Summary on LDG R&D Roadmap

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ESPPU and Accelerator R&D

In the 2020 update of the European Strategy for Particle Physcis (ESPPU) it was underlined how the construction of the new generation colliders (post LHC) is an extremely challenging task

The ESPPU document explicitly states: «The European particle physics community must intensify accelerator R&D and sustain it with adequate resources…Deliverables for this decade should be defined in a timely fashion and coordinated among CERN and national laboratories and institutes»

CERN Council has given mandate to the European Laboratory Directors Group (LDG) to supervise the development of the roadmap for the accelerators R&D, in parallel to the supervision work on the detectors R&D roadmap performed by ECFA

Laboratory Directors Group (LDG)

LDG is formed by the directors (or their representatives) of the major european laboratories for particle physics. Specifications for these labs are:

- National role
- Strong participation in particle physics reaserch
- Active role in accelerator or particle physics facility R&D
- Important role in the construction or operation of PP facilities
- Detector R&D and construction activities and infrastructures

As of today LDG is formed by: LNF (I), LNGS (I), CEA (F), IJCLab (F), DESY (D), PSI (CH), NIKHEF (NL), CIEMAT (E), STFC (UK), CERN (DG + Directorate's observers)

The LDG chair is an ex-officio member of the Strategy Secretariat and is invited to participate to the discussions of the CERN Council regarding the Strategy. At present it is Dave Newbold (STFC)

LDG Mandate

Cern Council, 25/3/2021:

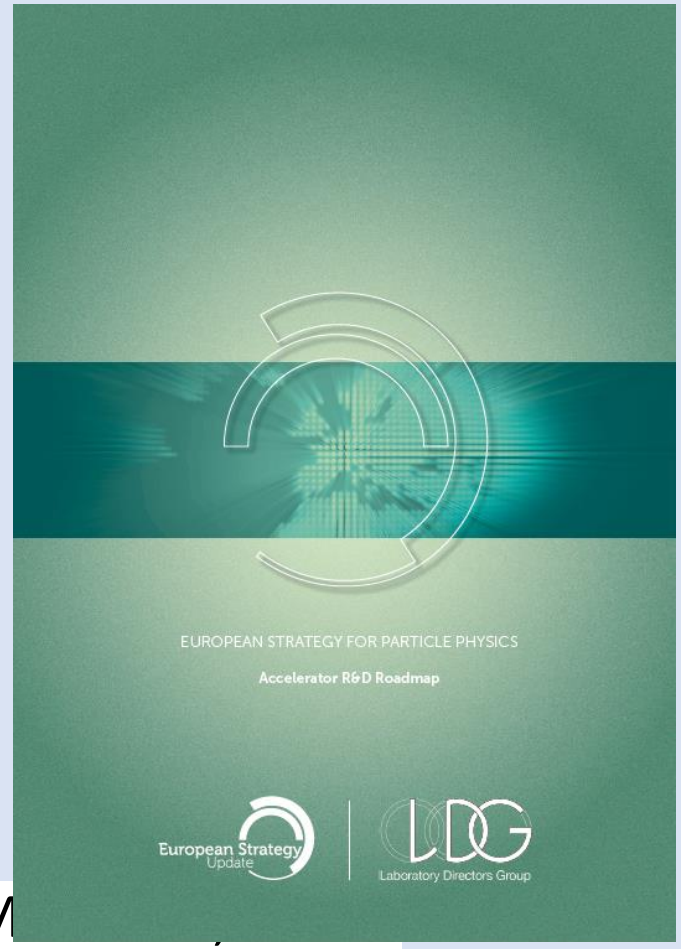
- Facilitate dialogue among Directors of Large National Laboratories and CERN
- Provide input to the European Strategy for Particle Physics
- Liase with the European Commission and national FA in order to ensure that the LNL speak with a single voice
- Maximise the regional and national benefits of investment in fundamental research and in CERN
- Keep abreast of the activities relevant to their own laboratories's activities being undertaken in laboratories outside CERN'S members states, and foster dialogue with them
- Draw up and maintain a prioritised accelerator R&D roadmap towards future large-scale accelerators
- Coordinate the accelerator R&D activities, with the aim of strengthening cooperation and ensuring effective use of complementary capabilities

Accelerator R&D first step

Five key areas have been identified, around which expert panels have been formed with the purpose of elaborating a document concerning the present status and the primary lines of research for the years to come, including estimates of the needs for funding and manpower

• High Field Magnets	*P. Vedrine (CEA)*
• High gradient RF structures	*S. Bousson (IJCLab)*
• Plasma and laser accelerators	*R. Assmann (DESY/INFN)*
• Muon colliders	*D. Schulte (CERN)*
• Energy Recovery Linacs	*M. Klein (Liverpool)*

