# I.FAST

Innovation Fostering in Accelerator Science and Technology

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# DELIVERABLE REPORT

# HTS European Strategy Group for Accelerator Magnets

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## ABSTRACT

The following document reports on the set up of a European strategy group on HTS accelerator technology and on its mandate, composition, and modus operandi. After discussions within WP8 and in line with the roadmap for implementing the European Strategy Update on Particle Physics, that CERN and the LDG (Laboratory Director Group) are in the process of defining, the group will be named HTS-AT, i.e. HTS for Accelerator Technology. The name emphasizes the need of a technological development before HTS becomes usable in accelerator magnets.

The main scope of the group is to organize workshops, forums, meetings, to present and discuss progress/plans on HTS for accelerator magnet technology in Europe: superconductors, magnets, cryogenics, modelling, testing, instrumentation, protection. This activity should implement synergies and favor collaboration among various institutes with representation from all I.FAST-WP8 beneficiaries and other key laboratories in the field. The kick-off meeting of the Group has taken place on seventeenth of March 2022.

For more information on IFAST, its partners and contributors please see https://ifast-project.eu/

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## *Executive summary*

*High Temperature Superconductors (HTS), have the potential of being a breakthrough in magnet technology. Their most appealing property is the high current capability at 4.2 K and in high fields or at higher temperatures. It is today acknowledged that many key issues still need to be understood and solved before HTS can be adopted for real applications. The creation of a European strategy Group on HTS accelerator magnets aims at establishing a strong coordination in the acceleration community oriented to use HTS. After discussions within the I.FAST-WP8, and in line with the roadmap for implementing the European Strategy Update on Particle Physics, that CERN and the LDG (Laboratory Director Group) are in the process of defining, it was decided to name the Group HTS-AT, i.e. HTS for Accelerator Technology. This name emphasizes the need of a technological development before HTS becomes usable in accelerator magnets.*

*The activity of the Group encompasses organization of workshops, forums, meetings, with the objective of presenting and discussing progress/plans on HTS accelerator magnet technology in Europe: superconductors, magnets, cryogenics, modelling, testing, instrumentation, protection. The scope is to implement synergies and favor collaboration among various institutes. Topical workshops will enable material scientists, magnet designers, technologists and engineers to gather and discuss, propose joint programs and promote topics of common research for funding by national programs in the framework of an international coordination.*

# 1. Introduction

High Temperature Superconductors (HTS), have the potential of being a breakthrough in magnet technology. Thanks to their high current capability at 4.2 K and in high magnetic fields, they are an enabling technology for magnets generating fields beyond the limits of Low Temperature Superconductors (> 16 T). Their thermal stability, given by the large operational temperature margin, can solve issues, like training, that strongly affect Low Temperature Superconductors. In addition, thanks to very good transport properties also at temperatures well above liquid helium, HTS can deliver high currents up to about 20 K, enabling dry cooling of magnets via cryocoolers. This is particularly significant for small accelerator systems and beam transfer lines, like low energy synchrotrons or hadron therapy complex. Operation at higher temperatures implies reduced cost of the cryogenic refrigeration: at 20 K the energy consumption at the plug is at least ten times less than at 1.9 K, for He II cryogenics.

However, many key issues still have to be addressed and solved before HTS can be adopted for real applications. In this context, it is important that the community of accelerator magnets coordinates the effort on HTS, continuing the tradition of FP7-Eucard2 and H2020-Aries that have organized five European workshops on HTS for accelerator magnets [1]-[5]. The setup of the European Strategy Group on HTS accelerator magnet is a mean to reinforce this coordination. After first discussion within the I.FAST-WP8 collaboration, [6] and also following the roadmap for implementing the European Strategy Update on Particle Physics, that CERN and the LDG (Laboratory Director Group) are in the process of defining also for the High Field Magnets [7], the group will be named HTS-AT,

i.e. HTS Accelerator Technology. The name emphasizes the need of a technological development before HTS becomes usable in accelerator magnets.

In the following sections, we report on the mandate of the group, on its composition and modus operandi.

# 2. Mandate of the HTS-AT (HTS accelerator technology) Group

The HTS-AT Group, is generate from the H2020-I.FAST WP8 collaboration and is composed by academic institutions, research laboratories and industrial partners that have an interest in HTS accelerator magnet technology.

The main mission of the group is to organize workshops, symposia, inter-laboratory meetings, and other similar events, to discuss progress and plans on HTS accelerator magnet technology in Europe: superconductors, magnets, cryogenics, modelling, testing, instrumentation, protection. The scope is to implement synergies and favour collaboration among various institutes. Topical workshops will enable material scientists, magnet designers, technologists and engineers to gather and discuss, to propose joint programs and promote topics of common research for funding by national programs in the framework of an international coordination.

For each event, an in particular for the Workshops, the Group will agree to assign to a host Institute and will nominate a chair. The chair will nominate a Scientific Program Committee (SPC) and communicate to the Group members the members of the SPC, for comments.

It is foreseen that the Group issues documents reporting on the status of the research, in Europe, on specific topics related to HTS technology.

## 2.1 FORMAT OF THE WORKSHOP

The discussions will take place via workshops organized on a regular basis, typically every 2 years, possibly without interfering with the participation to EuCAS (European Conference on Applied Superconductivity). Participation in person will be preferred, if possible. The duration of the Workshops will be about two days. We envisage up to about 50 participants. Typically, one workshop every two years is foreseen, suggesting it is at least few months far from the dates of EuCAS and of other relevant events (like workshop on HTS held by other communities or workshop/meetings on magnets for accelerators in general).

