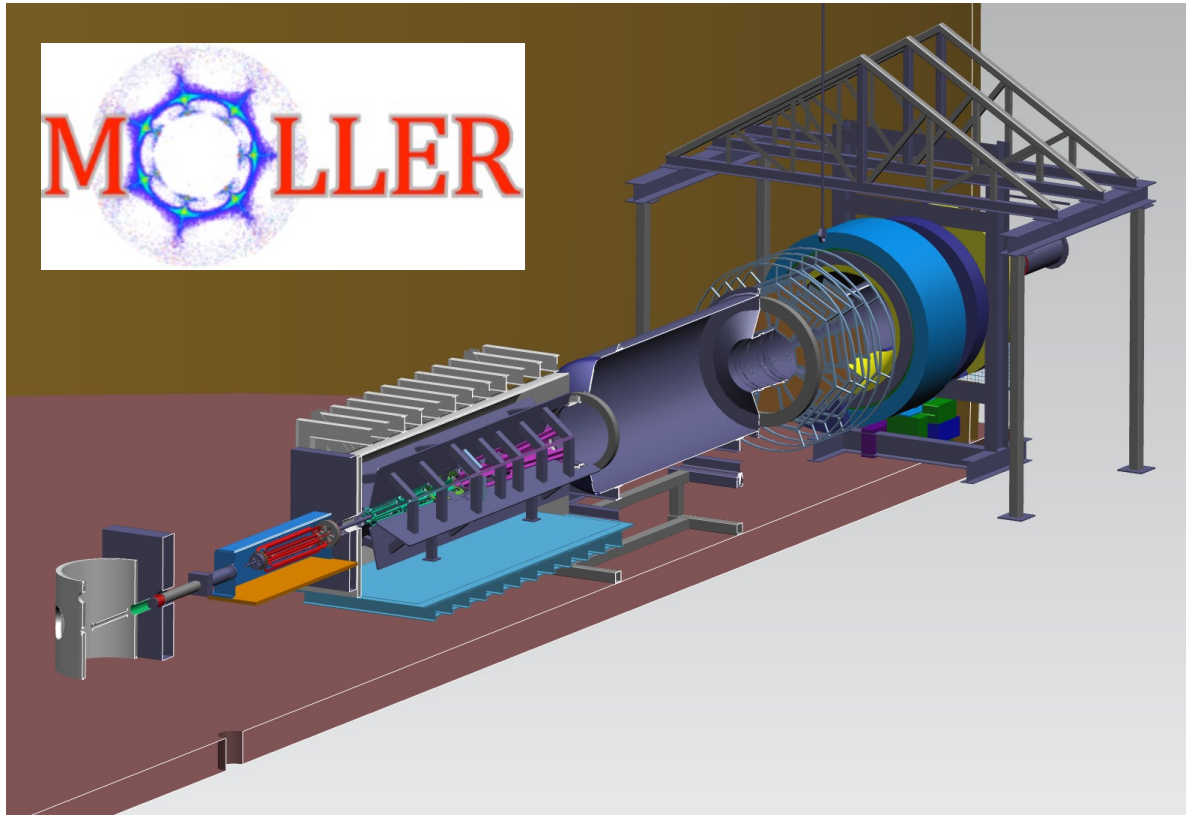
MOLLER Project and Hall A Update

MOLLER Collaboration Meeting

June 2021



Jim Fast

Jefferson Lab

U.S. DEPARTMENT OF ENERGY | Office of Science

JSA

MOLLER – a DOE Major Item of Equipment (MIE)

