



# USM: Experimental Program, Technical Facilities



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Centro Científico  
Tecnológico  
de Valparaíso

# USM Nuclear and Particle Physics

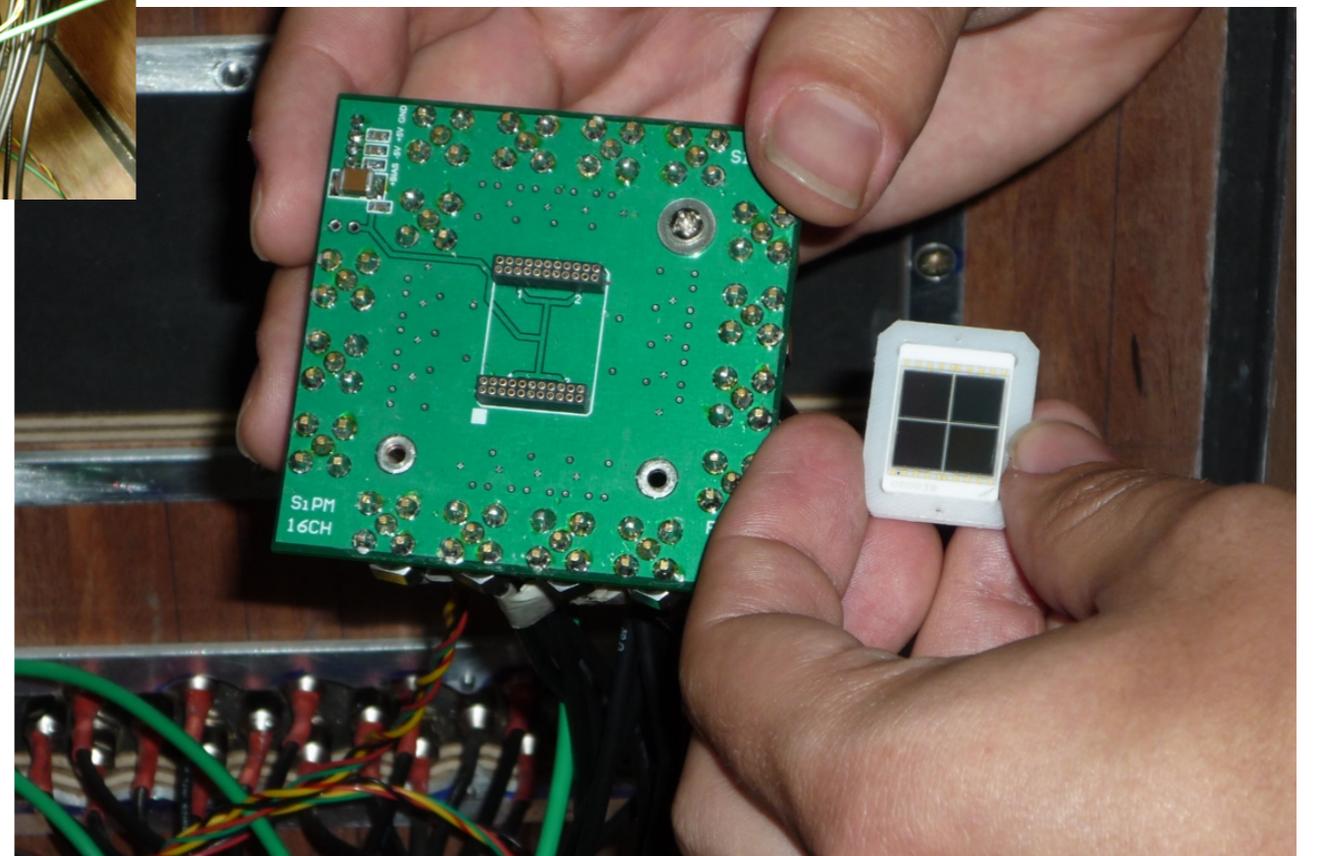
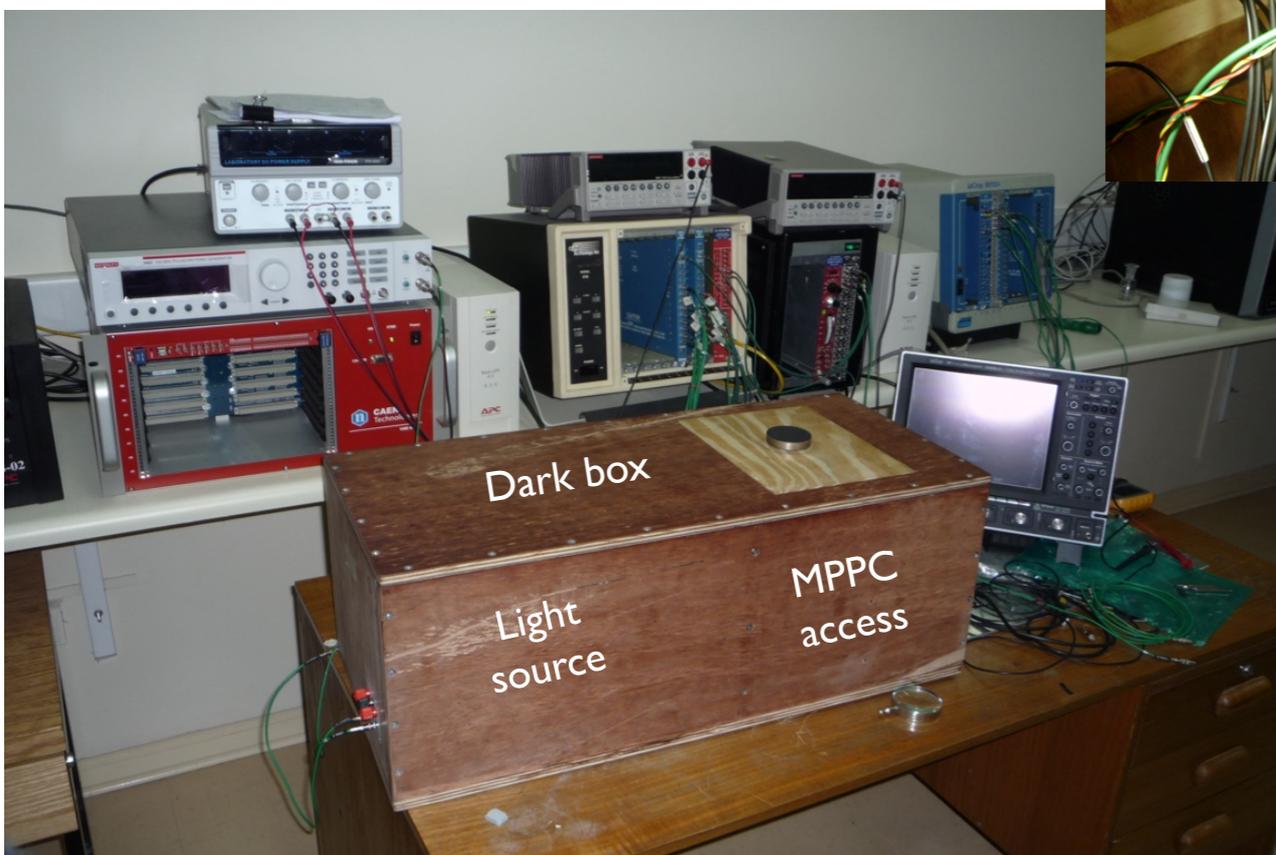
- >20 PhDs in group, ~30 students
- *Valparaíso Center for Science and Technology* embedded within the university, one of 13 Centers of Excellence in Chile
- Collaboration between three groups: nuclear/particle physics, electronics, high performance computing
- Physics/Detector Collaborations: ATLAS/LHC, Halls B&D/JLab, MINERVA/FNAL, NA61/CERN; RD51, RD42
- Detector Facilities: 5 rooms in existing Physics building; University approved construction a new Physics building with large experimental area, ~1 year (also, extensive electronics labs and HPC)
- Grants: Chile - FB 021 (BASAL), ACT-119 (Ring), Fondecyt (~10 grants) ~1.7M\$US/year. Europe: ePlanet (travel)~150k

