WP8 – 3rd meeting – 07.Sept.2021 – virtual meeting

Lucio Rossi – INFN-MI-LASA

This is a I.FAST WP8 (magnets) Meeting

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& I.FAST

WP8 Listing

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INFN-LASA
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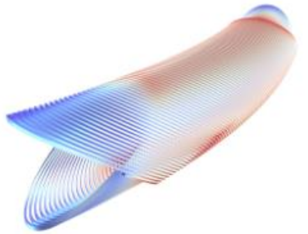
Permanent slot for our IFASTG-WP8 meetings

- Remind: standard meeting slot is **Tird Thursday of each MONTH at 9h00**.
- (HITRI*plus* WP8 is the first Tuesday at 16.00)This si special ut of standard meeting. Las meeting was in June, and 21-22 Sept there is the CCT workshop.
- As from October 21, we resume normal standard slot meeting.

CCT-Computation & Design Workshop

HITRI plus
Heavy Ion Therapy Research Integration

iFAST



CCT-CDW - 1

Timetable

Tue 21/09 | Wed 22/09 | All days

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15:00	**Welcome and recap of HITR/IFAST WP8 scope**	*Lucio Rossi*	15:00 - 15:15
	CCT for HFM accelerator: the why of a return	*Shlomo Caspi*	15:15 - 15:35
	CCT program for HFM @ LBL: computation, design, technology and test results	*Diego Arbelaez*	15:35 - 15:55
16:00	**HiLumi CCT and other possible LHC use: computation, design, technology, results**	*Glyn Kirby*	15:55 - 16:40
	Mathematics of curved CCT: computation tooling, design, technology and results of proton gantry magnet	*Lucas Brouwer*	16:40 - 17:25
17:00	**Break**		17:25 - 17:40
	CCT computation for SuShi	*Daniel Barna*	17:40 - 18:05
18:00	**An approach for field quality for curved magnets: report form the HITRI WG.**	*Elena Benedetto et al.*	18:05 - 18:40
	Discussion		18:40 - 19:00
19:00			

Timetable

Tue 21/09 | Wed 22/09 | All days

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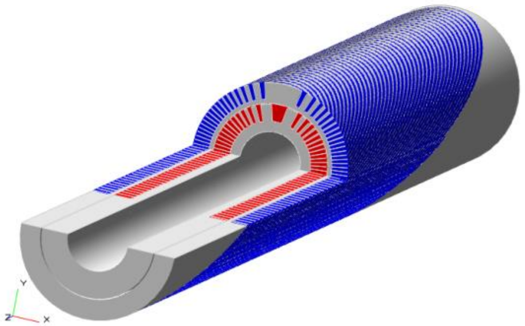
15:00	**Computation, Design, test results of the CCT**	*Bernhard Auchmann*	15:00 - 15:30
	Computation tool developed at LASA	*Ernesto De Matteis et al.*	15:30 - 16:00
16:00	**Novel design and issues for straight and curved CCT (LTS and HTS)**	*Glyn Kirby*	16:00 - 16:30
	HTS and hybrid CCTs	*Tengming Shen*	16:30 - 17:00
17:00	**RAT: a powerful design code specially tuned for CCT**	*Jeroen van Nugteren*	17:00 - 17:45
	Break		17:45 - 18:00
18:00	**A new optimization algorithm for optimizing FQ of curved CCT**	*Dora Erzsebet Veres et al.*	18:00 - 18:25
	FQ/Optics otimization	*Reed Teyber*	18:25 - 18:40
	Discussion		18:40 - 19:00
19:00			

WP8 duration: from M1 to M48 !! (HITRI+ WP8 is 36 months) Scope of our WP8

- Here we want to develop technologies supporting the EU Industry that wish to learn about the CCT developed by CERN.
- We aim at something useful for advanced HatronTherapy (SEEIIST)
- → 1 HTS CCT preceeded by 1 NbTi of same dimension as “gauge”
  - 2 HTS CCT ideal: need additional effort for budget (HTS tapes -> CER…

