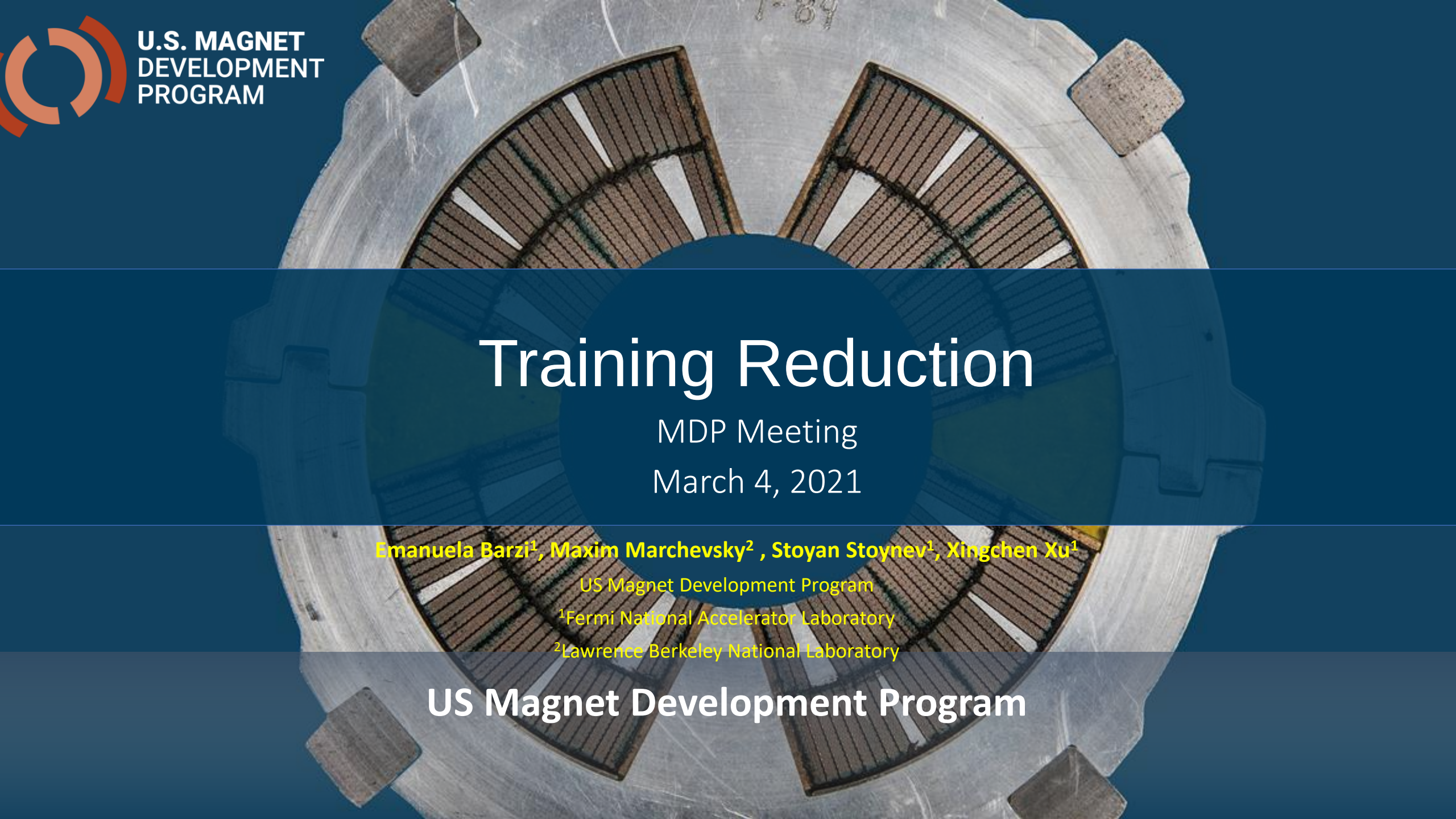

U.S. MAGNET DEVELOPMENT PROGRAM

Training Reduction

MDP Meeting

March 4, 2021

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US Magnet Development Program

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US Magnet Development Program