- Falls under DOE-O-413.3B Change 5

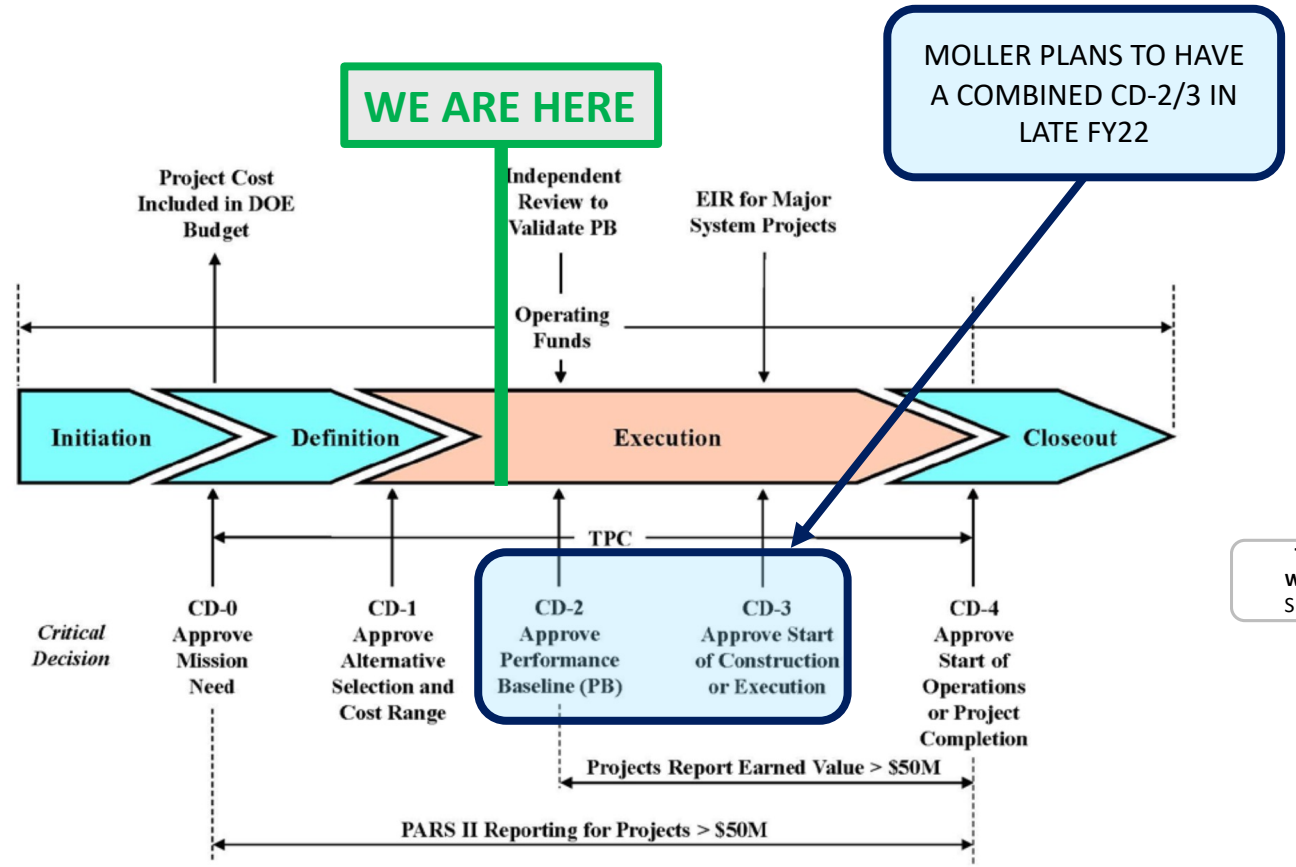
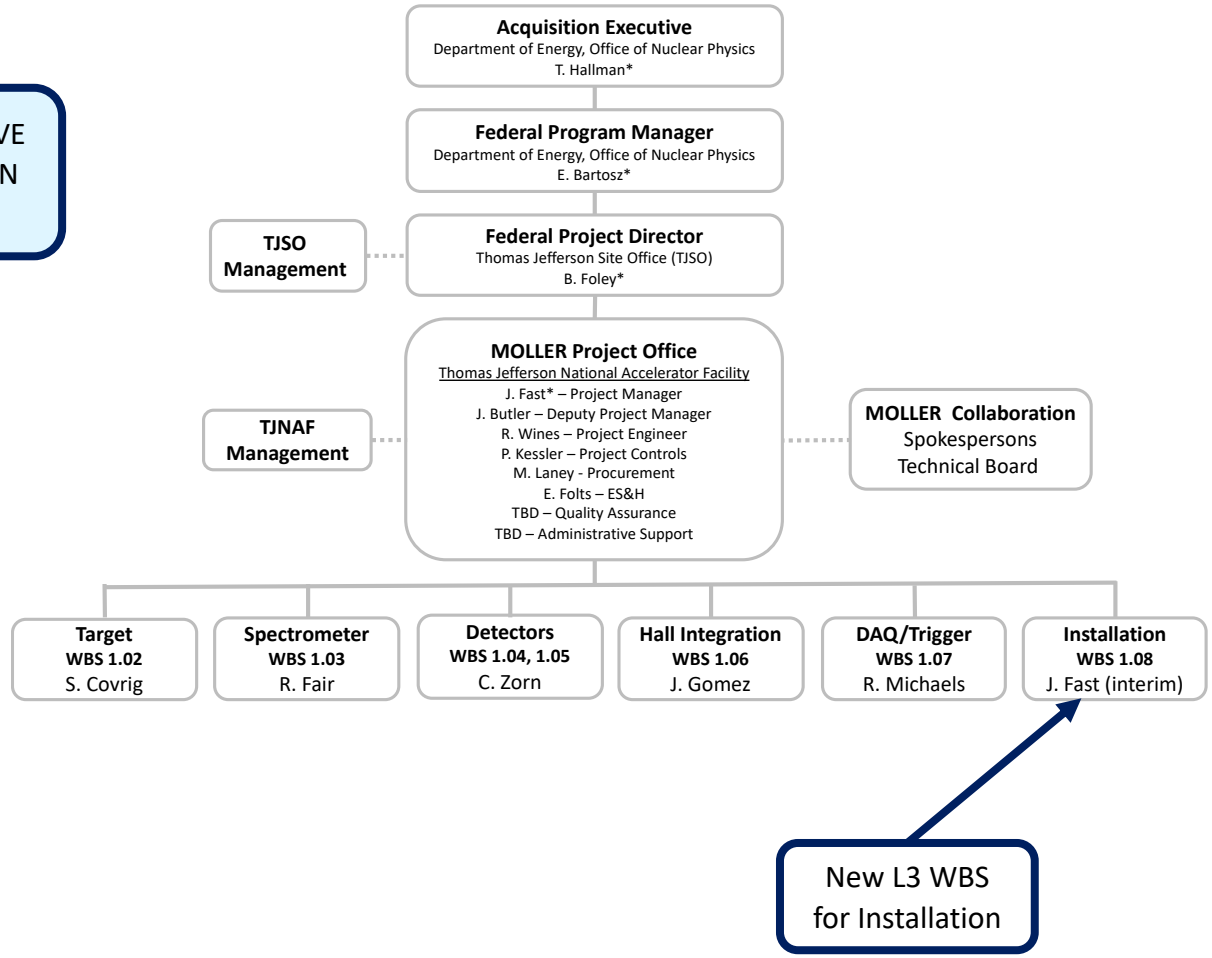