This has resulted in a voluminous paper (about 250 pages) issued at the beginning of this year
arXiv:2201.07895



A (very) short summary of the topics addressed by the five panels is

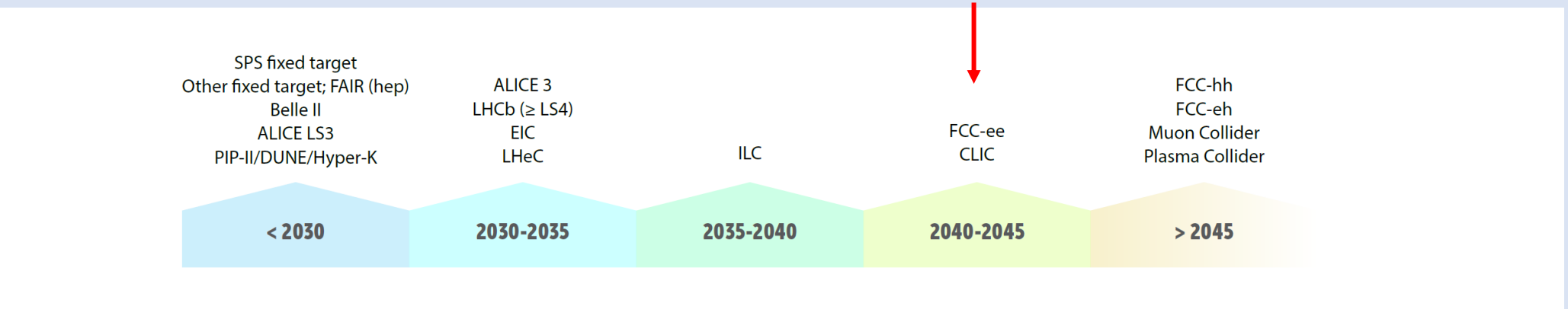
- **HF Magnets**: a) Nb_3Sn magnet technology improvements for large scale production b) Sustainability of High Temperature Superconductors (HTS) for accelerator magnets applications
- **High Gradient RF**: a) Superconducting cavities b) Normal conducting cavities c) Ancillary systems (RF sources, couplers…)
- **Plasma Acceleration**: a) Sustained simulation b) Positron and Electron acceleration c) Emittance preservation d) Efficiency and stability e) Interaction Point
- **Muon collider**: a) Proton driver bunch compression b) Muon cooling design c) Interaction region d) Detector Backgrounds e) Neutrino radiation
- **ERL**: a) High current electron sources b) High power superconducting RF

Cross correlation among various areas has been somehow remarked and taken into account

It must be underlined how this work was not focussed on a specific machine, rather on a set of possible solutions used as guidelines to judge about the relevance of well defined hardware developments

These reference colliders, of which it is given a short description in the document, are the FCC, ILC e CLIC, and, obviously, the Muon Collider

On purely illustrative grounds it is used however an indicative timeline for the implementation of the various options, some of which are, obviously, mutually exclusive at least for costing reasons



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Estimation of the resources

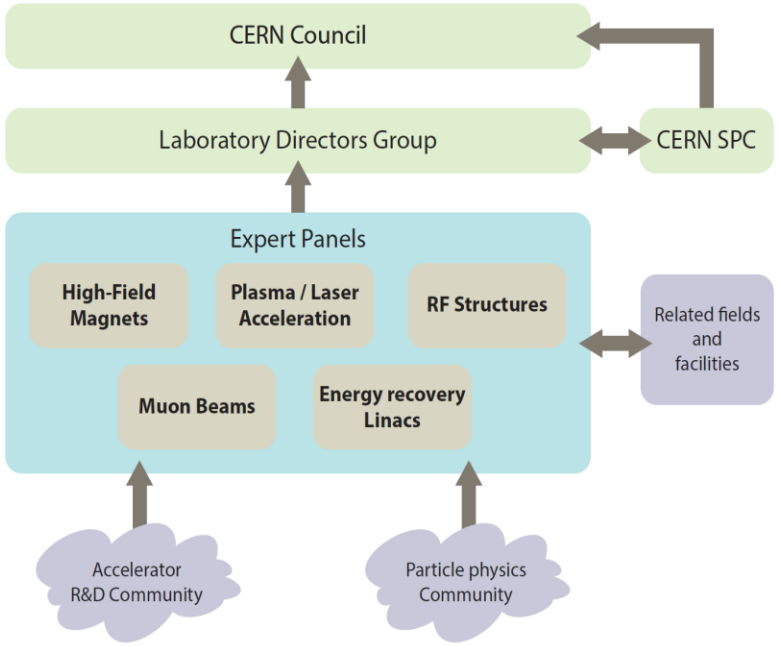
One important output of the work is an estimation of the financial and manpower resources needed to pursue the various R&D programs, considering three possible scenarios, dubbed as «nominal», «aspirational» and «minimal» with obvious meaning of the wording

