

**AIDA**<sup>2020</sup>

Advanced European Infrastructures  
for Detectors at Accelerators

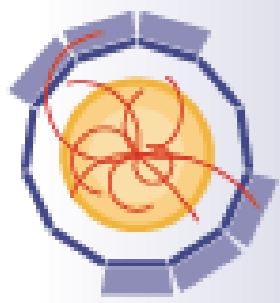
# AIDA-2020 and the roadmap to Horizon Europe

Paolo Giacomelli  
INFN Bologna

III RICH Workshop  
Brussels, May 14, 2019

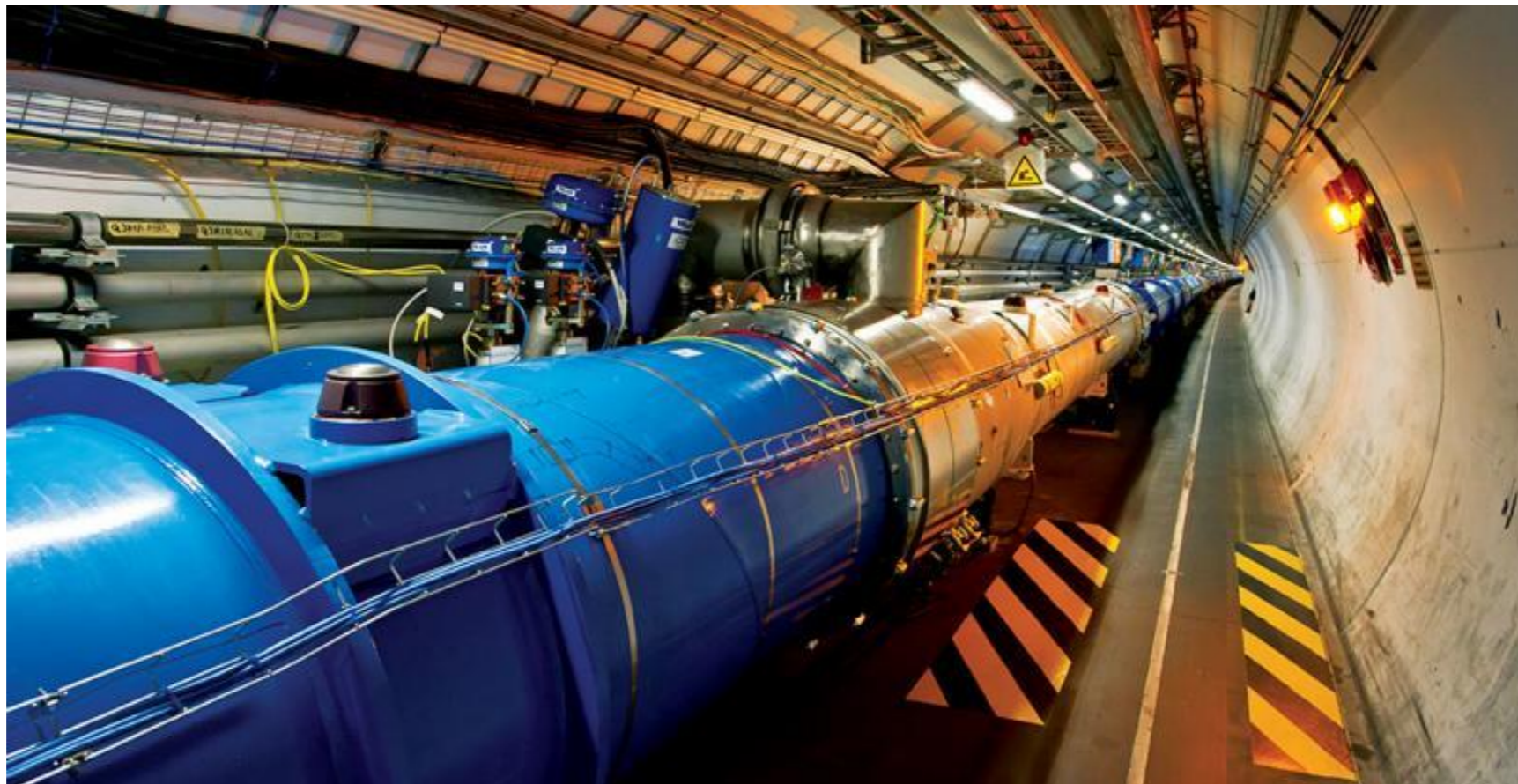


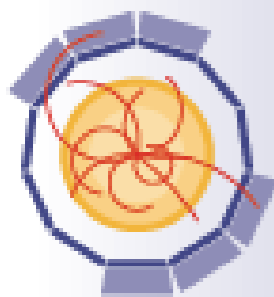
*This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654168.*



