster synergies in AIDA-2020.



Management and Coordination

- WP1 (MGT): Project management and coordination

Networking Activities

- WP2 (NA1): Innovation and Outreach
- WP3 (NA2): Advanced Software
- WP4 (NA3): Micro-electronics and interconnections
- WP5 (NA4): Data acquisition system for beam tests
- WP6 (NA5): Novel high voltage and resistive CMOS sensors
- WP7 (NA6): Advanced hybrid pixel detectors
- WP8 (NA7): Large scale cryogenic liquid detectors
- WP9 (NA8): New support structures and micro-channel cooling

Transnational Access

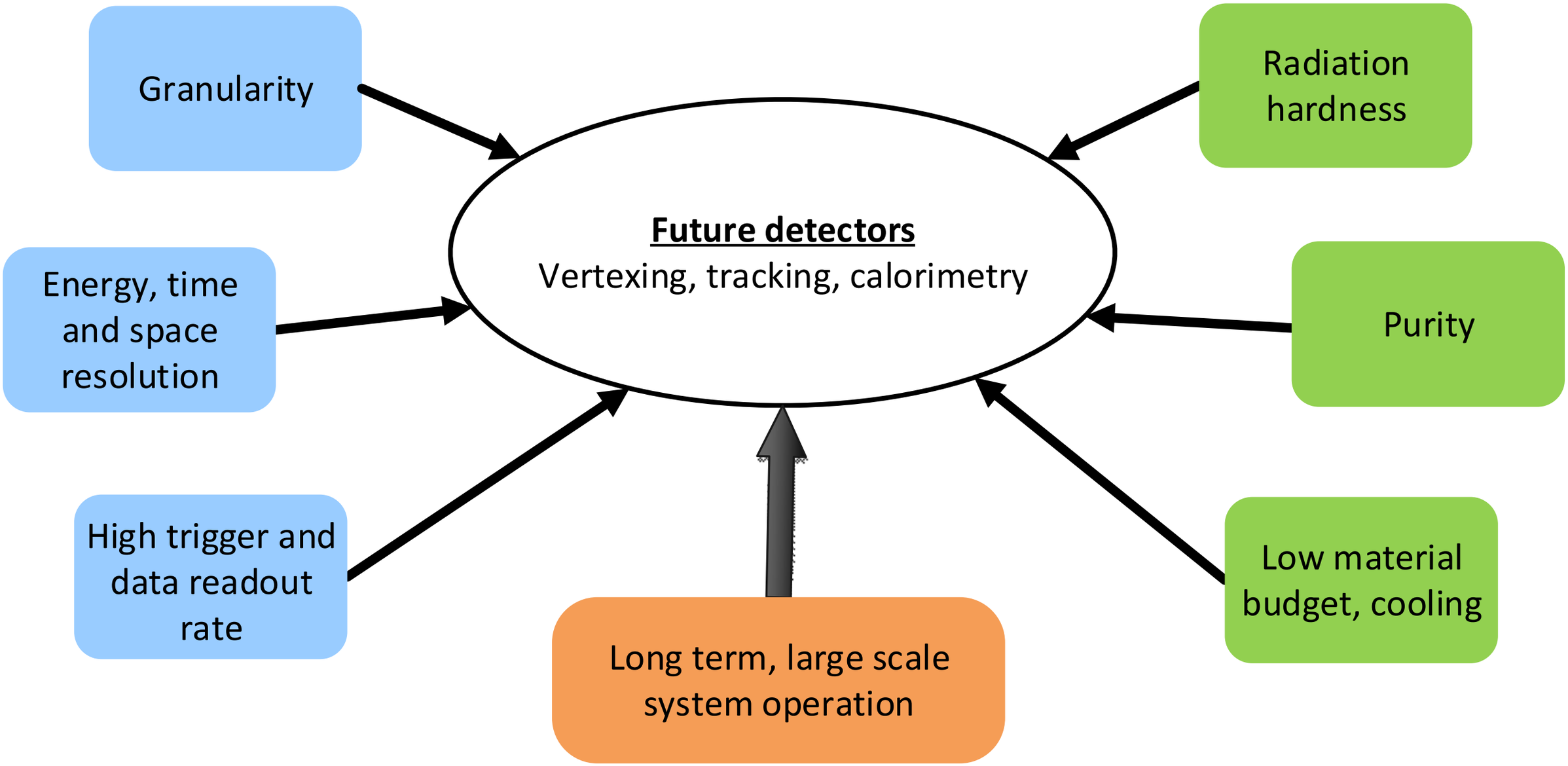
- WP10 (TA1): Beam test facilities
- WP11 (TA2): Irradiation test facilities
- WP12 (TA3): Detector characterisation facilities

