

# Training Reduction (part 3)

MDP Meeting  
November 11, 2021

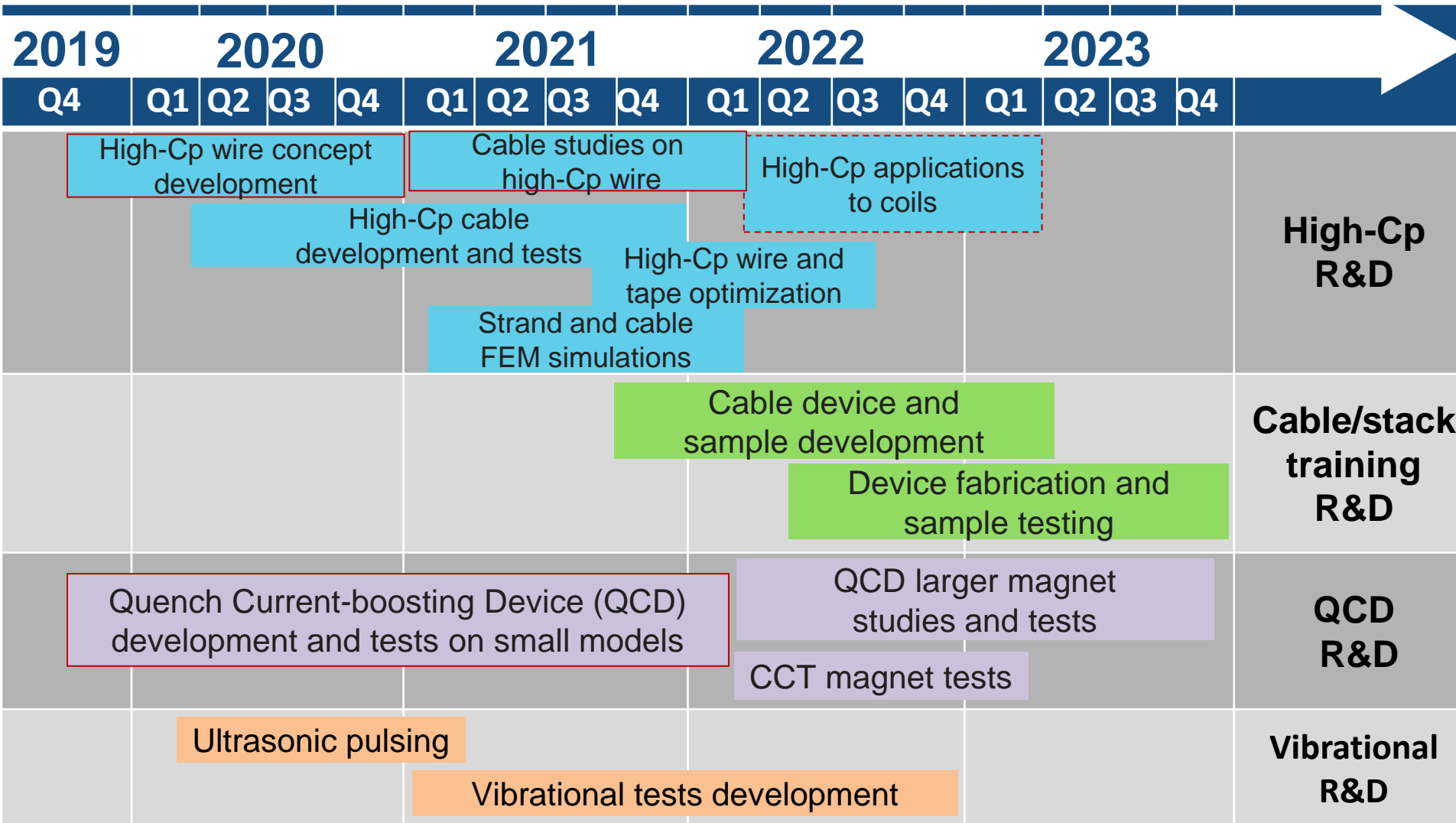
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US Magnet Development Program