The participation to the Workshop will be by invitation, to assure a coherence of the audience and proper representation of all pertinent competences. It will be extended also to non-European academia and institutions, always by invitation. At the first kick -off meeting the HTS-AT Group has decided that:

1. Industry active in HTS can be invited freely by the SPC (both EU and non-EU, according to needs).

2. Industry active in magnet design and manufacturing, non-beneficiary of H2020-I.FAST, cannot be invited freely. If the SPC of the workshop deems to invite magnet companies else than the IFAST beneficiaries, *it has to inform and ask approval to the HTS-AT Group (where the industry which are beneficiary of IFAST can comment the proposal).*
3. The workshop will be named **WAM-HTS**, following the previous tradition established in FP7-Eucard2 and H2020-Aries.

Submission of abstracts for oral presentations and small inscription fees will be required (though this point will be discussed for each workshop and will depend on the hosting Institute). Speakers will be invited to present and discuss different topics related to HTS accelerator technology. Presentations will be made available on a Web site (with public or restricted access) or, in alternative, to encourage openness and discussions, presentations will not be available (speakers may decide to provide their slides). No publications will be requested. Executive summaries will be written after the Workshops.

As workshop follow-up the organization will issue a short document with highlights and results emerged from the workshop and guidelines/suggestions/recommendations to reinforce coordination of the effort among EU lab on HTS for accelerators.

## 2.2 ORGANIZATION AND MEMBERSHIP

The Group is chaired by a representative of CERN (as host of the HFM program including HTS for future accelerators). The deputy chair is a representative of INFN (as coordinator f I.FAST-WP8). The members of the Group are initially representatives of the I.FAST-work package 8. Representatives of other major laboratories in Europe - active on HTS related to accelerator - will be done by cooptation (unanimously approved at the HTS-AT Group meeting. Non-European representatives may be invited as observers.

**Initial members are:**

CERN (IFAST, chair)

INFN (IFAST, deputy chair)

CEA (IFAST)

CIEMAT (IFAST)

GSI (IFAST)

IEE Institute of Electrical Engineering, Slovak Academy of Sciences (IFAST)

ILK Institute of Air and Refrigeration Technology Dresden (IFAST)

PSI (IFAST)

UG- University of Geneva (IFAST)

UT- University of Twente (IFAST)

UU- Uppsala University (IFAST)

Wigner RCP – Wigner Research Center for Physics-Budapest (IFAST)

BNG – Industry (IFAST)

Elytt – Industry (IFAST)

Scanditronics – Industry (IFAST)

**Further EU members to be coopted, as decided at the first kick off meeting are:**

KIT (Karlsruhe, DE)

University of Southampton-SOTON (UK)

Other institutes or universities may be added later if the Group deems so.

**Non-EU observers (academia or institutes)**

BNL (USA)

FNAL (USA)

LBNL (USA)

NHMFL/ASC (USA)

TcSUH (Texas center for Superconductivity at University of Houston)

KEK (JP)

Univ. of Kyoto (JP)

IHEP (CN)

Other Institutes could be added later if the Group deems so.

## 2.3 MODUS OPERANDI

The Group will meet at least once a year. The meeting will be called by the chair (CERN). At the meeting, upon proposal of the chair, the group will decide the location and date of the workshop (or other event), the topic(s) to be discussed and will suggest a preliminary list of invited speakers. The Group may discuss and encourage the organization (without obligation) of other types of events like schools or training initiatives. For the workshops, and other initiatives, the Group will create a program committee and nominate 5 to 6 scientists that together with a local organizing committee will be the responsible of the organization of the events.

# 3. Conclusions and future plans

The creation of a Group, called HTS-AT (HTS accelerator technology) Group, for coordinating the R&D effort, in Europe, on HTS accelerator technology has been discussed. This Group should constitute a reference framework aiming at promoting and tightening the collaboration among academia, research laboratories and industry. The Group will work in close contact with other bodies coordinating the HFM for future accelerators and ESAS. The European Group is open also to observers form other continents.

The first kick-off meeting discussing the mandate and composition has taken place on 17 March 2022 in the frame of the WP8 meeting.

WP8 coordination will write to the co-opted laboratories (KIT and SOTON) to ask them to accept to sit in the Group and the name of representing person.

Once the D8.1 (this document) formally approved by H2020 management, WP8 coordination will inform the observers if they want to provide a representing person and the other concerned bodies.

The first Workshop is planned to be take place in the week of February 6-10, 2023. This is sufficiently far from EuCAS2023 (September 6-10, 2023, in Bologna) and other events (like ASC2022).

The workshop will be hosted by CERN and chaired by Amalia Ballarino.

# 4. References

[1] WAM-HTS-1, Hamburg May 21-23, 2014, https://indico.cern.ch/event/308828/

[2] WAM-HTS-2, Kyoto, Nov 12-14, 2014, https://indico.cern.ch/event/319762/

[3] WAM-HTS-3, Lyon, Sep 10-11, 205, https://indico.cern.ch/event/396905/

[4] WAM-HTS-4, Barcelona, Feb 15-17, https://indico.cern.ch/event/588810/

[5] WAM-HTS-5, Budapest, Apr 11-13, https://indico.cern.ch/event/775529/

[6] IFAST – WP8 meeting # 6, Jan 20, 2022, https://indico.cern.ch/event/1118037/

[7] Pierre Vedrine, Luis Garcia-Tabares, Bernhard Auchmann, Amalia Ballarino, Bertrand Baudouy, Luca Bottura, Philippe Fazilleau, Mathias Noe, Soren Prestemon, Etienne Rochepault, Lucio Rossi, Carmine Senatore, Ben Shepherd, “High Field Magnet Development for HEP in Europe : A Proposal from LDG HFM Expert Panel”, arXiv: 2203.08054,
URL: https://arxiv.org/abs/2203.08054