Content of the talk

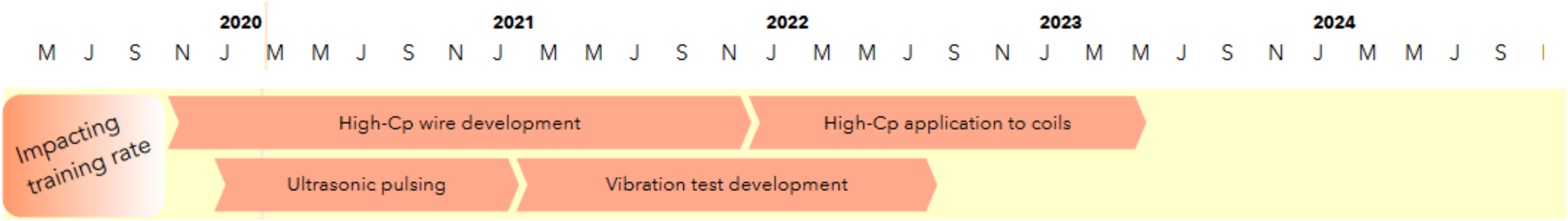
Following planning of the current meeting those points are addressed
(charge question numbers addressed will be shown in red over yellow):

1. Summarizing the current status of the R&D topic…
2. Discussion of the current or incoming (next 6 months) milestones – can they be met?

The most recent update on the topic was in December

Official training reduction roadmap

Roadmap as in the official document:



https://science.osti.gov/hep/Community-Resources/Reports
MDP roadmap there

Training Reduction Milestones

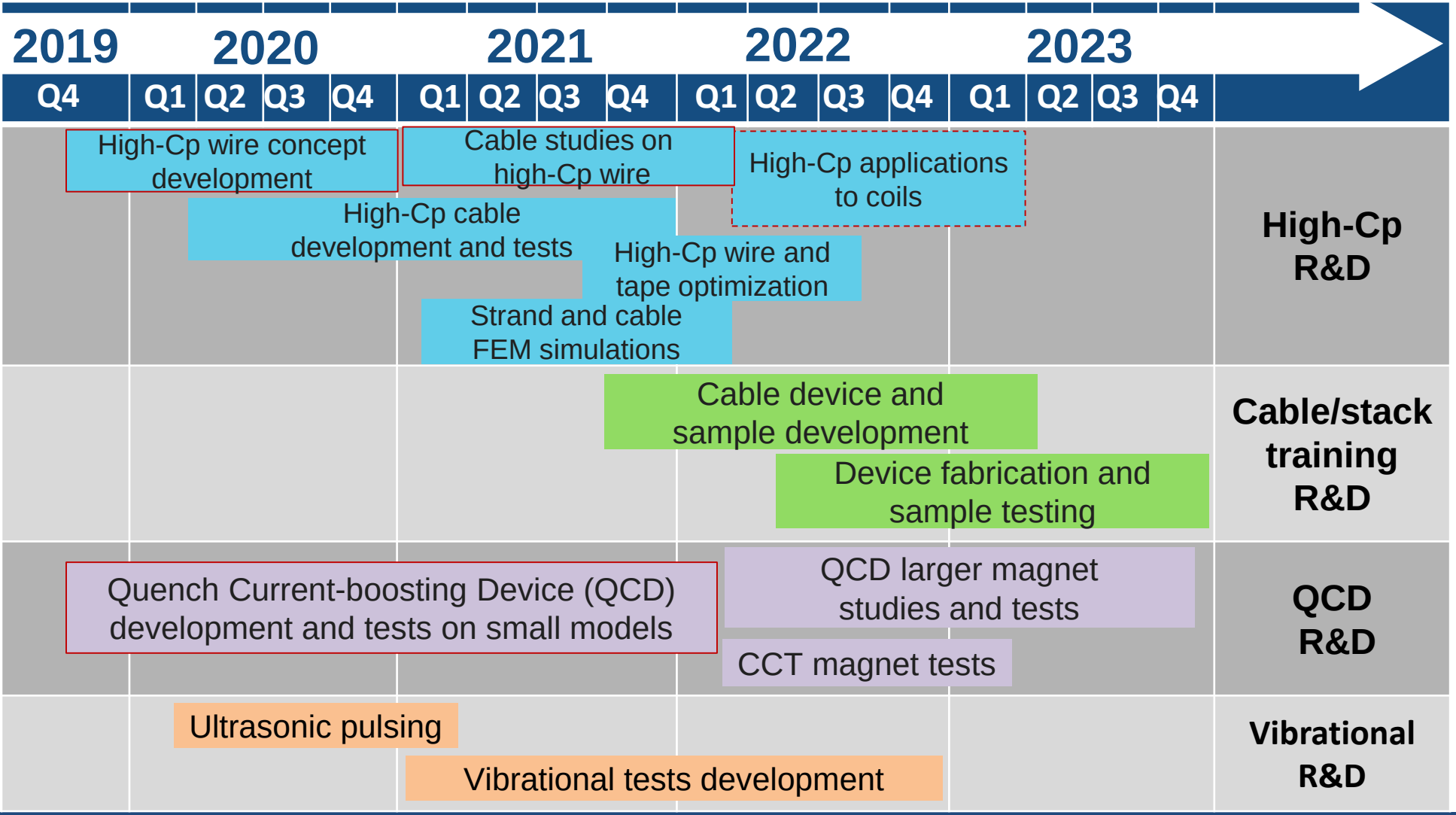
Formally we don't have yet Milestones to report on, we'll comment on them later

