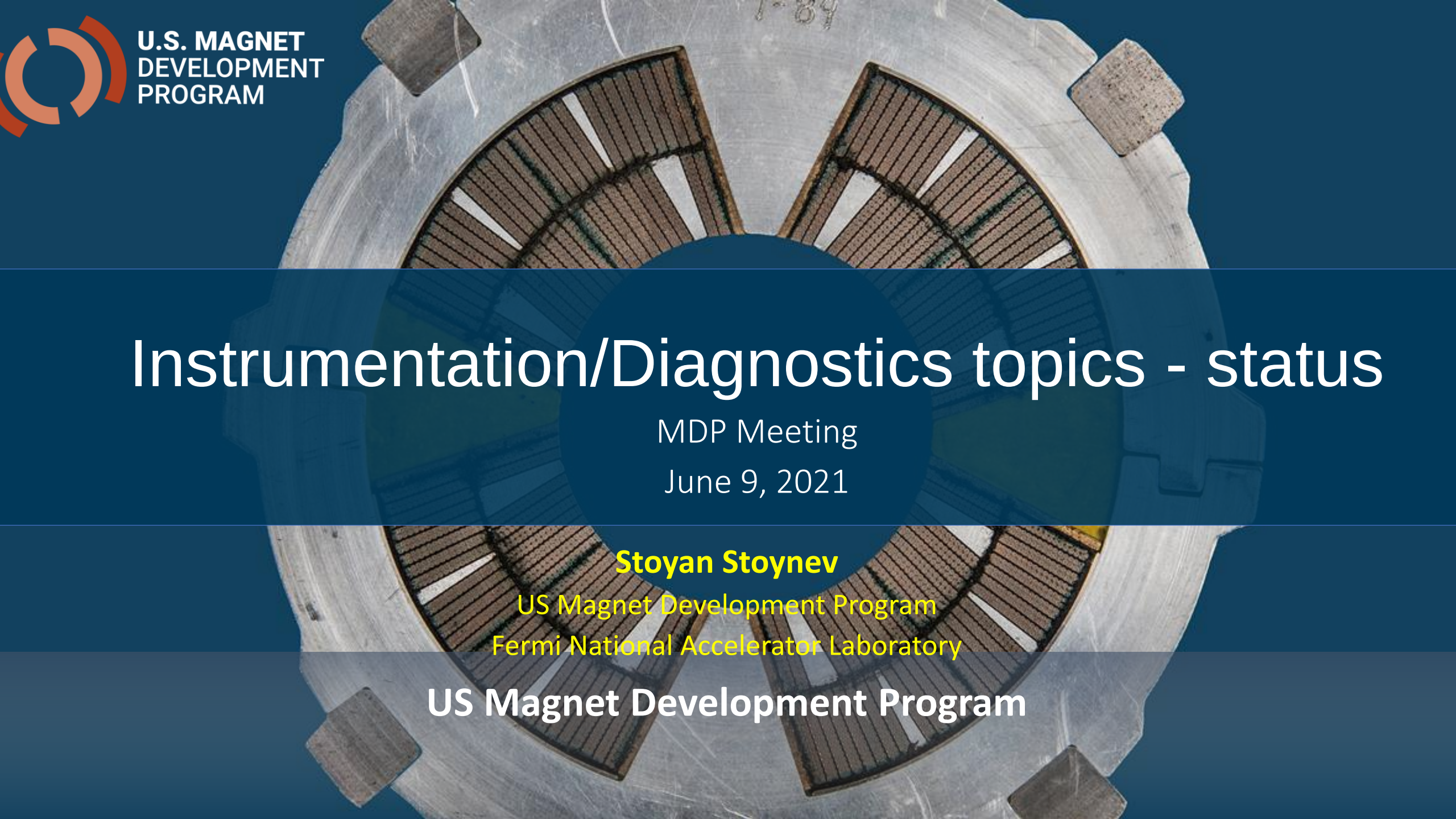


U.S. MAGNET DEVELOPMENT PROGRAM

Instrumentation/Diagnostics topics - status

MDP Meeting

June 9, 2021

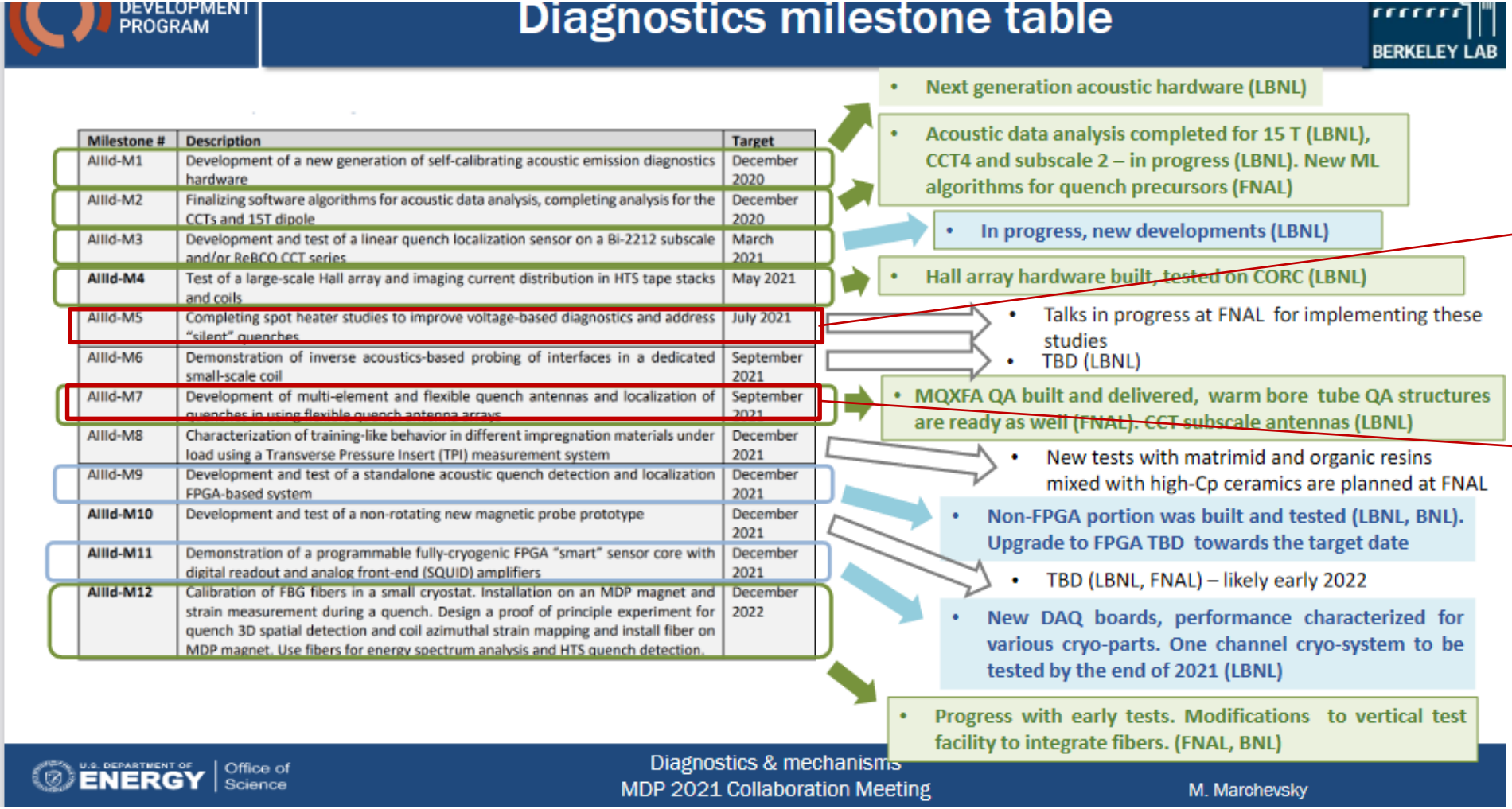
Stoyan Stoynev

US Magnet Development Program

Fermi National Accelerator Laboratory

US Magnet Development Program

Milestones



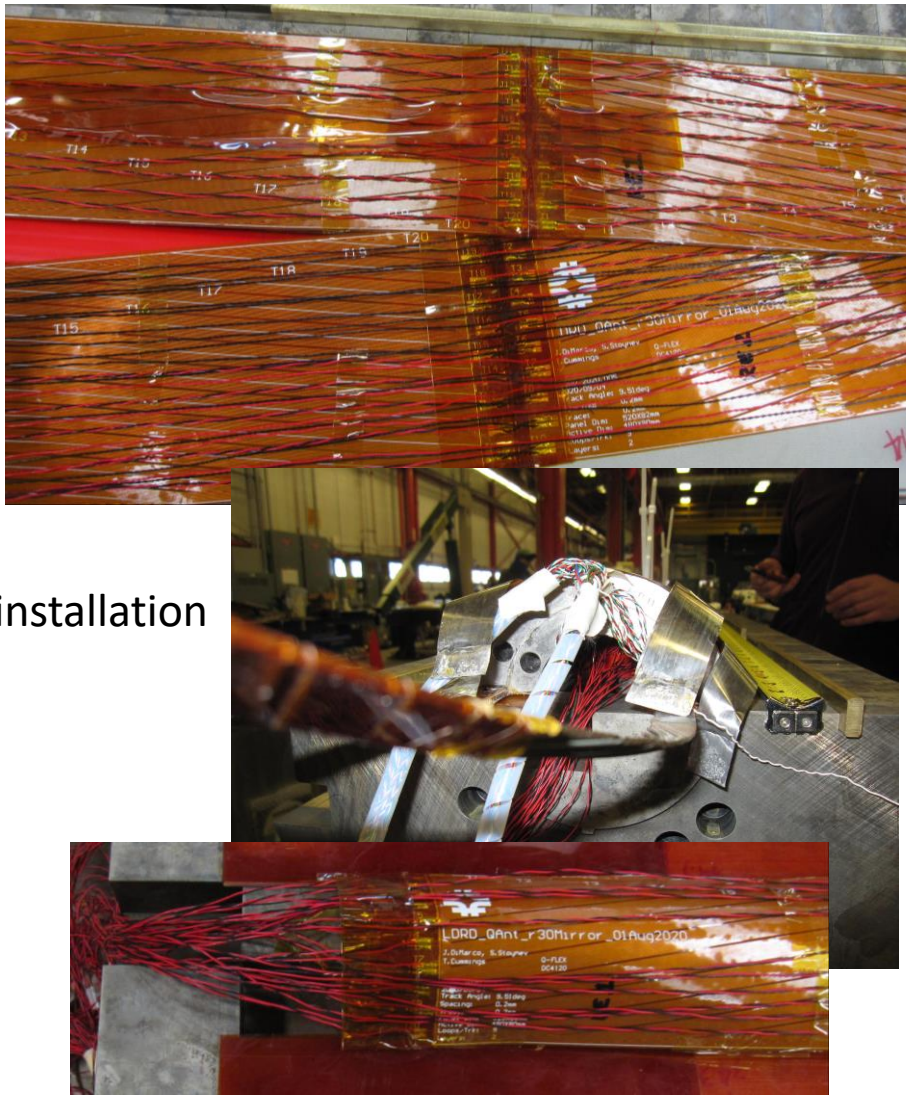
"Spot heater array" studies

Flex-QA development

(and I'll give the status of other relevant activities too)