# USM Nuclear and Particle Physics

## *Technical Projects (hardware/electronics)*

- Complete characterization of 2800 16-cell MPPC/SiPMs for JLab Hall D
  - temperature-controlled measurements 5-20 degrees C: dark rate, gain, photon detection efficiency, pulse characteristics, all 45,000 cells
  - currently underway, ~35% complete
- Fabrication of 4000 UV-transmitting lightguides, 10 different irregular-trapezoidal geometries
  - 5-axis CNC mill + hand polishing to finish
  - currently underway, about 8% complete
- Electronics (MAROC3) for the CLAS12 RICH detector in Hall B
- Characterization of copper ore enrichment through neutron capture
- Port security device fabrication (Valparaíso port authority)
- Recent: Shashlik-style calorimeter for JLab two-photon-exchange experiment; ATLAS ZDC EM module upgrade, NA61 testing of MAPD devices and new DAQ for new PSD
- Past: HCAL of CMS, EC of CLAS, IC of CLAS
- Future: muon chambers for ATLAS upgrade

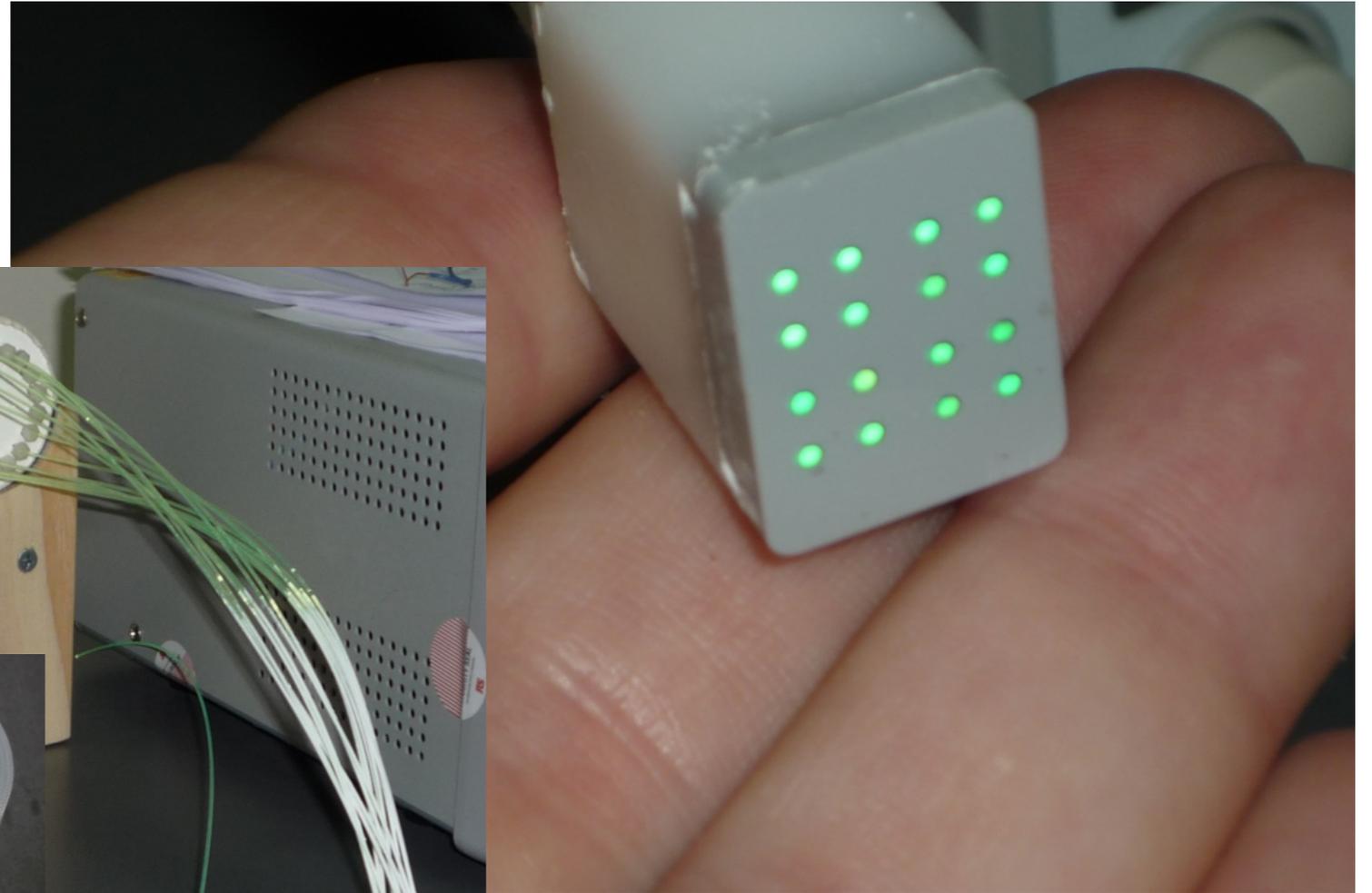
# PDE Station (Stage II)



# USM PDE Station Light Source

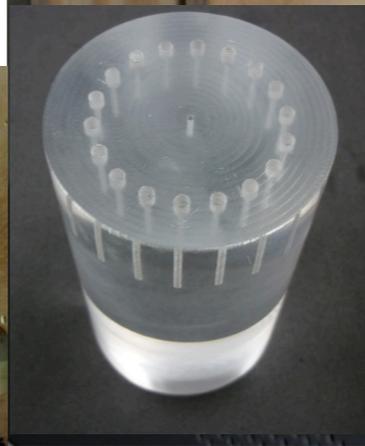
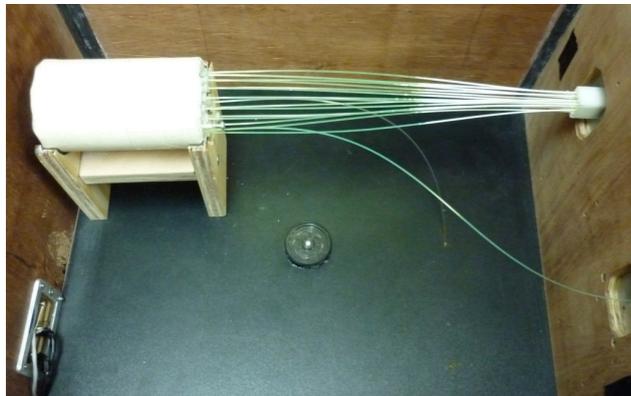
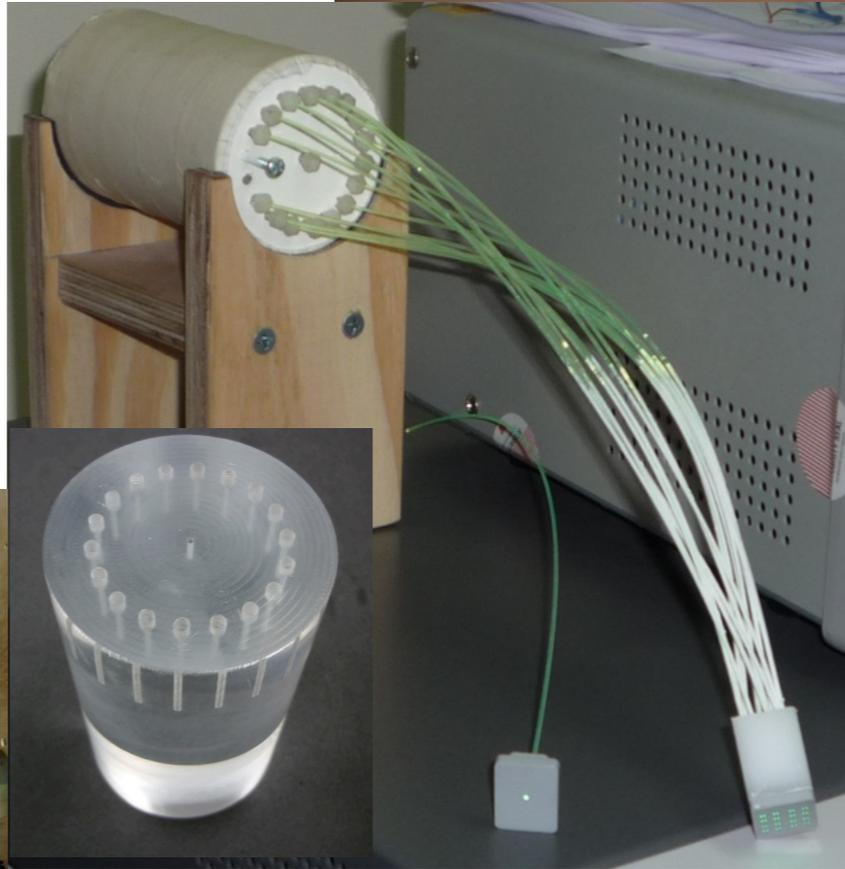