Joint Research Activities

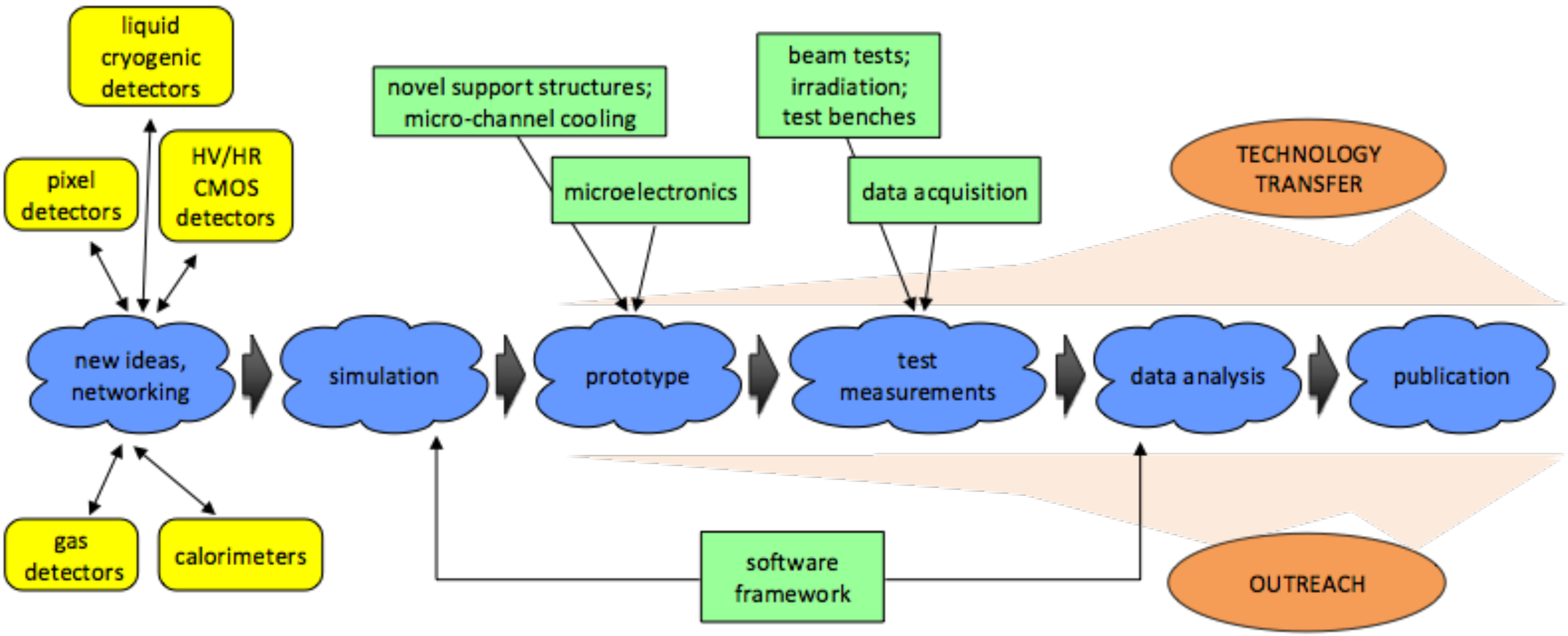
- WP13 (JRA1): Innovative gas detectors
- WP14 (JRA2): Infrastructure for advanced calorimeters
- WP15 (JRA3): Upgrade of beam and irradiation test infrastructure

