



LAr Experiments

Cristiano Galbiati
Princeton University
Gran Sasso Science Institute

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Snowmass CF1 Meeting

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Direct Detection Experiments
for >10 GeV Dark Matter

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August 7, 2020

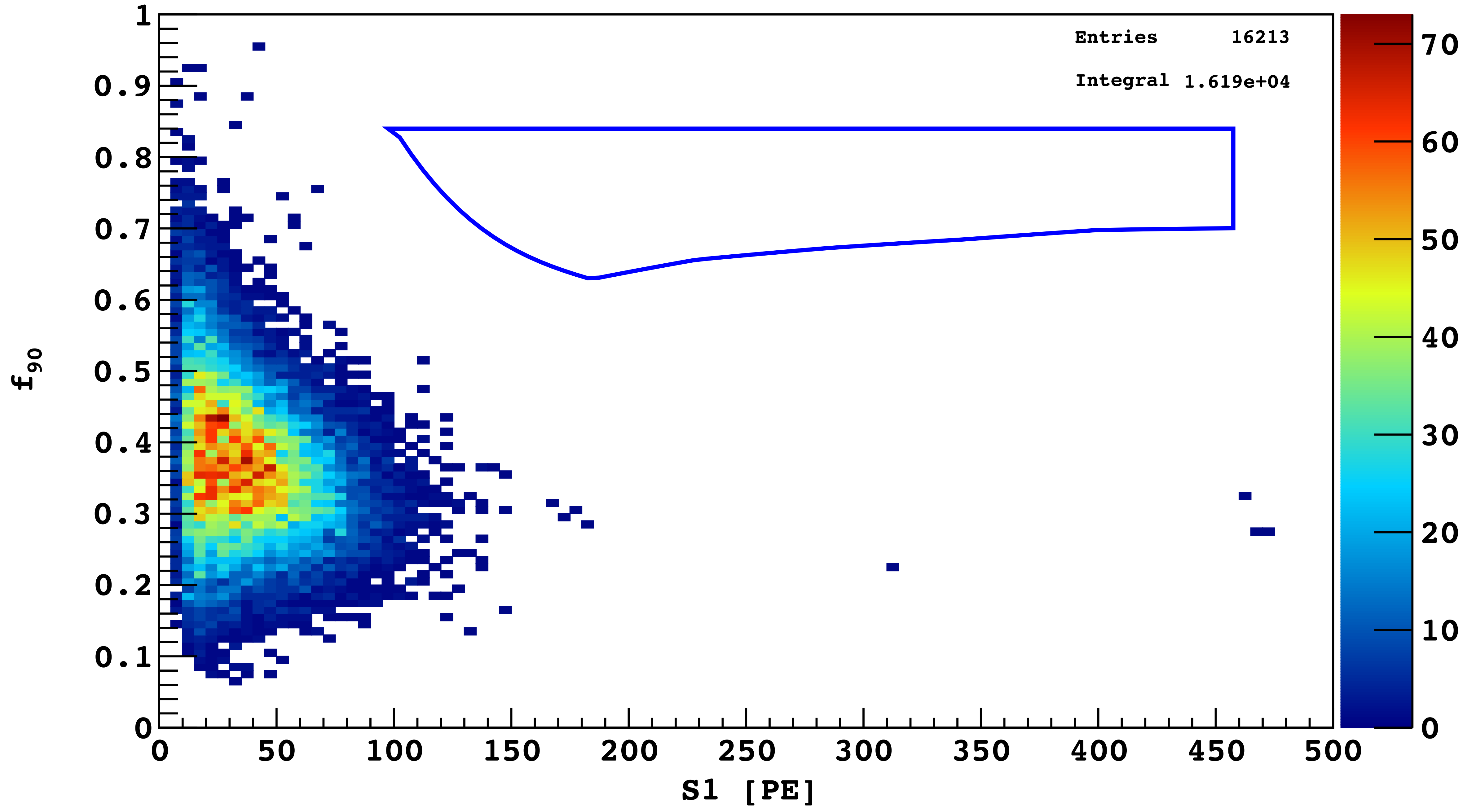
THE GLOBAL ARGON DARK MATTER COLLABORATION AND ITS PROGRAM FOR DARK MATTER SEARCHES

- O(400) scientists coalesced in single international argon collaboration, with strong US participation
 - The Global Argon Dark Matter Collaboration
- A sequential, two-steps program:
 - DarkSide-20k (200 tonne \times yr fiducial)
 - Argo (3,000 tonne \times yr fiducial)
- The goal: explore heavy dark matter to the neutrino floor and beyond with zero instrumental background