Recessed positioner; fibers on this side, MPPC on other side



Output of 16 green fibers following mixer

light mixer (clear fiber goes into center)



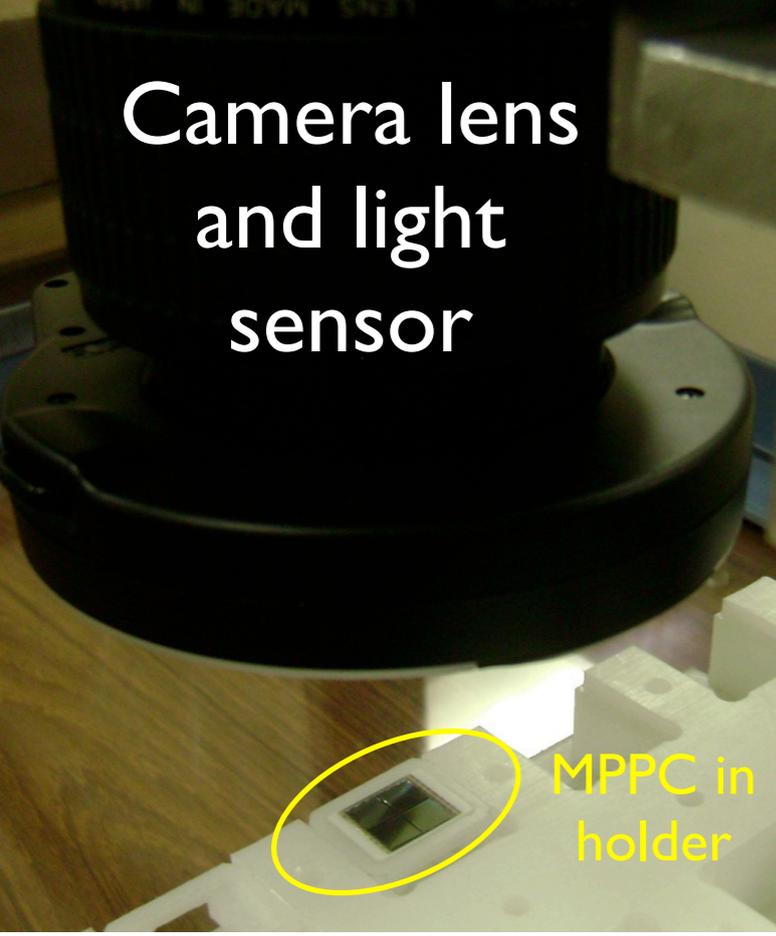
Blue LED feeding clear fiber

1-fiber input, 17-fiber output (16 to MPPC, 17th to monitor PMT)