Milestone #	Description	Target
AIIIe-M1	Commissioning of QCD	May 2021
AIIIe-M2	First Ultrasound based test	May 2021
AIIIe-M3	First high-Cp cable fabrication	September 2021
AIIIe-M4	First magnet test with QCD	September 2021
AIIIe-M5	Results from High-Cp cable studies	December 2021
AIIIe-M6	Optimized strand and cable FEM simulations	December 2021

Continues for next years…

https://science.osti.gov/hep/Community-Resources/Reports
MDP roadmap there

Training reduction roadmap (as presented last in 2020)



In red border lines – independent funding

High Cp-wire studies status

1a

- New high-Cp material Gd_2O_2S obtained
  - Supposedly much higher Cp than Gd_2O_3 which was obtained earlier
- Wires with both materials fabricated
- Steps up to and including heat treatment completed
- Further steps on hold
  - Testing has not been done yet
  - Possible schedule delay, trying to resolve the issue

More in a separate presentation

High Cp-cable studies status

1a

- Cu/Gd_2O_3 ribbons with ~30% of Gd_2O_3 powder and two different thicknesses were produced by Hyper Tech Research, Inc.
- Wire and cable samples outfitted with these high-Cp ribbons, or tapes, were prepared and tested at FNAL for the Minimum Quench Energy (MQE).

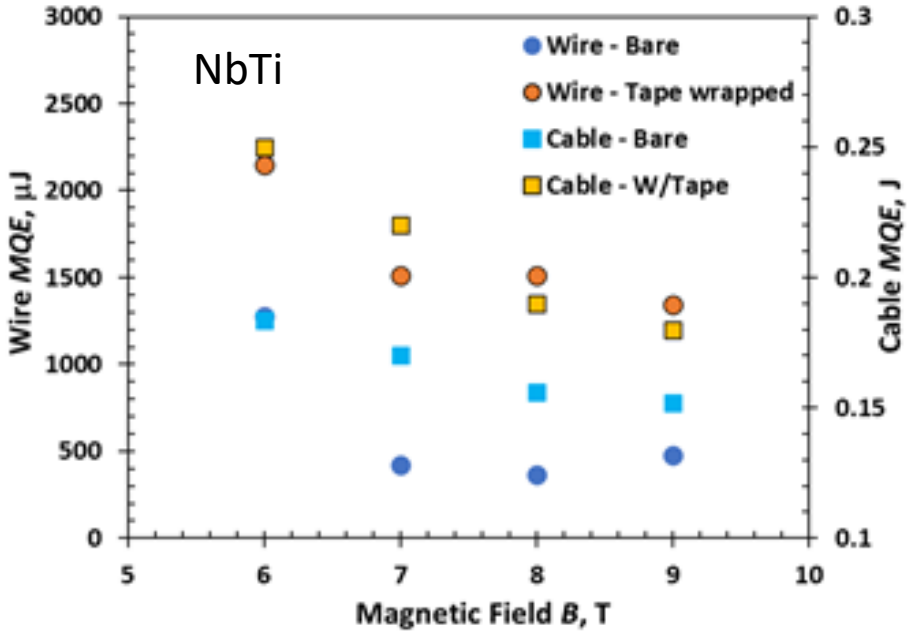
- The NbTi cable test results with high-Cp tape on both sides compares well with the wire wrapped with the ribbon.