Technology challenges

Pushing detector technologies beyond state-of-the-art



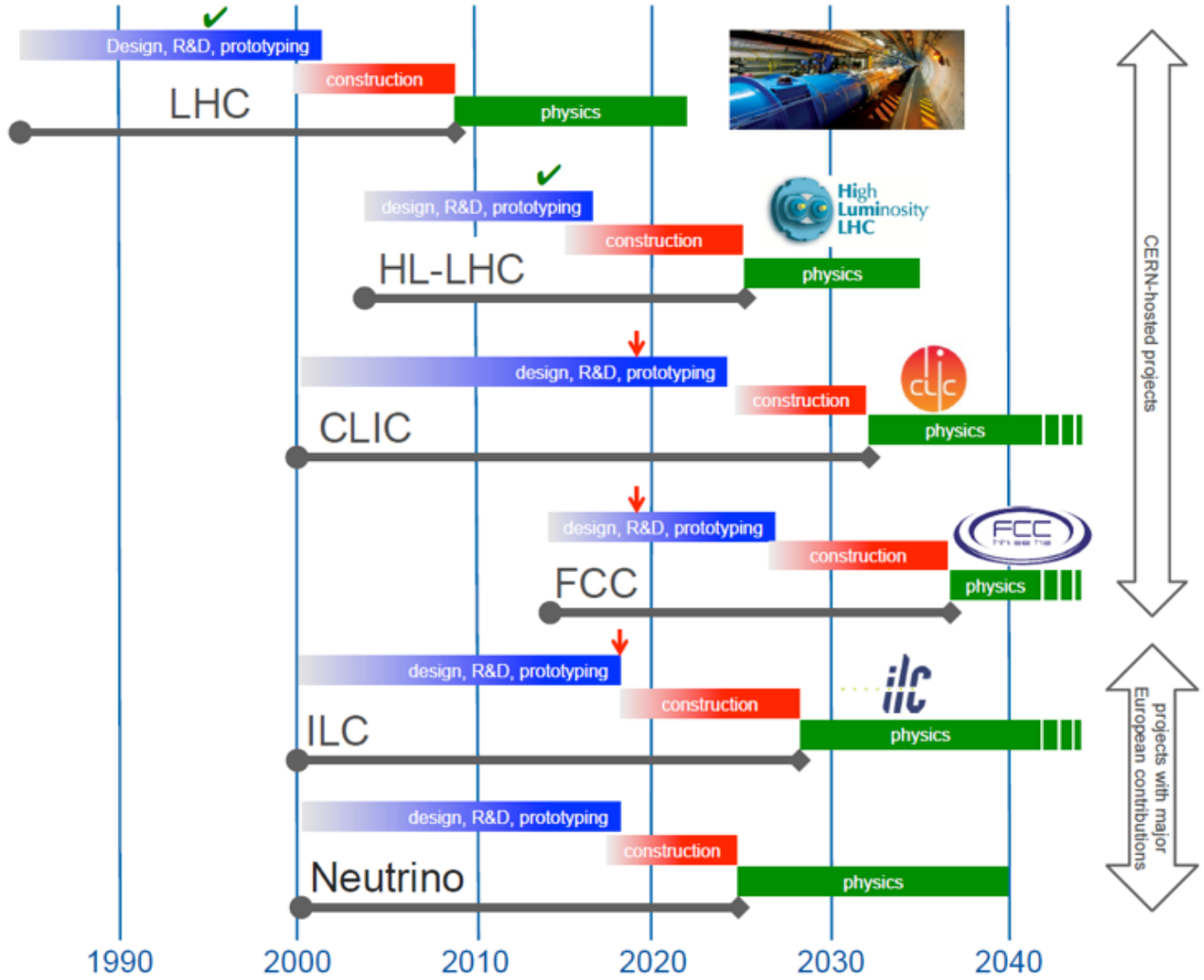
Detector life cycle



Strategy

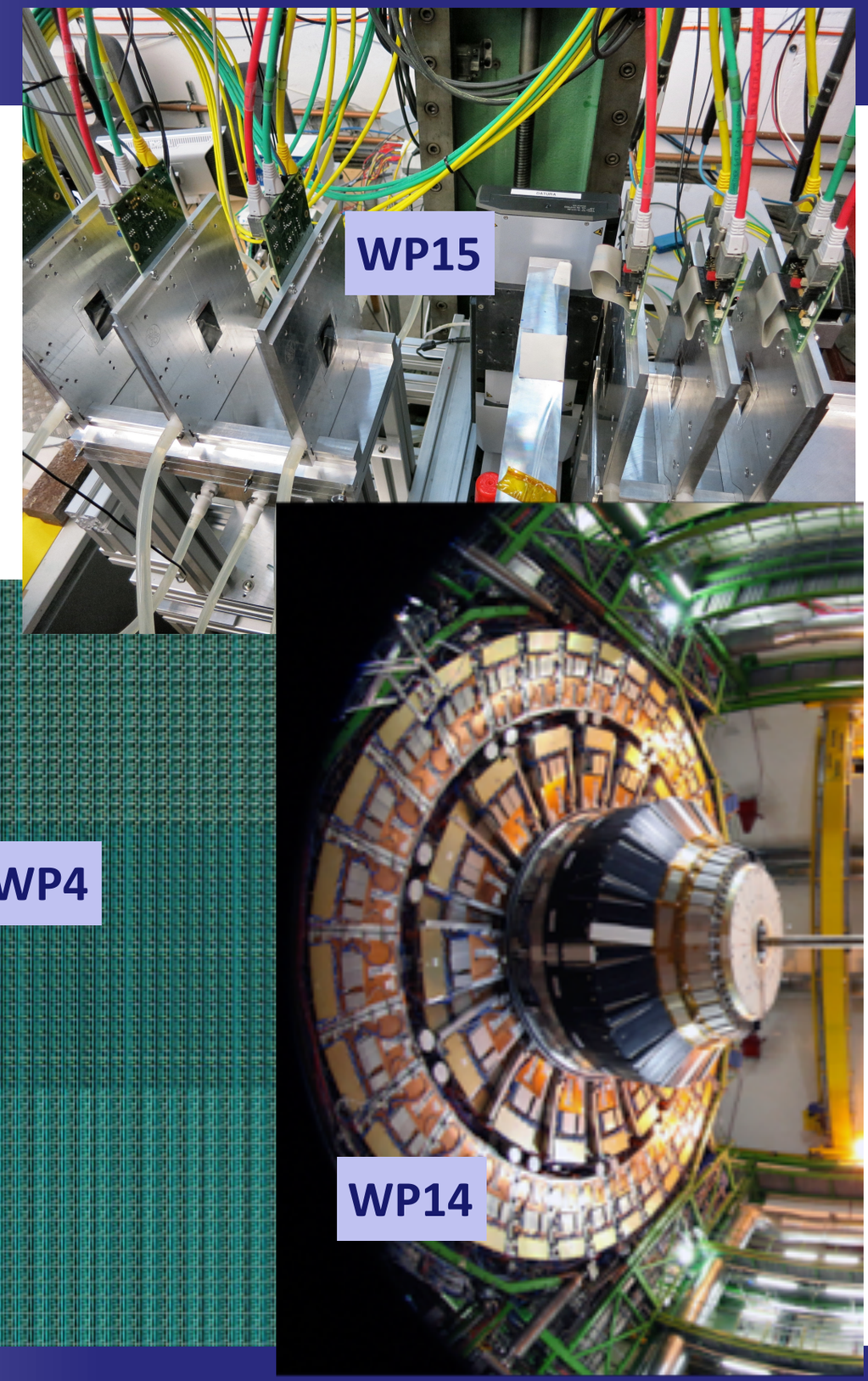
- European strategy for particle physics
  - Process led by CERN Council
  - Input from global community
- Updates 2012-13, 2019-20

- Future projects have many detector R&D issues in common
- **EC initiatives unique in creating coherence at European level**
  - **Closely follow European Strategy**



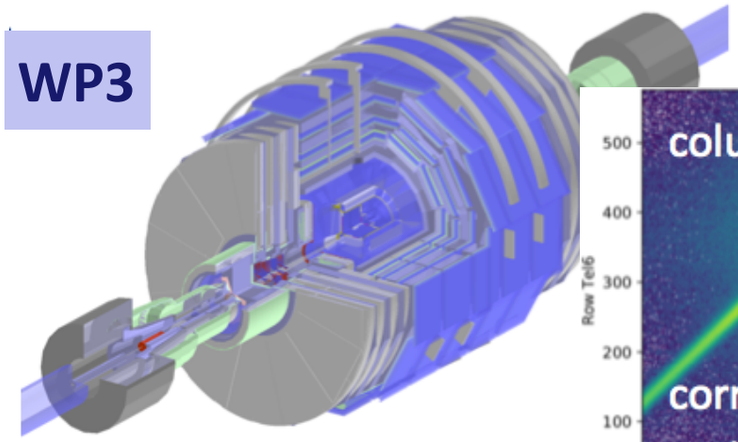
Highlights

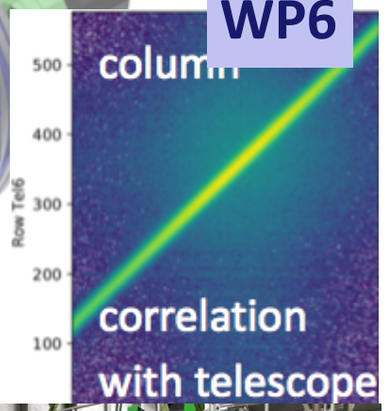
- Common micro-chip development
  - Expensive submissions
- Test beam instrumentation
  - Keep pace with increasing precision
- Common test beam DAQ
  - Easy prototype integration, LC **and** LHC
- Common software frameworks and tools
  - Parallel and vector computing
- Joining forces for novel detectors
  - LHC tracker technology and LC calorimetry -> imaging calorimeter for HL-LHC
- Test infrastructures
  - Mechanics, cooling, optical materials, electro-magnetic, irradiation, data base support….