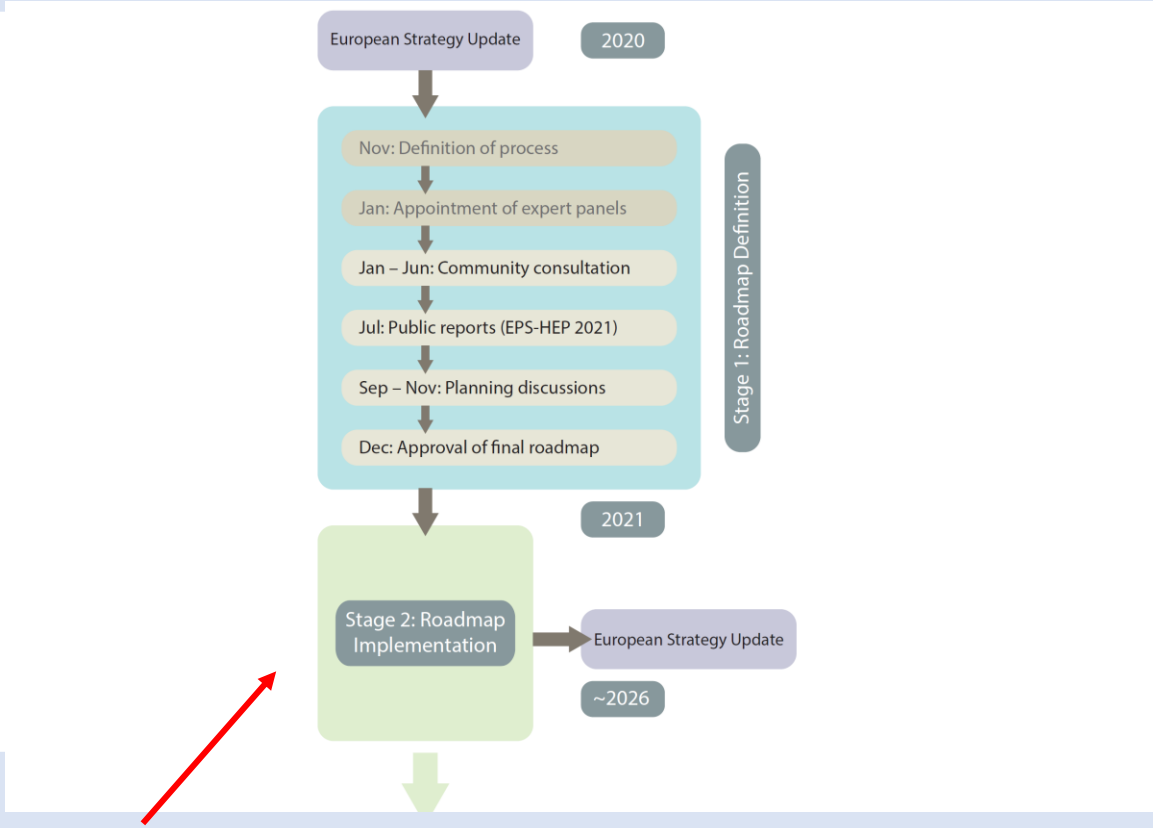
For instance the HFM panel estimates that 150/90/97 MCHF and 607/728/346 FTEy will be required over 7 years in the three aforementioned scenarios

Part of these resources are already in place, but in general there is a consistent amount of them that has to be found ex-novo

As previously remarked, part of the required resources can be shared among different key areas

The decision making structure of the process described so far is shown in the left figure below. Its flow-chart is shown on the right: we have now arrived at the implementation phase, which is the topic that we will discuss now