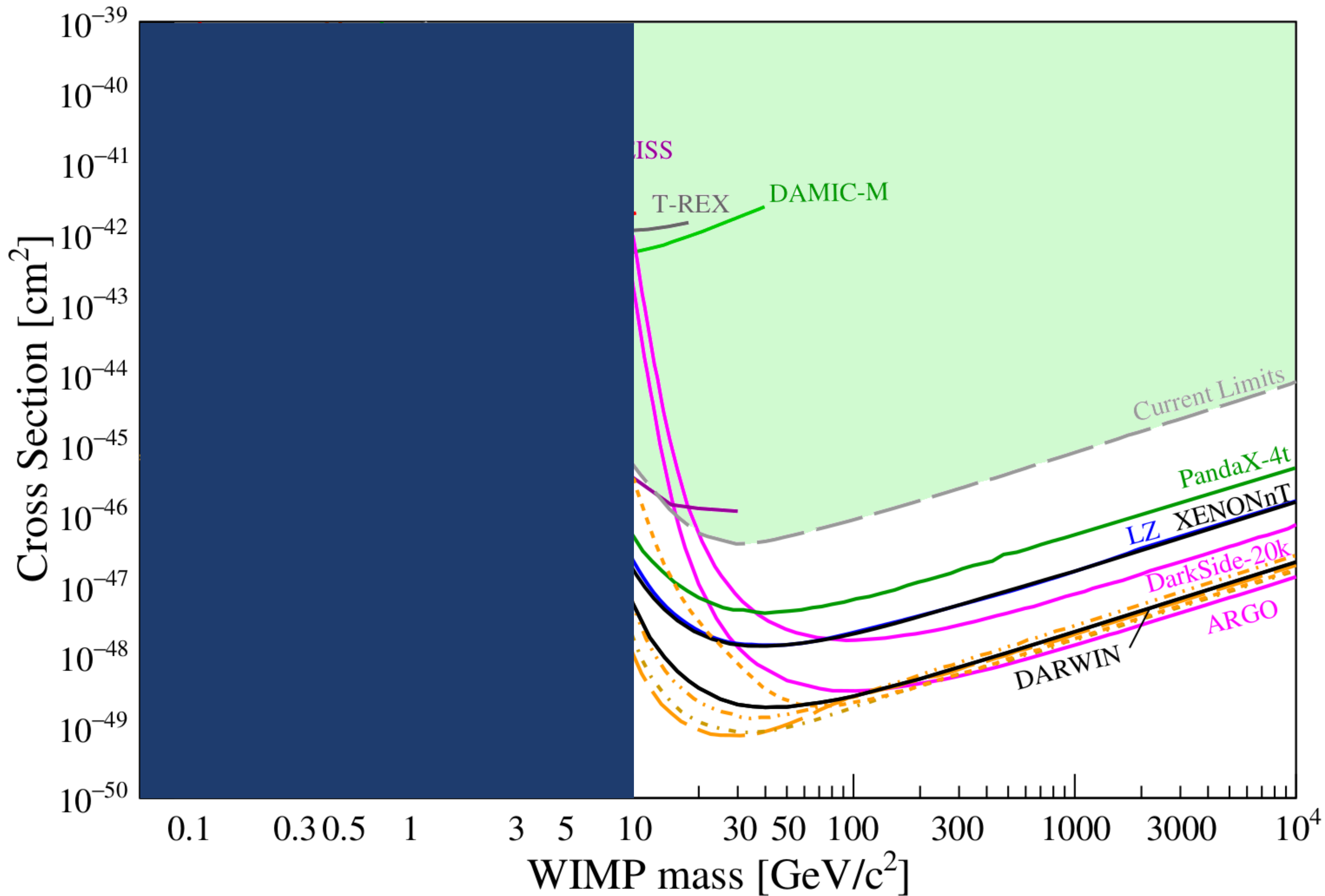
HIGH MASS SEARCH REQUIREMENTS

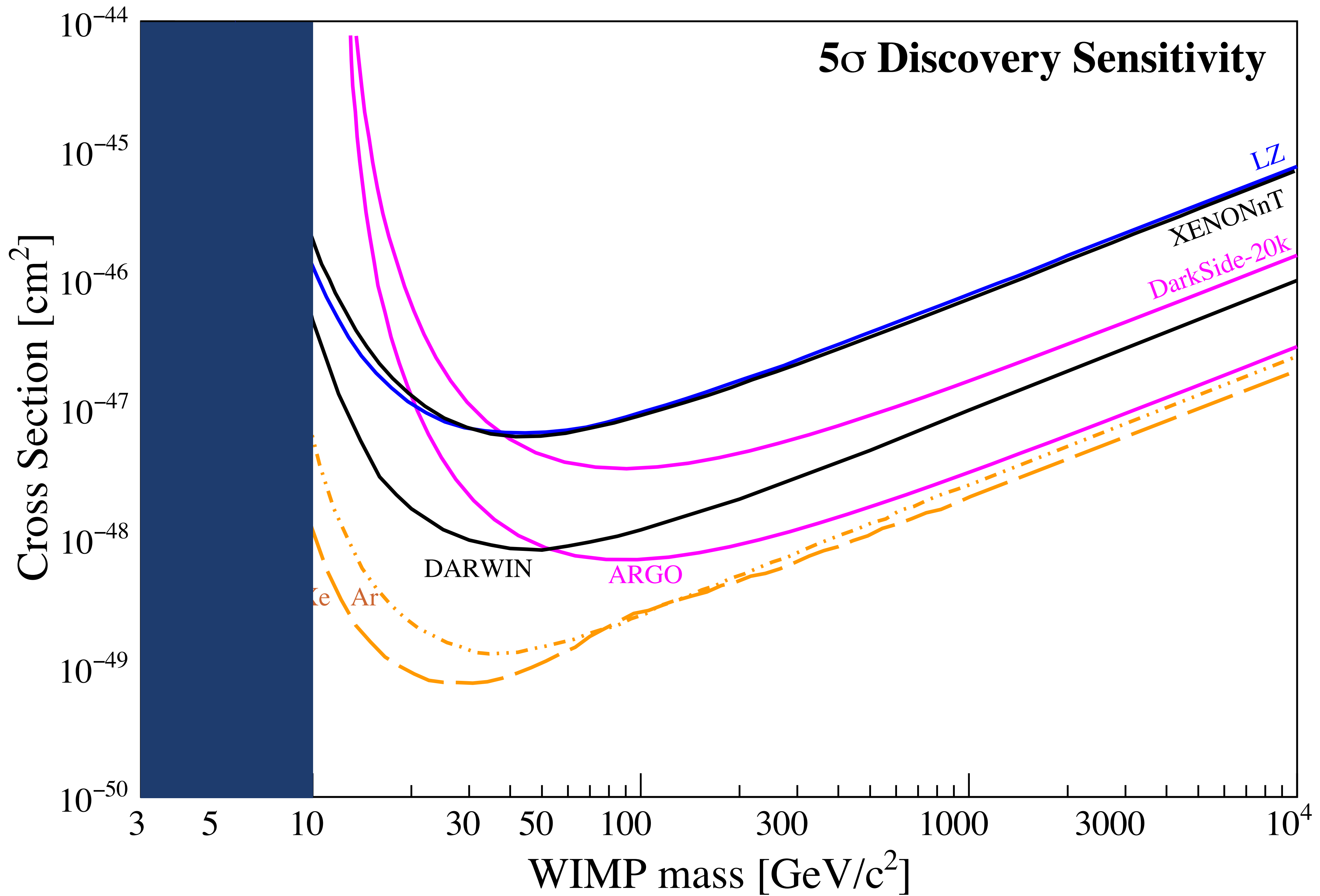
- Exposure of $O(1,000 \text{ tonne} \times \text{yr fiducial})$ to explore dark matter at the neutrino floor
- Solar neutrinos become background, requiring rejection of minimum ionizing background of at least $1:10^5$; background from radon equally treacherous
- Path to potential discovery of dark matter at the neutrino floor with argon thanks to combination of underground argon and background rejection capability already demonstrated at the tonne-scale level with atmospheric argon (DEAP-3600, DarkSide-50)
 - With underground argon, we project zeroing out instrumental background thanks to PSD rejection power better than $1:10^8$

+r<10 cm && 50% loss S2/S1 cut (70d)



Physical Review D 98, 102006 (2018)

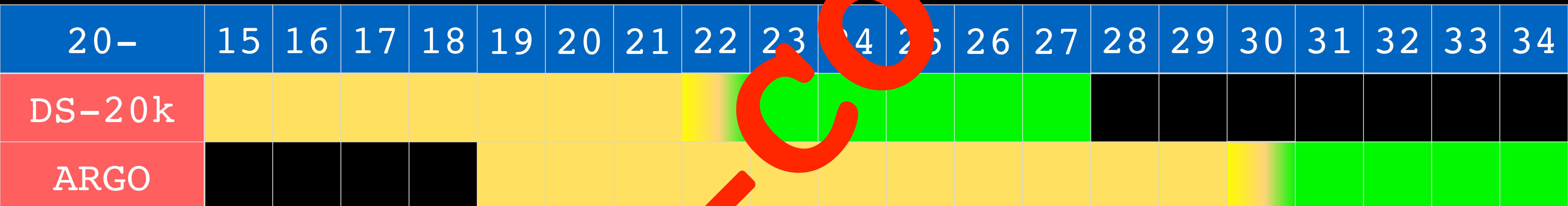




DarkSide-20k

20-tonnes fiducial dark matter detector
start of operations at LNGS within 2023

200 tonne×year search for dark matter free of instrumental background



Argo

300-tonne depleted argon detector
start of operations within 2030

3,000 tonne×year search for dark matter free of instrumental background
precision measurement of solar neutrinos

DURING COVID-19 EMERGENCY

- Decision to suspend activities of collaboration and exploit know-how in technical gases to develop pulmonary ventilator
- MVM ventilator (<https://mvm.care>) fastest project ever from conception to U.S. FDA Emergency Use Authorization, now certification ongoing by Health Canada and CE
- Outstanding orders for over 10,000 units



TECHNOLOGICAL ENABLERS

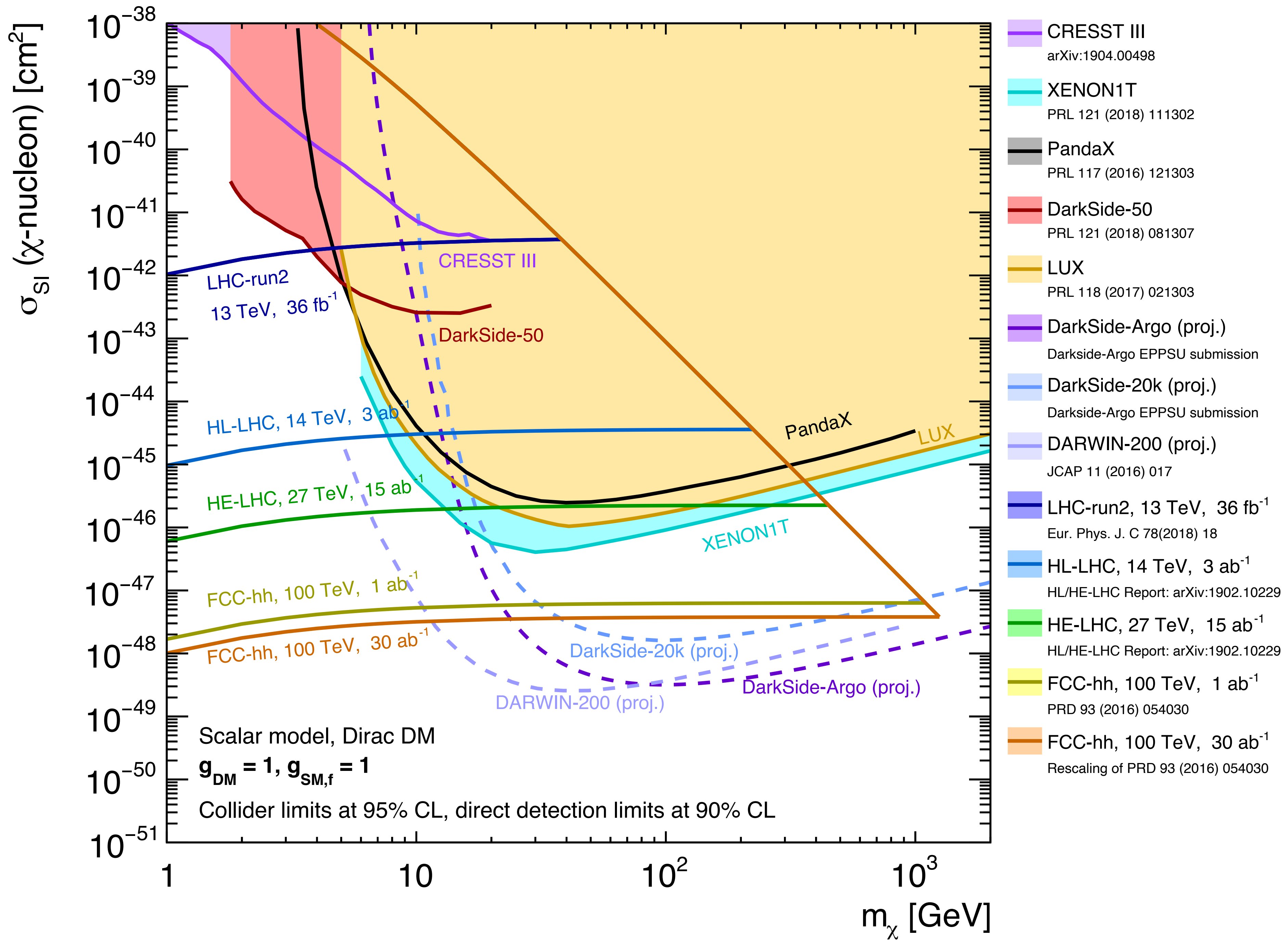
- Custom SiPM-based cryogenic photodetectors
 - Broader impact: DUNE, medical physics
- ProtoDUNE-like cryostat for hosting detector and active veto
- Custom ^{39}Ar -depleted liquid argon
- All demonstrated to meet requirements for physics performance projection
- Future developments proceeding

