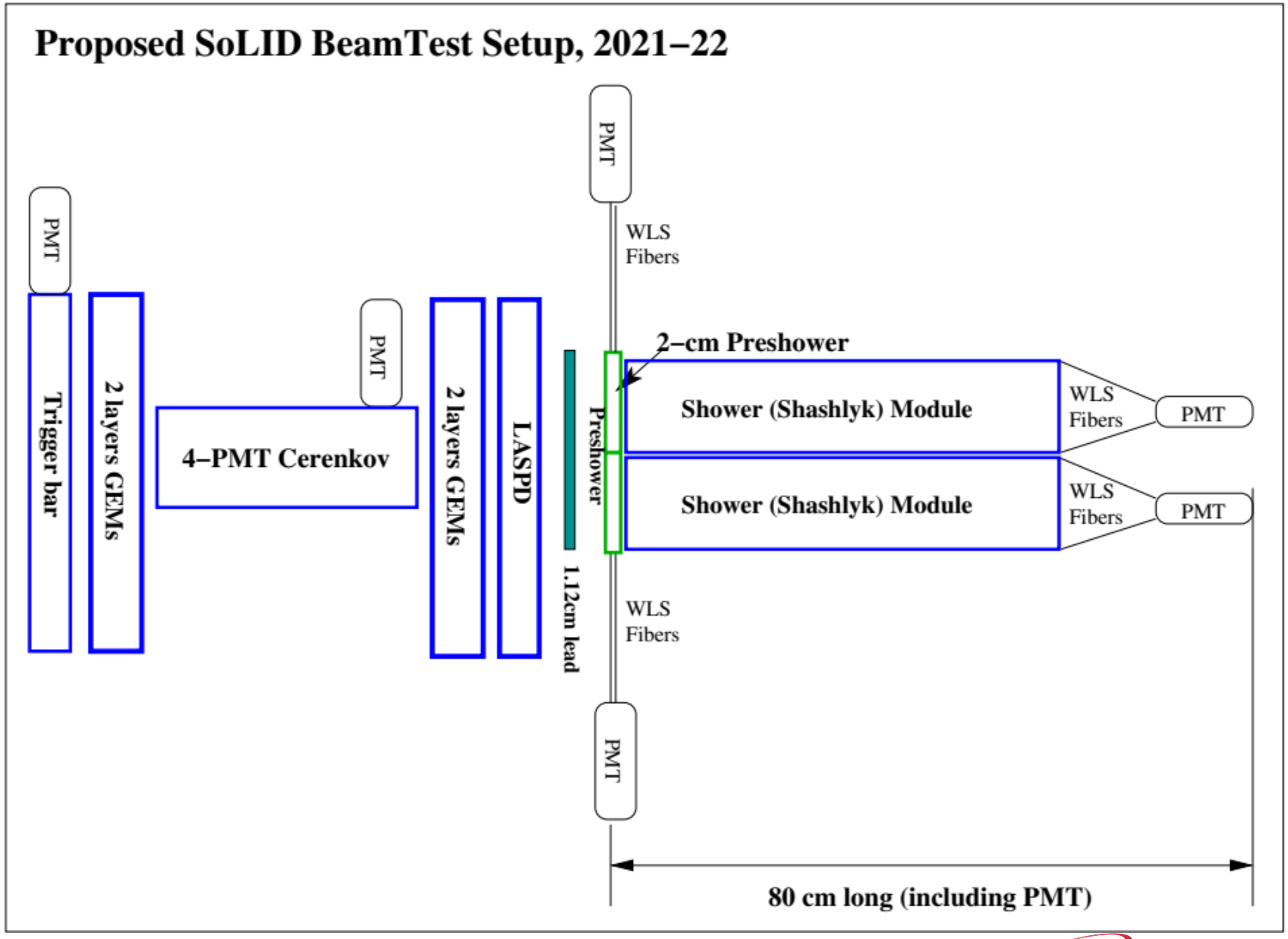
SoLID FY22 Research Rampup Plan

- Beamtest in FY22 – high luminosity (high rate and high radiation) beam test of detector setup and DAQ system, as suggested by the Feb 2021 Director's Review of SoLID
  - Cherenkov detectors had high rate tests in 2020
  - ECal had calibration tests at FTBF, while simulations showed no show-stopper, need high rate beam test
  - GEM with new VMM readout is currently being bench tested with (x-ray mimic) high rate. Needs high radiation test with beam.
  - → Focus will be high rate on ECal and GEM VMM3 readout

- Beam test of detector and DAQ at high luminosity will help to identify issues, optimize design choice, thus reduce cost and scheduling risks.