# Inspection Station (Stage I)

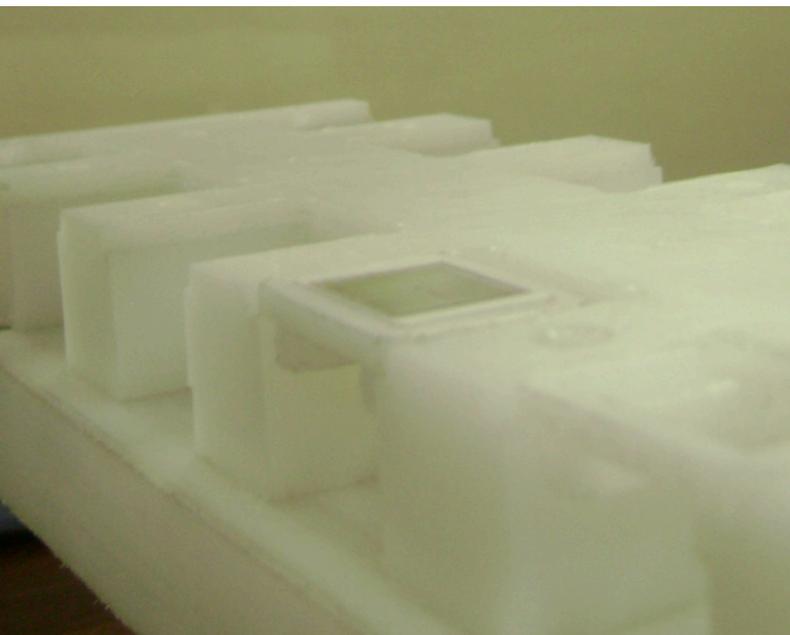
Camera lens  
and light  
sensor



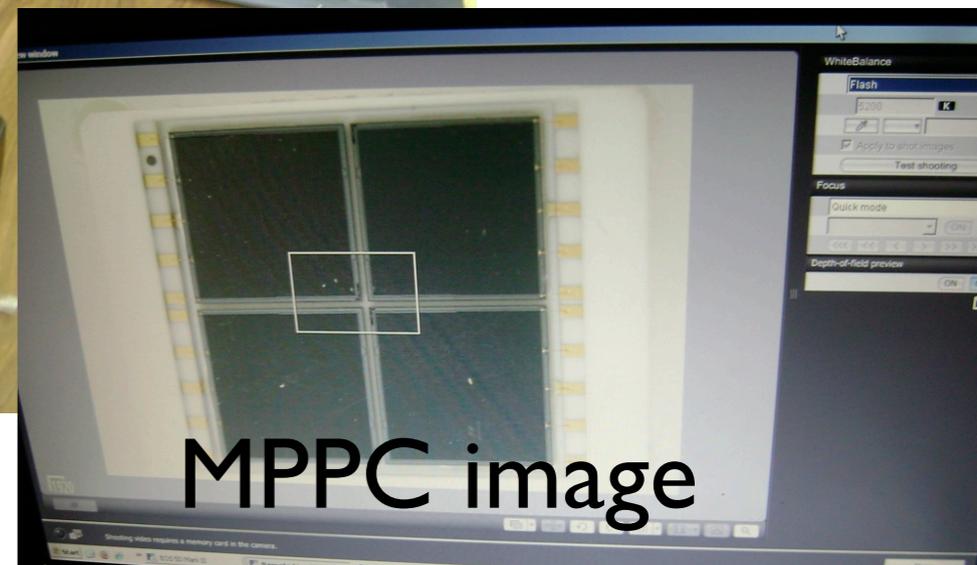
MPPC in  
holder



Fire-resistant safe  
containing MPPCs

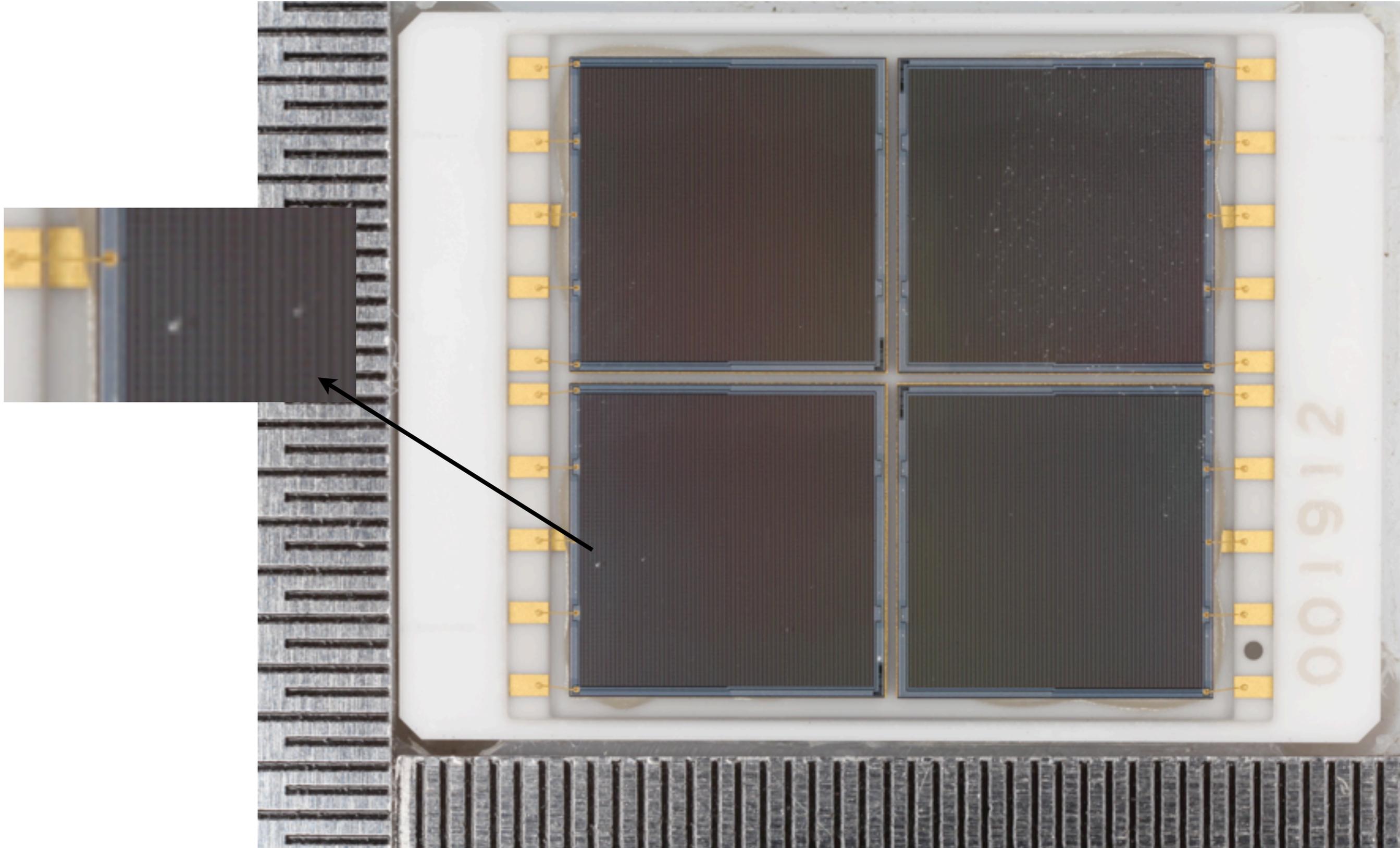