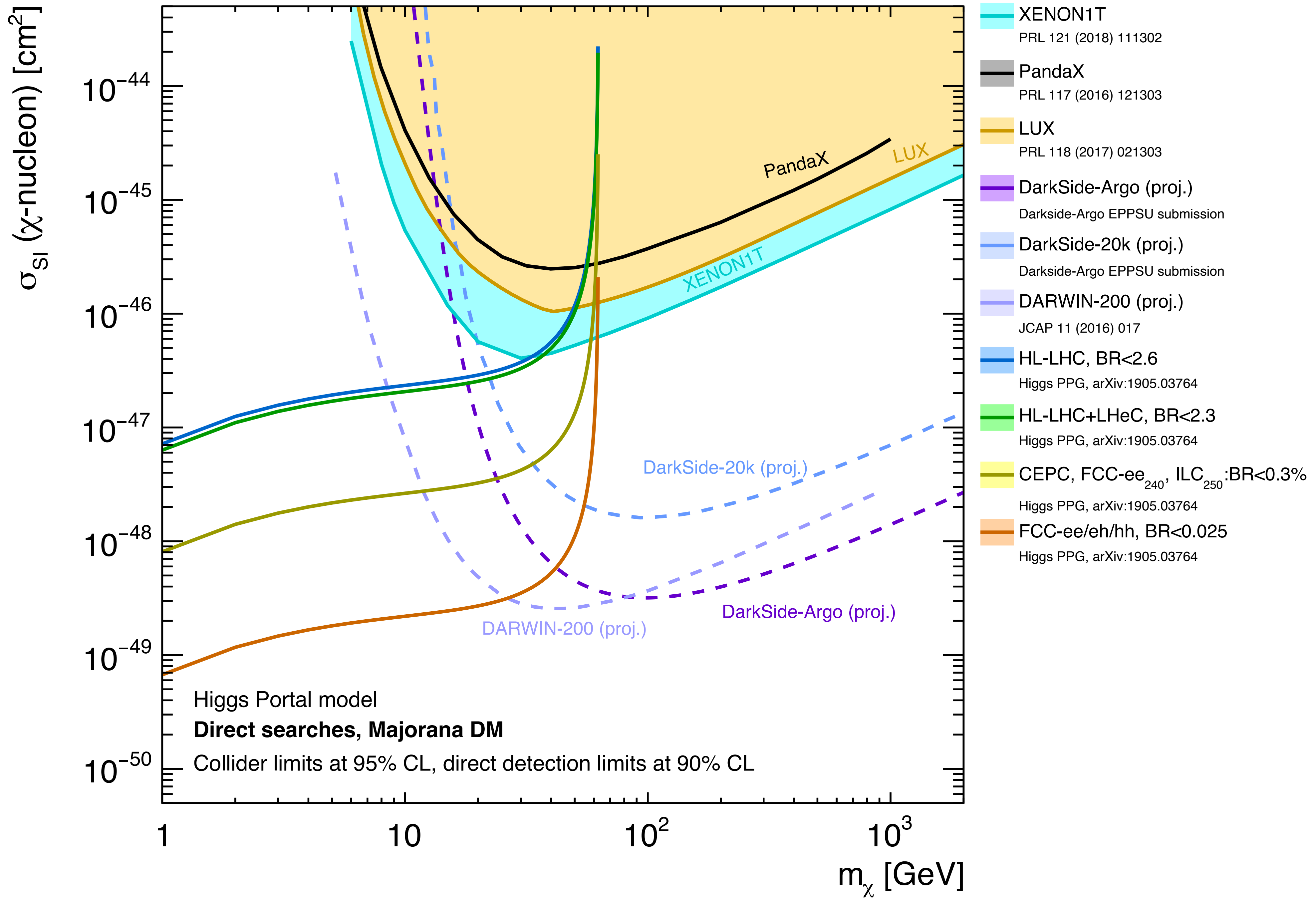
UNDERGROUND ARGON

- DarkSide-50 able to provide background-free results thanks to Cortez UAr
- Significant advantages when moving close to neutrino floor thanks to tight control of electron backgrounds made possible by UAr
- Cortez site development for UAr production at 90 tonnes/year a uniquely strong US resource, possibly enabling other physics and technology goals
- Cortez development: US capital funding complete and international funding nearly complete

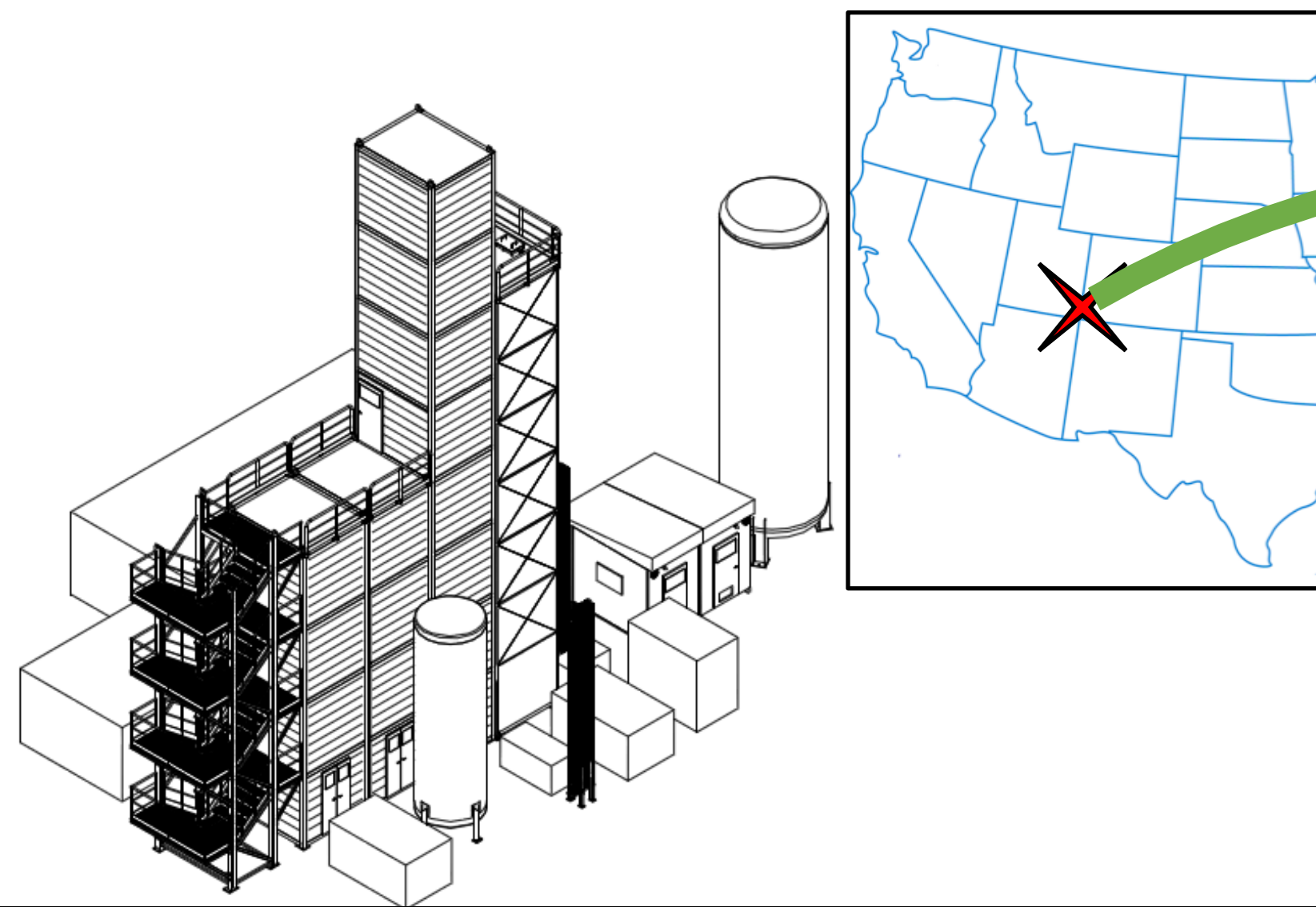
DARKSIDE-20K STATUS

- O(400) scientists from 14 countries
- Detailed design nearly complete, prototype testing in progress
- Significant leap in sensitivity at high masses
- Total project cost \$130M (USD)
 - More than 75% of cost already funded
 - Remainder of funding under review, with decisions in the next few months