… to … the

CCT dipole
4 T operative
5 T target; Ø =60-90 mm;
500mm < L < 1000 mm



iFAST HITRI+

- Straight!, since we consider that

We asked two modfications to the governing Board

1. Extnsion for deadline ESG

INFN
Istituto Nazionale di Fisica Nucleare

iFAST

Memo INFN-LASA-IFAST N. 1 of 5 August 2021

From: Lucio Rossi, INFN-Milano LASA, I.FAST WP8 Coordinator

TO: Maurizio Vretenar, CERN, I.FAST Project Coordinator

CC: A. Ballarino (CERN), Th. Lecrevisse (CEA)

Subject: Amendment request to IFAST GA: shift of Deadline 8.1 "HTS European Group"

In the I.-FAST WP8 (Innovative superconducting Magnets) program one of the first activity that was foreseen is the set up of a "European Strategy Group", ESG, composed by a representative of I.FAST-WP8 beneficiary and open to world wide partners, to discuss the European strategy for HTS magnets for accelerators. The setup of such ESG is deliverable D8.1 and is due by M6 (i.e., by end of October 2021.

This initiative was supposed at the time of proposal (spring 2020) to be well synchronized with the Update of the European Strategy for Particle Physics, required by the CERN Council. The European Strategy Update for PP, ESU-PP, was presented and approved in the special CERN Council session of June 2020. It contains explicit support to a strong R&D of HTS for accelerators, and D8.1 was therefore found well in line ESU-PP, and kept in the final IFAST GA.

However, the implementation of the roadmap for high and very high field magnets, including HTS magnets for next generation accelerators as required in the ESU-PP, is taking more time than anticipated one year ago. Such a roadmap definition will be approved by the CERN Council in December 2021. Therefore the H2020-I.FAST-WP8 D8.1 (*set up of HTS ESG*) should be put in place only after the roadmap approval, in order to be effective and synchronized with the global EU strategy.

Therefore, for the above-mentioned reason, as WP8 Coordinator I kindly ask the Project Coordinator to initiate an amendment to our terms of deliverable dates and in particular to modify due date of the D8.1 from M6 to M12, i.e., from October 2021 to April 2022.

L. Rossi on behalf of all IFAST-WP8 members.

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21:34:17
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Memo INFN-LASA-IFAST N. 2 of 5 August 2021

From: Lucio Rossi, INFN-Milano LASA, I.FAST WP8 Coordinator

TO: Maurizio Vretenar, CERN, I.FAST Project Coordinator

CC: Th. Lecrevisse (CEA)

Subject: Amendment request to IFAST-GA: modification of deliverables (and associate milestones) description and corresponding task title and description

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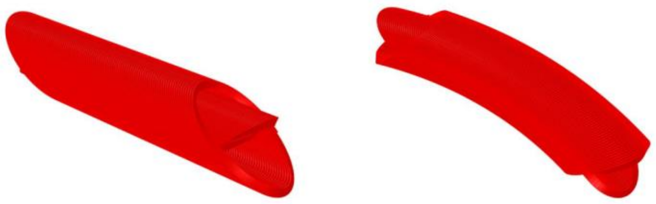
The lead beneficiary, (24 – INFN) of the Workpackage 8 – Innovative superconducting magnets [1] asks the project coordinator to submit an amendment request for a small modification of the objectives, deliverable and milestones titles of the WP8.

The modification regards the description of the task 8.2 and 8.4 of WP8, and in particular to remove “curved CCT” and to substitute it with the following “combined function CCT”.

The main technical motivations are, as discussed in the IFAST-WP8 Meeting#2 https://indico.cern.ch/event/1050948/ :

1. to have a similar geometry between the two demonstrators in order to easily compare the performance of the two magnets. Since for the task 8.3, the HTS CCT demonstrator has straight geometry, also for the task 8.2 and 8.4, is netter to pursue Nb-Ti or Nb3Sn combined function CCT demonstrator with the same straight geometry (Fig. 1)[2].