Camera setup

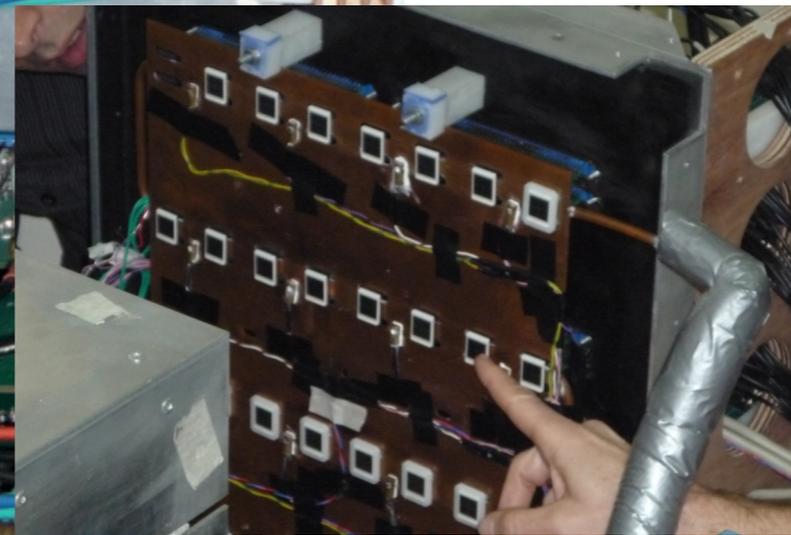
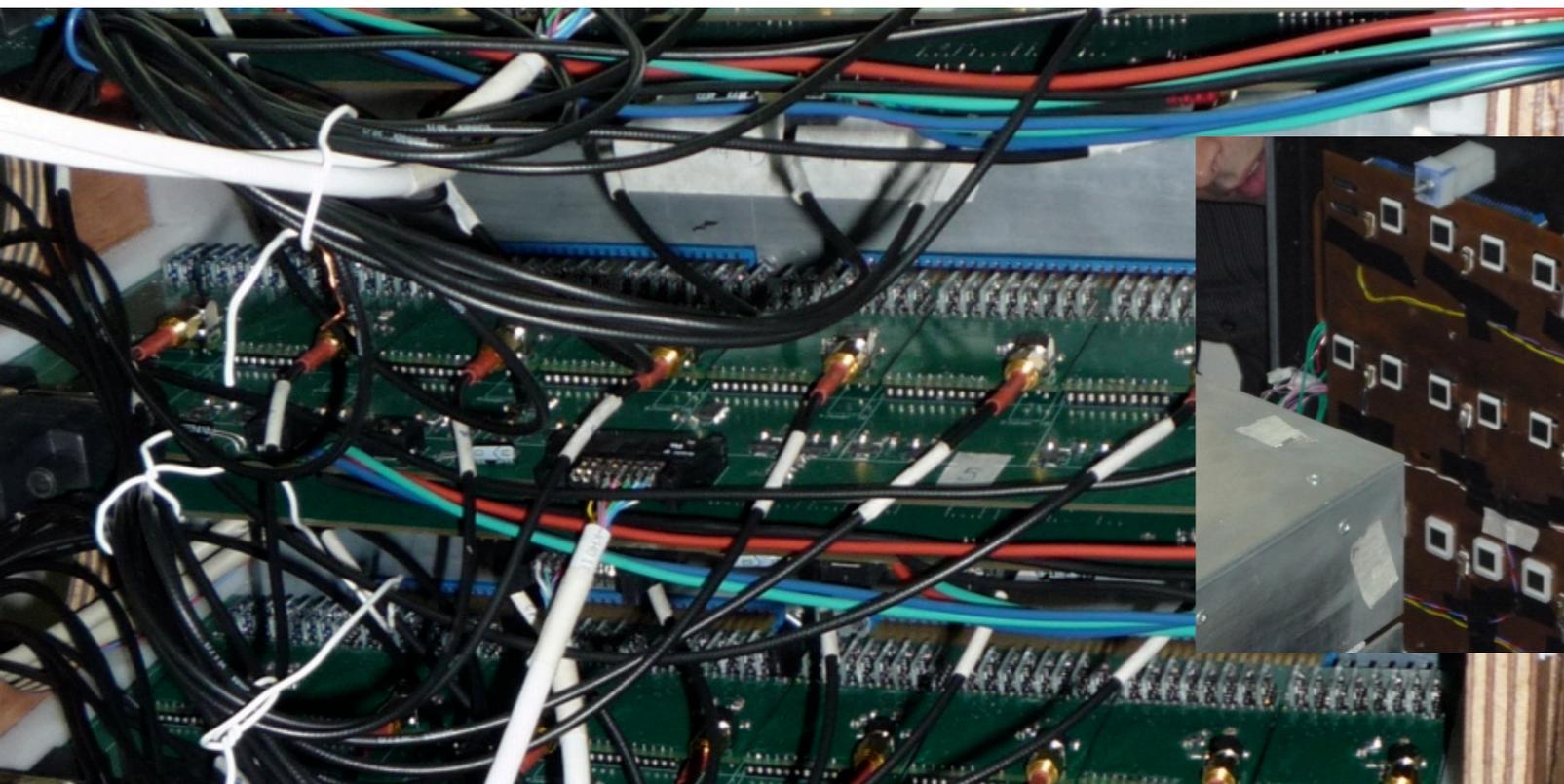
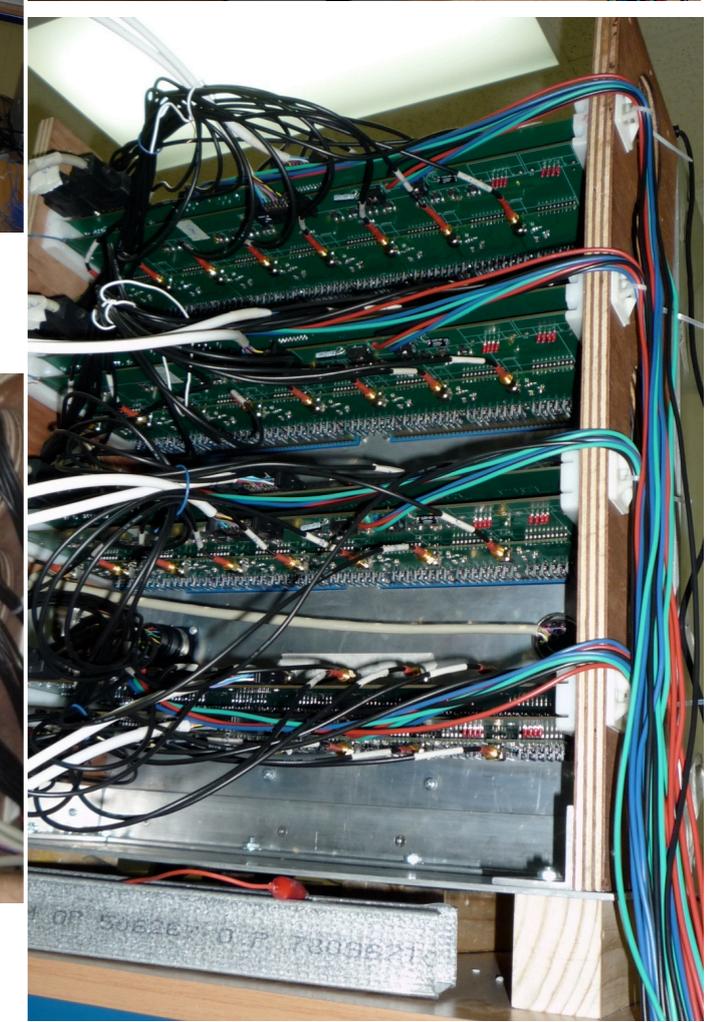
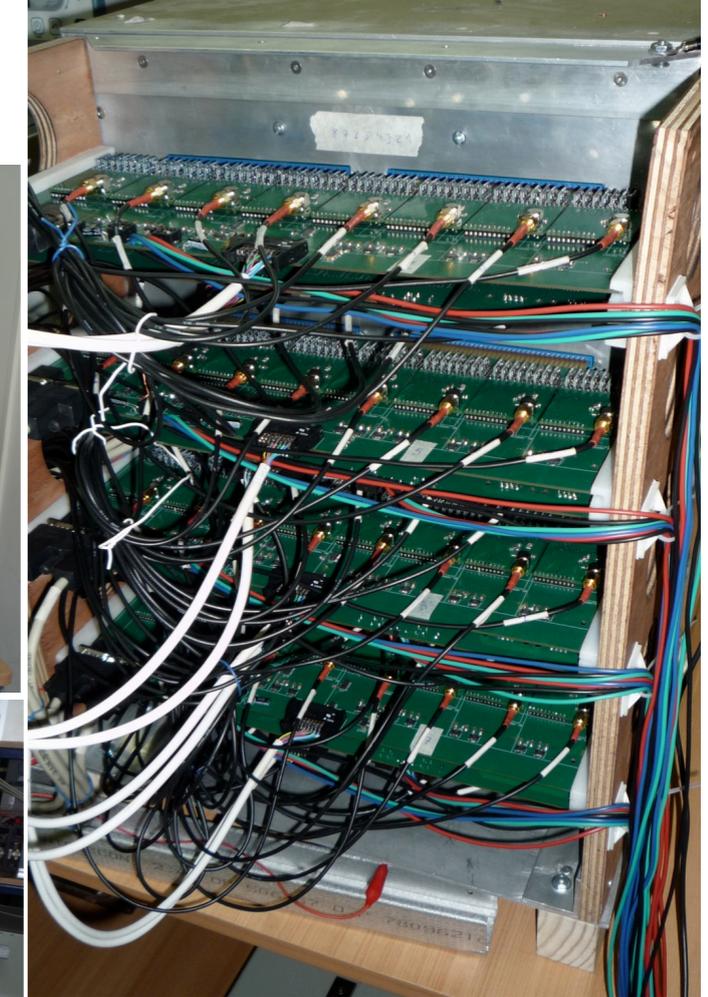
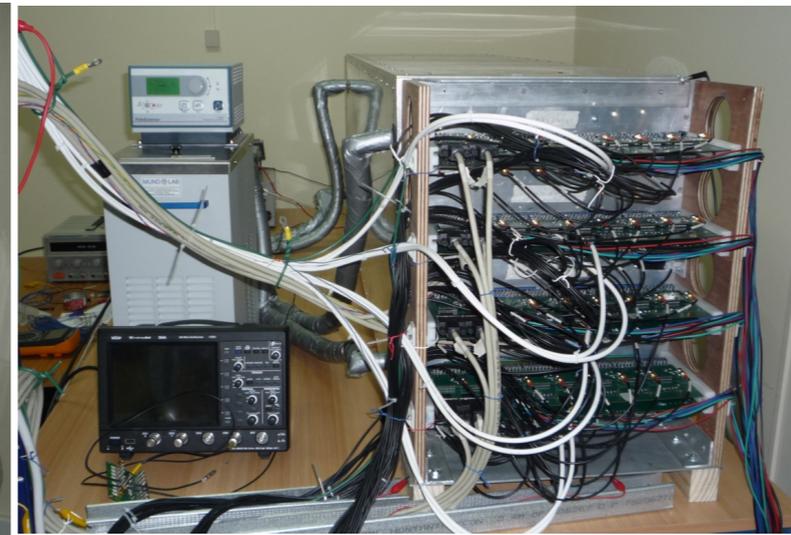
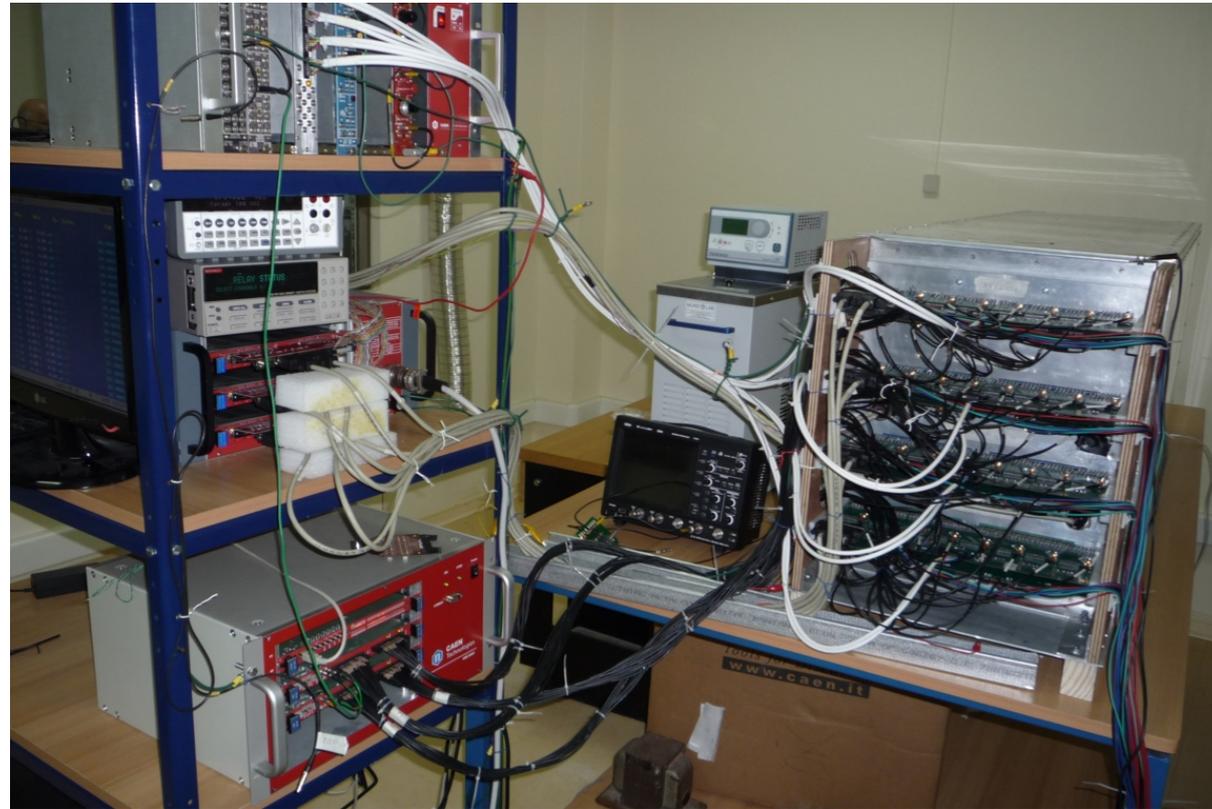