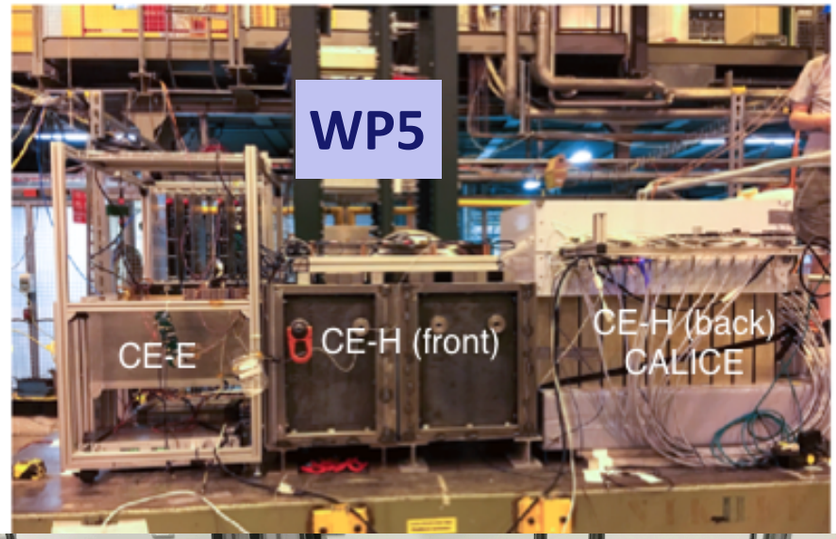


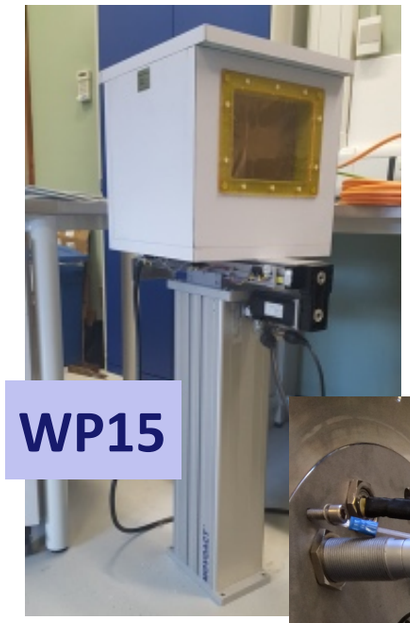
More Highlights

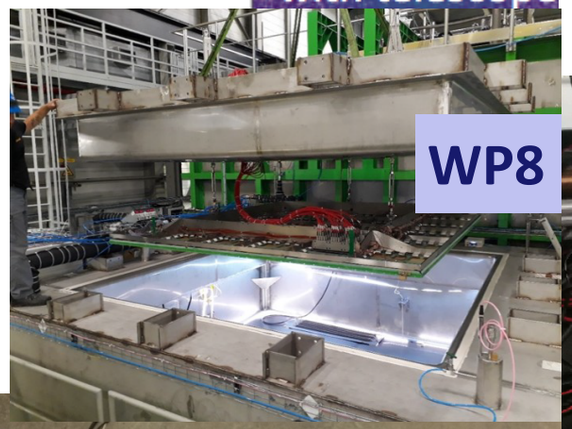
- WP3 VecGeom for CMSSW
- WP5: Common DAQ for LHC & LC beam tests
- WP6: DMAPS beam tests
- WP8: LAr dual phase operation
- WP9: CO_2 facility
- WP13: High-rate μRWELLs
- WP14: Test bench stands
- WP15: Cold irradiations