### High Energy Physics (HEP)

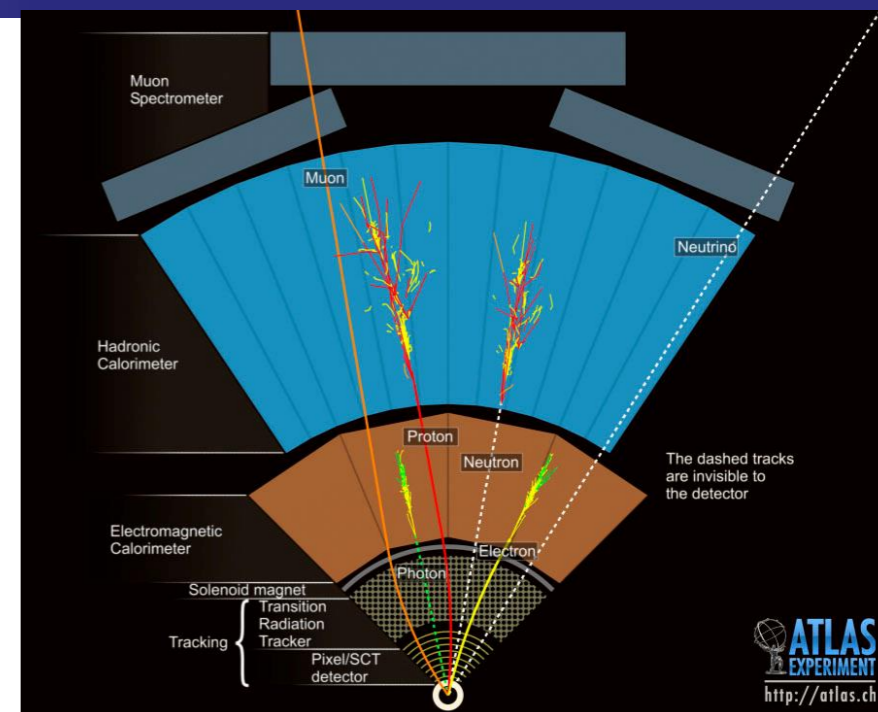
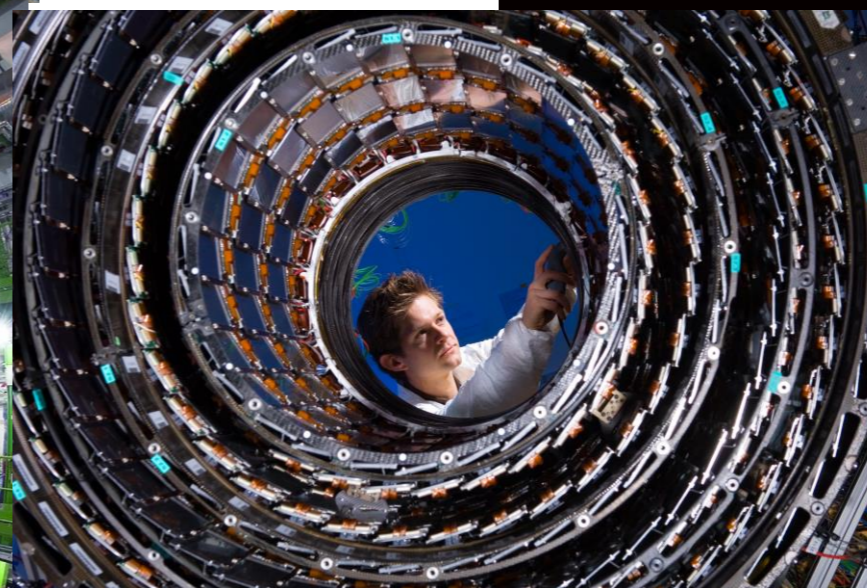
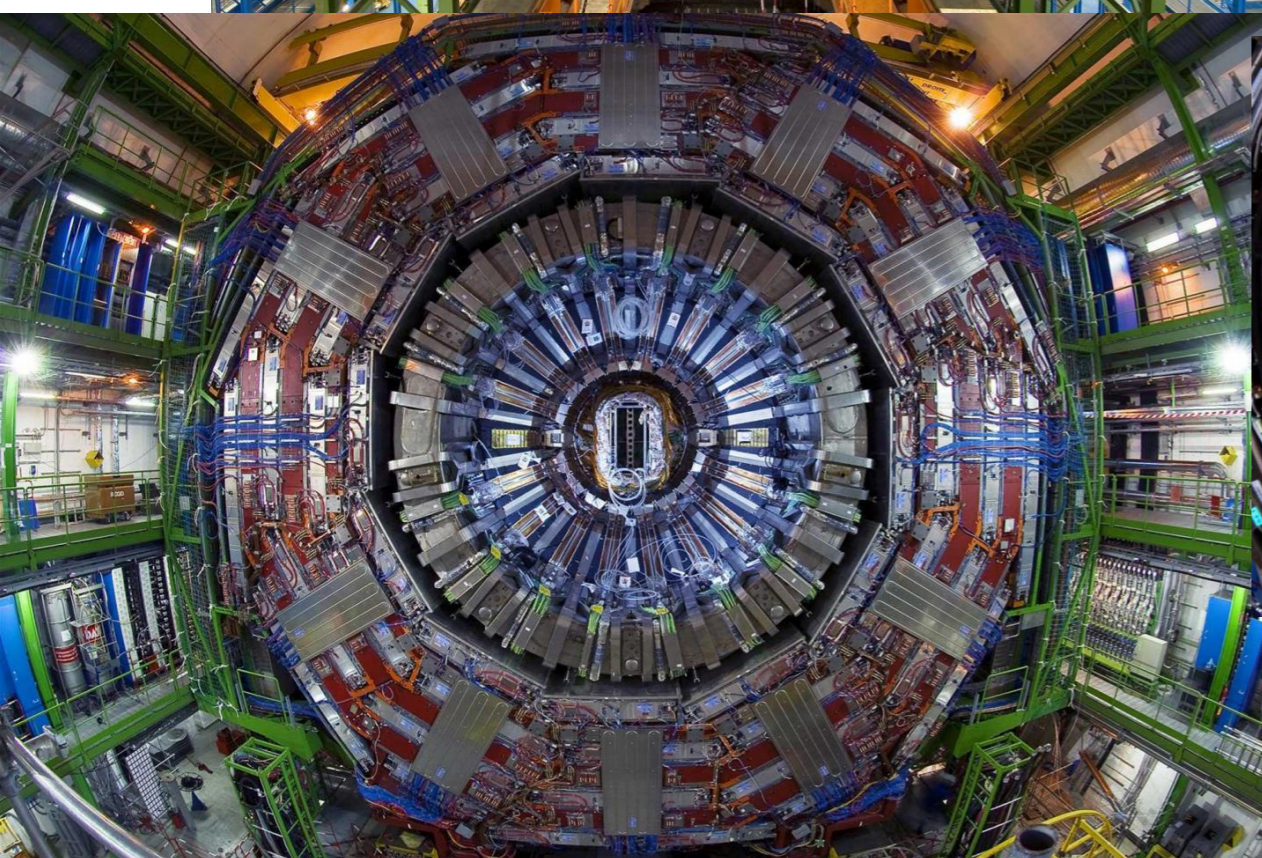
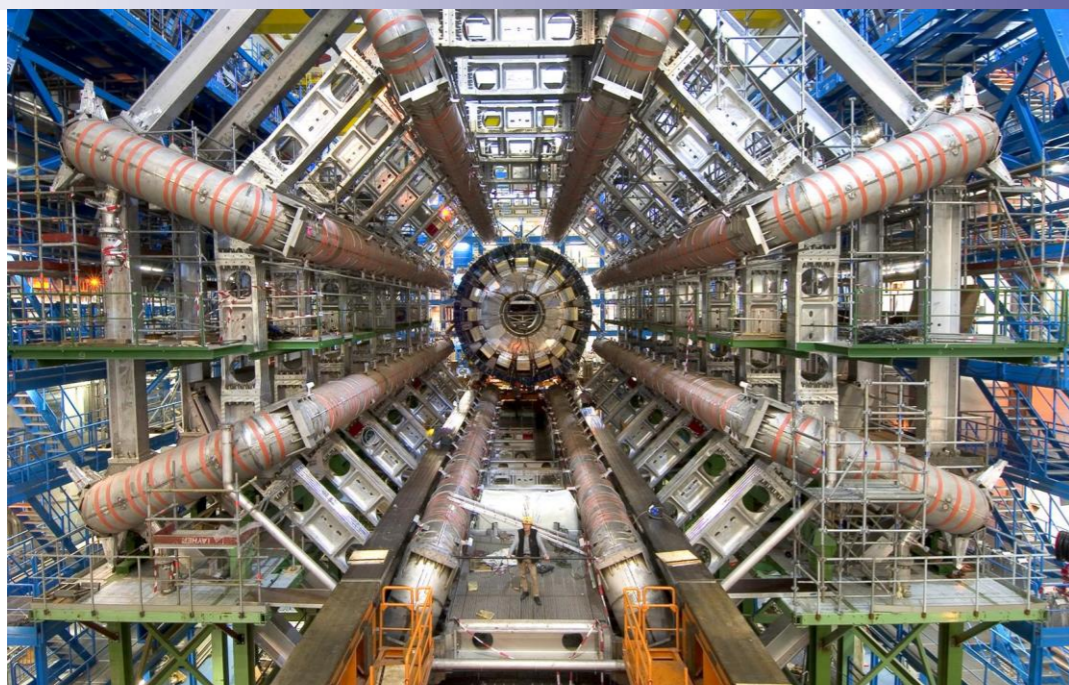
- A global community of > 10'000 researchers
- Strong network in Europe with world-class laboratories and CERN as a hub
- The LHC: the largest scientific instrument so far
- Future projects at CERN, in America and in Asia

