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Date: April 28, 2016 **DRAFT**

Report from the EuCARD-2 Scientific Advisory Committee

The third meeting of the EuCARD-2 Science Advisory Committee (SAC) took place from April 26 to April 29, 2016, during the EuCARD-2 Annual Meeting held in Valletta. Present for the SAC were Akira Yamamoto (KEK) and Stephen Peggs (BNL). The SAC mandate is in Appendix A.

The specific objective for the SAC at the 2016 meeting: Contribute to identifying key achievements and results of EuCARD-2 in preparation for the Final Report due in June 2017.

1 EXECUTIVE SUMMARY

We congratulate and thank all the participants of the annual meeting for their hard work, careful thought, excellent presentations, and hospitality. The presentations made by EuCARD-2 collaborators were of consistently high quality.

Enormous progress has been made since the 2015 Annual Meeting. SAC is impressed with the breadth and depth of the reports on EuCARD-2 activities, at the end of the third year. We look forward to reading the fourth and final chapter of this book, and anticipate the next volume, as outlined in the ARIES proposal.

It is impossible for SAC to systematically review technical and scientific results and developments, within the limited resources and time available.

Ties to industry have been further strengthened and exploited in several Work Packages, but more progress is still possible in this vital area. Work Packages (WP) 2 and 4 ("Catalysing innovation" and "Applications of accelerators") have an especially important role to play.

SAC is happy to note the more systematic accumulation of statistics in describing Work Package activities, especially in describing the demographics of Networking Activities. The statistics on the participating number of junior physicists and engineers are healthy. In common with other domains, the effort to increase the level of female participation needs constant attention.

2 OVERVIEW AND GENERAL COMMENTS

EuCARD-2 activities are separated into categories of "Management", "Networking Activities", "Transnational Access (to Research Infrastructure)", and "Joint Research Activities" (sometimes also called "Research & Technology Development").

WP1 Management and communications

SAC is pleased to note the enhanced visibility of the smaller institutes and universities at the annual meeting, and to note the visibility of younger researchers. The presentation of "special topics" was, again, successful and stimulating.

Meeting at the University of Malta is consistent with the goal of locating meetings and workshops at the smaller institutes, laboratories and universities. This makes EuCARD-2 activities more visible to communities that are usually enthusiastically receptive. It is also part of the networking success of EuCARD-2.

Work Package leaders and the presenters at the annual meeting were asked to highlight their "key achievements and results" in the last year. Success in identifying a few key results was mixed, perhaps in part because of the desire to make a complete list of all achievements, in part because of the will to make sure all participants are recognized. The selection of a few carefully chosen representative achievements and results will be especially important at the final annual meeting.

3 NETWORKING ACTIVITIES (NA) – Work Packages 2 to 7

WP2 Catalysing innovation
WP3 Energy efficiency
WP4 Accelerator applications
WP5 Extreme beams
WP6 Low emittance rings
WP7 Novel accelerators

In general, Networking Activities have been very successful. The need to provide quantitative indicators – and the challenge to provide them – is especially strong in NA's.

WP2 Catalysing innovation

Knowledge Transfer activities and communications with industry are naturally organised by the large laboratories, such as CEA, CERN, DESY, and STFC. At this point it seems that mainly CERN and STFC are active. We recommend that the involvement of CEA and DESY be strengthened as far as possible in the fourth year, partly in preparation for ARIES. We suggest paying attention to the need to address diverse industrial communities, especially in those European countries that are technologically less competitive. We recommend highlighting successful initiatives that have materialised into real projects or benefits.

WP3 Energy efficiency

This important initiative is well structured and is advancing well, with goals that are essential for future generations of accelerators, large and small. Continued and improved application of superconducting systems (magnets and RF) is promising. Significant RF power source efficiency improvements (magnetrons, klystrons, modulators) have been understood and achieved, at least on paper. Energy management, including short and medium timescale storage systems, has received attention. This Work Package is well connected with other similar global and regional accelerator initiatives towards the same objectives – EuCARD-2 networking is also global.

WP4 Accelerator applications

SAC sees good progress with the generation of the "Applications of Particle Accelerators in Europe" (APAE) document, which will provide readily accessible and useful information for policy-makers and funding agencies. This will be useful during ARIES, and in future presentations to the European Commission. The document would be stronger with increased involvement by accelerator technology companies and other industrial partners.

It is important that the entire EuCARD-2 community embrace and support the APAE contents – broad active involvement in the editing process is desirable. SAC will be happy to be involved, in some appropriate fashion, in the editing of APAE.

WP5 Extreme beams

This Work Package is especially active in networking. Topics addressed have deliberately straddled the boundaries between accelerator sub-disciplines. Three representative cross-disciplinary efforts are:

1. Beam dynamics & magnets: advancing FAIR, light sources, medical accelerators, and industrial ties
2. Dynamics & diagnostics: particularly beam halo measurement
3. Dynamics & materials: collimation, quenching, photon stops, e-cloud

WP5 (in common with other Work Packages) also crosses boundaries between universities, laboratories, and companies, helping to enhance communications between participants with very different professional advancement criteria, publication policies, institutional goals, and collaboration styles. SAC continues to support and recommend giving diversified visibility to many partners from multiple European institutions and projects, especially junior participants.

WP6 Low emittance rings

This is a well-structured and balanced effort, with encouraging results from all of the tasks in a rapidly evolving field. Today, many of the worlds leading synchrotron light rings are pursuing low emittance efforts, often through upgrades, following the successful commissioning of MAX-IV. There is a new branch on the "universal" curve of natural emittance versus storage ring circumference!