Tasks with listed Milestones

- Flex-QA (flexible PCB quench antenna) - Joe DM, Stoyan, Tom C.
  - A version of the flex-QA was developed and procured (LDRD funds)
  - Boards were installed in a mirror magnet
  - The magnet is assembled (only partially with LDRD funds) and ready for testing but waiting for QCD project (LDRD) funds to complete the QCD itself
  - New designs with improved/extended features under development: so far delayed by 6-8 months due to lack of priority (LDRD funding available), getting there slowly



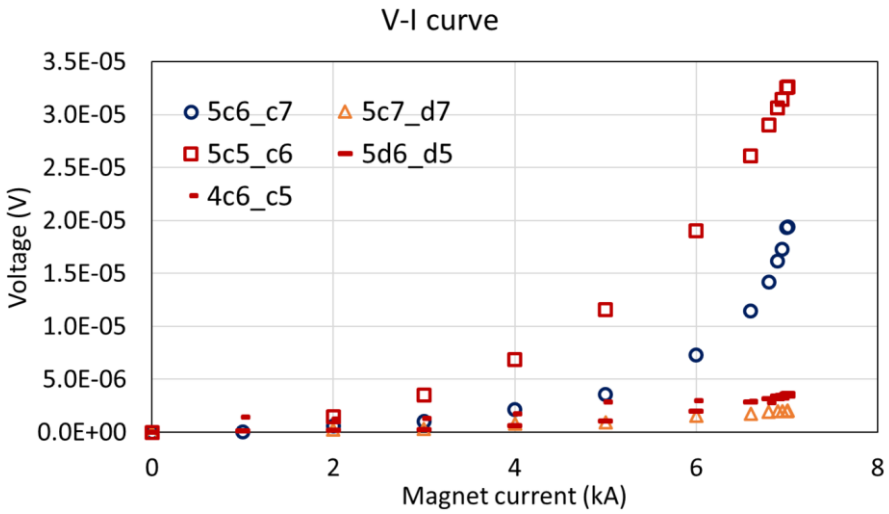
Flex-QA installation

- "Spot heater array" studies
  - It is also a current sharing and other diagnostics experiment
  - A FNAL note written (as requested/strongly advised earlier)
  - An updated presentation with targets and narrative given
  - Discussion on next steps initialized with management
  - Waiting for stated support (and support)