MPPC image

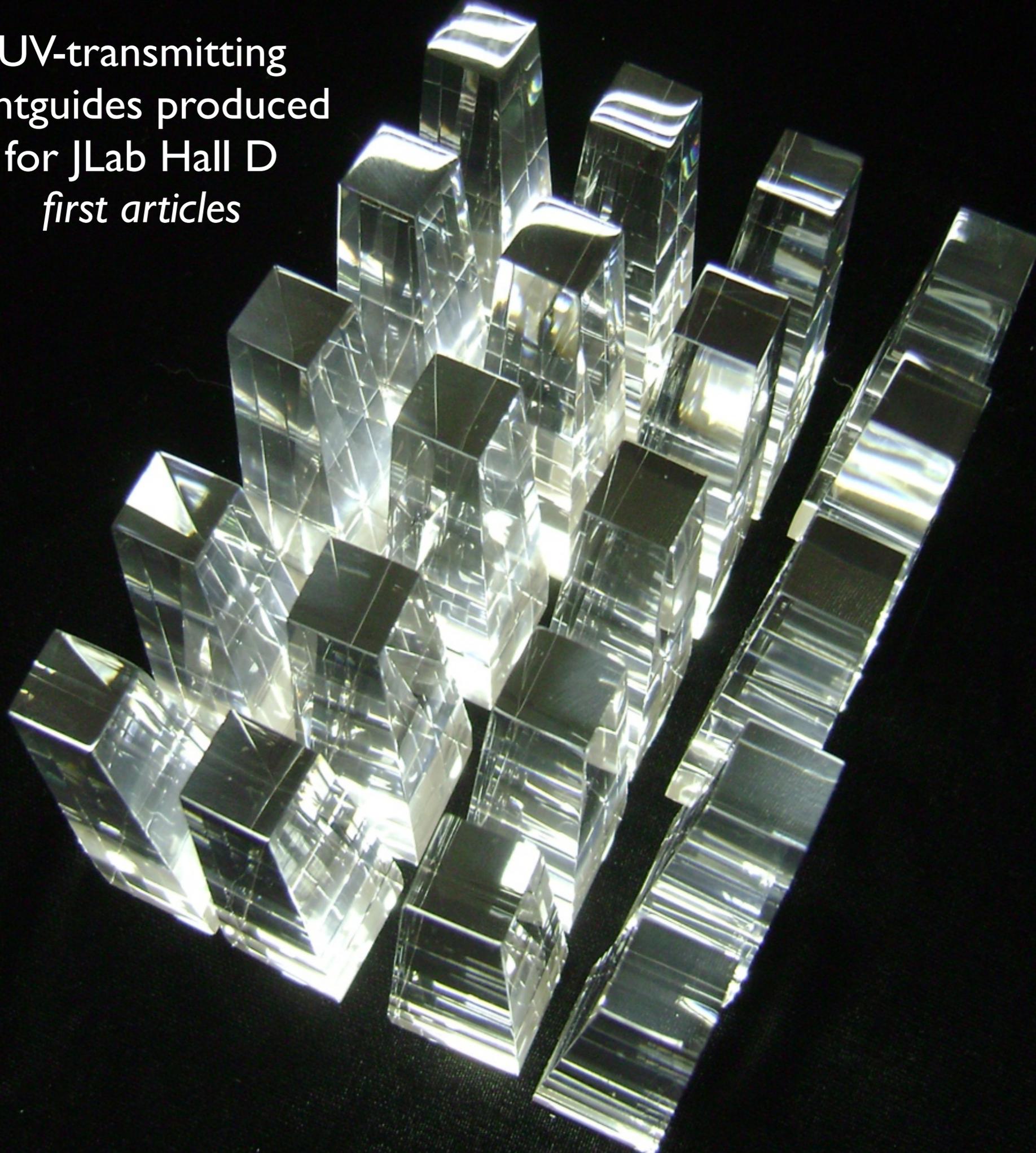
# MPPC image

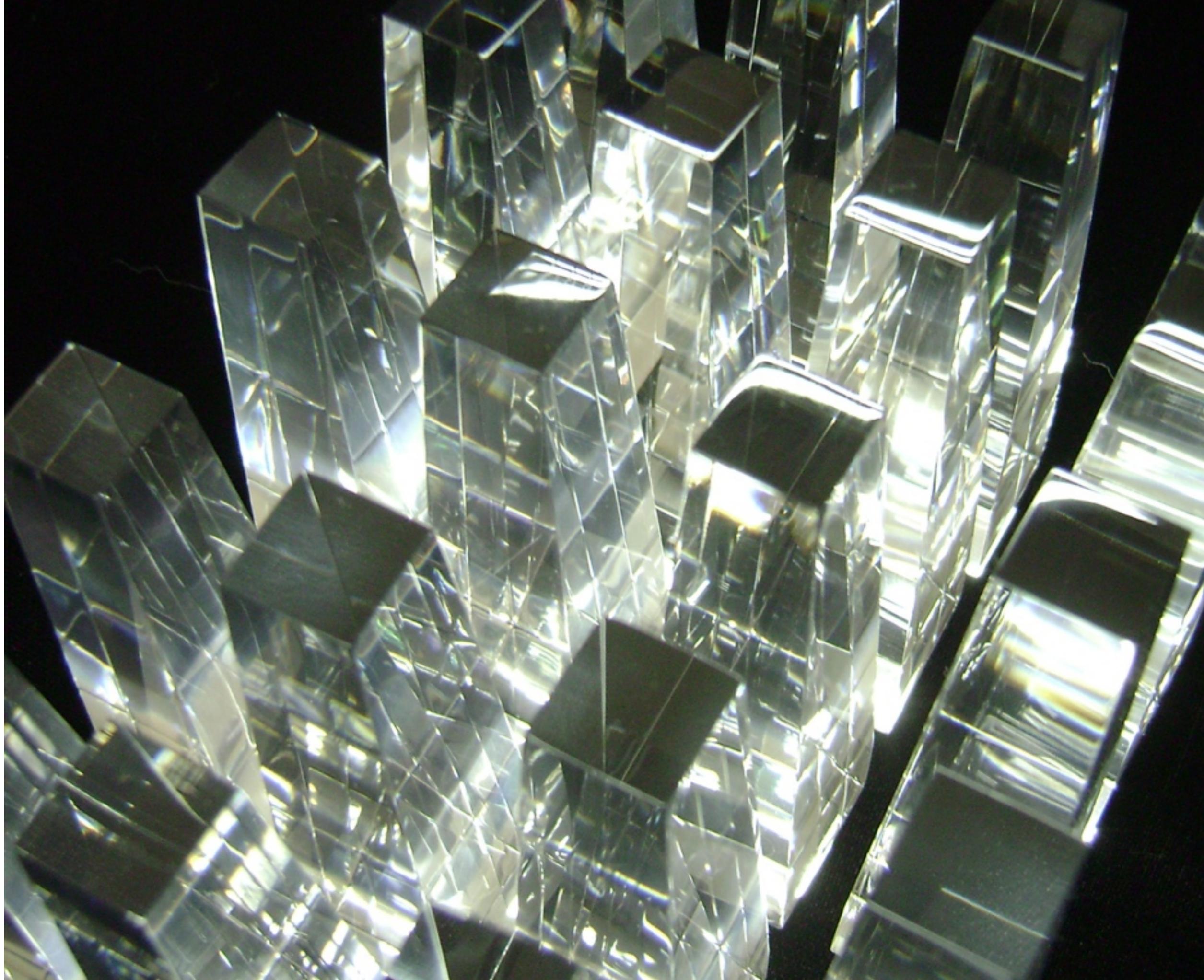


# Temperature-Controlled Station (Stage III)



UV-transmitting  
lightguides produced  
for JLab Hall D  
*first articles*





# Conclusions

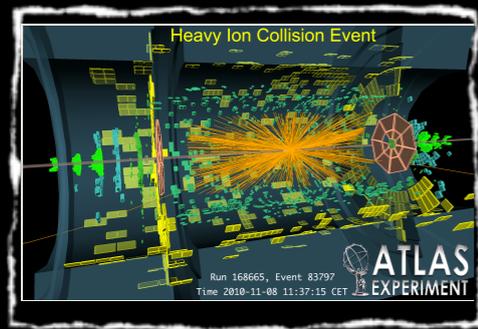
- USM has the technical infrastructure, expert knowledge, and manpower to construct the proposed pre-shower detector
- See backup slides for more about USM activities