<sup>1</sup>Fermi National Accelerator Laboratory

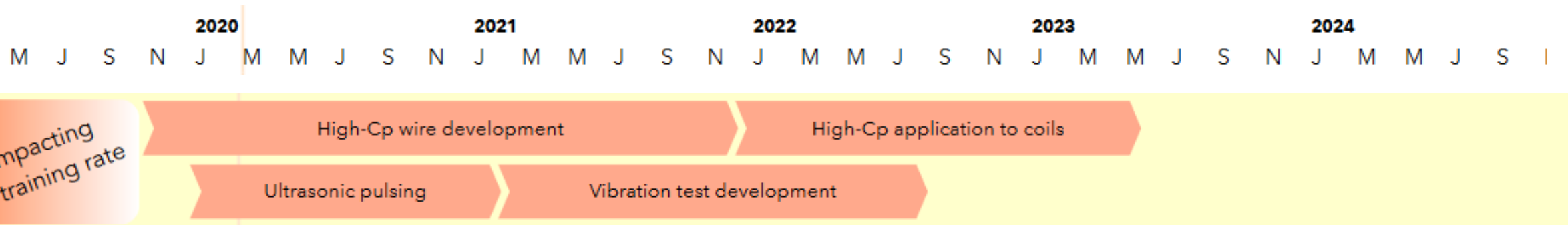
**US Magnet Development Program**

# Training reduction roadmap (as presented last in 2020)



# Official training reduction roadmap

Roadmap as in the official document:



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

# Training Reduction Milestones

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



**QCD**



**Ultrasonics**

**QCD**

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

**QCD**

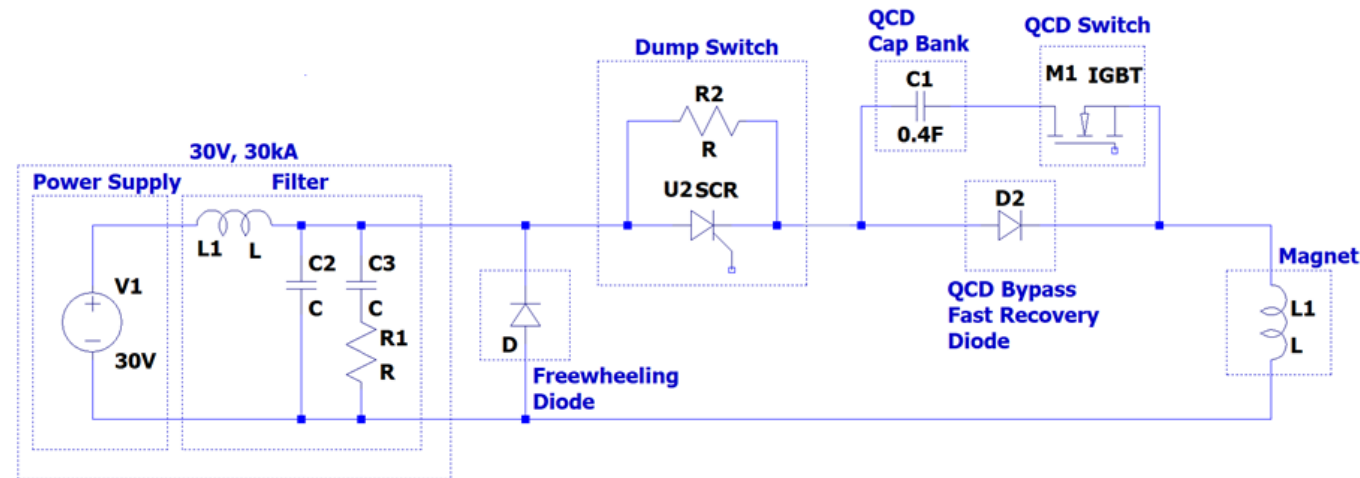


**Vibrations**

# QCD

**Quench Current-boosting Device** is a capacitor-based device aiming to significantly increase magnet current at quench time and thus help reduce magnet training time

- LDRD funded but a lot of “integration” work (PS preparations) were and are supported by the Lab
- LDRD funds will be closed by March 2022
- We are on track to be done, including testing, by February 2022
- We did not manage to conclude in FY21 because of LDRD funding issues