A B

Figure 1. Different CCT geometries: A) straight and B) curved.

2. A combined function magnet layout (dipole and quadrupole, Fig. 2 [2]), present an attractive solution to achieve a compact design with respect to the nested layout (series winding of dipoles and quadrupoles in the same layout). Therefore, this choice meets the need to find a compact solution for the gantry (for gantry compactness is more important than synchrotron since it had to rotate). At the time of writing the proposal this was not so evident as it is now.

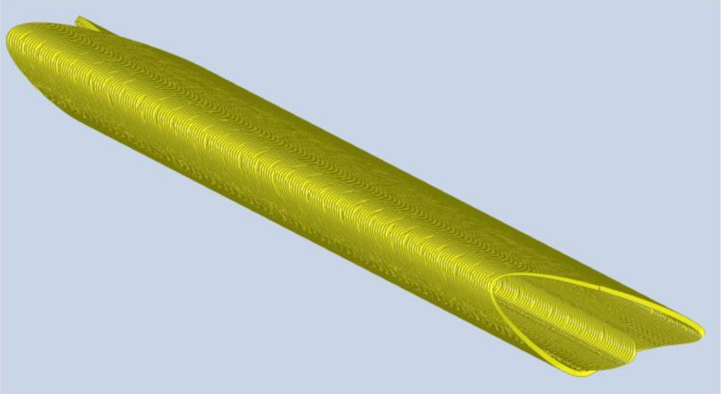


Figure 2. Combined Function CCT magnet (Dipole + Quadrupole).

Text modifications [1]:

Tasks Titles

Tasks	Old title	New title
8.2	Preliminary Engineering design of **curved** CCT magnet	Preliminary Engineering design of **combined function** CCT magnet
8.4	Construction of **curved** CCT magnet demonstrator	Construction of **combined function** CCT magnet demonstrator

Task objectives

Tasks	Old objective	New objective
8.2	Define some options for the magnet structure and magnetic design at conceptual level for a CCT scaled demonstrator with new integrated **curved** coil geometry, in Nb-Ti and/or Nb3Sn.	Define some options for the magnet structure and magnetic design at conceptual level for a CCT scaled demonstrator with new integrated **combined function** coil geometry, in Nb-Ti and/or Nb3Sn.

Deliverables Titles

Deliverable Number	Old title	New title
D8.2	Conceptual Design of **curved** CCT in LTS	Conceptual Design of **combined function** CCT in LTS
D8.4	Construction of **curved** CCT demonstrator	Construction of **combined function** CCT demonstrator

Milestones Titles

Milestone Number	Old title	New title
MS31	Construction readiness of **curved** CCT demonstrator	Construction readiness of **combined function** CCT demonstrator
MS34	Construction of the **curved** formers for CCT winding	Construction of the **combined function** formers for CCT winding

References

[1] EUROPEAN COMMISSION, Directorate-General for Research and Innovation, “GRANT AGREEMENT NUMBER 101004730 — I.FAST”, Associated with document Ref. Ares(2021)1655963, 05/03/2021.

[2] Internal design images, INFN Milano- LASA, Italy, 2021.

L. Rossi on behalf of all IFAST-WP8 members.

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Comment on this request of change

- The ESG postpone of six months is not a big deal.
- The change in scope (from a curved CCT to a combined function is not without suspicion that we want to save money and effort…
- A selection of a special material like MgB_2 would be certainly a way to dissipate the doubt. Low loss Nb_3Sn would be also a very attractive solution. But I think Industry is not ready to take up the extra-cost… (and who provide the wires?).
- I propose we take a decision before the 5 Oct (Gov. Board).
- Conductor is to be supplied by CERN (like HTS). INFN was committed to provide low loss Nb-Ti that ahs in house. Quantity of MgB_2 maybe important in the 20 km of wire or more, to get >3 T.
  - Do we explore this solution? If yes, I propose that INFN and CEA discuss with CERN the possible solution and prose to the companies, namely BNG and SCX that must wind it. The field must be at least 3 T… Otherwise better to stay on Nb-Ti and close the business.
  - INFN has to deliver D2 : conceptual design of the ~~curved~~ combine function LTS first demonstrator, by February 2022, indeed. Time is passing fast!