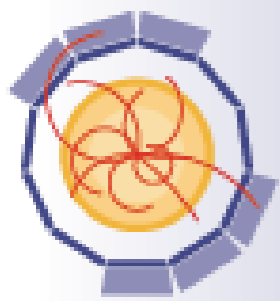




# AIDA<sup>2020</sup>

## LHC detectors

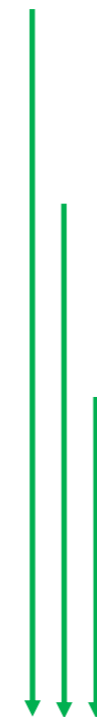




# AIDA<sup>2020</sup>

## 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**



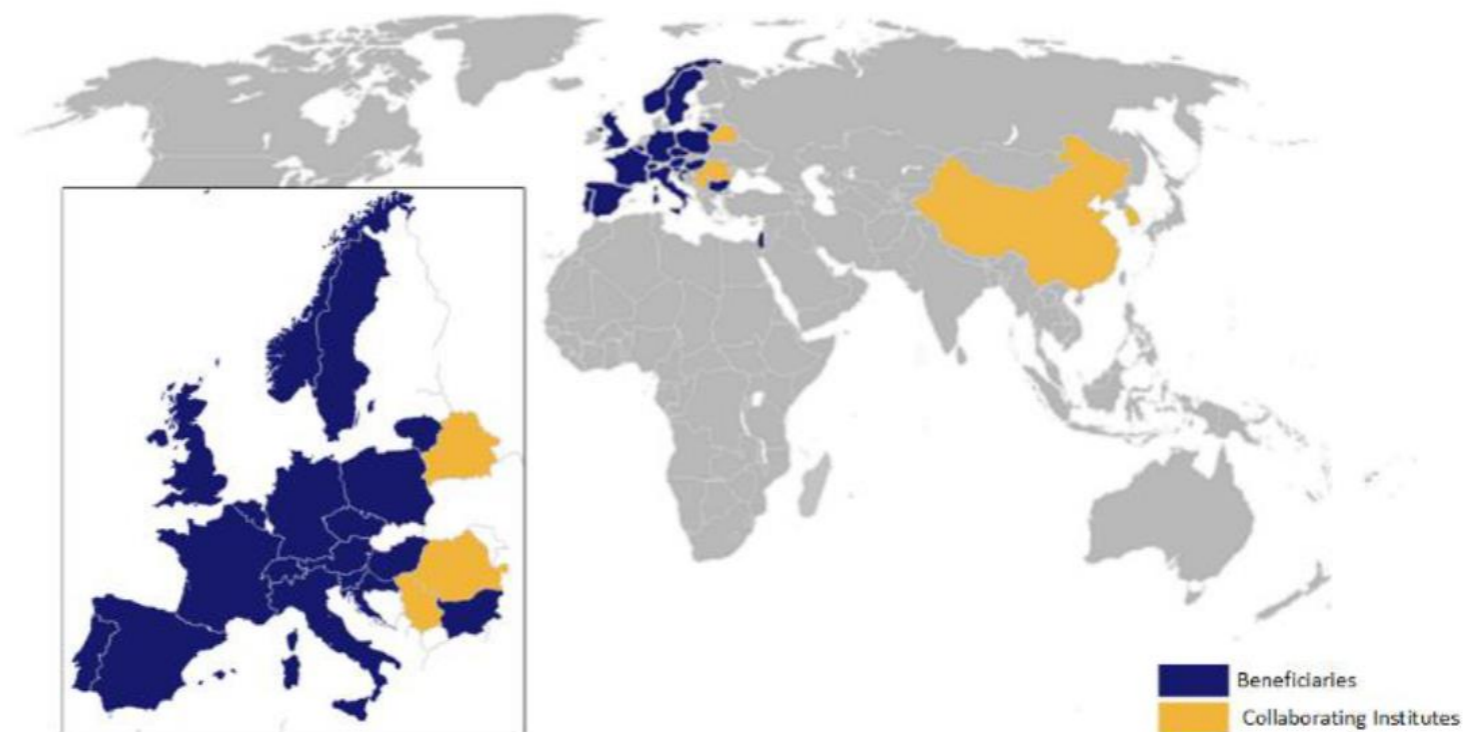
Increasing  
level of  
integration



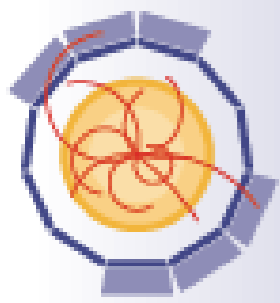
# AIDA<sup>2020</sup>

- Collaborative framework
- Infrastructure: common interest
- 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%)

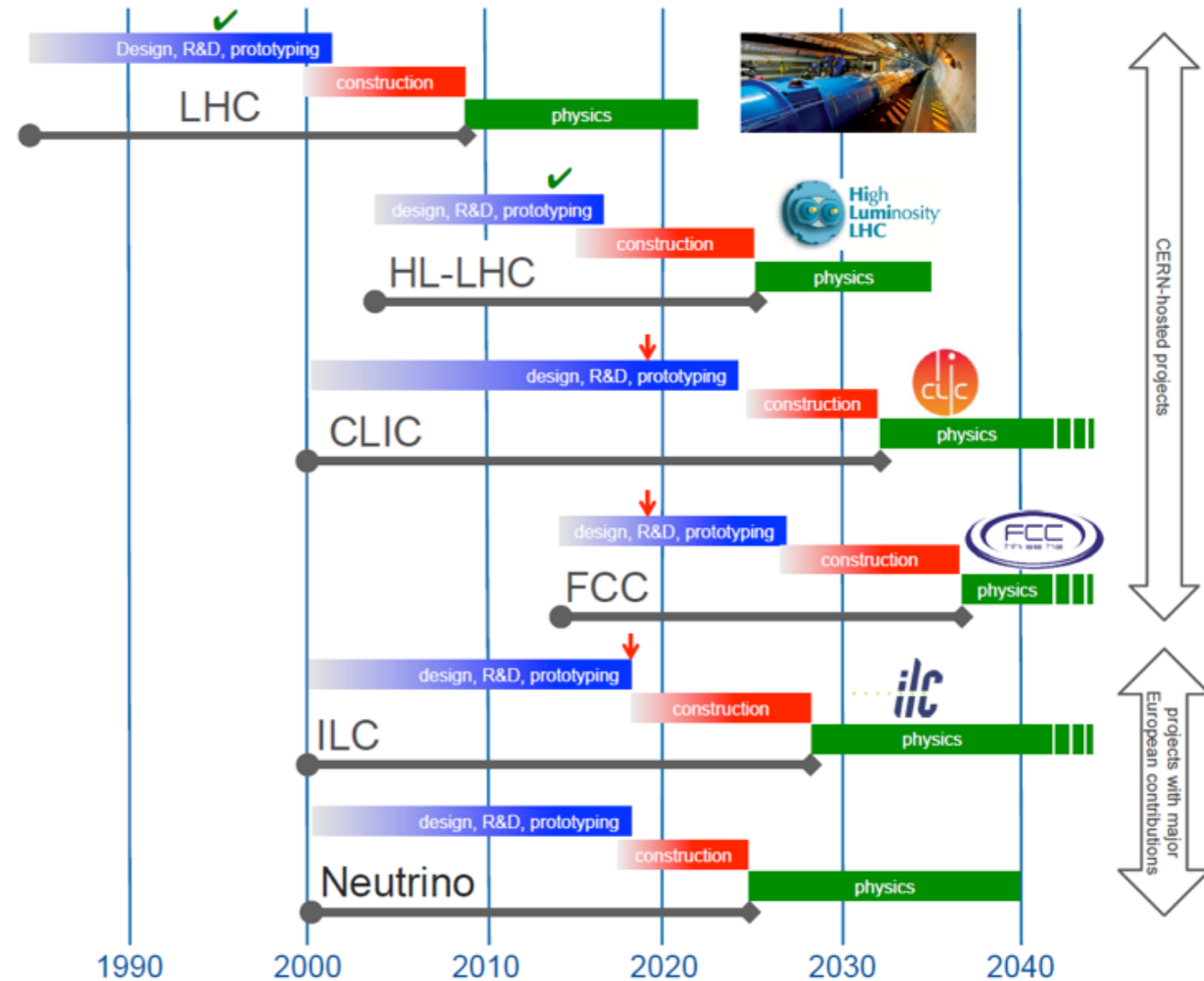
<https://aida2020.web.cern.ch>

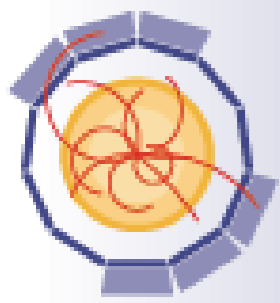


Participants bring in complementary competences  
and a balanced coverage of projects.