Beam test

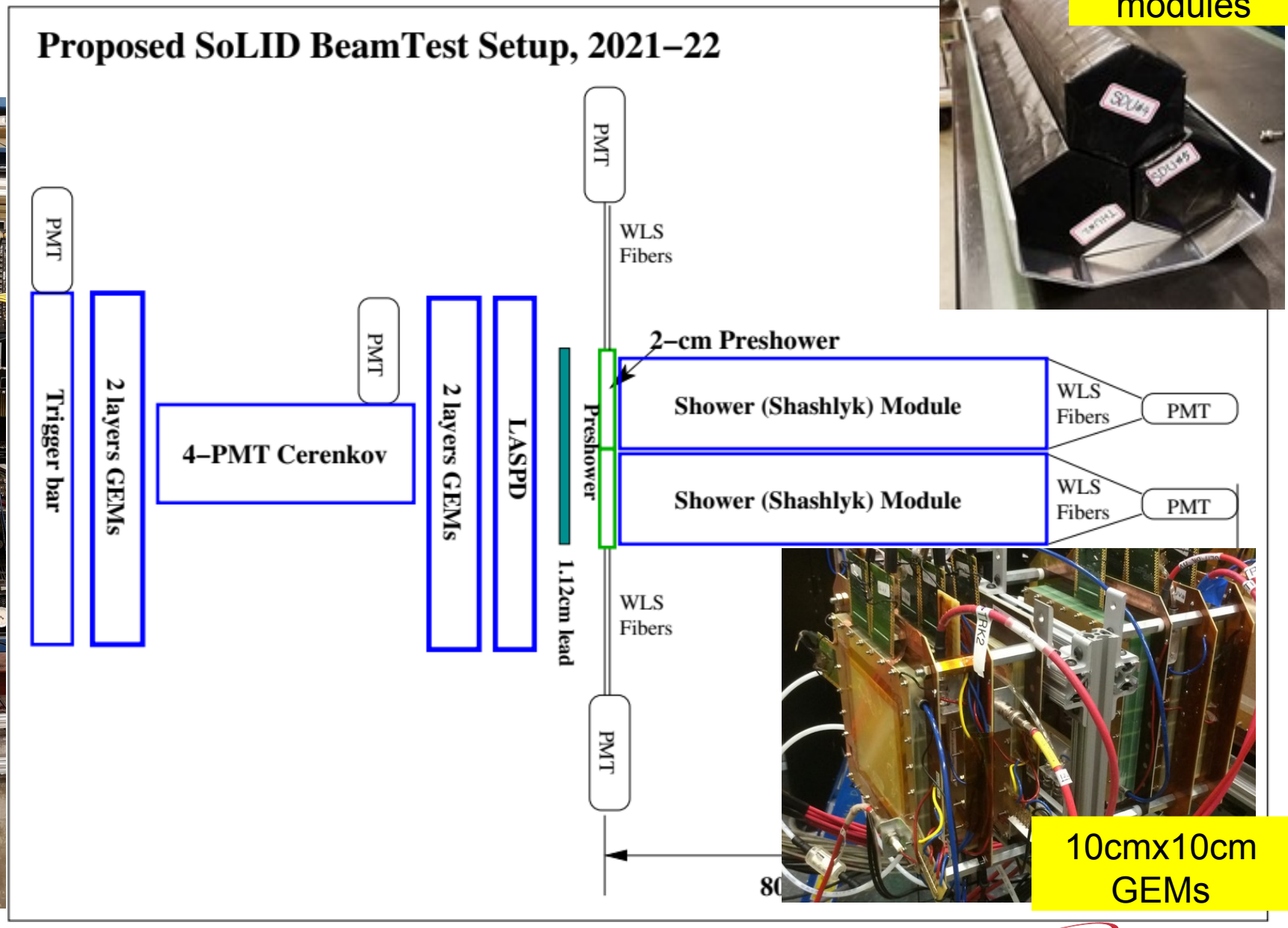
- Realistic detector setup using existing prototypes