Task 8.2:Preliminary Engineering design of curved CCT magnet (INFN, CERN, CIEMAT, UU, Wigner)

The partners will carry out conceptual design and preliminary engineering design of a CCT scaled demonstrator with new integrated curved coil geometry. Various options, with different structural and superconducting layout will be examined to approach an achromatic beam transport: nested dipole and quadrupole, co-wind of dipole and quadrupole in the same winding, series winding of dipoles and quadrupoles in the same layout. The design will consider for winding, as a first baseline, the use of LTS as Nb-Ti with fine filaments for low losses or low-cost Nb3Sn of fusion specifications, and evaluate advantages and disadvantages. The team will decide in ~~M12~~ **M10** the best solution and then will implement a realistic engineering design for a demonstrator of a length of 0.5-1 m. The figures of merit for the optimization are: total cost, mechanical structure, field quality, easy of assembly, coil ends, quench and protection, low-cost powering by limiting the operational current. The SC and thermal design will take into account that the final lay-out must be a "dry magnet", i.e. cooled either by gas or by solid conduction from a cryo-cooler.

The partners will share the design job and, for each important aspect like field quality and protection, there will be an independent verification. The superconductor, either low-loss Nb-Ti or high-stability (higher Tc) Nb3Sn, will be procured, in sufficient quantity for a complete demonstrator, and characterized in operative conditions. Particular care will be devoted, in case of choice, to the characterization vs. temperature of the Nb3Sn wire. We aim at wires of 0.7-0.8 mm diameter stabilized with cupro-alloy in order to reduce losses allowing the use of sweeping fields at a critical current density about 400 A/mm2 in operative conditions.

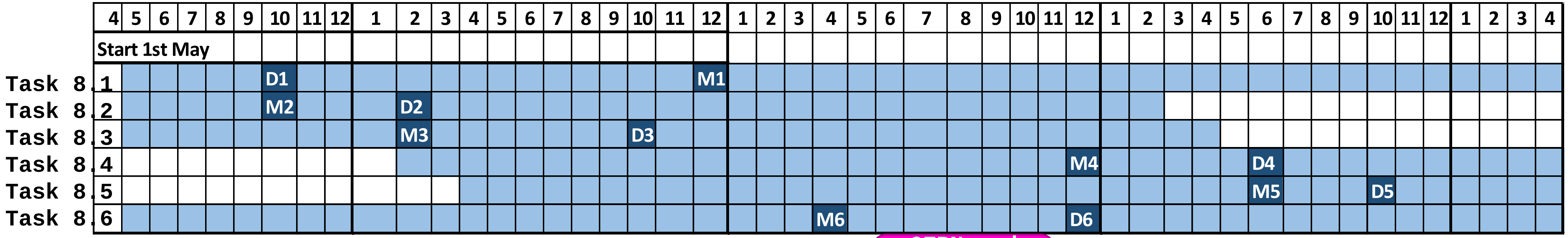
INFN will procure the wire; CERN, will provide inputs for the design and assure the SC wire qualification; Wigner RCP will carry out computations with CERN, CIEMAT and INFN, and will produce part of the of the engineering drawings with CIEMAT; CIEMAT will provide global integration of the design and contribute to engineering drawings; UU will consider aspects of the design interfering with testing.