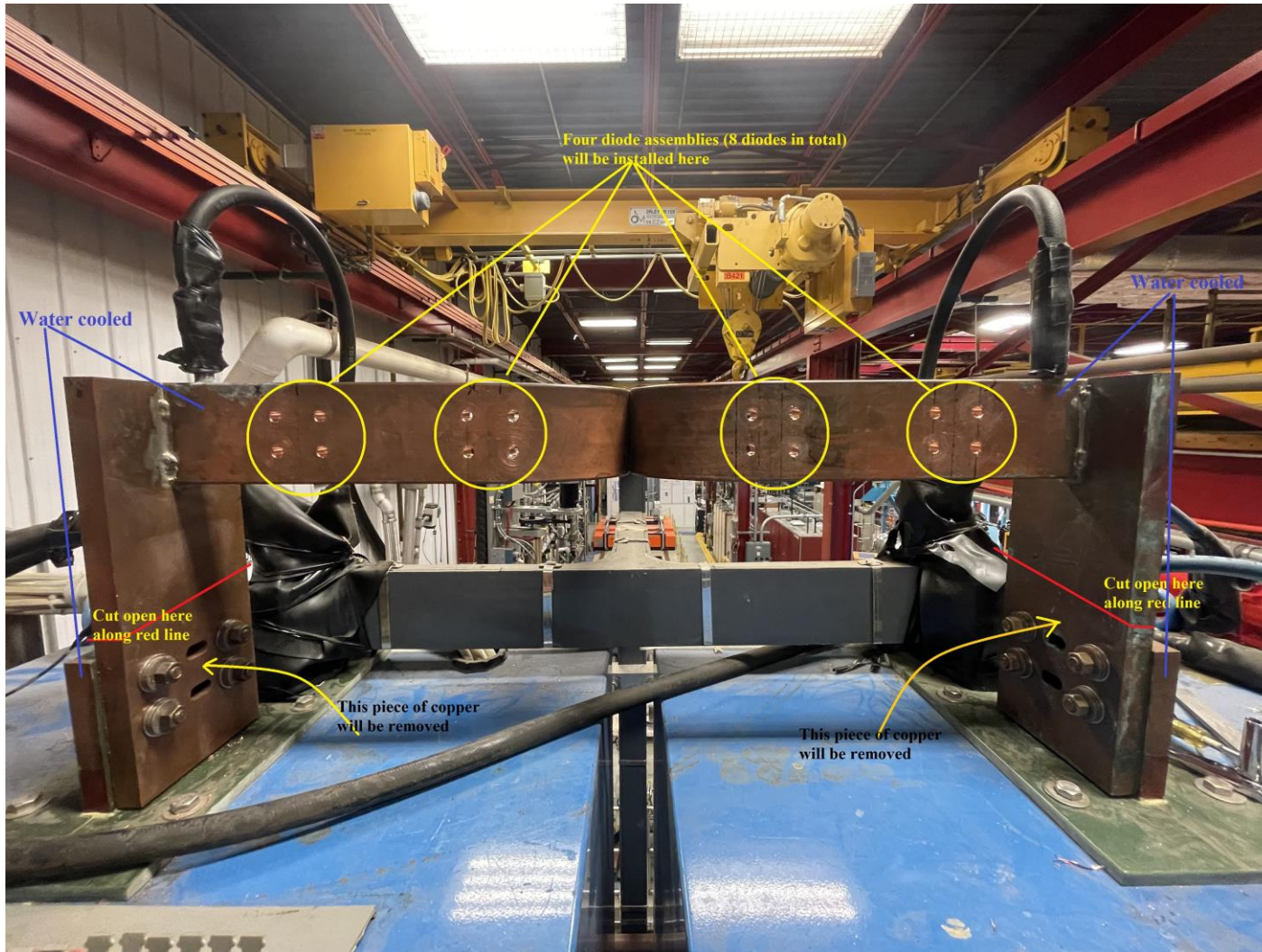


# QCD (2)

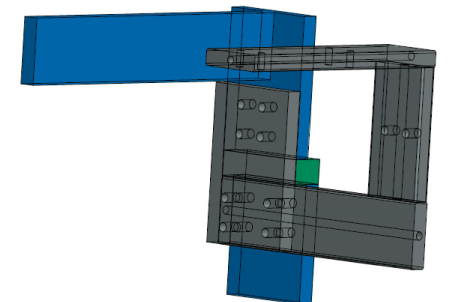
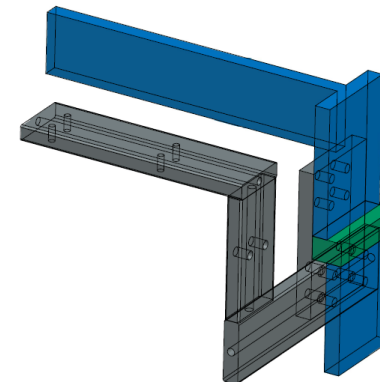