- 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**

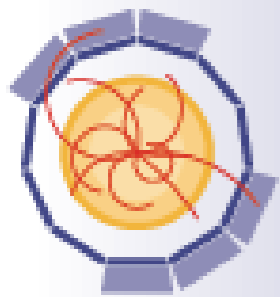




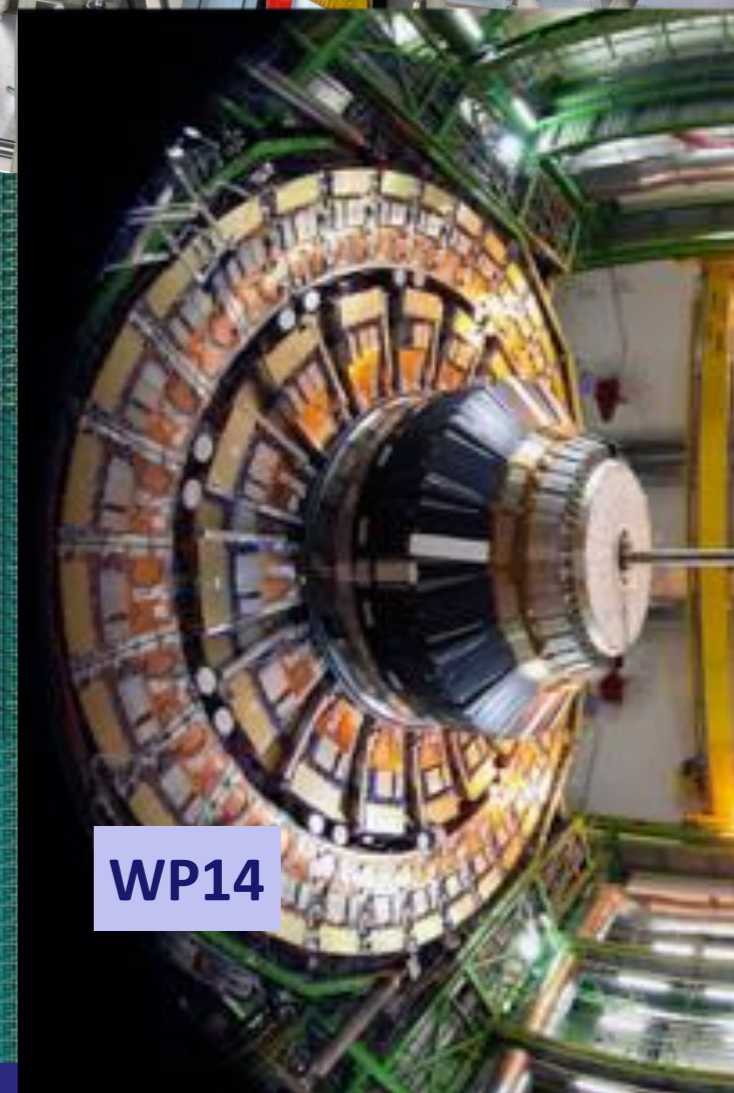
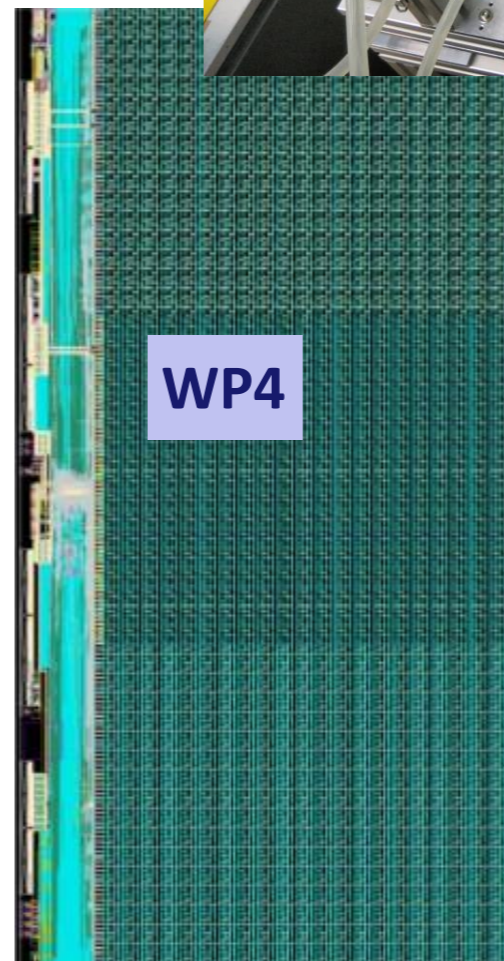
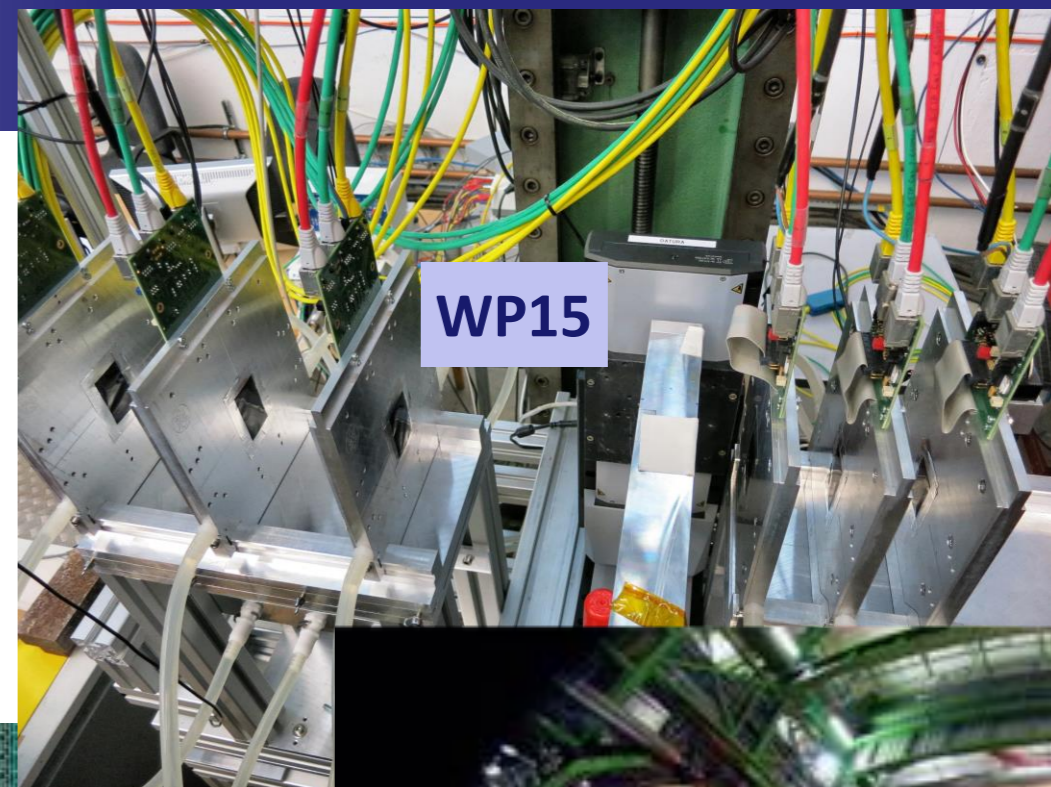
- For better monitoring our output: Introduced Score Board
  - Journal publications
  - conference proceedings
  - total (incl. other, e.g. posters)
- Only those with acknowledgment count
- **Target 60, 50, 180**
- **Achieved 78, 46, 264**