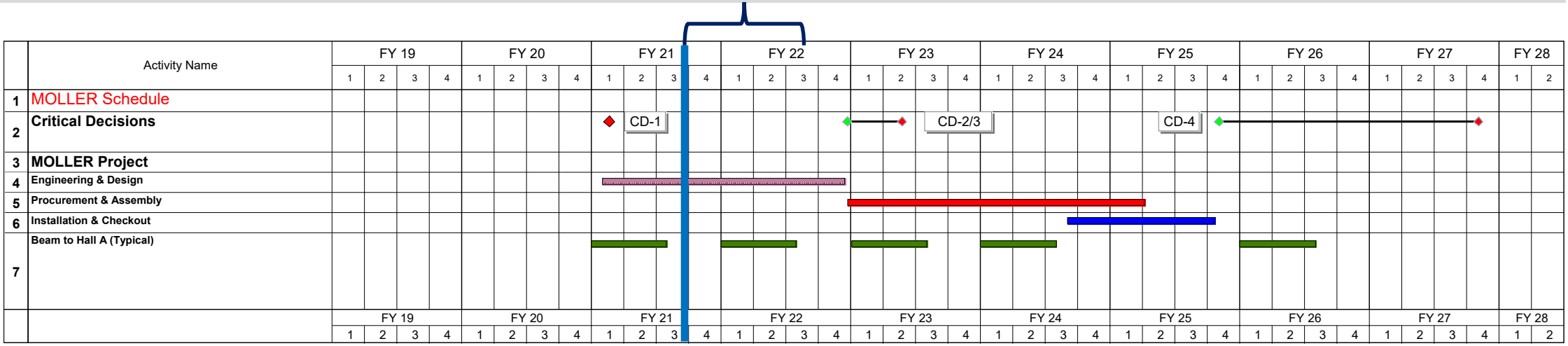
Figure 2. Typical DOE Acquisition Management System for Other Capital Asset Projects (i.e., Major Items of Equipment and Operating Expense Projects)



Project Status – Schedule

We are working very hard to keep CD-2/3 in late FY22 so we can start procurements for final systems

We have <u>only 10-11 months</u> to complete 90% designs and be ready for start of construction (CD-3) Director's Review



MOLLER Schedule dovetails with SBS run plan

Activiy	Start	End
SAD and SBS Installation	9/21/20	9/1/21
SBS Physics Run 1	9/2/21	12/24/21
SBS Physics Run 2	5/1/22	12/24/22
SBS Physics Run 3	1/15/23	5/15/23
SBS Physics Run 4	10/1/23	12/24/23
SBS Physics Run 5	1/15/24	5/15/24
MOLLER Design and Engineering	12/15/20	9/30/22
MOLLER Procurement and Assembly	9/1/22	3/15/25
MOLLER Installation and Checkout (no beam)	5/20/24	6/25/25
MOLLER Commissioning Run (49 PAC days)	6/26/25	10/2/25
MOLLER Physics Run 1 (60 PAC days)	1/15/26	5/15/26
MOLLER Physics Run 2A (57 PAC days)	9/1/26	12/24/26
MOLLER Physics Run 2B (60 PAC days)	1/15/27	5/15/27
MOLLER Physics Run 3A (57 PAC days)	9/1/27	12/24/27
MOLLER Physics Run 3B (60 PAC days)	1/15/28	5/14/28

Scope Update: Pre-Baseline Changes since CD-1

- PB-001 “Removal of NSF and CFI Scope and other updates post CD-1”
  - Major overhaul of project plan and project documentation
  - Project documentation is still under review/revision by ONP, but change is approved
- PB-002 “CTD403 Irradiations”
  - Added scope to do irradiations of fiberglass composite used to pot toroid windings
  - Goal is to fill data gap at anticipated MOLLER dose and test at MOLLER temperature versus prior data all done at cryogenic temperature
  - Samples arriving soon; contracting underway for encapsulation and irradiation
- PB-003 “Downstream Toroid Copper Conductor Procurement Strategy”
  - Outcome of Preliminary Design Review suggestion
  - Split out copper conductor procurement from prototype coil fabrication
  - Minimum order quantities for conductor sufficient to fabricate production coils for three of the four sub-coils and decision taken to order enough for SC-4 as well
- Others in the works
  - Subcontracting upstream toroid, enclosure and collimators design (and ultimately build) to MIT-Bates
  - Procuring/fabricating prototype magnet power supply and DS coil handling and alignment equipment to support prototype coil testing
  - Moving the target vessel downstream window scope from Spectrometer (beampipes) WBS to Target WBS