# QCD (3)



Bus bar at the PS, design and preparations for installing a by-pass line



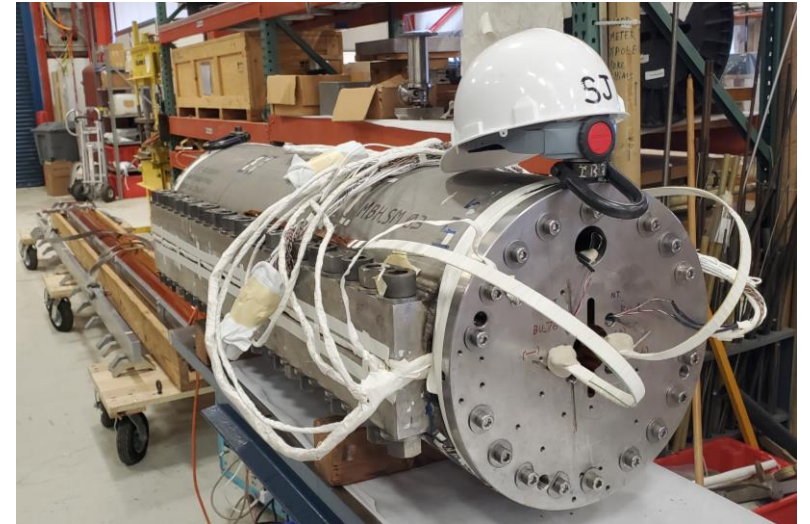
# QCD (4)

The **QCD** is to be commissioned (“dry” test) in December – ORC planned for November-December.

**Final work** - controls (logical structure) of the device is being integrated, wiring of the whole system on-going, should be done by mid-November.

A **mirror magnet has been** assembled.

The **earliest start of the magnet test is mid-January**.





# Ultrasonics

- The initial idea was to use MQXFS1 for testing – not a short-term option for the last year and counting
  - and an existing ultrasonic welding machine had to be available
- There was no SC magnet test in FY21
- We are to install more powerful acoustic transducers on the end plates of the QCD mirror
  - This is a mitigation and extension, not really aligned well with the initial goal
- We'll talk about an additional lead spliced and connected to a CLIQ lead at the instrumentation tree
  - The availability of the ultrasonic welding machine is questionable

# Vibrations

“Vibrations” and “Ultrasonics” have something in common  
but are not the same thing.

- To meet the milestone of “design” in September 2022 one needs to start studies now

- In January 2021 I concluded my presentation about the subject like this:

<https://conferences.lbl.gov/event/515/>

- Studies show that vibrations in any direction with respect to friction force have similar characteristics although quantitatively there are some (small) differences
- In sliding over non-rigid material one can expect a window of vibration frequencies ( $w_1, w_2$ ) where friction is suppressed

$$w_1 < w < w_2$$

- Granular “imperfections” induce a characteristic critical (friction) velocity related to their size

$$\xi_c \sim (A\omega)_c^2/g$$

- Other authors point out that rearrangements in the frictional media (which affects friction) can be induced when the mechanical wavelength is of the order of the rearrangement scale

- Dedicated research by focused individual(s)
  - Postdoc (or may be a PhD student)
  - Development of simulations/software framework
  - Dedicated tests at small-scale (benchmarking)
  - Larger scale test plans
- Dedicated material support
  - Specialized ultrasonic machine(s)
  - Likely close coordination with manufacturers
  - Integration with other developments

There are no projections yet any of those will be supported. Then we can invest in small auxiliary experiments, extending run plans in other tests. We could hope that those small-scale tests will give us more insights or results making attraction of funds more likely.

There are no projections those will get enough “critical mass” either. So “we” can decide to work along those lines or dedicated individuals may have to decide how dedicated they can afford to be.

## US Magnet Development Program (MDP) Goals:

### GOAL 1:

Explore the performance limits of Nb<sub>3</sub>Sn accelerator magnets with a focus on minimizing the required operating margin and significantly reducing or eliminating training.

*What resources and distribution we want to provide for reaching Goal 1?*

**Nothing changed since then.**

I will plan to arrange a meeting with perspective participants.

If you are one, please let me know!

# Spare