This work package has played a significant role in standardizing and validating the new standard optics of Multiple Bend Achromats, for example showing that large (enough) dynamic apertures can be achieved. Tracking tool development and maintenance has been enhanced, the "longitudinal gradient" concept has strengthened, and new low emittance cells concepts have been proposed. Low emittance collective effects have been examined in more detail. The state-of-the-art has been advanced in vacuum chamber coating, high-field low period wigglers, and stripline kickers, through a number of EuCARD-2-mediated collaborative activities between ALBA, ANKA, BINP, CERN, Diamond, ESRF, MAX-IV, and Spanish industry.

WP7 Novel accelerators

The EuPRAXIA design study has begun. The participation of many universities and small labs (as well as big labs like CERN and DESY) in the long-term development of plasma-based accelerators is an example of EuCARD-2 networking contributions. Particularly exciting is the current race to first achieve free electron lasing with a plasma accelerator, even with very modest performance parameters. We encourage further similar proposals in integrating programs – see comment under WP13 "Novel acceleration techniques".

4 TRANSNATIONAL ACCESS (TA) – Work Packages 8 and 9

WP8 Ionisation Cooling Test Facility – ICTF at STFC
WP9 High radiation & magnet tests – HiRadMat & MagNet at CERN

Transnational Access activities are enhanced in the ARIES proposal, building on the experience gained in these 2 Work Packages. (We advocate adding the phrase "research infrastructure" to "transnational access" in the future, perhaps including "regional", "inter-institutional", and/or "test facilities".) TA activities are a successful example of EuCARD-2 activities.

WP8 Ionisation Cooling Test Facility – ICTF at STFC

Currently the ICTF beamline at RAL serves the Muon Ionisation Cooling Experiment (MICE) collaboration and community. MICE is now taking data in the Step IV configuration, in preparation for the final Cooling Demonstration configuration, with RF re-acceleration. TA activity foreseen under EuCARD-2 has been achieved, although only at a modest level.

WP9 High radiation & magnet tests – HiRadMat & MagNet at CERN

Both the HiRadMat and MagNet test facilities at CERN are successful in attracting significant numbers of external international users, although not without interruptions due to equipment upgrades, et cetera. The statistics show promising extension of this activity into ARIES.

5 JOINT RESEARCH ACTIVITIES – Work Packages 10 to 13

WP10 Future magnets
WP11 Collimator materials
WP12 Innovative RF technologies
WP13 Novel acceleration techniques

SAC is impressed by the large number of ongoing JRA activities, and by third year results. EuCARD-2 serves as a complement to what individual labs development efforts, and provides them with an efficient mechanism for multi-lab collaboration.

WP10 Future magnets

WP10 is a well-structured Work Package headed by CEA and CERN, plus a specific industrial partner, looking at the (post-FCC) far future. The ultimate hardware deliverable is a 5 T HTS dipole magnet prototype coils made from Roebel HTS cable in an "aligned block" design. The dipole will be inserted and tested within the 13 T FRESCA-2 Nb3Sn test facility at CERN.

Impressive progress seem likely, with significant implications for future HTS magnets, especially if one or more model magnets can be tested before the end of EuCARD-2. Evaluating the future path towards accelerator quality performance will be key.

In the future perhaps this Joint Research Activity (and others like it) could be more clearly co-ordinated with Transnational Access activities, since both are multi-institutional (joint) activities that use international (European) test facilities.

WP11 Collimator materials

This effort is making systematic progress, in a collaboration of many institutions. It is focused solely on the CERN projects and proposals HL-LHC and FCC. Many activities are under way. Two promising materials have been identified for future collimators: copper-diamond and molybdenum carbide-graphite. Plans outside EuCARD-2 include testing a full-scale prototype of an HL-LHC collimator in the HiRadMat facility.

WP12 Innovative RF technologies

This diverse Work Package is making progress on many fronts, including Nb3Sn deposition on cavity surfaces at CERN, wakefield monitor tests at PSI, crab cavity development at the University of Lancaster, flexible modulators at Uppsala, and HOM simulation development at the University of Rostock. Co-ordinated efforts between the tasks in this Work Package are building a strong foundation for the future, for example in the ARIES proposal.

WP13 Novel acceleration techniques

We were presented with an impressive list of activities, results and simulations. However, it was not immediately clear to SAC what were the "key achievements and results" in advance of the final report, next year. Confusing to SAC is the overlap between this WP, "Nov(b)el acceleration techniques", and WP7 "Novel accelerators". Assuming that such overlap continues in the ARIES proposal, it is desirable to more transparently and efficiently co-ordinate these parallel activities.

APPENDIX A – SAC MANDATE

Mandate of EuCARD-2 Scientific Advisory Committee

The EuCARD-2 Scientific Advisory Committee (SAC) is an external advisory body composed of members with an international reputation endorsed by the Governing Board upon proposition of the EuCARD-2 Steering Committee.

This committee will receive the EuCARD-2 Yearly Activity Reports and is expected to meet at least once per year during the EuCARD-2 Annual Meeting.

The role of the committee consists in:

- Monitoring the scientific and technical activities and advising the EuCARD-2 management in case of possible failure/delays in the EuCARD-2 deliverables/milestones.
- Giving recommendation to the EuCARD-2 management about scientific/technical choices to be made throughout the project or actions to be taken with the partners and or within the Work Packages.
- On request of the EuCARD-2 management, participating to an EuCARD-2 internal review.
- Providing a short document after each SAC meeting, and reporting at the EuCARD-2 plenary or EuCARD-2 governing board meeting

Finally the scientific advisory committee is expected to participate to the strategy reflections about the continuation of EuCARD-2 within the European framework but also with non European partners.