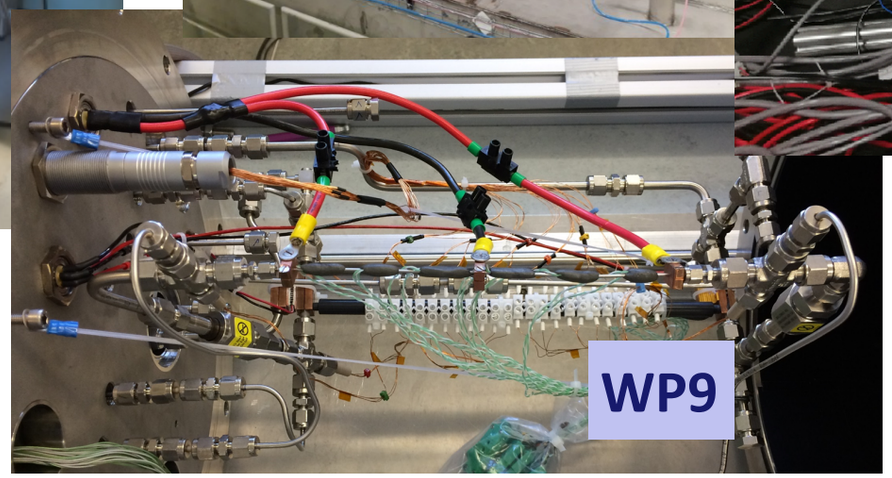


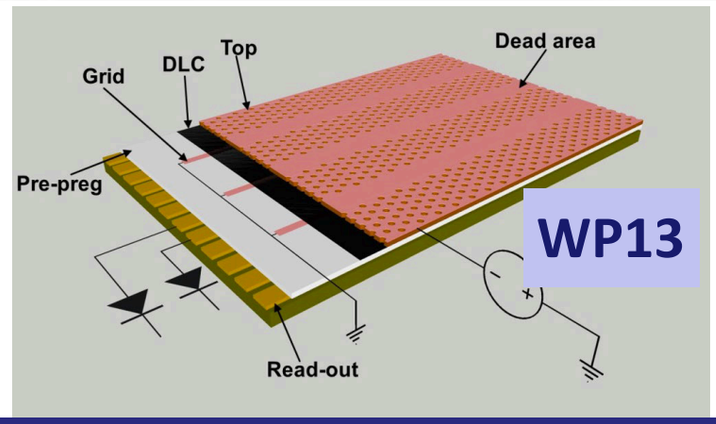












New Call in Horizon 2020

- Informal information from meeting at Brussels on March 5
- FP8 Call 5: Large initiatives and support measures to **foster the innovation potential of research infrastructures:**
  - New directions in EC funding instruments, addressing established communities
  - Following consultations with communities to prepare for FP9
  - To be published in summer
- INFRAINNOV-03-2020 - Co-Innovation platform for research infrastructure technologies (2020 – xx M€)
  - This is where ATTRACT phase 2 will be
- INFRAINNOV-04-2020 - **Innovation pilots** (2020 – yy M€, max zz M€ each)
  - Innovation in light source technologies
  - **Innovation in detector technologies**
  - Innovation in accelerator technologies
- **Deadline March 17, 2020**

New Pilot call INFRAINNOV-04-2020

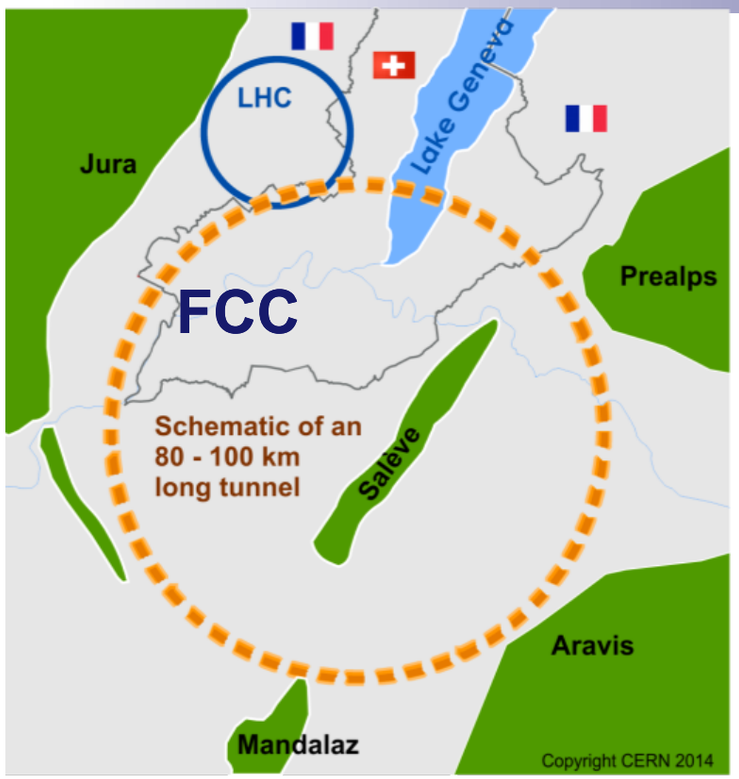
OBJECTIVES

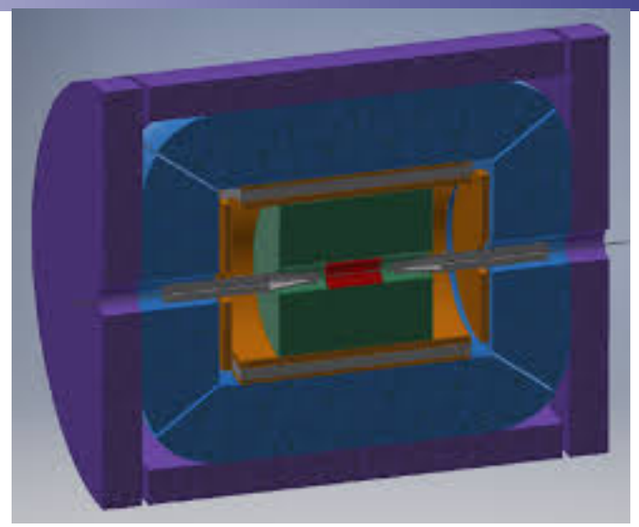
- **Integrate the key players** of the HEP detector community, unite them behind **common goals and interests**, based on the **major challenges** defined with a broad **consensus**.
- **Coordination** of transversal R&D activities **between different technologies**, e.g. between sensors and their read-out electronics and data acquisition, which is essential for the overall progress towards detector **systems**.
- Maintain the **world-class level of the European** detector development and test **infrastructure.**
- **Leverage national funding** through the matching resources of all participants, thus achieving far more ambitious objectives than with the EC funding alone
- A **unique collaborative European platform** for coherent and coordinated efforts for detector R&D programmes towards and across future projects in HEP.
- Strong **impact on innovation** through joint R&D programmes with **knowledge transfer to European industry** to tackle the challenges of series productions for large-scale experiments.