Production and Purification



UAr transported via boat
for final purification at Aria



Production: Urania

- Commercial-scale plant to extract UAr
 - Located in Southwestern Colorado
- UAr extracted from CO₂ well gas at the tonne scale

Focus of this talk

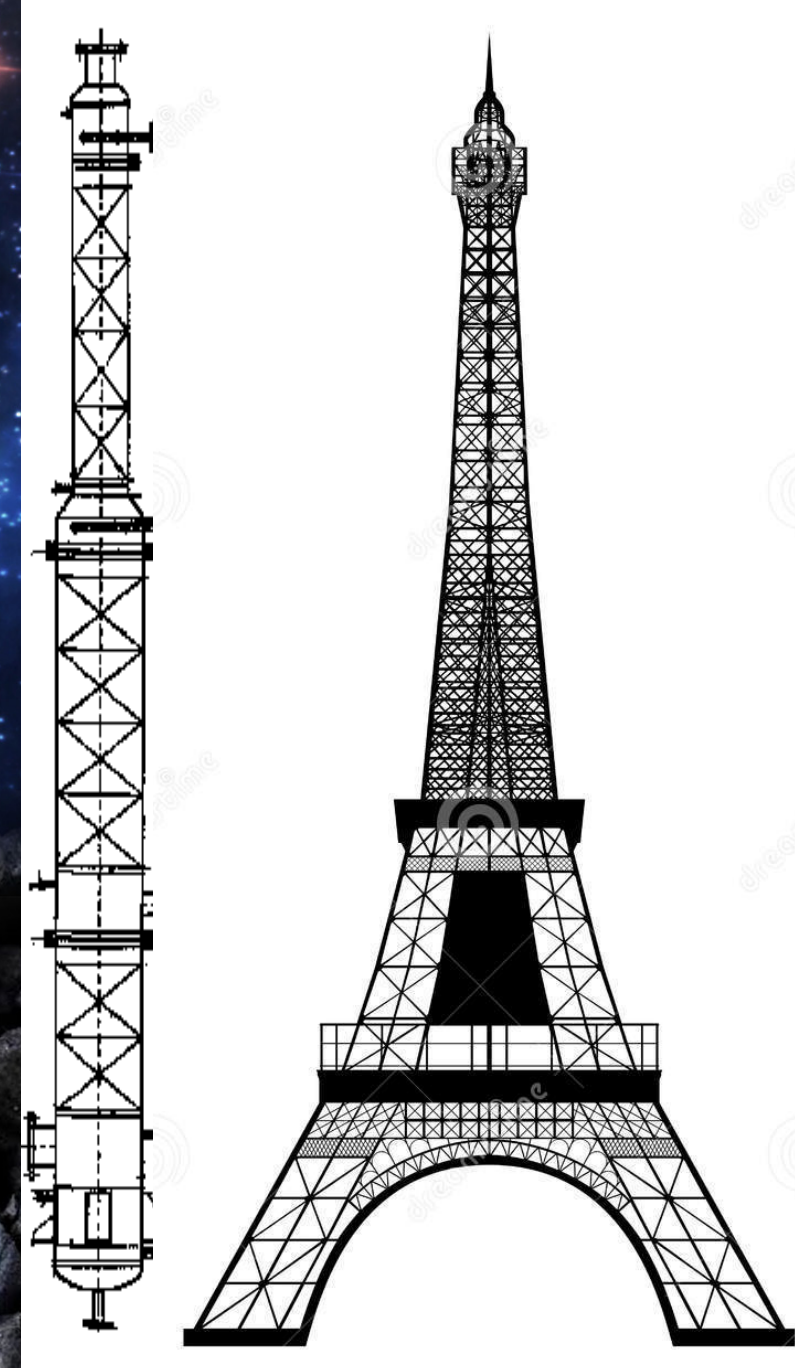
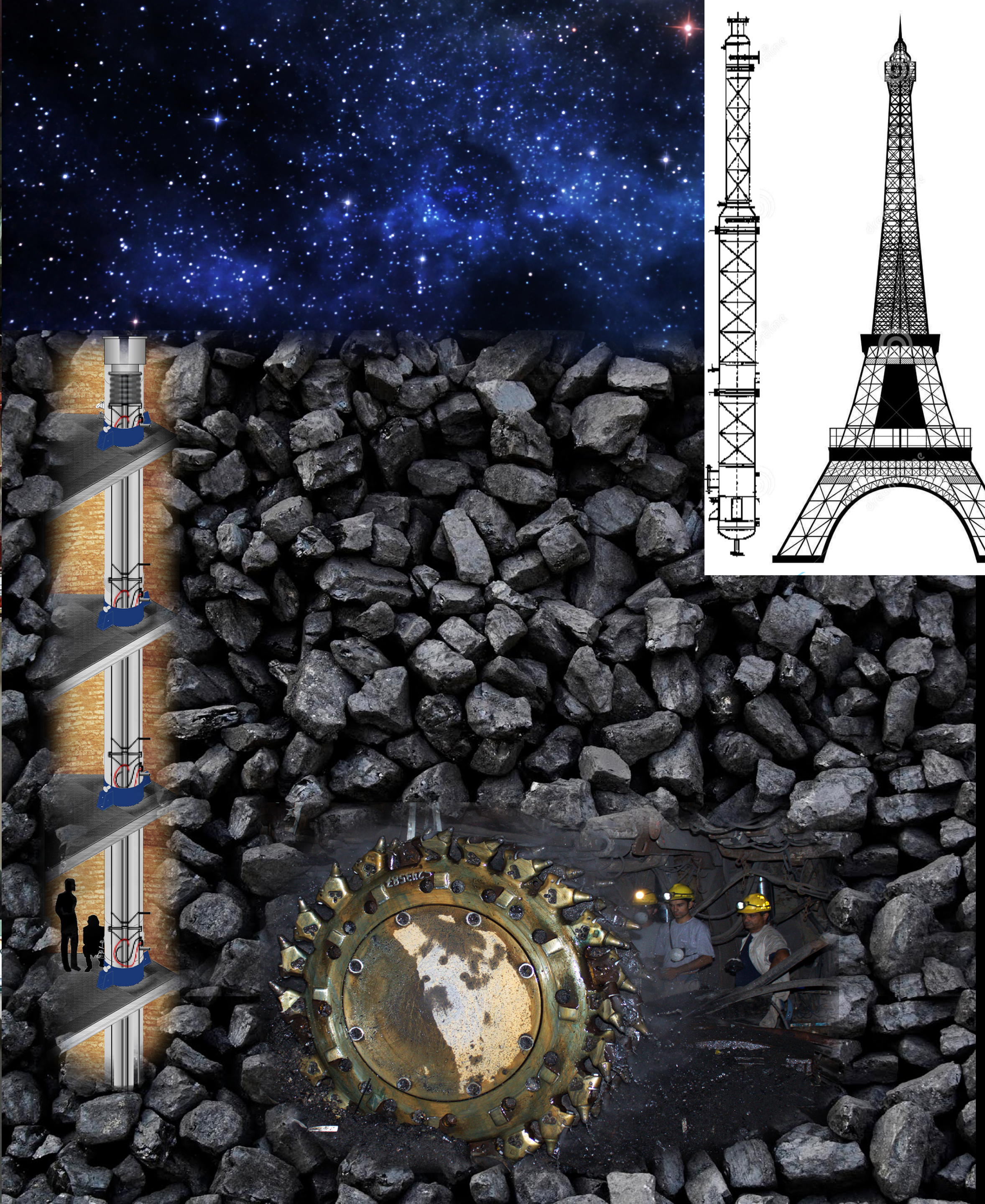
Purification: Aria

(see M. Simeone's talk for details)