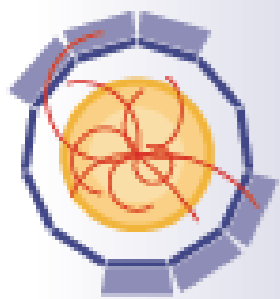
**Publication Score Board**

WP	No. of journal publications	No. of conference/ workshop proceedings	Other publications	Total
WP2	0	0	7 press articles 11 "On track" newsletter issues 1 Academic dissertation	19
WP3	5	1	7 presentations 3 scientific notes	16
WP4	2	2	1 presentation 1 poster	6
WP5	0	2	7 presentations 2 scientific notes 2 posters	13
WP6	23	5	1 poster	29
WP7	20	10	13 presentations 1 scientific note 2 posters	46
WP8	4	3	0	7
WP9	1	0	8 presentations 1 scientific note 2 poster	12
WP13	4	5	4 presentations 3 posters	16
WP14	15	11	18 presentations 3 scientific notes 1 poster	48
WP15	4	7	20 presentations 8 scientific notes 13 posters	52
<b>TOTAL</b>	<b>78</b>	<b>46</b>	<b>140</b>	<b>264</b>
<b>TARGET</b>	<b>60</b>	<b>50</b>	<b>-</b>	<b>180</b>



- 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....

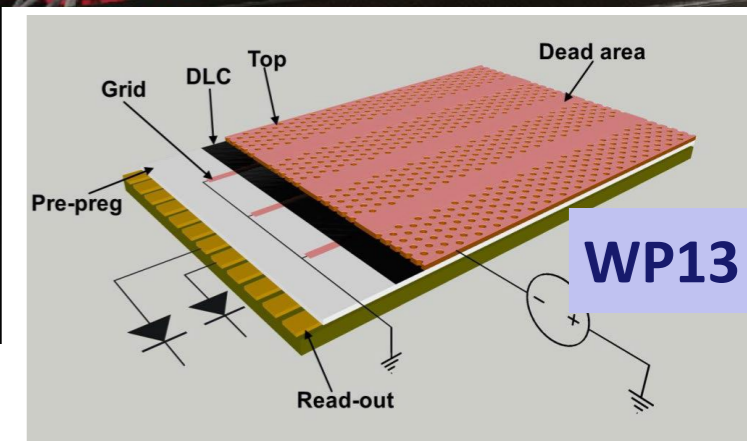
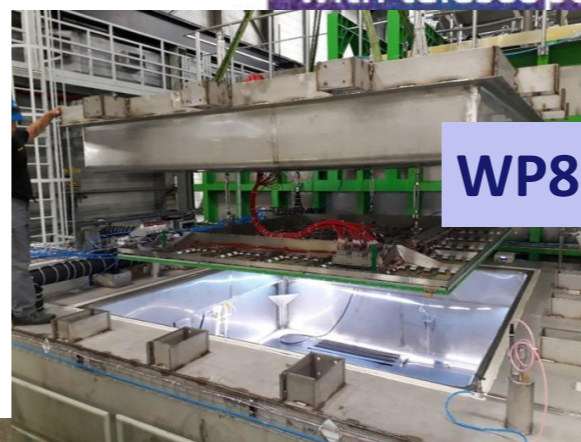
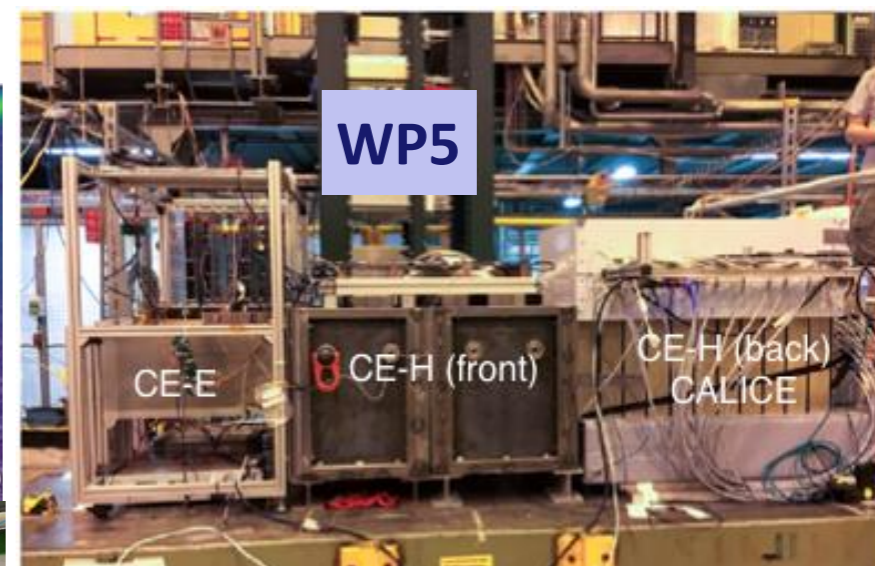
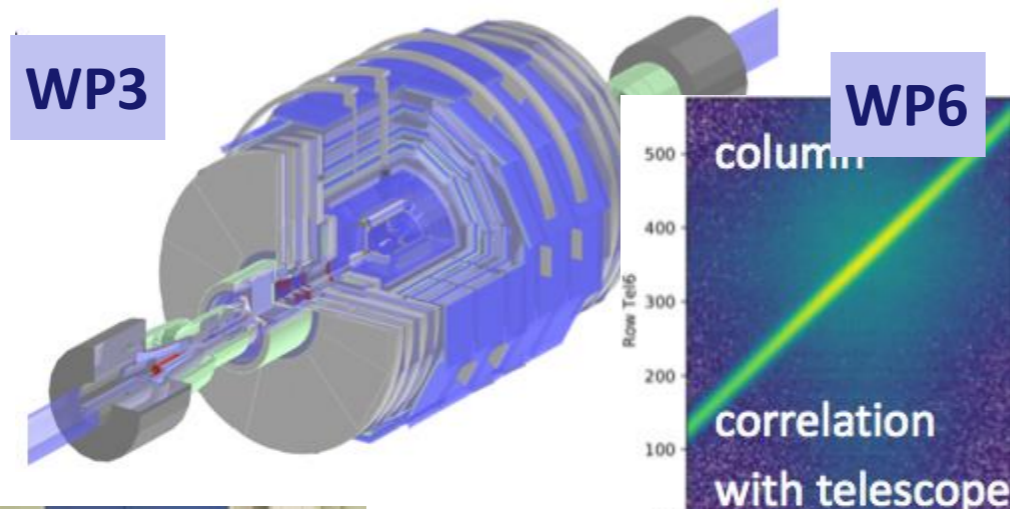