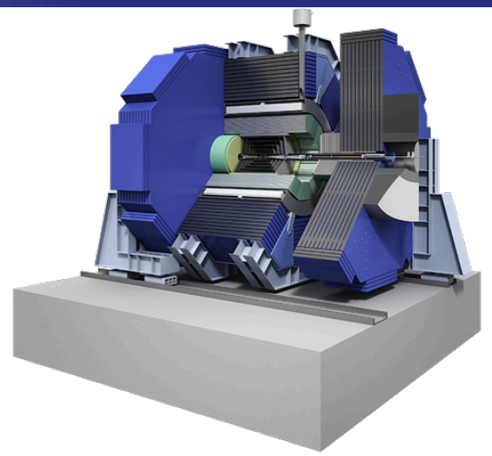
Upcoming Challenges

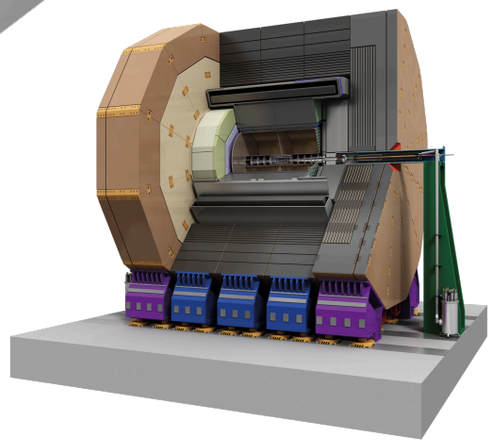
- HL-LHC upgrades now moving to production
  - R&D largely done - will not guide AIDA++
- New in AIDA-2020 – could be expanded
  - Precision mechanics and CO_2 micro-cooling
  - Large cryogenic detectors
- Future lepton colliders
  - Higher precision, less material
  - Requirements for linear and circular machines very similar
    - Except electronics, powering, cooling
    - Circular machines have much higher rates and require continuous powering
    - Need to push limits of particle ID
    - Gaseous tracking
  - Most aggressive requirements may be posed by the Z factory
    - 10000 x LEP statistics
- Future hadron colliders
  - Fast timing for pile-up rejection increasingly important
    - Sensors, electronics and test infrastructures, beam instrumentation
  - Radiation tolerance requirements even more demanding
    - Sensors, electronics and “low-tech”: powering
    - Highly granular LAr calorimeters
    - Irradiation facilities
  - Machine learning for fast track and image reconstruction, trigger
- Non-collider experiments