- 350 m tall cryogenic distillation column to purify UAr and isotopically separate argon and other elements
- Located in refurbished carbon mine shaft in Sardinia, Italy
- Will chemically purify the UAr for DS-20k to detector grade

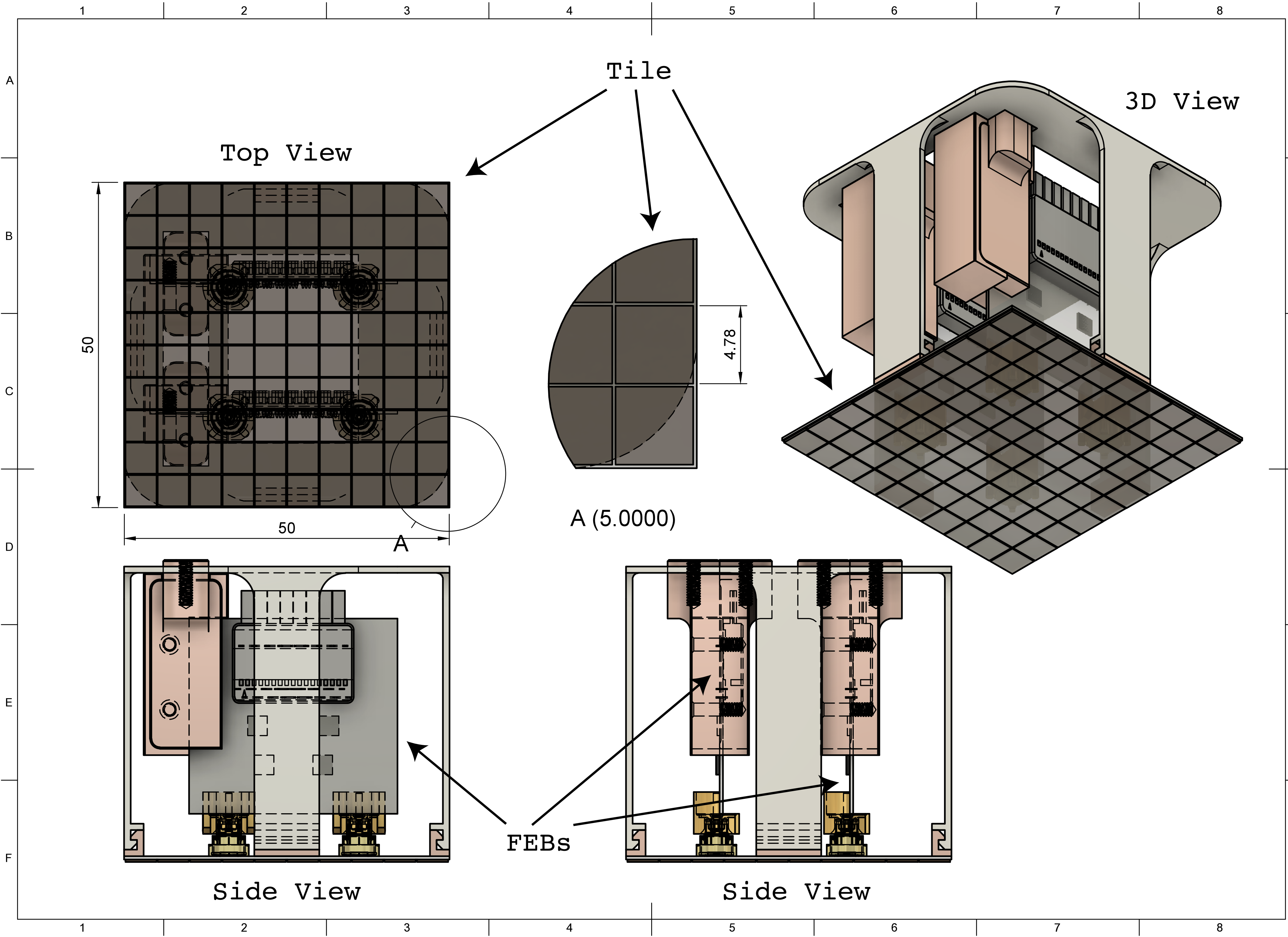


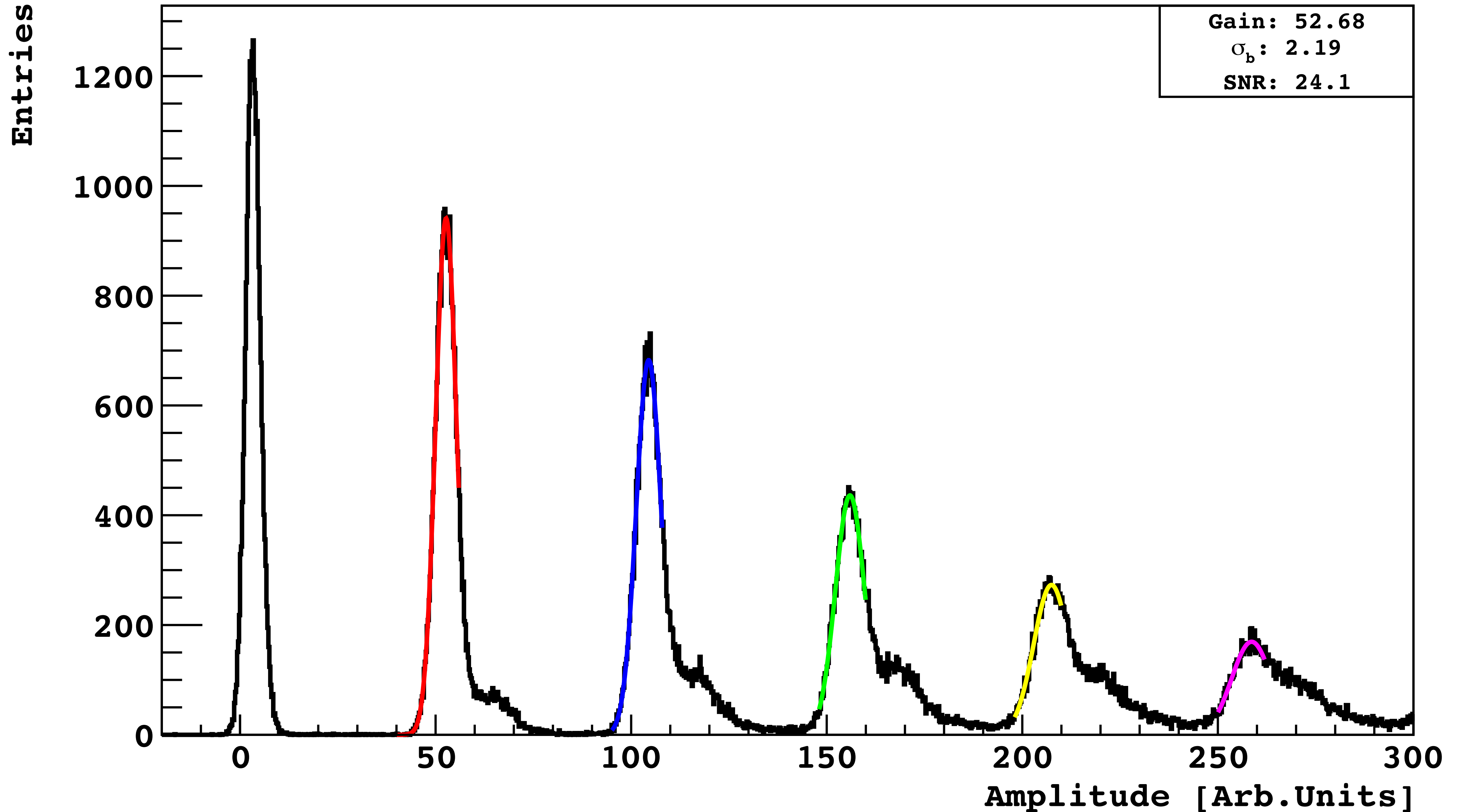


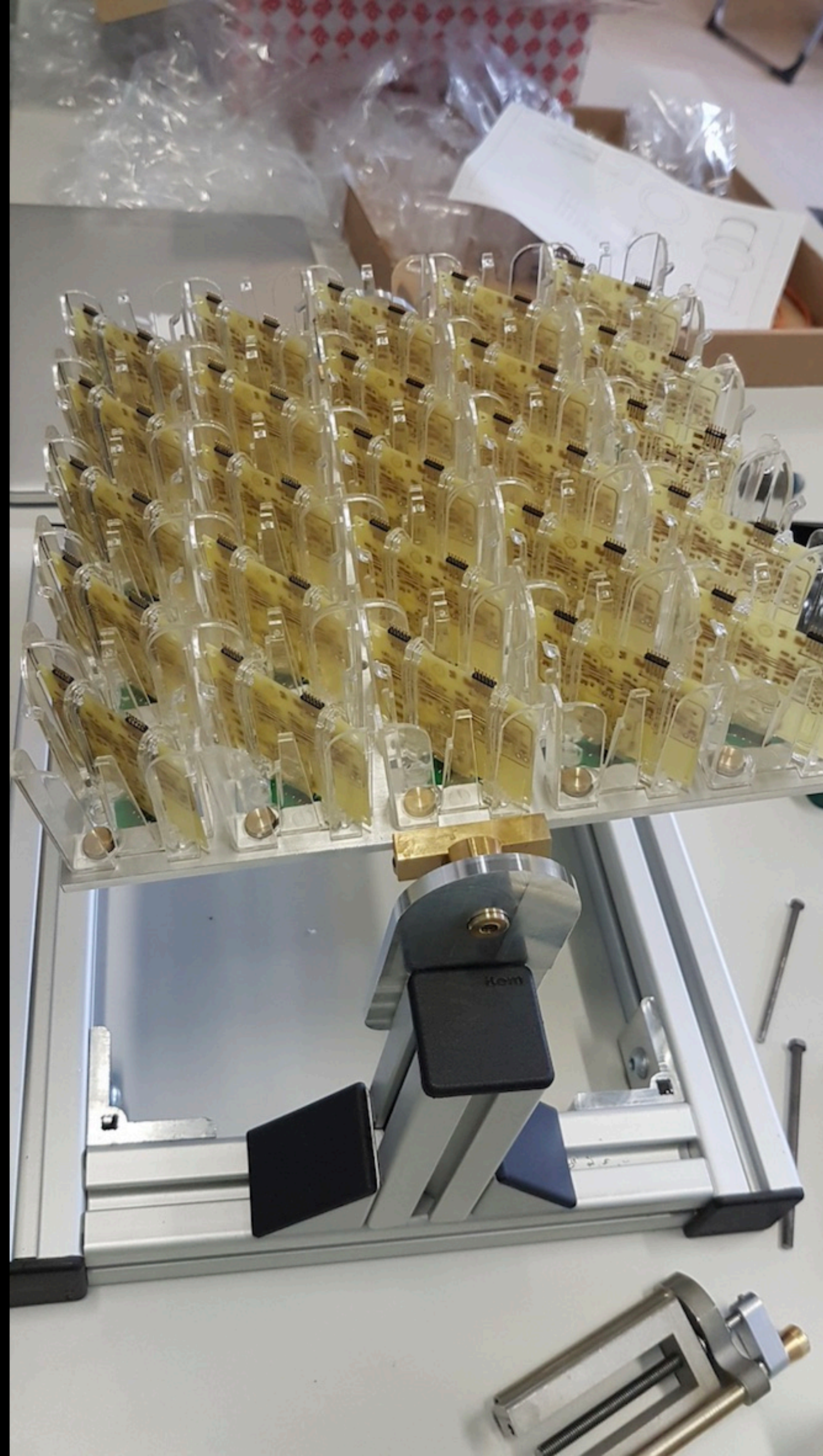
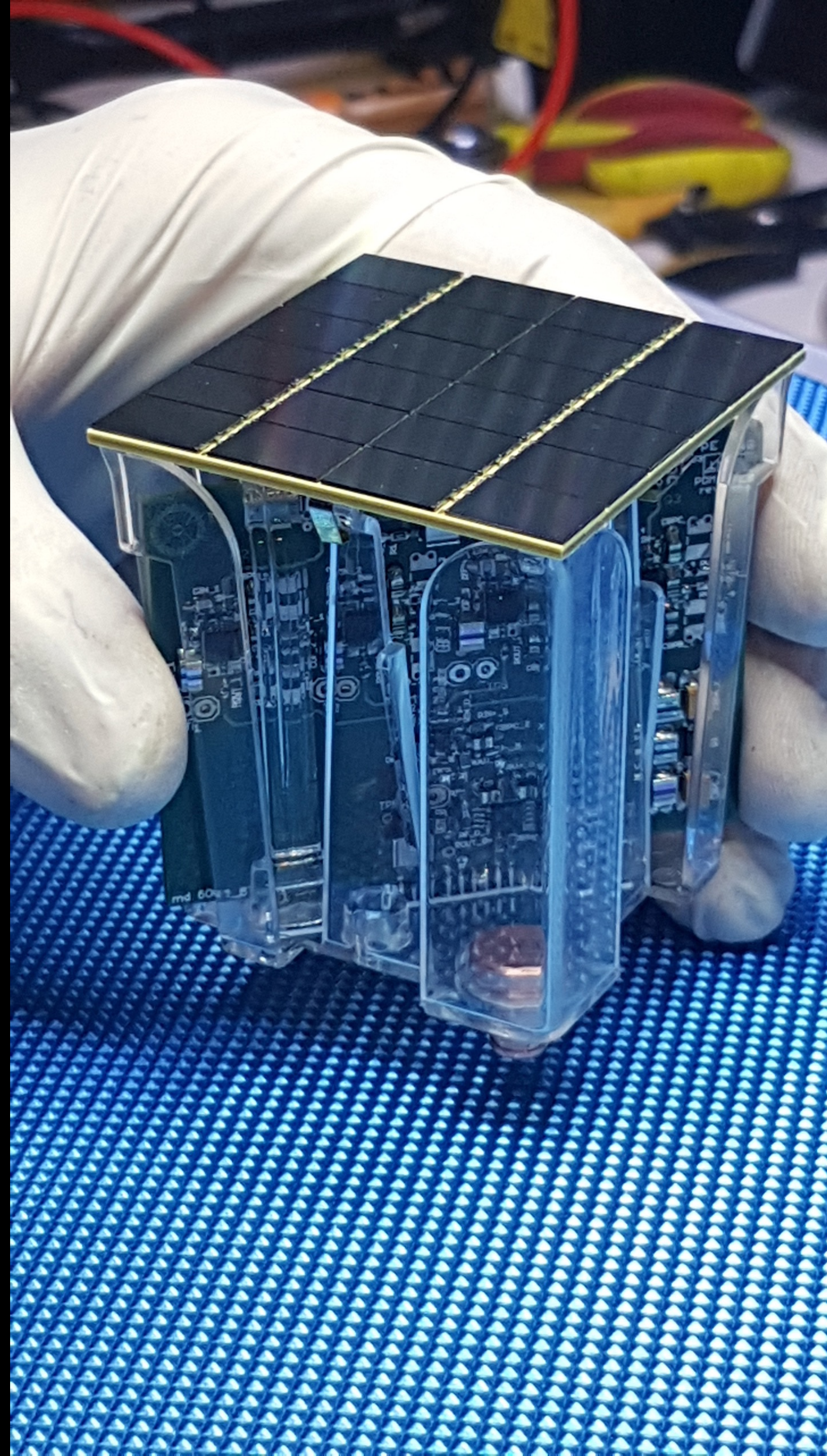