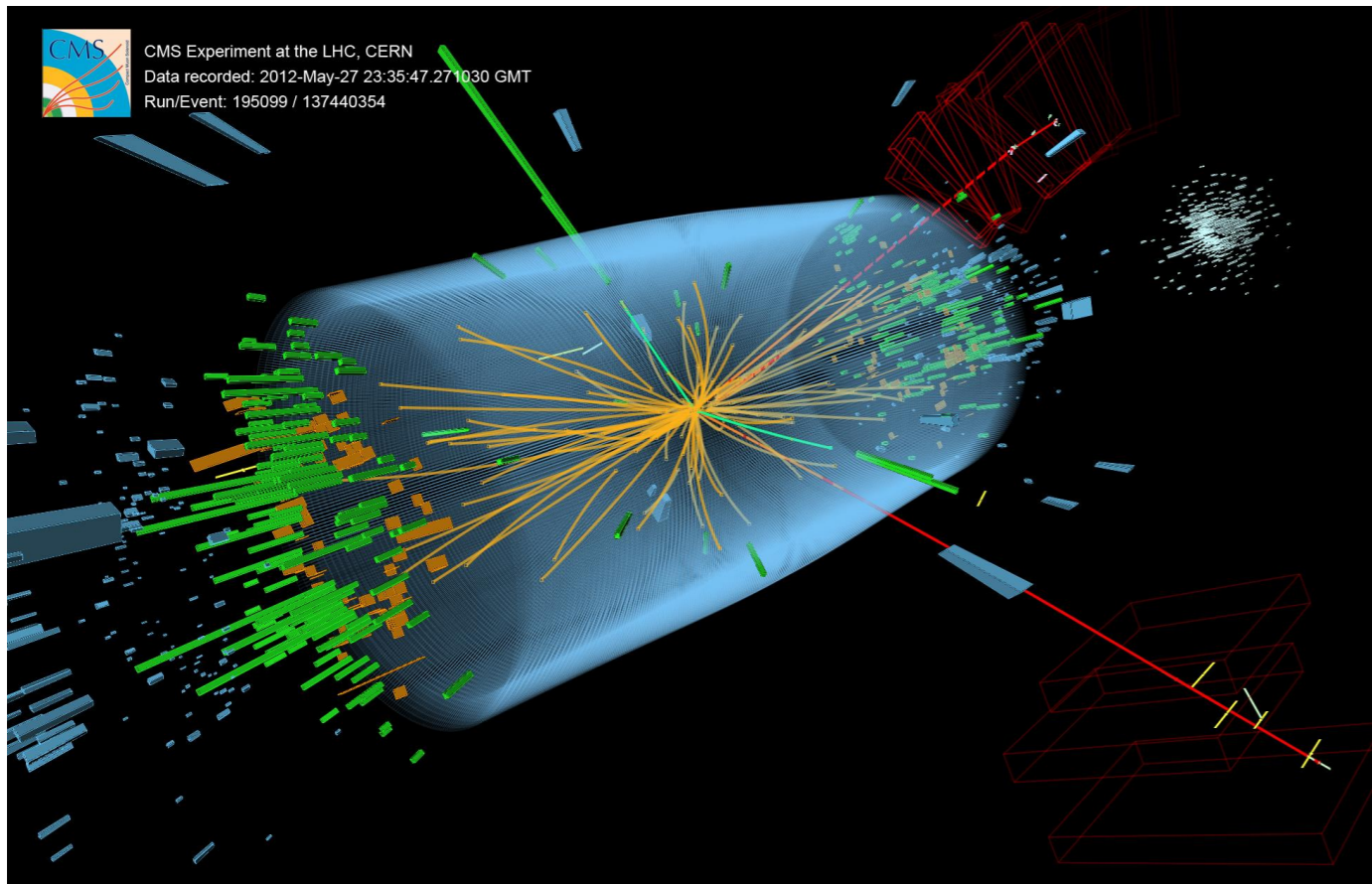
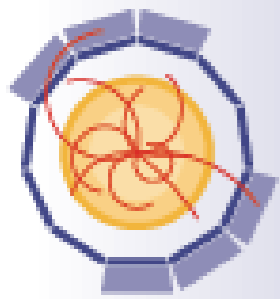


# AIDA<sup>2020</sup>

## 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<sub>2</sub> facility
- WP13: High-rate  $\propto$ RWELLS
- WP14: Test bench stands
- WP15: Cold irradiations

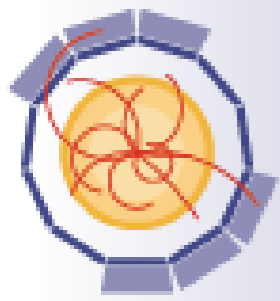




- LHC pp collision energy 13 TeV
- Higgs event

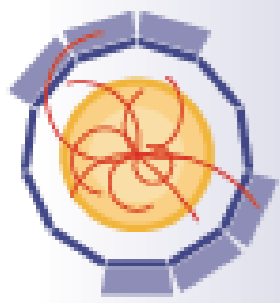
- Something completely new
- Particle properties and mass (= energy)
- Englert and Higgs : Nobel prize 2013



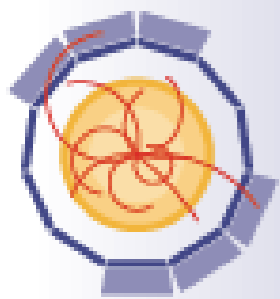


### OBJECTIVES

- **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.