# CERN-ATLAS

## Technical Contributions

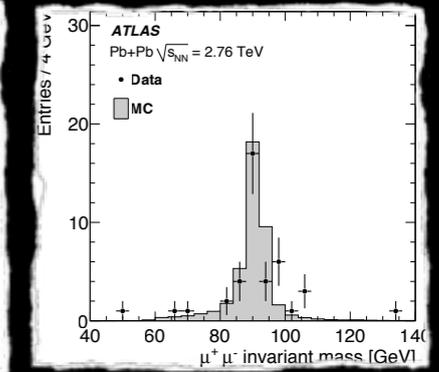
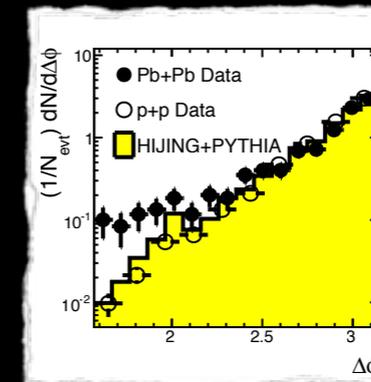
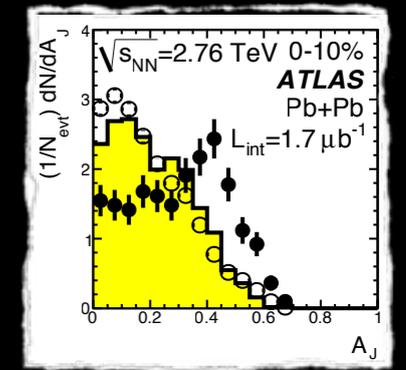
- Grid computing software development - Raquel Pezoa
- Trigger software validation tools - Alejandro Oyarzun
- Fully certified level 3 computing cluster performing grid computations full-time since 2009 - Dr. Yuri Ivanov
- Zero-degree calorimeter simulation integration - Dr. Edson Carquin
- Zero-degree calorimeter hardware upgrade - Dr. Sergey Kuleshov



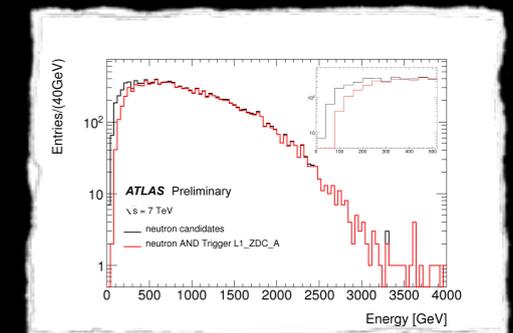


# CERN-ATLAS

## Physics Contributions



- ATLAS Heavy ion physics working group co-convener - W. B.
- Forward physics - diffraction and low-x cross sections - Dr. Edson Carquin
- Exploration of heavy quark production in pp/heavy ion collisions - Javier Salazar





# CERN-ATLAS

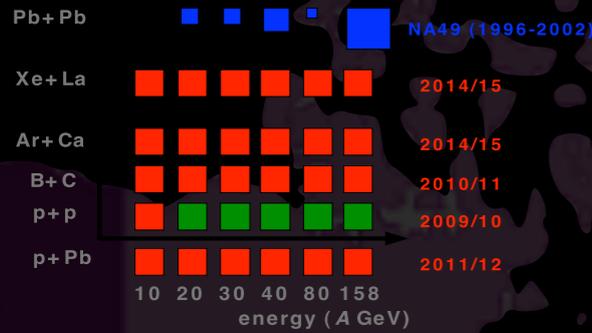
## Data-taking and Analysis Operation

- ATLAS Grid shifts, monitoring worldwide grid computations for ATLAS
- Trigger and ZDC shifts, run management for heavy ion run

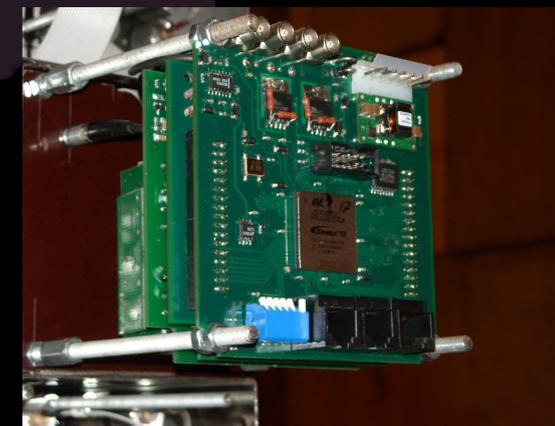
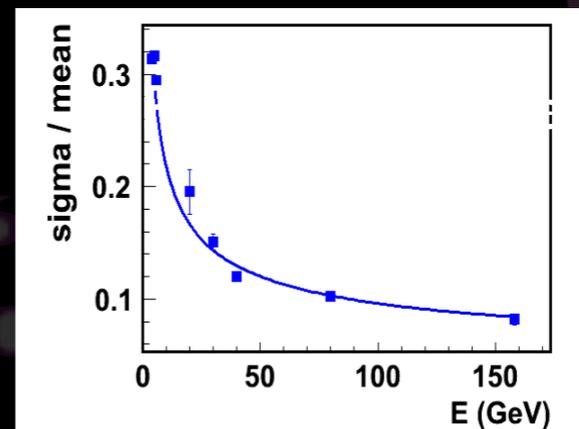
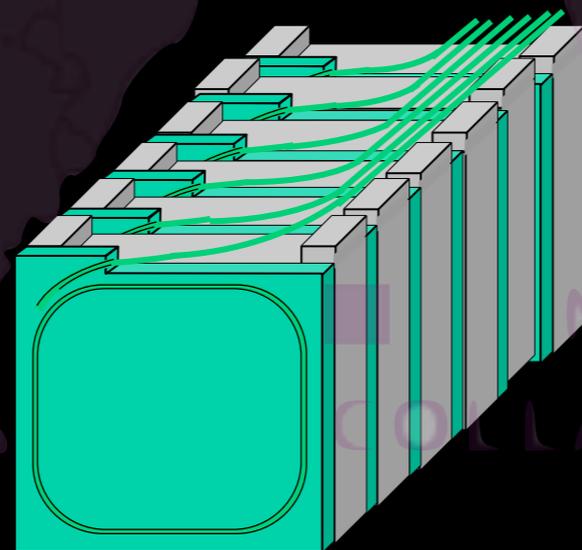
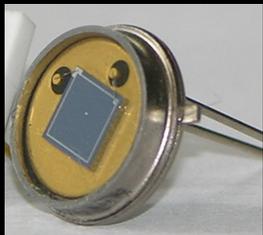


# CERN-NA61

## Technical Contributions

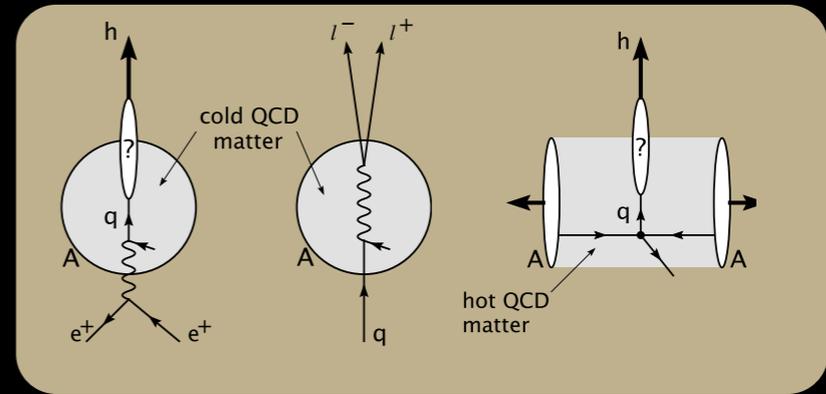


- Purchase of 100 and tests of 150 MAPD devices and new DAQ for new PSD - René Rios, Pedro Toledo, Dr. Sergey Kuleshov
- Port of NA-61 software into CERN Grid environment - Dr. Yuri Ivanov