Budget Update – President's Budget Request for FY22

- The PBR for FY22 was recently released
  - This is ***not*** the appropriation for FY22; it is the starting point for negotiations with Congress
  - NP PBR of $720M looks nearly flat, but $66M Isotopes program was pulled out so ***NP is up 11% sans Isotopes***
    - *Note that FY21 PBR for NP was $580M vs $713M enacted; FY20 was also $713M enacted*
  - Rumor has it that NP and HEP are hedging to get additional funding for projects from one or more infrastructure bills and intentionally put more funding towards research and operations in the base budgets in the PBR
- **MOLLER MIE funding request in PBR is $7M, up $2M from FY21 but well below our $13M request**
- Budget profile at CD-1, after pulling out NSF/CHI-RM, and quick-look with FY22 PBR number:

K$	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	Total
Redacted									

- ONP requested our estimate of impacts on the project
  - We assumed FY23 and FY24 capped at $13M each year
  - **Estimated impacts**
    - **CD-2/3 date holds, but CD-4 is pushed out ~3 months**
    - **$1M cost increase (escalation, standing army, some added overheads)**
  - Mostly recoverable if we can get an additional $1.5-2M in FY23-24

Jlab Operations budget is up 22% in the PBR which will allow for "operating at 90% of optimal" – this bodes well for executing the SBS run program in FY22

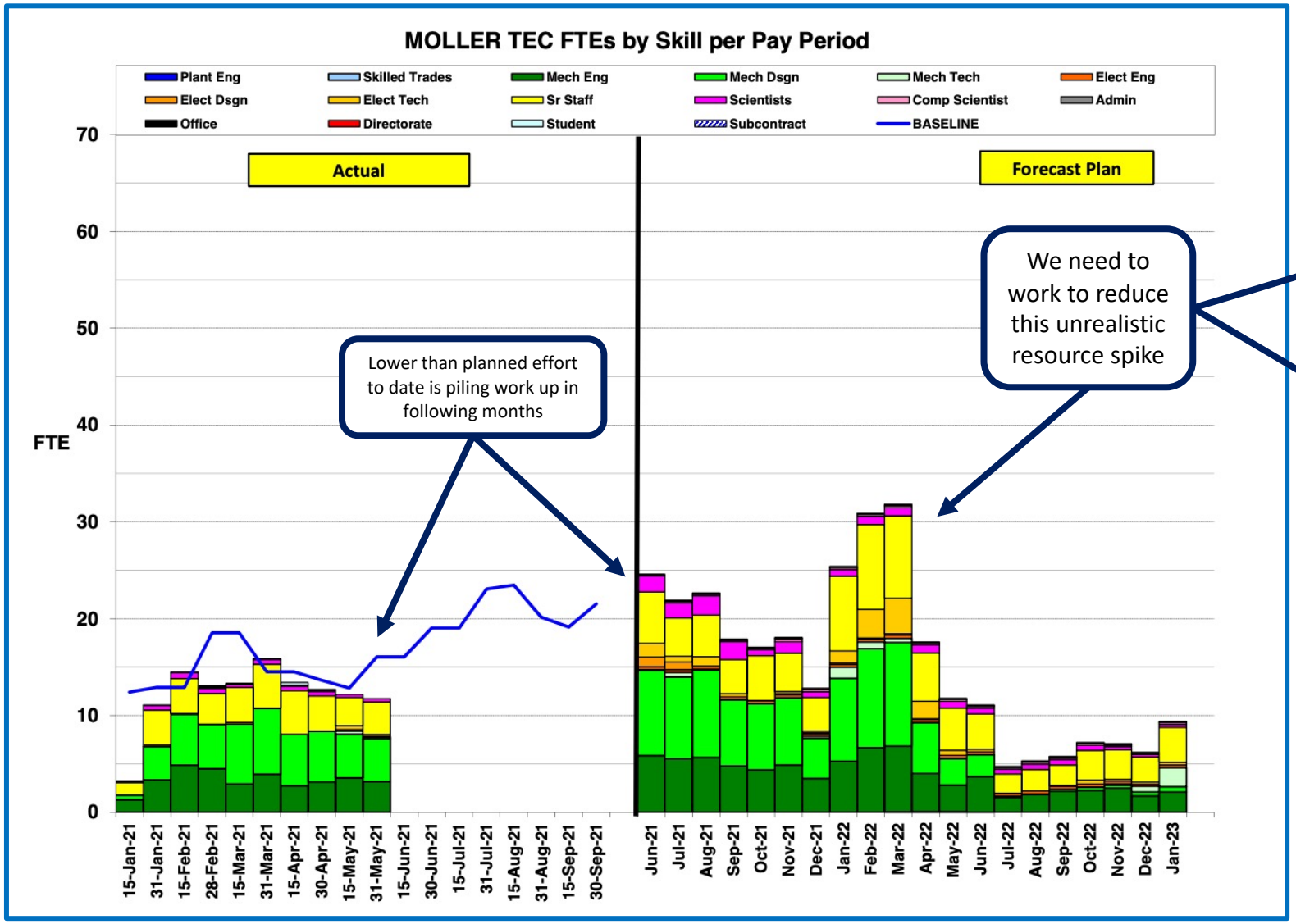
My message to the project team – no real impact on FY21-22 efforts