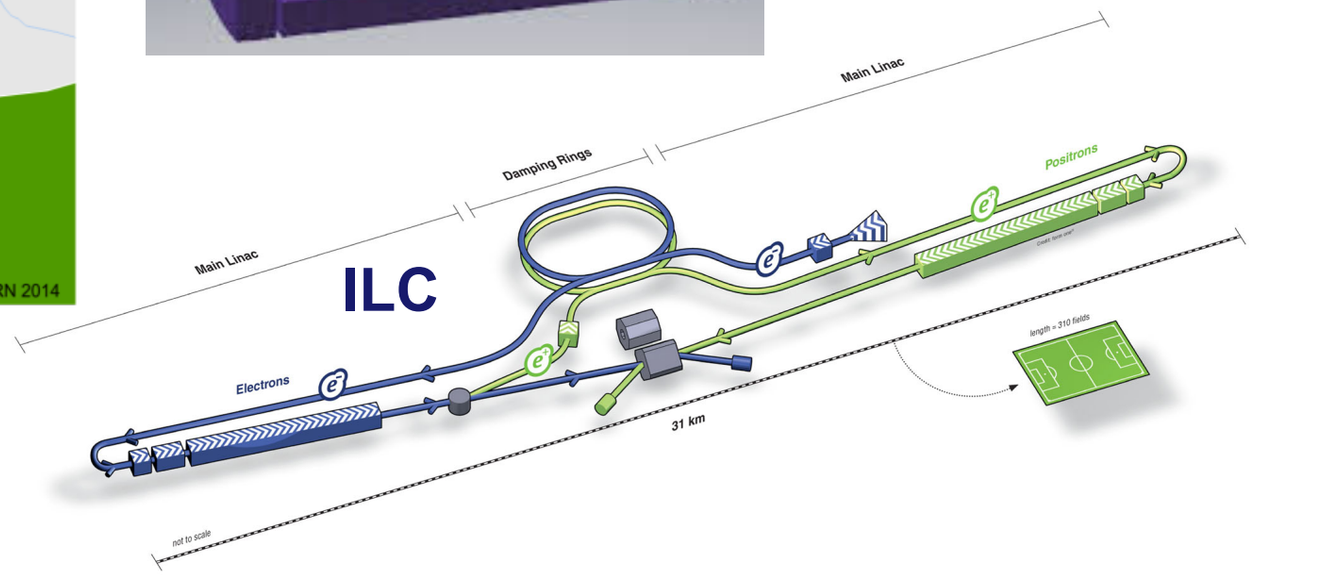
Upcoming Challenges

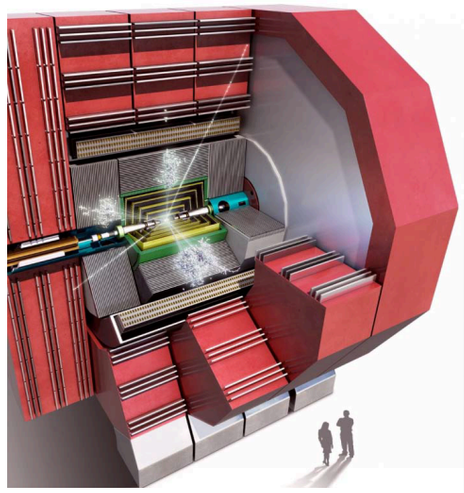


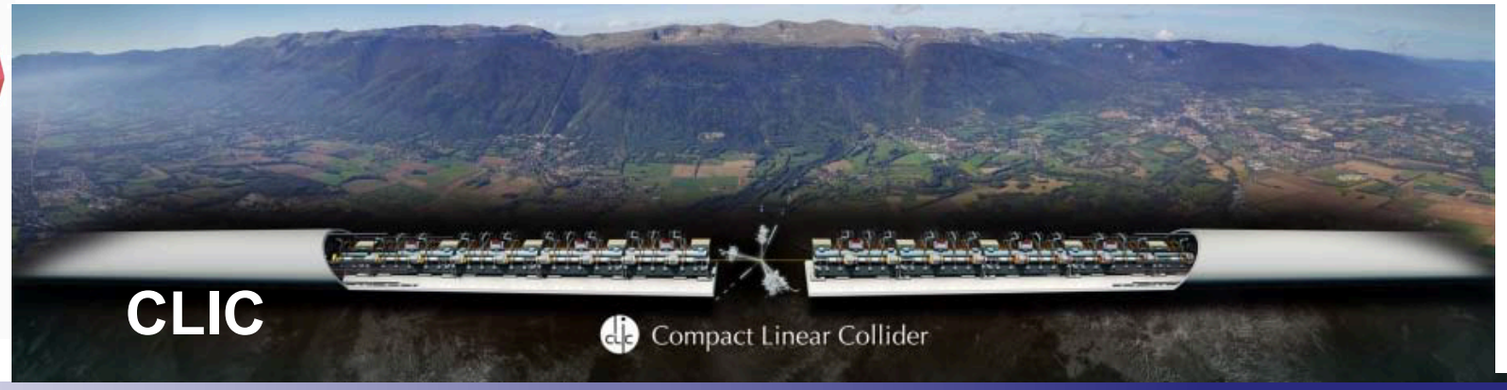


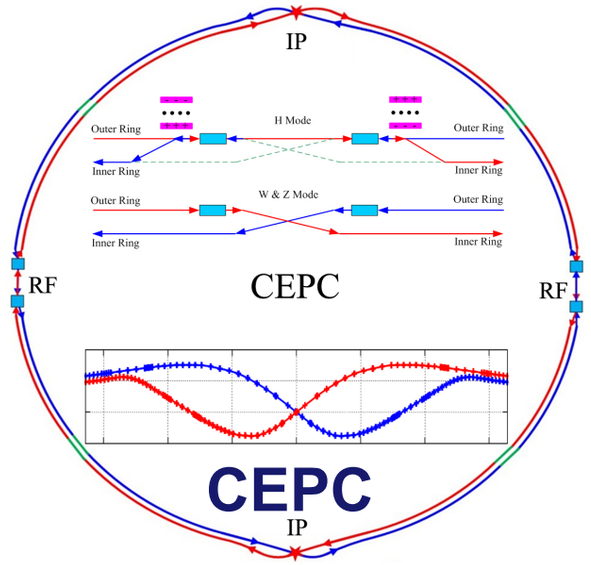












Sketch of AIDA-2020++

Possible topics:

- **Advanced R&D and infrastructure** for detectors at future colliders
  - Leptonic colliders
    - Circular
    - Linear
  - Hadronic colliders
- **Novel detector technologies** for large-scale particle physics experiments
- **Innovative software** solutions (ML, etc.) for future detectors
  - Triggering
  - Tracking
  - Calorimetry
- Extended neutrino WP with also short baseline neutrino detectors
- **Joint R&D** programmes with **industrial beneficiaries**
- Proof of Concept (competitive allocation after start of project) higher risk projects (“blue sky” R&D)

Preparation of AIDA-2020++

Actions:

- **Sent e-mail** requesting for **Expressions of Interest (EoI)**
  - Deadline for EoIs is **July 15th**
- Based on the EoI received start preparing the new structure of AIDA-2020++
- **General meeting** at CERN on **September 4th**
- After the meeting define a **Proposal Committee (order 10 persons)**
  - Define **WPs** and respective **coordinators**
- Prepare the proposal
  - **Deadline** to submit the proposal **17/03/2019**
- If successful, AIDA-2020++ could be funded as early as **October 2020**

Preparation of EoIs

Expression of Interest

- **One-page document**
  - 2-6 participating institutes (**companies** as **beneficiaries** is a **plus**)
  - Contact for each institute
  - Description of the **activity**
    - At the level of a **Task** (not a WP!)
  - List of **Deliverables** (max. 3)
  - **Budget** estimate
    - **Manpower**
    - **Full cost**
      - Including **Personnel** and other **direct costs** (**1/3 EC contribution**, **2/3 matching funds**)
      - Do not include overheads!

Preparation of EoIs

Meeting Italia

- **C. Meroni (and myself)** is organising an Italian meeting to try and coordinate the EoIs to be submitted for AIDA-2020++
- Date is 7/6 at 10:00:
  - Agenda: **https://agenda.infn.it/event/19410/**
  - People interested in submitting EoIs are warmly encouraged to attend

IDEA Collaboration meeting

IDEA

- **New detector concept for an experiment at a Circular e^+e^- Collider**
  - Proposed by several INFN groups
  - Accepted by both **FCC-ee** and **CEPC**
  - Described in both **CDRs**
- **Collaboration meeting** in Bologna
  - **June 13th and 14th: https://agenda.infn.it/event/19360/**
  - **Main items**
    - Review of the **status** of the various **sub detectors** and **software**
    - **Preparation** of **EoIs** for **AIDA-2020++**
      - Collaboration with **foreign institutes** (**China**, **Russia**, **Serbia**, **Switzerland**, **USA**, **UK**)
      - Collaboration with **industries**, **CAEN** will participate (**Eltos** also interested)
- Will be preceded, on **June 12th and 13th**, by a special **Software Workshop**
  - **Aim** is to reach a **common software framework**
  - **Participation** from **CERN, ILC, CLIC, FCC, CEPC and HSF** communities

Summary

- **AIDA-2020** has already a **long history** behind it
  - **EUDET**
  - **AIDA**
- AIDA-2020 (and its predecessors) has proven to be a very successful example of an **EC co-funded scientific project**
- The new pilot call INFRAINNOV-04-2020 gives this community the possibility to:
  - Prepare and respond to **upcoming challenges** represented by **future experiments** with **new accelerator** facilities
  - Further improve Academia-Industry collaboration on **R&D and infrastructures** for **detectors at accelerators**
  - Develop **innovative detectors** and complete systems with all the needed services (HV, LV, electronics, cooling, software, DAQ, etc.)
  - Further **extend the network of collaborating institutes** and researchers
  - Significantly enhance **European's excellence** in this field

Backup

Innovation Pilots

- Objective*:*
- Support RI*networks developing and implementing a **common strategy/roadmap including** technological development required for improving their services through **partnership with industry;**
- Support **incremental innovation** and cooperation with **industry and academia** in areas such as scientific instrumentation

- Target:
- **Advanced Integrated Activities****, which have reached a high level of integration and can **focus on joint** research developments

- * RI – Research Infrastructure
- ** e.g. AIDA-2020

ATTRACT & AIDA-2020++

ATTRACT

- Emerging communities
- Competitive
- Independent projects
- Fully bottom-up approach

- Break-through development
- Co-innovation for non-HEP markets
- Third-party funding
- Diversifying