Beam test

- Realistic detector setup using existing prototypes

4-PMT Cherenkov

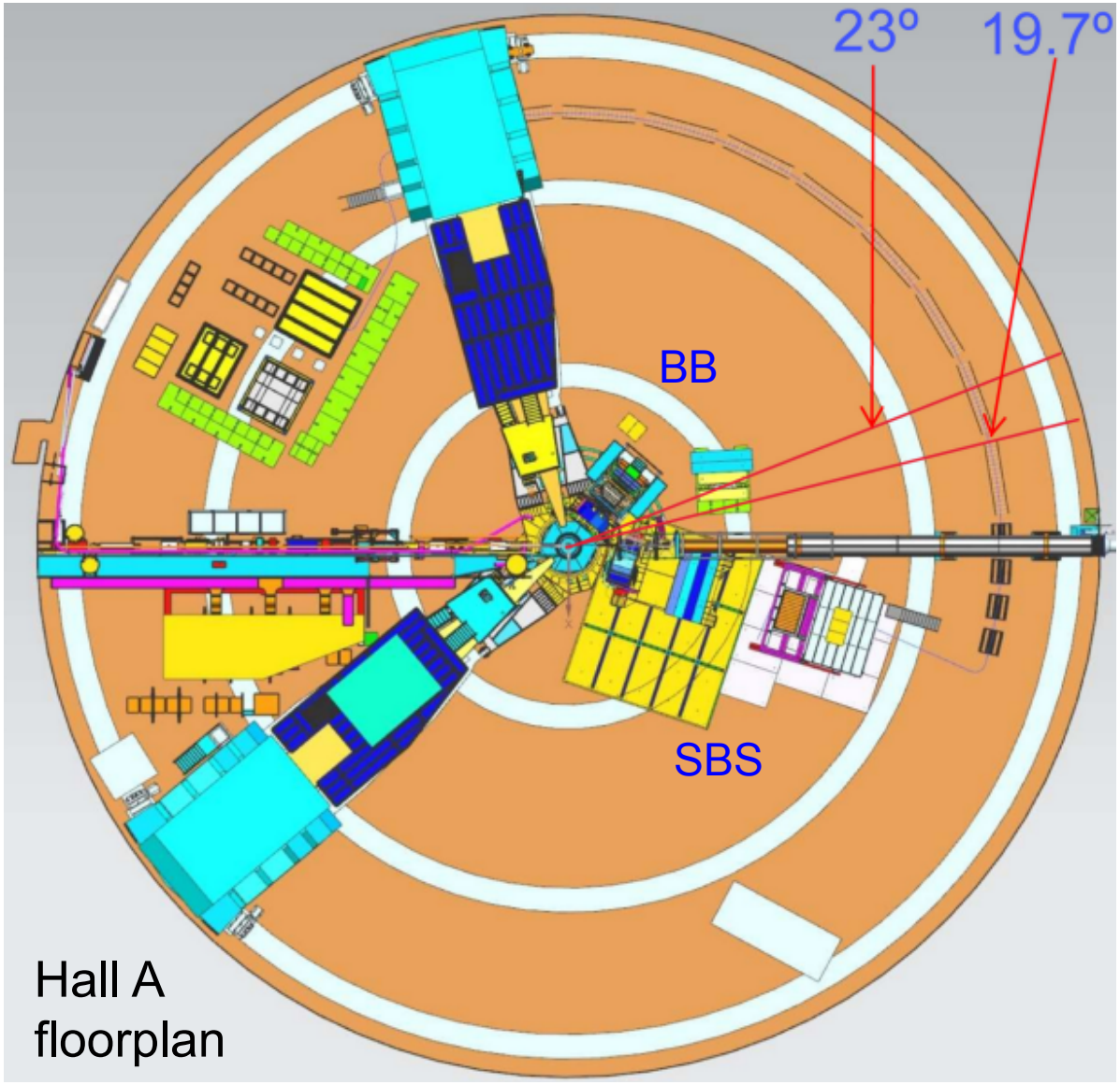


3x shashlyk modules

10cmx10cm GEMs

Beam test – Location

- SBS program in Hall A close to SoLID running
- Hall C also possible;