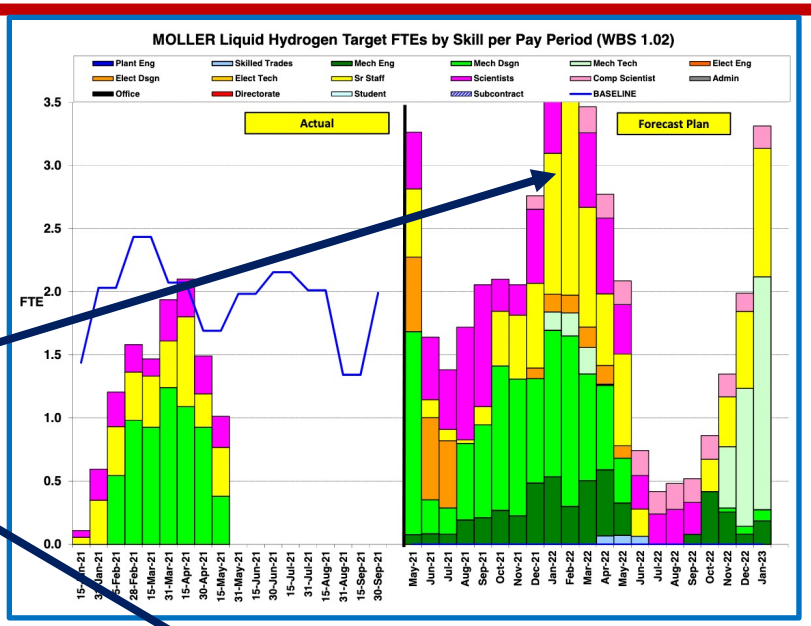
"The real-world impact will be that I will be more closely scrutinizing proposed BCRs that require additional expenditures in FY21-22 to assure we can continue to fully fund the engineering effort, but that in no way means we cannot continue to optimize the project flow by continuing to split out pre-production prototyping of various sub-systems to advance the designs an reduce risks. I do still have a pool of contingency baked in to the FY21-22 budget to accommodate these sorts of changes. We are still very much "over-funded" in FY21 so anything we can do that can move FY22 scope forward to FY21 is highly encouraged – we are going to get beat up for not spending the funding they gave us in FY20-21. I want to reiterate that the reduced funding ONLY impacts procurements planned for very late FY22 and in no way touches available funding for engineering and design work.

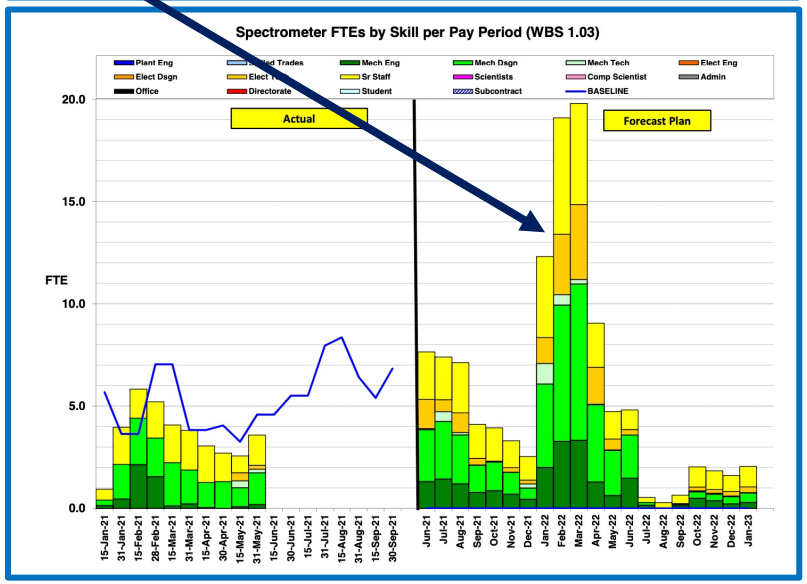
Bottom line is that we need to stay the course and continue to press full speed ahead towards our goal of CD-2/3 in Q4FY22."

- No change in plans, despite apparent significant shortfall (I am strategic in my requests…)
- We very well may get more funding after the dust settles in Congress (base or infrastructure bill)
- It is critical that we *spend what we have received* to demonstrate need for future funding

Staffing has largely ramped up to plan – *but levels need to continue to climb*







Project Staffing Needs

- We have largely been able to ramp up engineering/design staffing to planned levels
  - We now have planning and forecasting tools in place to more clearly see where we are at
- We still have another ~5 FTE to go to reach plan
  - Management team is under-charging relative to plan – this is OK
  - Target group is hiring a junior engineer to provide required support
  - Upstream toroid subcontracting to MIT-Bates is about 2 FTE
  - Engineering division has provided resources for infrastructure team – ahead of plan now
- We have been technically limited to date
  - Many inter-related systems that need to advance somewhat in unison
  - We have a number of efforts that are waiting on the NSF team to complete preliminary designs
    - NSF funding was late to arrive and they are moving quickly now
  - We have other design issues that need physics input
    - Task forces stood up in collaboration to provide needed inputs to engineering
- But we may well find we are resource limited at JLab in the coming months
  - That is my job to fix with lab management (prioritization, matrixing staff, hiring)
  - I can't argue for more resources until the current ones are overloaded…
  - Flat funding for EIC, if it sticks, may free up some engineering/design staff in FY22