Other tasks

- V-I technique development – Stoyan, Tom C. (Darryl O.)
  - First tests with borrowed multi-channel nano-voltmeter (“MUX”) were successful in the “15 T”
  - We need much improved version of the MUX to accommodate our needs
  - Development of MUX started – virtually all hardware procured
  - Further development halted due to lower priority status (we don’t have an imminent magnet coming for testing) and insufficient resources

V-I measurements for “15 T”



- Multichannel fast DAQ (for QA, etc.) – Steve, Stoyan, (Darryl O.)
  - We upgraded hard-drives which were rate bottlenecks
  - We bought additional cards to get to 64+ differential channels
  - Tested functionality at this stage – all good
  - Commissioning involves cabling and software development – all planned
  - Work halted due to lower priority status (we don’t have an imminent magnet coming for testing) and insufficient resources

One of two NI-crates

Other tasks (2)

- "Cold" electronics – Steve, Stoyan, Ryan R., … (just the FNAL side)
  - Currently waiting and arranging for electronics "cold" testing (Marcos (LBNL), Ryan R.)
  - Despite my personal believe that "cold" electronics is one of the most crucial subject for R&D development in instrumentation in our field we (magnet sector at FNAL) will not be able to contribute for its development beyond testing due to insufficient resources

Requirements/wish list (input from various people):

- at least 128 channels per (possibly network) cable connection
- at least 16 channels for one serial communication line
- fully differential input
- at least 250 kHz sampling per channel
- at least 24 bits in (-5 V, 5 V) signal range; preferably configurable
- another preferred option is the use of "cold" amplifiers with at least gain of 10
- separately – development of isolation amplifiers for use at the above conditions is encouraged
  - differential input protection of 500 V in working conditions
  - 2 kV channel-to-channel, and channel-to-ground isolation in working conditions
- developed electronics should use less than 100 mW of power per channel
- the system should be able to start and operate in liquid helium

Cryo-DAQ

THE Roadmap

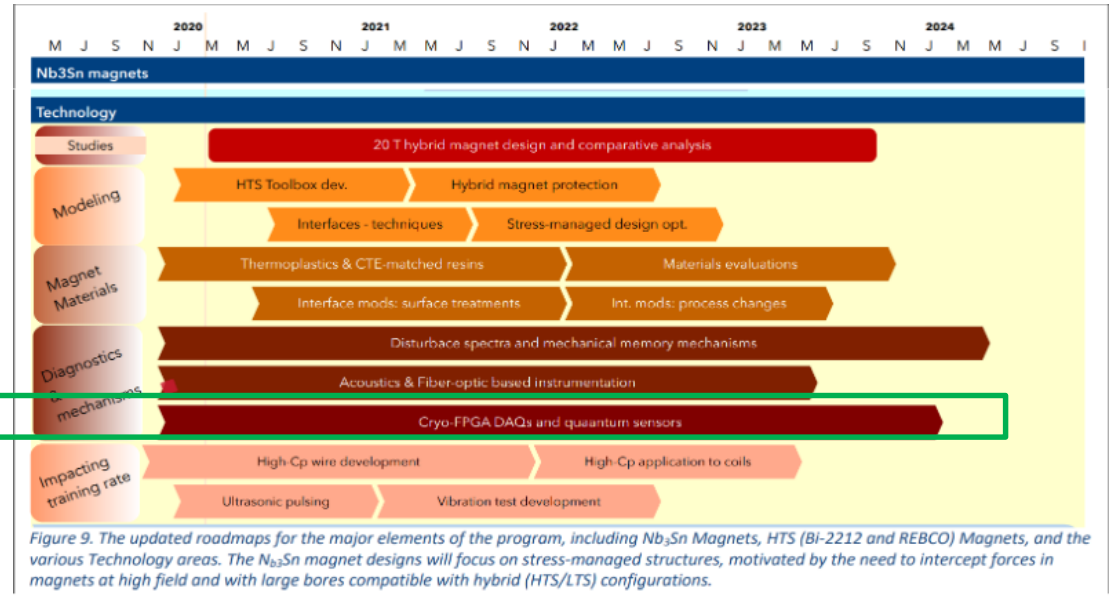


Figure 9. The updated roadmaps for the major elements of the program, including Nb_3Sn Magnets, HTS (Bi-2212 and REBCO) Magnets, and the various Technology areas. The Nb_3Sn magnet designs will focus on stress-managed structures, motivated by the need to intercept forces in magnets at high field and with large bores compatible with hybrid (HTS/LTS) configurations.