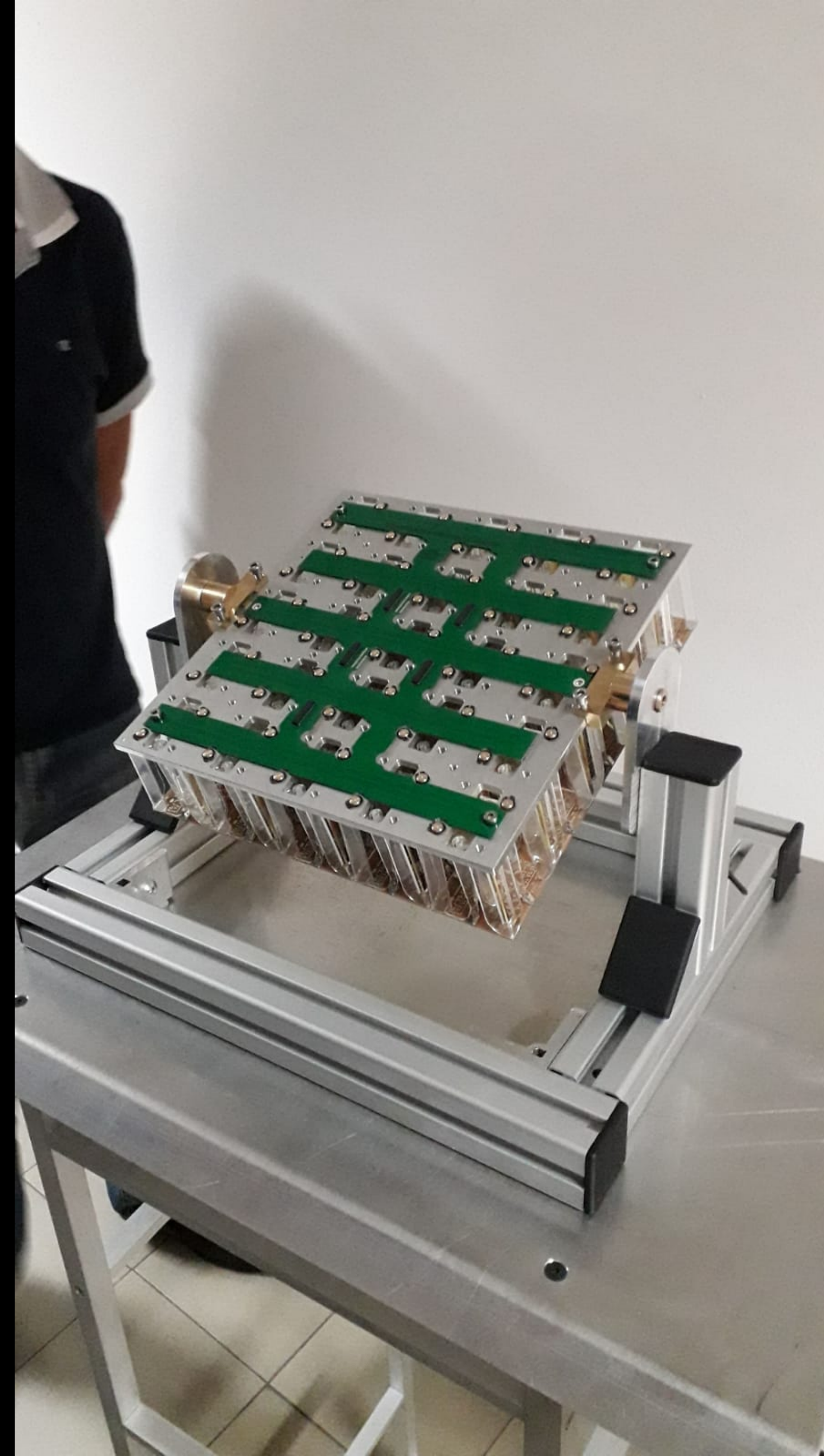
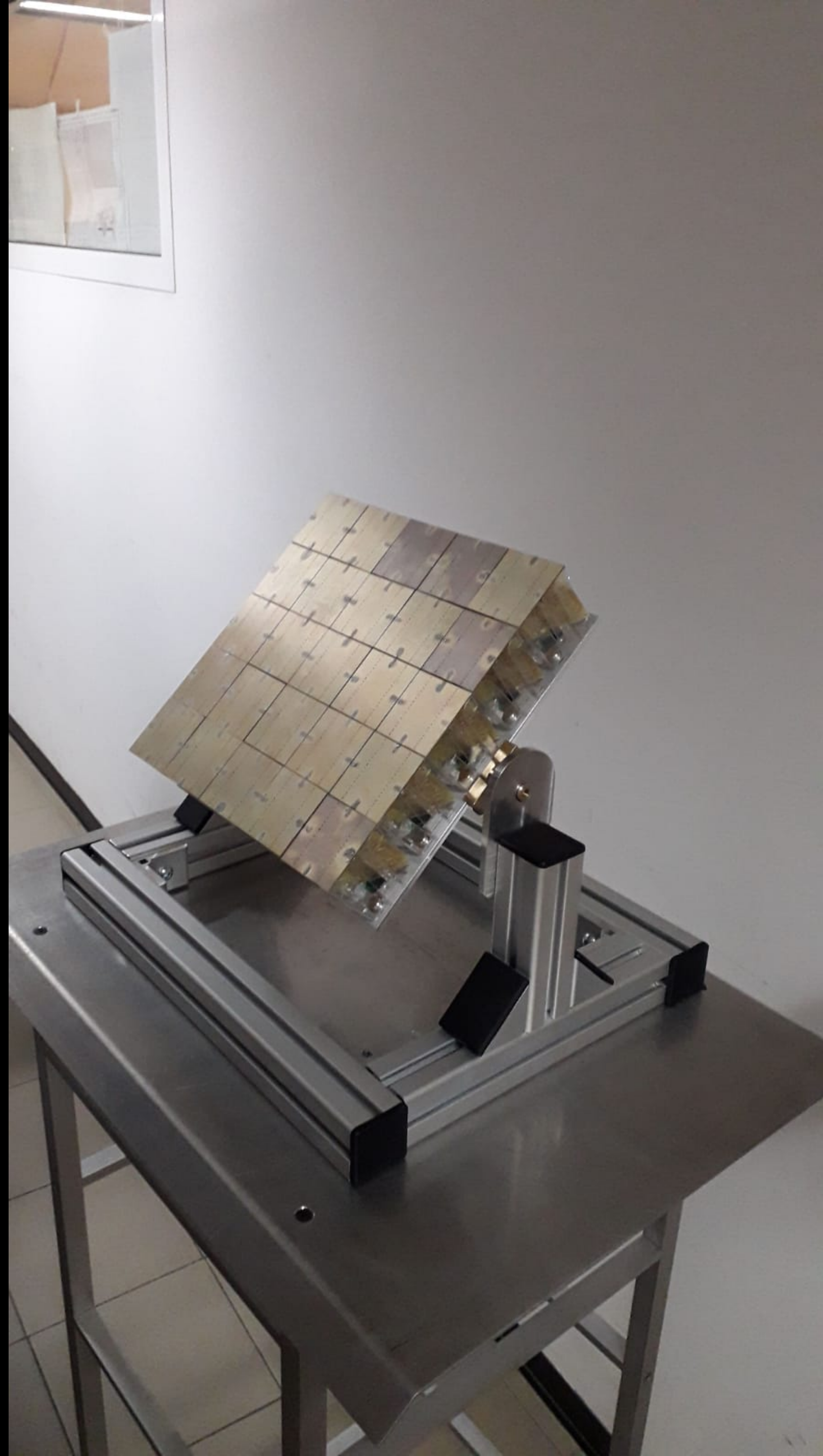