PDRs and FDRs

- The project will hold Preliminary and Final Design Reviews for all subsystems
- Preliminary Design Reviews
  - Expectation is that design is at 60% - full 3D CAD models reflecting “final” design
  - If R&D prototyping is warranted, that has been completed to validate design
  - Engineering/physics calculations complete to back up design
  - PDR completion required to proceed to 90% design effort
- Final Design Reviews
  - Expectation is that design is at 90% - full drawing package completed
  - Pre-production prototypes constructed and tested to validate designs
  - Demonstration that all requirements and interfaces are satisfied by design
  - Present plan to validate requirements during production
  - Evaluation of risk and risk mitigation strategy for production
  - Integrated reviews will be held to assure integration of systems
    - E.g. target and shielding bunker; beampipes and detectors
  - ***Completion of all FDRs is required to proceed to CD-2/3***

PDRs – driving pre-production prototyping efforts

- Downstream Toroid Coils
  - Copper conductor ordered
  - RFI complete for coil fabrication; vendors identified
  - Working on final drawings for RFQ for prototype coils
- Data Acquisition and Trigger system
  - NSF team is starting to purchase DAQ and trigger components to prototype the system
- Spectrometer Power Supplies, Leads and Jumpers
  - Plan for Pre-Baseline Change to build 1 of 5 required supplies as a prototype
- Planning underway for GEM detectors (including tracking, polarimeter and pion GEMs)
  - Gates procurements of foils from CERN and other specialty items from Europe

Preparation for these reviews and feedback from the review teams has been very helpful

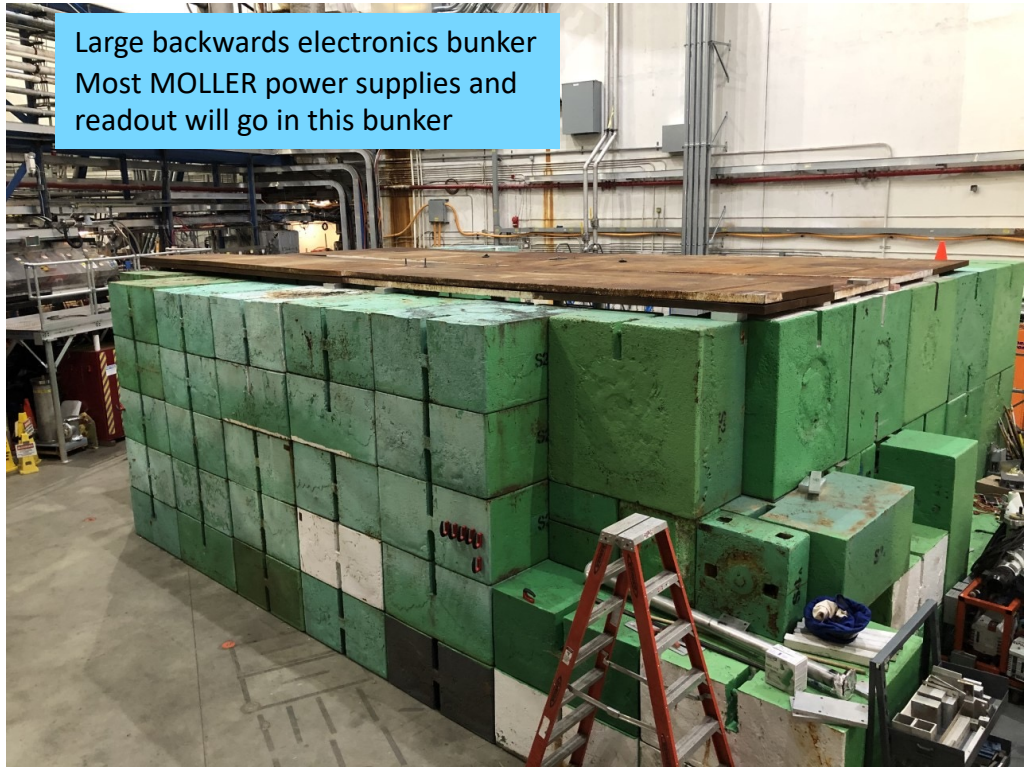
Update on project dependencies

- Hall A LCW upgrade nearly complete – on track to finish prior to SBS running
- Hall A electrical power upgrade nearly complete – on track to finish next month
- Injector upgrades are nearly complete
  - One ¼ cryomodule to move next year
  - Ongoing beamline and instrumentation upgrades planned through 2023
- Polarimeter upgrades are progressing
  - New Pockels cell complete
  - New Compton electron detector design is advanced, but there have been delays in identification of suitable readout ASICs for diamond sensors
  - Prototype diamond sensor substrates have been received; OSU will fab detectors
- End Station Refrigerator 2 (ESR-2) behind schedule
  - Other activities took precedence during SAD- delays attributable to COVID restrictions
  - Still scheduled to complete ahead of MOLLER, but we are watching progress