- Nb_3Sn cable test results with high-Cp tape on both sides will be compared with Nb_3Sn wire outfitted with tape soldered to it

- Then we can expect an MQE increase of ~50% in Nb_3Sn cable with a high-Cp tape as a core

More in a separate presentation

Wire and cable MQE values as a function of magnetic field for measurements performed at 80% Ic.



High Cp-cable milestones

1a, 1c

- M5 is in progress with MQE tests of wires and cable - studies are performed with high-Cp tape Cu/Gd_2O_3 . Both NbTi and Nb_3Sn used for these experiments since we are interested in relative effects of high-Cp tape. Completed extensive MQE tests of a NbTi cable with distributed heat perturbation. In the process of testing MQE of Nb_3Sn cable (with distributed heat perturbation). In the plan by the deadline, tests of NbTi cable with local heat perturbation are included.

- M3 : Hypertech is producing high-Cp tape with Cu and Gd_2O_2S. MQE tests will be performed on this tape to select most performing material.
- M6: summer graduate students work was supposed to contribute to this part but with COVID19 it is not clear that we'll get any this coming summer. Still, we will try to meet the goals according to the roadmap.

Within 6 months

Milestone #	Description	Target
AIIIe-M1	Commissioning of QCD	May 2021
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On track

QCD

1a, 1b

Quench **C**urrent-boosting **D**evice is a capacitor-based device aiming to significantly increase magnet current at quench time and thus help reduce magnet training time

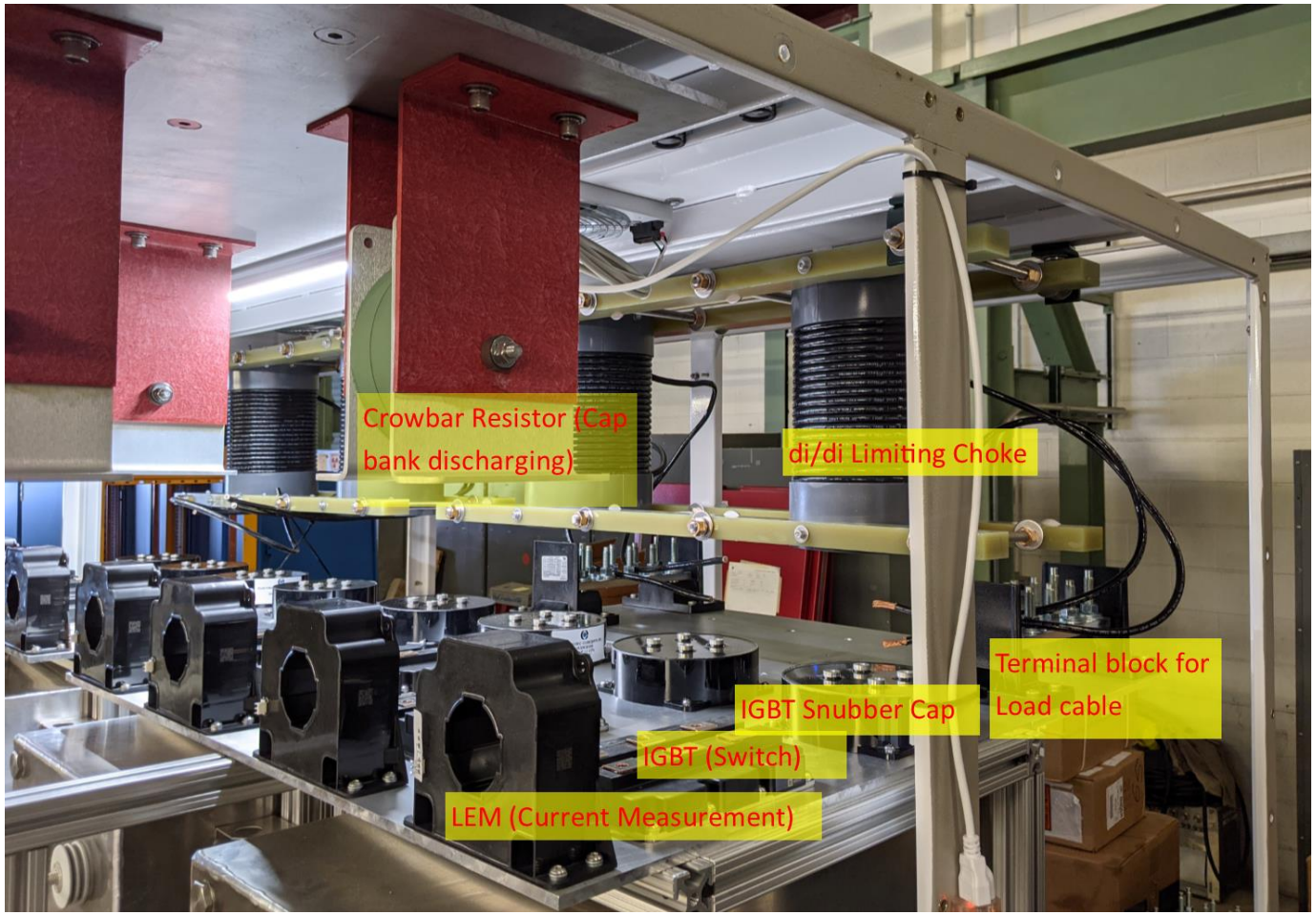
- The power-part of the QCD to be tested at AD in early March (an explicit agreement with AD reached)
  - to complete: asking LDRD management for budget credit (from next FY) or refund of cut funds
- The control-part of the QCD is to be ready in late March, work in APS-TD