We are here

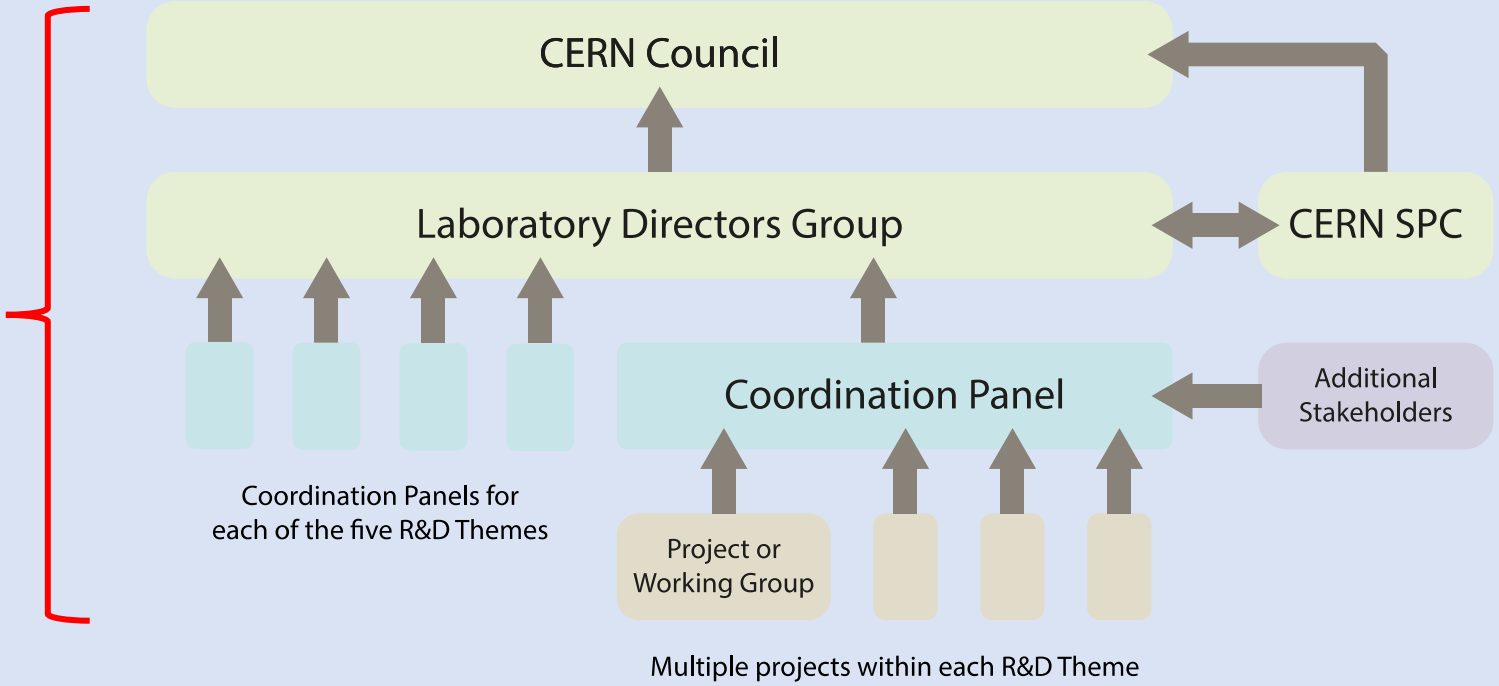
As previously specified we are now starting the so called implementation phase, i.e. the process that has to define, start and follow the progress of the specific programs aiming at putting in practice the ideas discussed in the document

Again LDG has been required to propose a scheme on how to proceed. We met twice since the beginning of the year, together with the chairs of the five panels and have finally produced a proposal to be presented to the Council this week

The main difficulty we have encountered comes from the fact that the five communities have already different levels of organization and, somehow, also different scientific programs to pursue. Think for instance at the plasma-acceleration community which is presently focussed on photon-science projects more than particle physics's ones

The structure shown below is intended to insure that the program is fulfilled, while respecting the principle that technical planning and prioritisation must be a coordinate action of the experts accross each R&D theme

Four levels structure



The tasks of each layer of the structure are basically the following

- **Council/SPC**: Oversight of the entire process of the European Strategy
- **LDG**: Maintain an overview of objectives accross the R&D program, assess progress against milestones, review and agree prioritisation decisions, track the evolving resource usage to deliver them, receive proposals of new initiatives
- **Coordination Panels**: Maintain the detailed plan of each R&D theme, and coordinate the work within it, ensure that decision are made on a sound technical basis, submit recommendation to LDG about possible change of objectives, scope or prioritisation of their R&D theme
- **Projects**: Take the responsability of specific portions of the R&D deliverables on a specific theme, construct and operate a facility supporting the programme

As previously underlined, this will presented to Council for feedback, so some details could change

Funding

The funding for the programme will likely be allocated both at the Panel level (for instance through dedicated agreements among laboratories) and at the Project level (for instance through applications to national funding agencies)

Where required the Panels will be responsible for setting up and maintaining any necessary formal agreements (for instance MoUs). This is particularly relevant where the R&D work is structured as a formal collaboration

One key point to be clarified is the interaction of the FA with the structure described so far. Here, advise from Council is requested.

Next Steps

Depending on the feedback from the Council the following action should be

- Definition of the formal terms of reference of each body of the proposed structure
- Discussion with FA and other appropriate bodies about priorities and committments
- Definition of the Panels

Following the inauguration of the Panels

- A first round of prioritisation of R&D and definition of the deliverables
- Agreement on the future reporting cycle

The hope is to have a final approval of the coordinating structure by June 2022, and a first annual progress report by December 2022