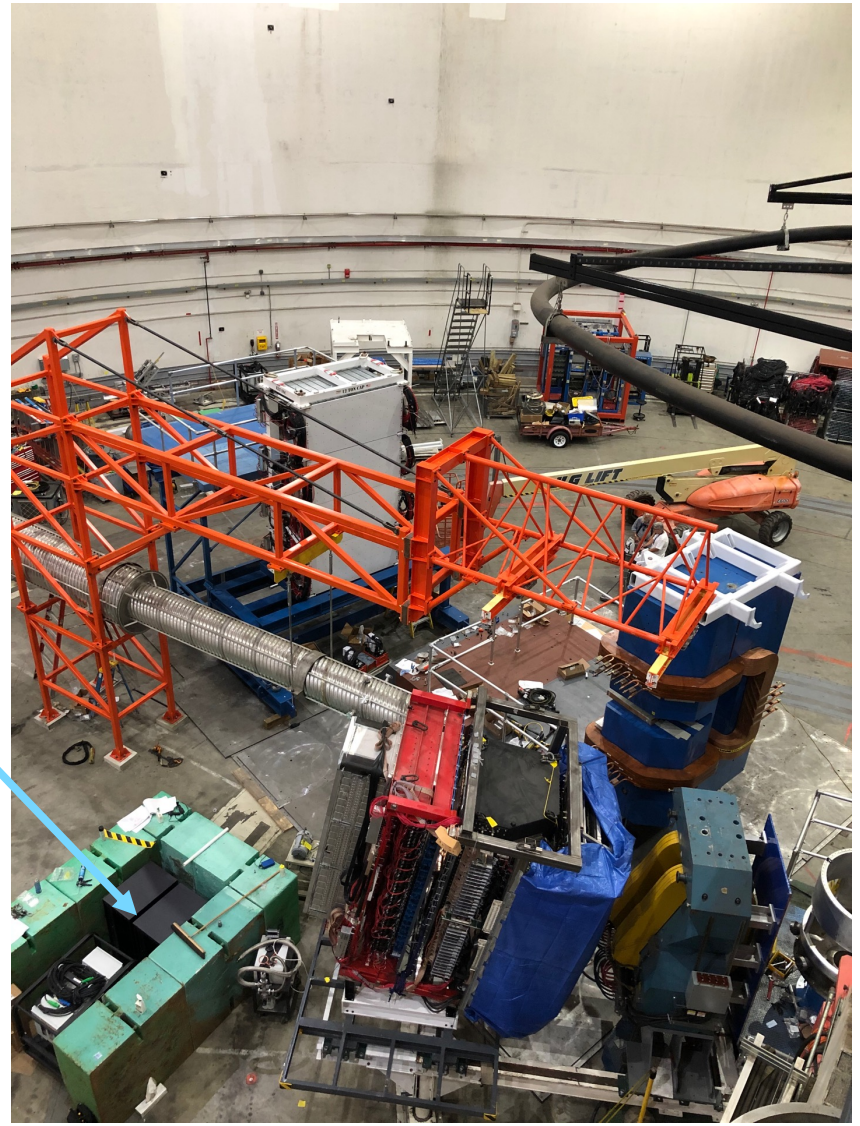
Proposal from Jay to partially implement Hall A incoming beamline changes in FY22 SAD
Would need to be funded by MOLLER MIE as “prototyping” effort
Project management and the collaboration are considering this proposal

Hall A preparations for SBS – MOLLER will benefit from infrastructure

- CREX is out, new SBS and BigBite spectrometers are installed
  - Even with the overhead crane down and COVID restrictions!
  - Provides input to – and confidence in – planning for MOLLER installation
- Lage backward and small forward electronics bunkers installed
  - Backward bunker will be used by MOLLER
  - Forward bunker will be moved to service GEMs (may need two)



Small forward bunker for GEM electronics (MPDs)
MOLLER may need one on each side of beamline



Counting House Renovations in preparation for SBS – MOLLER will benefit from upgrades

2016-2019 Review Recommendations that remain OPEN – *we need to close these*

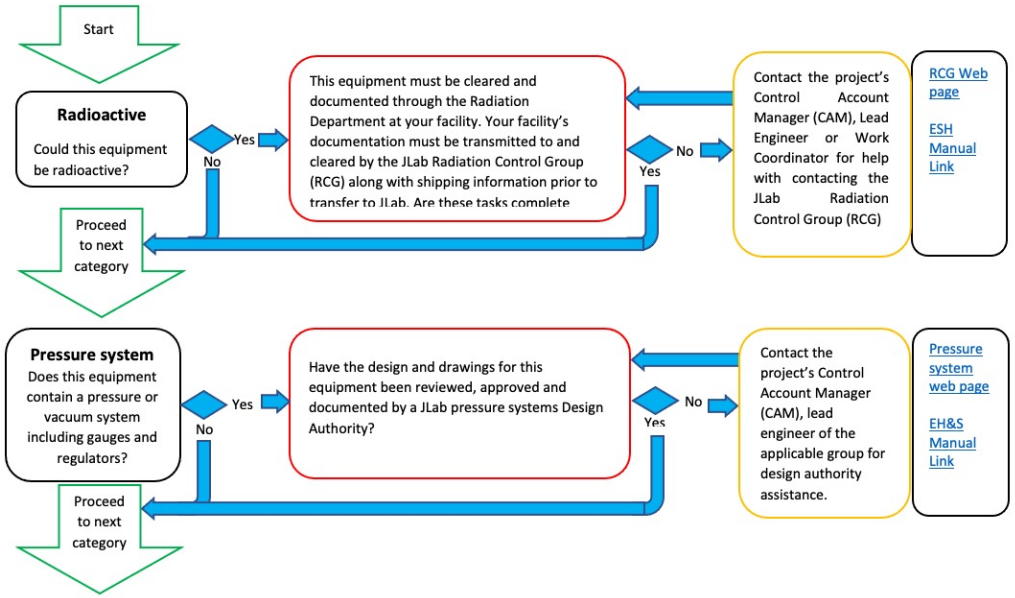
- 2016 Director's Review:
  - Pursue a more realistic, detailed cell window design and check/refine with CFD.
    - Silviu is actively working on this now.
  - Simulations of the combined apparatus and hall are needed, for example, to assess backscattering backgrounds from the dump in the pion detectors.
    - Simulations team is working on this, but pressing engineering questions have been taking priority.
  - Cross-talk between detector regions due to showering in the support structure of the Thin Detector should be simulated.
    - This simulation relies on accurate engineering models for the support structures.
    - These are largely available now so this work should proceed now.
  - Develop a consistent and actionable approach to sensitivity analysis for both backgrounds and helicity-correlated effects, and associated specification derivation, such that technical designs can be evaluated, manufacturing tolerances specified, and resulting hardware measured.
    - Sensitivity analysis approach defined. Working on flow down to evaluation of manufacturing tolerances.
    - Perhaps this can be a deliverable of the Alignment Taskforce?
  - The technical risk assessment, using accepted technological readiness levels, for reaching the stated statistical and systematic uncertainties should be completed.
    - Mark Pitt has been working this, but it needs to come to fruition in a technical note.
  - Additional 7 "science" recommendations to collaboration; 5 remain open
- Conceptual Design Review, December 2019
  - All 6 recommendations are physics related and being managed by the collaboration