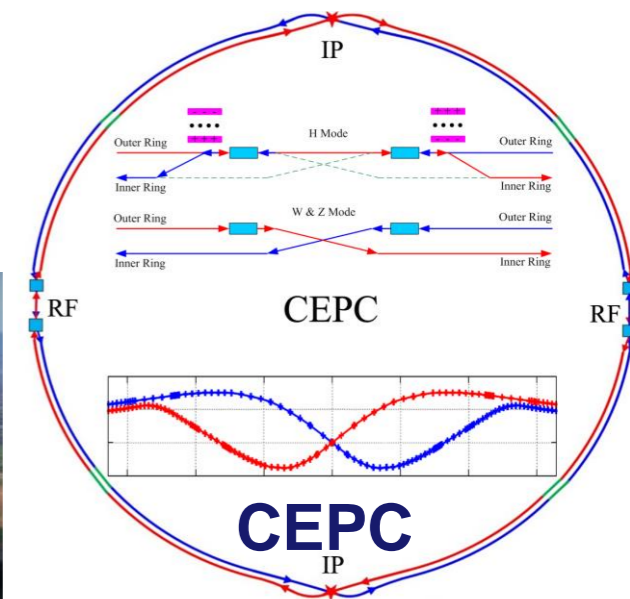
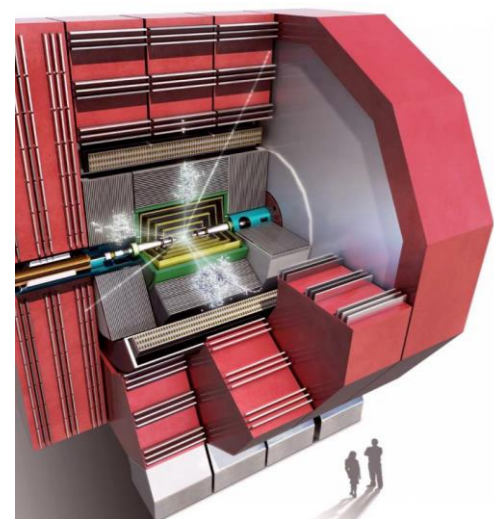
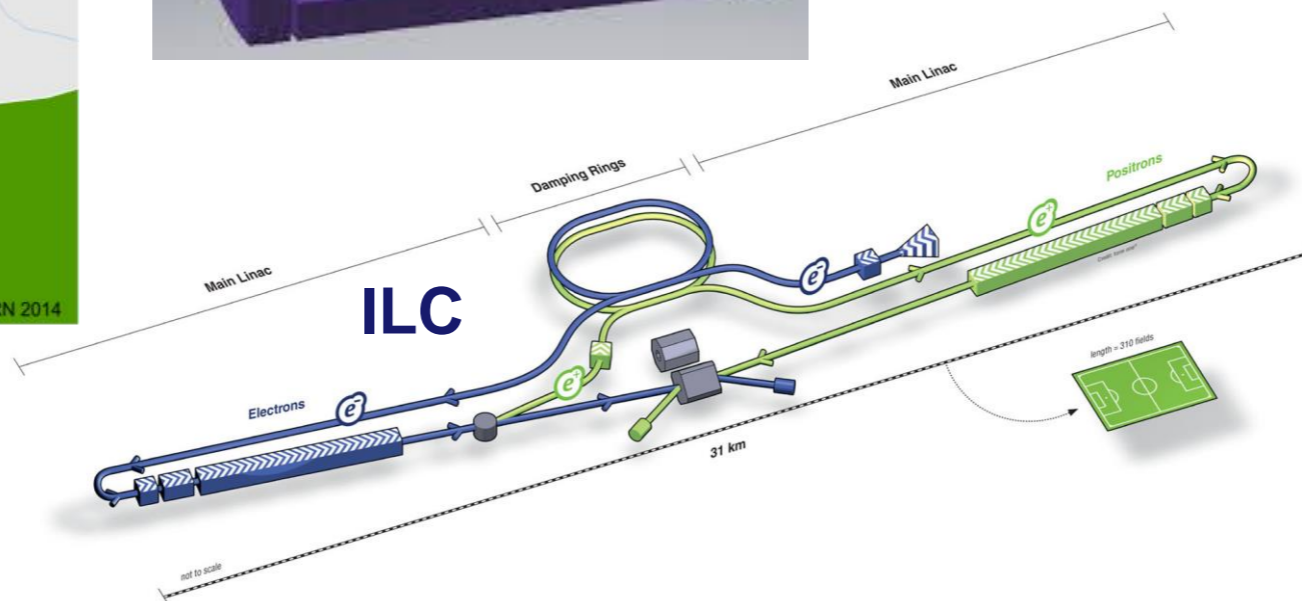
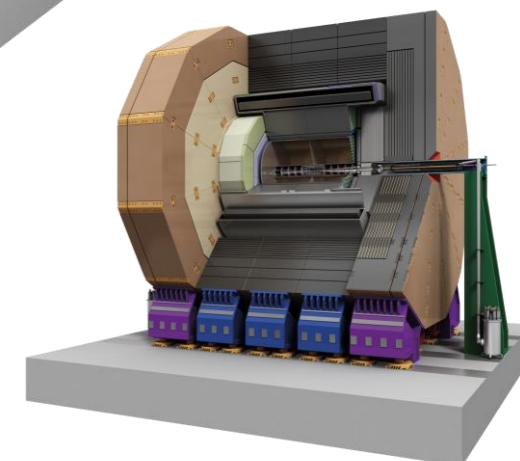
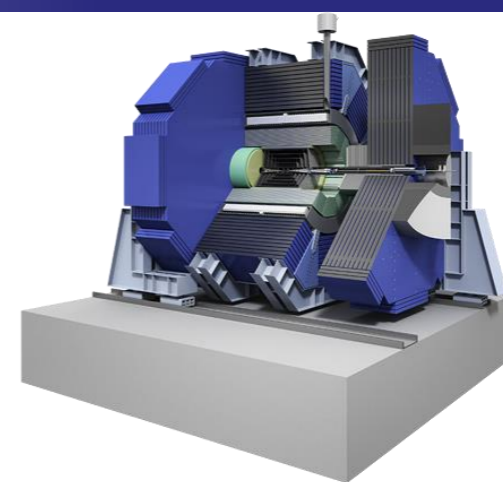
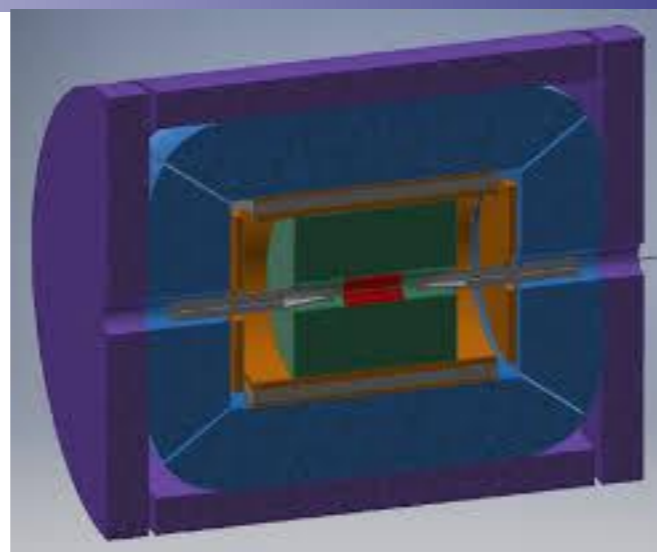
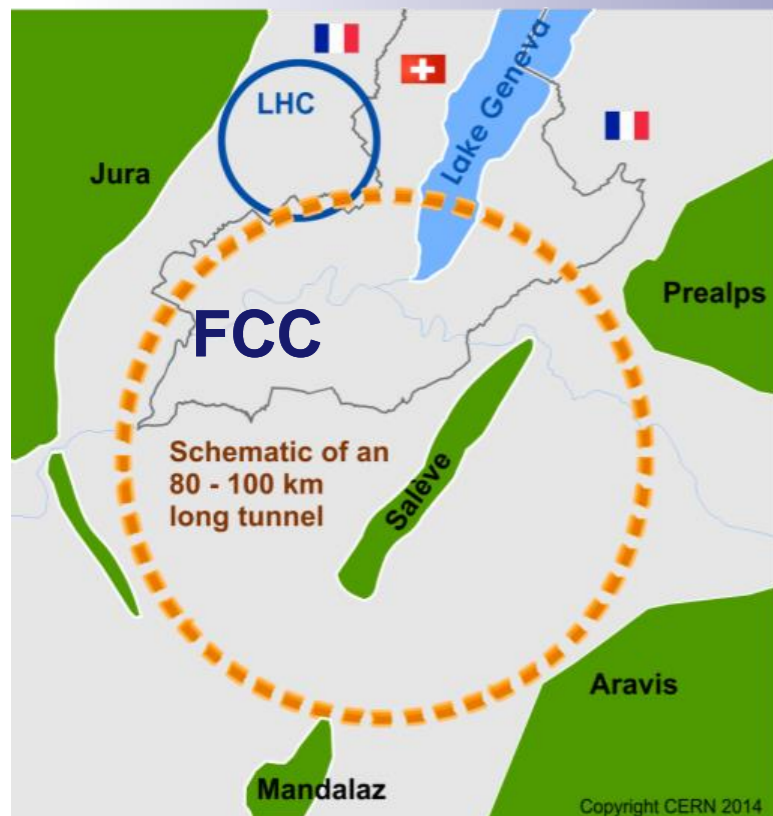


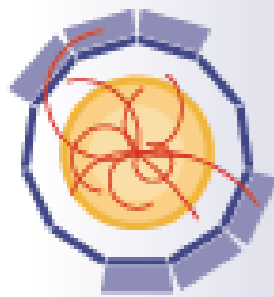
- HL-LHC upgrades now moving to production
  - R&D largely done - will not guide AIDA++
- New in AIDA-2020 – could be expanded
  - Precision mechanics and CO<sub>2</sub> micro-cooling
  - Large cryogenic detectors
- Future lepton colliders
  - Higher precision, less material
  - Requirements for linear 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



# AIDA<sup>2020</sup>

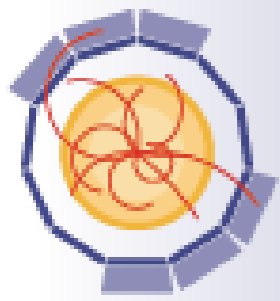
## Upcoming Challenges



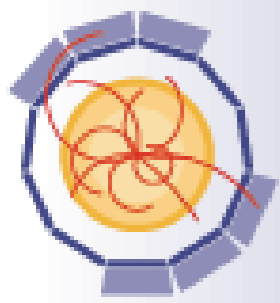


### Possible topics:

- **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)

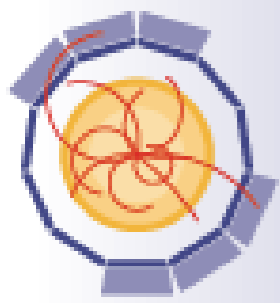


- **AIDA-2020** has already a **long history** behind it
  - **EUDET**
  - **AIDA**
- AIDA-2020 (and its predecessors) has proven to be a very successful example of an **EC co-funded scientific project**
- The new pilot call INFRAINNOV-04-2020 gives this community the possibility to:
  - Prepare and 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