Applications outside HEP

AIDA-2020++

- Advanced community
- Collaborative, compete globally
- Interdependent work packages
- Aligned with European Strategy and corresponding roadmaps

- Evolutionary development
- Innovation mainly via pre-procurement R&D for HEP
- Leverage on national funding
- Integrating

Applications within HEP

We will establish frameworks for regular information exchange between the two projects

Innovation in AIDA++ and ATTRACT

- **Separation** between call II-03 and II-04, in particular AIDA++ and ATTRACT
- II-03 aims at **innovation for markets outside RI**
- II-04 **innovation for the delivery of services, or new services of RI**

- What is **Innovation**?
- For ATTRACT: launch of a new product to market
- For us: we are invited to interpret the topic for our community
  - Can be incremental
  - Low and high TRLs**

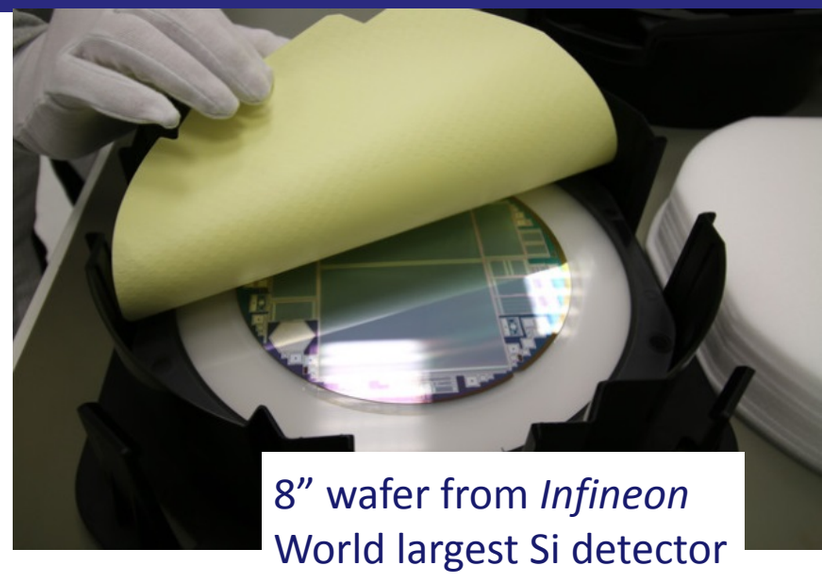
- * **RI** – Research Infrastructure
- ** **TRL -** Technological readiness level

Main Challenges for a New Proposal

- **No Transnational Access:**
- This was one of our biggest successes; need to find new ways of directing EC funds to facilities; WP15-type of upgrade (“innovation”) activities, network
- Involvement of **industrial partners as beneficiaries:**
- Works in parallel Accelerator Initiative ARIES; need to understand how to protect their IP; start with known partners
- Emerging **roadmap** of future collider projects:
- Need to establish our own technological roadmap, in the proposal and during the project, long-term projects require intermediate goals
- **Sustainability** of matching funds:
- Will need to find ways to demonstrate the long-term commitment of partners

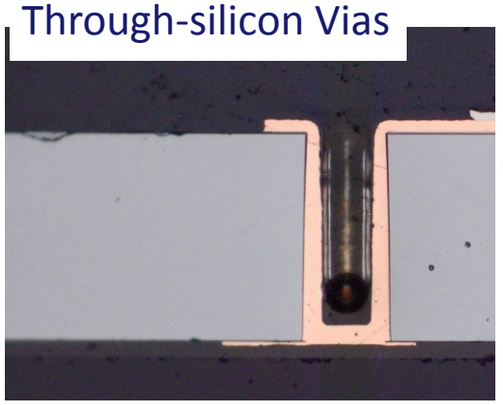
Innovation

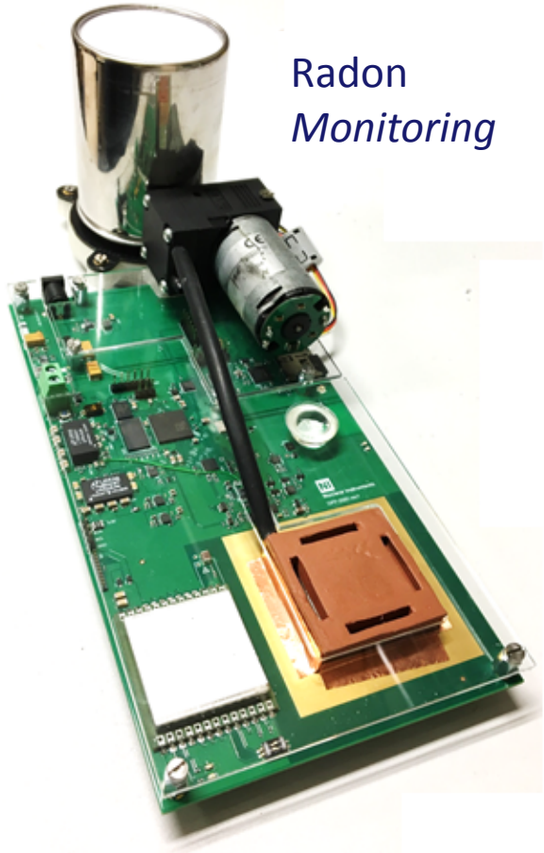
- Technology transfer to industry: two pillars:
- 1. Pre-procurement R&D
  - Detector elements needed in large quantities
  - But: not off-the-shelf products
  - After initial R&D: involve industry to adapt design to mass production requirements
  - Then transfer technology and cooperate in qualification of protocols
  - Industrial partners use acquired knowledge in non-HEP markets
- 2. Spin-off to non-HEP applications
  - Typical examples in dosimetry, medical imaging and generic image sensor technologies
  - Starting from higher TRLs
  - Co-innovation effort, often with SME
- Type 1 is more typical for HEP community
- AIDA-2020 supports both



8” wafer from *Infineon*
World largest Si detector

Through-silicon Vias





Radon
Monitoring