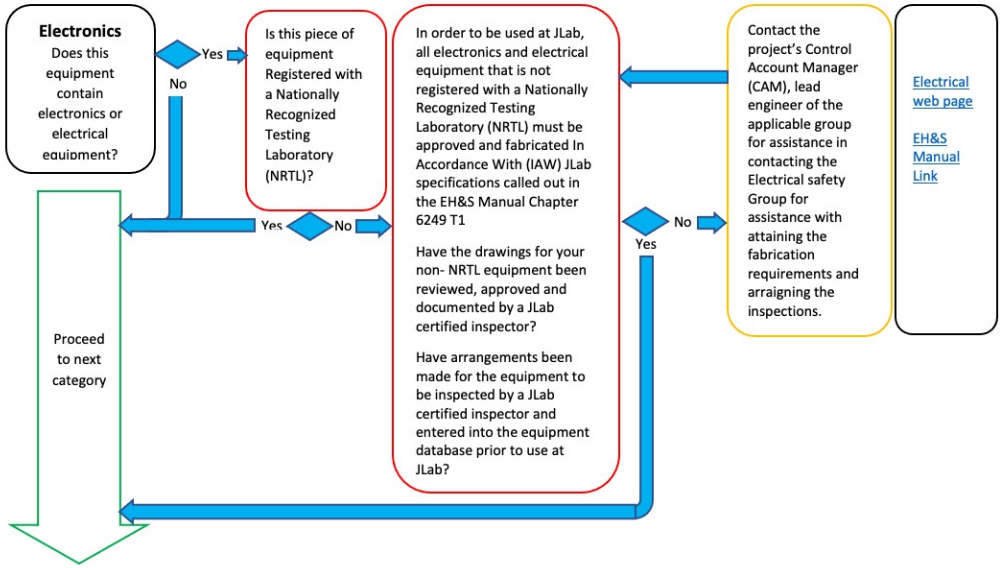
2020 Review Recommendations that remain OPEN

- 2020 OPA Independent Project Review
  - Enhance engineering and designer support to the target group **within the next 6 months** to advance the design off the critical path.
    - New position in Target Group approved by Division recently. Hiring process is underway.
  - Develop a detailed, resource-loaded installation plan prior to CD-2/3
    - Installation Requirements document is capturing this plan; reasonable draft in place
    - Reflected in updates to activities and flow in P6.
    - Alignment taskforce and SBS installation lessons learned will provide final inputs to close this out.
  - Add a Quality Assurance Professional to the project before CD-2/3
    - The lab does not have a pool to draw from. Elevated to a Lab management concern (Stuart/Allison/Bob).

Bringing equipment to Jlab – it is not too early to be planning for this

- Planning for bringing equipment to the lab needs to start *at the design phase*
  - A Jlab Design Authority must approve all design for pressure vessels, cryo systems, weldments etc.
  - All non-NRTL listed electrical equipment will require inspection and approval for use – this will take time as Jlab will only have one or two people available for inspections lab-wide, *and your non-listed equipment may not be approved*
  - All welding must be done by a certified welder – there are no exceptions so this must be factored in to the contracting process for all weldments
  - etc.…
- Ed Folts (ES&H Lead) has prepared a helpful guideline for people to remind you of the steps involved
  - Distributed to CAMs and L2 managers, KK and Mark
  - If you want a copy, let me know





Summary

- We have been making steady progress since CD-1; on track towards CD-2/3
- We have largely been able to ramp up engineering/design staffing to planned levels
- Most project dependencies will be completed during the current SAD
- FY22 funding in the PBR is sufficient to remain on course to CD-2/3 with minimal impact on CD-4
- Technical progress is good; initial PDRs have gone well and been very productive
  - Evolution of planning and execution are going smoothly with Pre-baseline Change Request process in place
  - We are already thinking carefully about receiving equipment and installation in Hall A
- We need the collaboration's help to close *all* prior recommendations prior to CD-2/3