Beam test – Resources

- Resources needed:
  - JLab: need 3x2 hours survey
  - JLab: need 0.5 design/engineering (or 0.1, 0.2?)
  - Collaboration: 2.0 FTE setup/test/analysis, 0.4 FTE DAQ, simulation 0.4 FTE
  - (0.5 existing UVA, need ??? new)
  - Material: 7 FADCs ($70 k), need more stuff (compact support structure, design/machining cost)

Other Topics – Overview

- Other topics from SoLID collaboration institutions PIs:
  - End-to-end simulation (recommended since Feb 2015 Director's review) (X. Zheng UVA)
  - Cherenkov testing and prototyping (cost saving and risk mitigation) (M. Paolone/ New Mexico State U., Haiyan Gao/Duke U.)
  - DAQ Streaming readout (suggested during 2021 Science Review) (Alexandre will add name: UMass 0.5 FTE?)
- Artificial Intelligence/Machine Learning – possible multi-institution proposal responding to new AI-focused FOA in 2022.

Backup Slides

2021 Director's Review Report:

3. The new experimental and theoretical research efforts and technical capabilities needed to accomplish the proposed scientific program.

Comments:

- From the presentations it was not possible to understand how far the R&D on the different detectors has been progressed to ensure the chosen technologies are able to perform to the physics requirements, especially to the occupancy expected due to the high luminosity of $10^{37} – 10^{39}$ $cm^{-2}s^{-1}$

End-to-end simulation

- Recommended since Feb. 2015 Director's Review

> 2015 Director's Review Report:
> 1. Physics Relevance and Risks
> 1a. Findings:End-to-end physics simulations for the core measurements are lacking.
> - Recommendations: End-to-end simulations with realistic subsystem responses and material budgets, and complete track finding and reconstruction should be developed.
>
> 1b. Findings: The SoLID simulation framework is in the beginning stages of development.
>
> Recommendations: The development of a simulation framework with realistic reconstruction and analysis should be pursued with high priority and increased resources.

- Need to develop framework that works for SoLID's entire life cycle, that includes:
  - event generation (physics and background)
  - detector simulation (GEANT-based), signal digitization
  - signal processing and event decoder
  - data analysis and extraction of physics results
  - (possible interface to AI/ML algorithm)

➔ Lead institution/PI: UVA/X. Zheng

Cherenkov Mirror Study

- High cost of CFRP (carbon fiber reinforced polymer) polished mirror blanks pushed collaboration to seek alternative mirror fabrication methods, to reduce cost and scheduling risks
  - attach reflective plastic-lexan film to polished carbon-fiber blanks, need: mirror blank testing, lexan-film adhesion and radiation hardness testing
  - alternative 3D-printing CFRP blanks
- MAPMT and WLS coating radiation testing
- Microchannel plate (MCP)-PMT testing

➔ Lead institution/PI: New Mexico State U./M. Paolone

- HGC Mirror mounting prototyping and readout gas tightness testing

➔ Lead institution/PI: Duke U./H. Gao

Streaming DAQ

- Suggested during March 2021 Science Review
- Simulation of event size and data processing will be performed to evaluate the amount of resources needed
- A streaming version of the VMM prototype could be built and tested in streaming mode

➔ Lead institution/PI: to be added – need inputs

Artificial Intelligence/ Machine Learning

- Need specific algorithm and optimization for SoLID's high rate, high background running condition:
  - AI for GEM tracking using momentum, track direction, hits, and track quality; need fast, high-efficiency track-finding algorithm;
  - AI for PID using ECal signal (amplitude, waveform, cluster identification) and Cherenkov;
- "Classic" machine learning approach: neural network, deep network, boosted decision tree, etc provide a good starting point;
- SoLID-specific AI/ML study and optimization will provide feedback to GEM, ECal, Cherenkov design, and end-to-end simulation
- SoLID-specific implementation

We will utilize existing simulation tool and FTBF test data, along with new data expected from the upcoming high-rate beam test → possible multi-institution proposal responding to AI-focused FOA in 2022