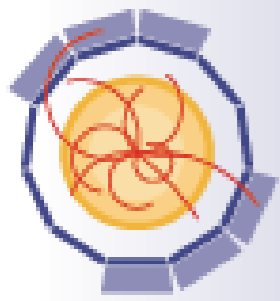
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# AIDA-2020 TA videos

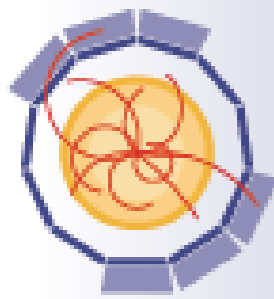


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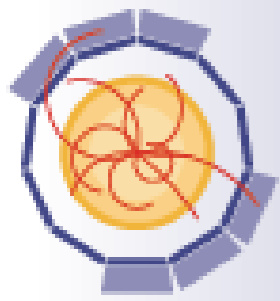
# Backup



- 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



- 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**



### ATTRACT

- Emerging communities
- Competitive
- Independent projects
- Fully bottom-up approach
- Break-through development
- Co-innovation for non-HEP markets
- Third-party funding
- Diversifying

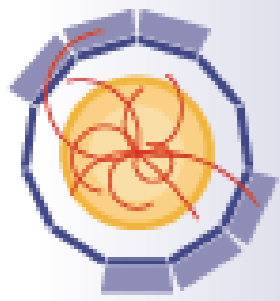
### Applications outside HEP

### AIDA-2020++

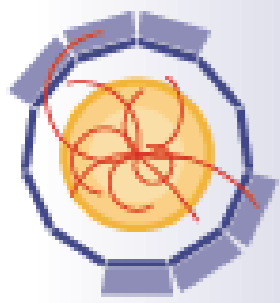
- Advanced community
- Collaborative, compete globally
- Interdependent work packages
- Aligned with European Strategy and corresponding roadmaps
- Evolutionary development
- Innovation mainly via pre-procurement R&D for HEP
- Leverage on national funding
- Integrating

### Applications within HEP

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



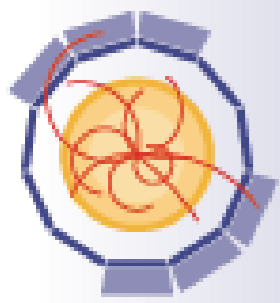
- **Separation** between call II-03 and II-04, in particular AIDA++ and ATTRACT
- II-03 aims at **innovation for markets outside RI**
- II-04 **innovation for the delivery of services, or new services of RI**
- What is **Innovation**?
- For ATTRACT: launch of a new product to market
- For us: we are invited to interpret the topic for our community
  - Can be incremental
  - Low and high TRLs\*\*
- \* **RI** – Research Infrastructure
- \*\* **TRL** - Technological readiness level



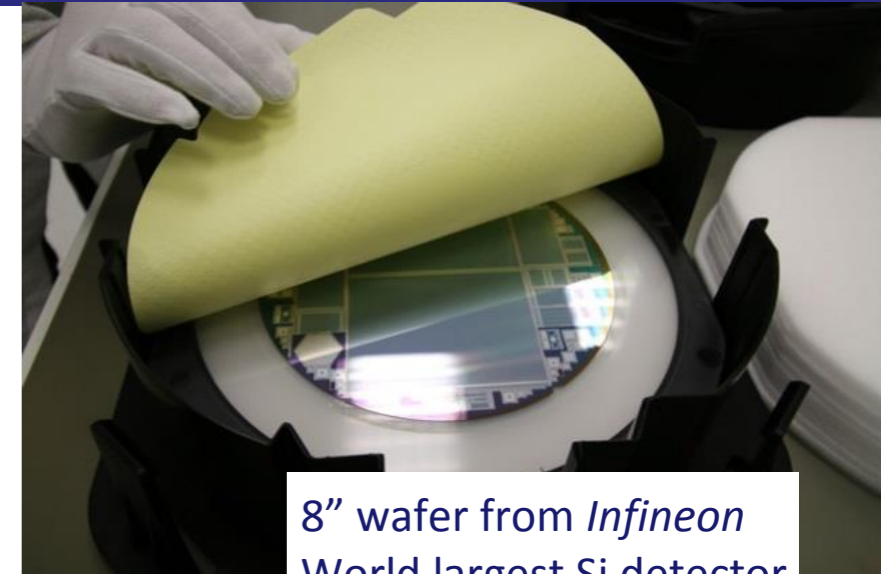
# AIDA<sup>2020</sup>

## Main Challenges for a New Proposal

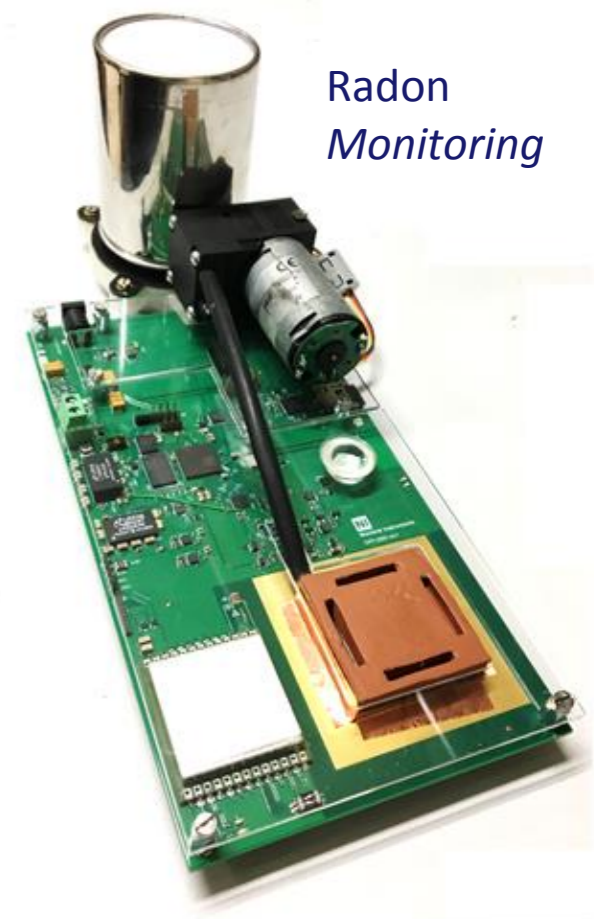
- **No Transnational Access:**
- This was one of our biggest successes; need to find new ways of directing EC funds to facilities; WP15-type of upgrade (“innovation”) activities, network
- Involvement of **industrial partners as beneficiaries:**
- Works in parallel Accelerator Initiative ARIES; need 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



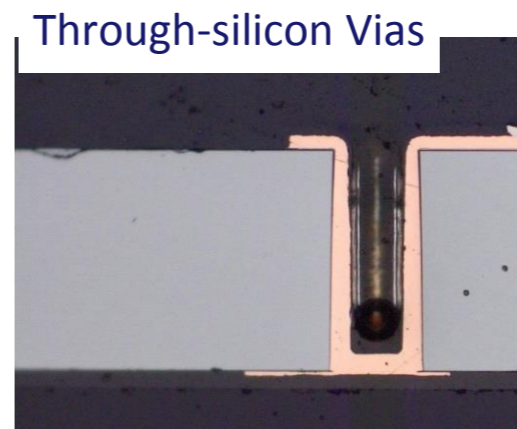
- Technology transfer to industry: two pillars:
- 1. Pre-procurement R&D
  - Detector elements needed in large quantities
  - But: not off-the-shelf products
  - After initial R&D: involve industry to adapt design to mass production requirements
  - Then transfer technology and cooperate in qualification 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



Radon  
Monitoring



Through-silicon Vias