- Integration work at the power supply by end of March, work by T&I
  - Ongoing safety controls work
  - Ongoing integration planning (mechanical, electrical)
- We expect to ORC the device in early April 2020

- Mirror magnet (for initial QCD testing) assembly in progress
  - All parts available
  - Assembly readiness review made valuable recommendations
  - The magnet is being assembled (by end of March 2020)

QCD (2)

1a, 1c



The **QCD** is coming to its projected shape.
The plan is to move it to IB1 in **early March** and start on-site work integration to the power supply.
Controls (logical structure) of the device is being implemented in parallel, till **end of March**.
ORC steps are also being started, it can not finish before **mid-April**.
The **mirror magnet** is being assembled (**end of March**).
With this steps the **earliest start of the magnet test is mid-April**.

However

a) We need more funding (>$25,000 fully loaded) to continue with the plan
b) we may not be able to test this FY in any case
c) AUP test is starting in early June

Milestones

1a, 1c

- M1 is awaiting decision to be completed on-time (up to ORC), M4 is to be delayed depending on M1
- M2 is with a changed scope as no LARP magnet can be tested soon enough; we'll do initial testing in a mirror magnet test; it is arguably not what we planned for (so formally this milestone can not be met yet).

Within 6 months

Milestone #	Description	Target
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AIIIe-M4	First magnet test with QCD	September 2021
AIIIe-M5	Results from High-Cp cable studies	December 2021
AIIIe-M6	Optimized strand and cable FEM simulations	December 2021
AIIIe-M7	First CCT test with QCD	February 2022
AIIIe-M8	High-Cp wire and tape optimized versions	May 2022
AIIIe-M9	Fabrication of first coil with High-Cp conductor	September 2022
AIIIe-M10	Design of a dedicated device/technique using vibrational methods	September 2022
AIIIe-M11	Design of a "cable/stack" testing device and samples	January 2023
AIIIe-M12	QCD preparations and test on a large magnet	February 2023
AIIIe-M13	Fabrication of a "cable/stack" testing device	September 2023

Meeting milestones?