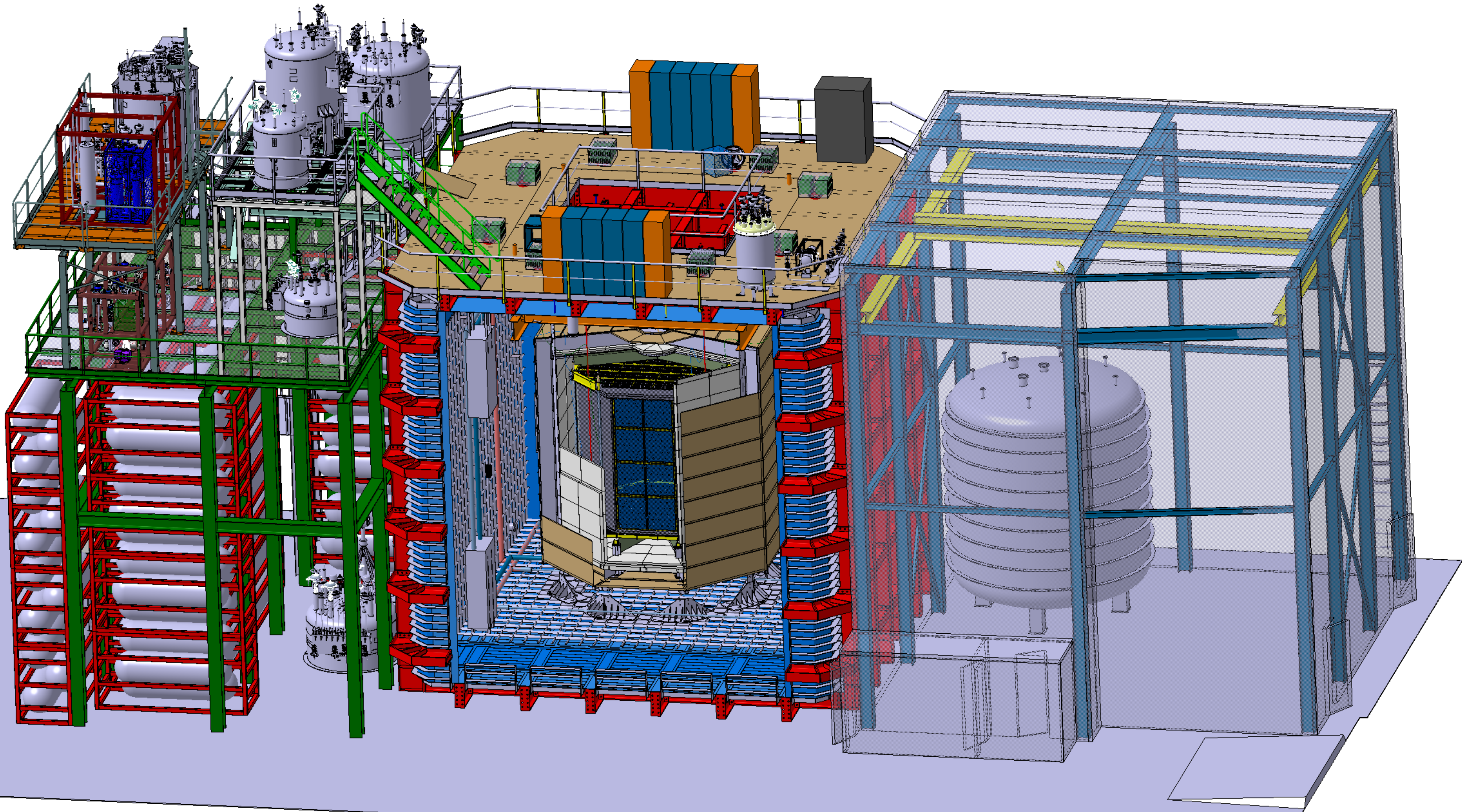


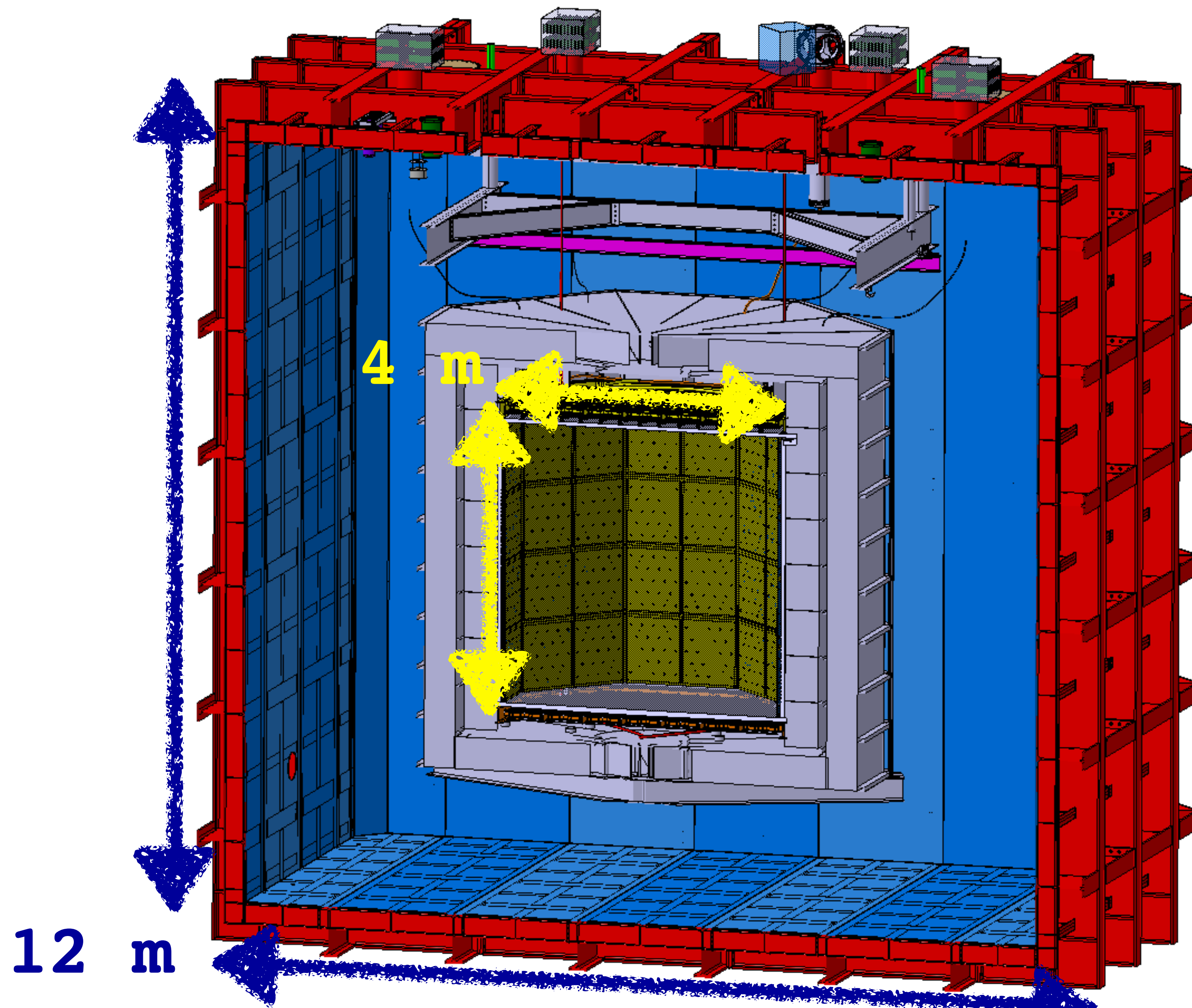


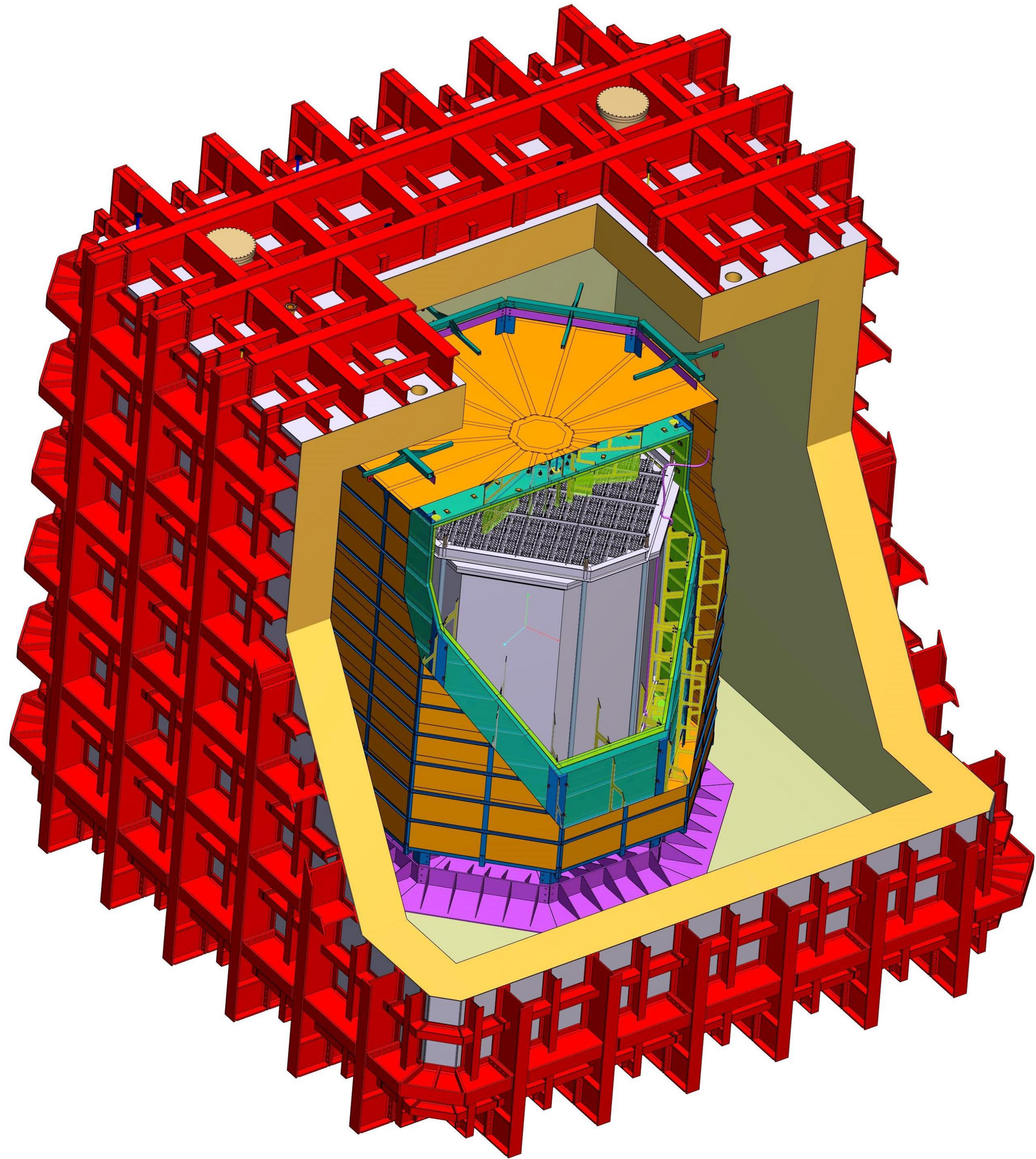














THE END