IFAST WP8 Design matrix (work charge)

	IFAST WP8 Design Option Matrix									
		Institutes	2021							
			5	6	7	8	9	10	11	12
Task 8	HTS SG	CERN-INFN								
Task 8.2	CCT - Nb-Ti	INFN-CERN-Wigner								
	CCT - Nb3Sn	No								
	CCT - MgB2	INFN- CIEMAT?								
	CCT - Bi-2212	INFNGE								
	CCT - B-2223	CERN?								
	CCT - REBCO	CEA-INFN-CERN-Wigner-Elytt								
	CCT - IBS	NO								

Timeline

IFAST WP8: Innovative Superconducting Magnets
Task 8.1 - Coordination and High-Temperature Superconductor (HTS) Strategy Group
Task 8.2 - Preliminary Engineering design of curved Canted Cosine Theta (CCT) magnet
Task 8.3 - Preliminary Engineering design of HTS CCT
Task 8.4 - Construction of curved CCT magnet demonstrator
Task 8.5 - Construction of the HTS CCT magnet demonstrator
Task 8.6 - Development of ReBCO HTS nuclotron cable



CERN and INFN under way…

IFAST Deliverables

	Task	Resp.	Type	Del. In Months	Name	Description
D1	8.1	CERN	Report	6	HTS European Strategy Group	Set up of the ESG and kick off meeting with approval of program, scope, and modus operandi.
D2	8.2	INFN	Report	10	Conceptual Design of curved CCT in LTS	Report with complete list of parameters motivating the choice for the design.
D3	8.3	CEA	Report	18	First Engineering design of HTS demonstrator	Report with a set of coherent parameters of the near-to-final design
D4	8.4	BNG	Demo	38	Construction of curved CCT demonstrator	Magnet demonstrator complete with electrical termination and transport constrains
D5	8.5	Ellytt	Demo	42	Construction of HTS CCT demonstrator	Magnet Demonstrator with electrical terminations and transport constrains.
D6	8.6	GSI	Report	32	Fast-cycling Nuclotron HTS cable design	Design parameters of the HTS Nuclotron cable aiming at 6 T magnetic field cooled by two phase forced flow Helium, AC loss measurements.

	Task	Type	Deliv. In Months	Name
M1	8.1	Review Report	20	Construction readiness of curved CCT demonstrator
M2	8.2	Measurement Report	6	Charac. of the first length of superconductor for low losses
M3	8.3	Design Report	10	Conceptual design of HTS magnet
M4	8.4	Rep. Conformity Cert.	32	Construction of the curved formers for CCT winding
M5	8.5	Rep. Test and Ass.	38	Test of mock up coils with dummy cable
M6	8.6	Lab. Test of Sample	24	HTS Nuclotron cable produced

Under way by INFN and CERN, UNIGE

Last task led by GSI

Task 8.6: Development of ReBCO HTS Nuclotron cable (GSI, UT, IEE, ILK)
This Task will design and assemble a HTS superconducting cable based on the Nuclotron cable technology already used at GSI. Its main purpose is the application in a fast-cycling accelerator magnet with a magnetic field of 6 T required for, e.g., a future 2nd stage of the heavy ion synchrotron for the FAIR project at GSI. The cable design requirements will meet the LTS Nuclotron design. To overcome the limitations of LTS, a HTS ReBCO superconductor will be used. In the envisaged design, multiple HTS tapes will be wound around a central cooling channel in order to obtain a high-current cable. Present design specifications call for a current level of 30 kA.
IEE will lead the tape choice based on magnet design parameters given by GSI. After a successful selection of the tape, tape procurement for cable manufacturing will be done by IEE/ILK. Cable manufacturing will be done by IEE, building on previous experience. After successful cable winding IEE will perform cryogenic testing on the cable at 77 K, while UT will characterize the cable at 4.2 K together with cable modelling to predict and understand the AC loss characteristics. ILK and GSI will perform forced flow testing of the produced cable to evaluate its thermal performance.

TBD next meeting…
is TODAY!!!