Depends on funding (and up to ORC)

Change of scope (original milestone out of reach)

On track

Depends, likely after October

It is too early to engage regarding the remaining points and no clear delays foreseen

More

We’ll be addressing points 2 and 3 (of the charge) in the discussion section

Spare

Training Reduction Milestones

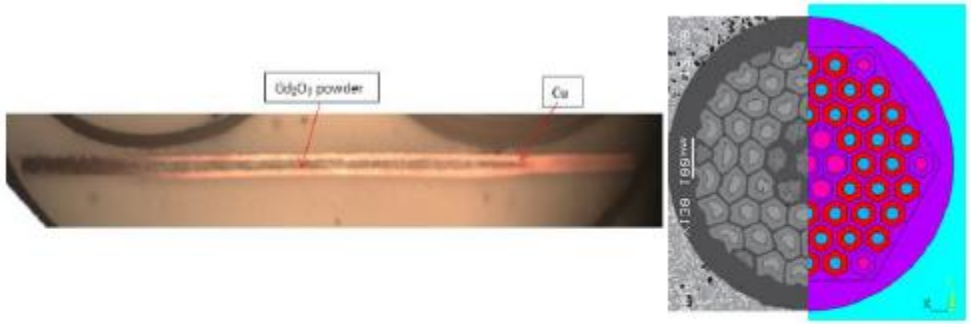

Fig. 1. Left: Cu tapes with Gd_2O_3 inside, 30% of the cross section is Gd_2O_3 (courtesy of Hypertech). Right: Hypertech Sn-in-Tube Nb_3Sn wire with 48 regular Nb-Sn subelements and 13 high-C_p ones made of Cu/Gd_2O_3.

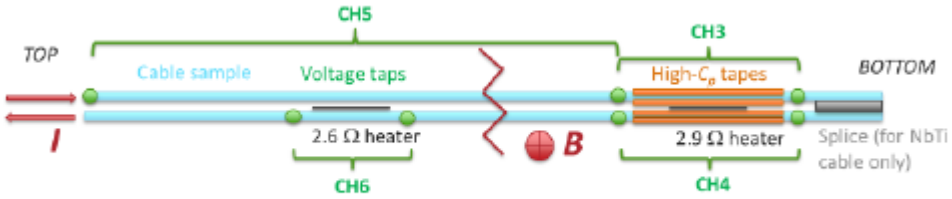

Fig. 7. Schematic of the instrumentation used for NbTi Rutherford cable tests.

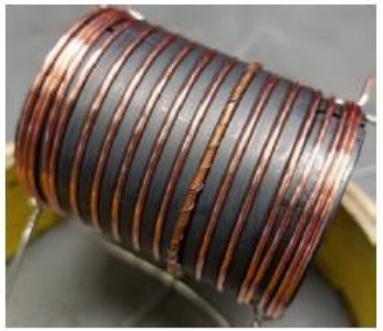

Fig. 3. Example of superconducting wire sample wrapped with Hyper Tech high-C_p tape cut down to ~1 mm width, along half a turn of the specimen.

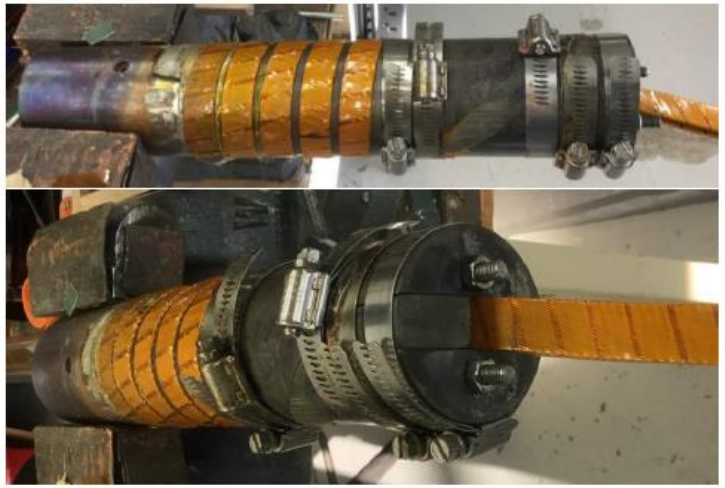

Fig. 10. NbTi cable sample assembly for *MQE* test of standard Rutherford cable and cable outfitted with high-C_p tape.

Presented at ASC2020, sent for publication