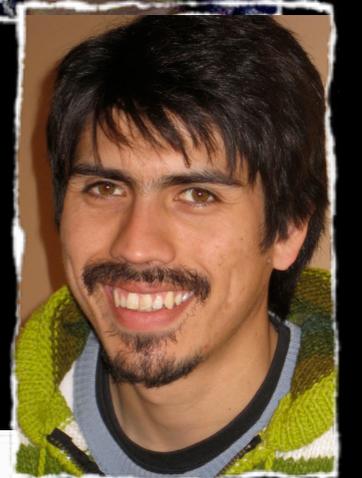


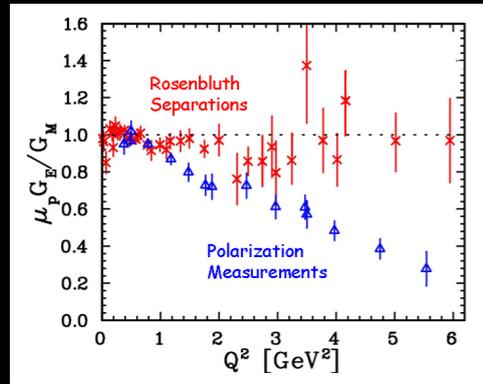
# Jefferson Lab

## CLAS EG2 Physics



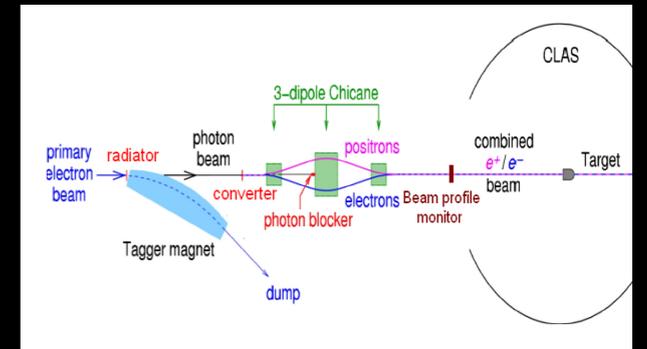
- Parton propagation through strongly interacting systems, hadron formation, quark energy loss
- Hayk Hakobyan, Cristian Peña, Miguel Arratia
- Measurement of semi-inclusive DIS on nuclear targets: transverse momentum broadening and hadron attenuation, and much more



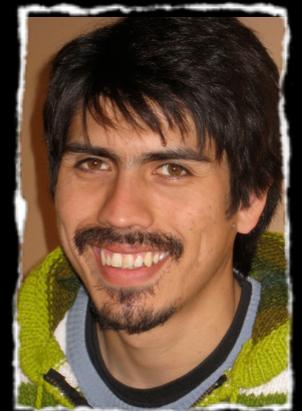


# Jefferson Lab

## CLAS TPE Physics



- Measurement of the proton electric form factor by two different methods produces different result
- Two-photon contribution to elastic scattering may explain this discrepancy
- Accessible via precision comparison of elastic scattering with positrons and electrons, in CLAS
- USM contributions: spokesperson, background simulation, calorimeter, data-taking (W.B., Hayk Hakobyan, Cristian Peña, René Rios, Sergey Kuleshov)



# Jefferson Lab

## CLAS Technical Contributions

- Software development for CLAS and CLAS12: Hayk Hakobyan, Sebastian Mancilla, Ricardo Oyarzun, Juan Pavez
- Implementation of electromagnetic shower calorimeter reconstruction software into CLARA distributed computing framework
- Radiative correction code for semi-inclusive electron scattering in C++ framework and for nuclear targets
- Testing of high-density VME discriminators for the 12 GeV upgrade at Jefferson Lab - Pedro Toledo





# Jefferson Lab

## Hall D Technical Contributions

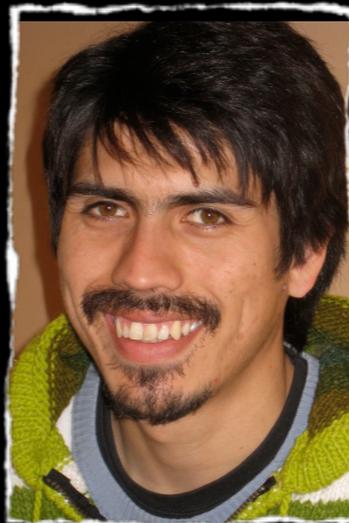


- Jefferson Lab Hall D is a new experimental area housing the GlueX spectrometer
- We are working on the barrel electromagnetic calorimeter (BCAL) readout
- We are doing two major technical projects:
  - Detailed temperature-controlled testing of **2800 large-area silicon photomultipliers** (Hamamatsu MPPCs) at 3 temperatures
  - Fabrication of **4000 optical light guides** (20 designs)
  - Dr. Sergey Kuleshov, Alam Toro, Iñaki Vega, Orlando Soto, Javiera Quiroz

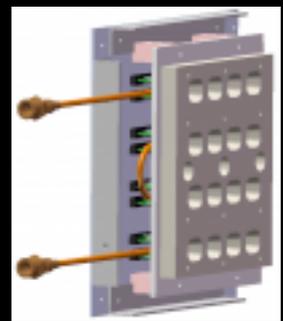
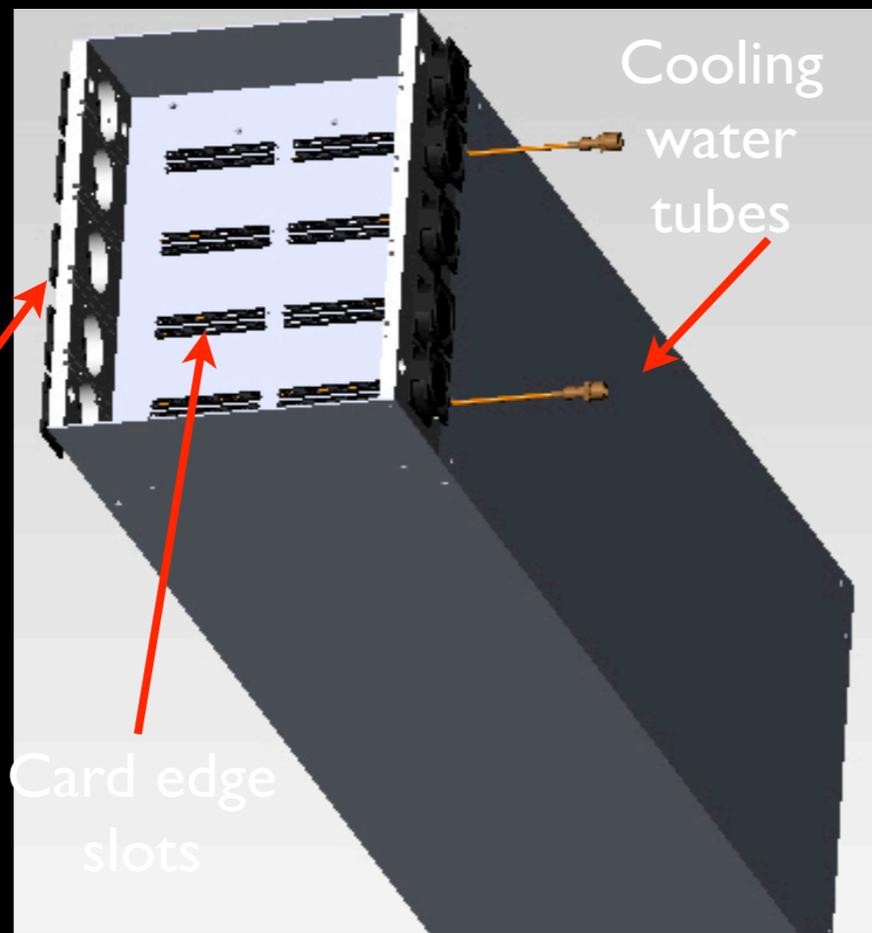
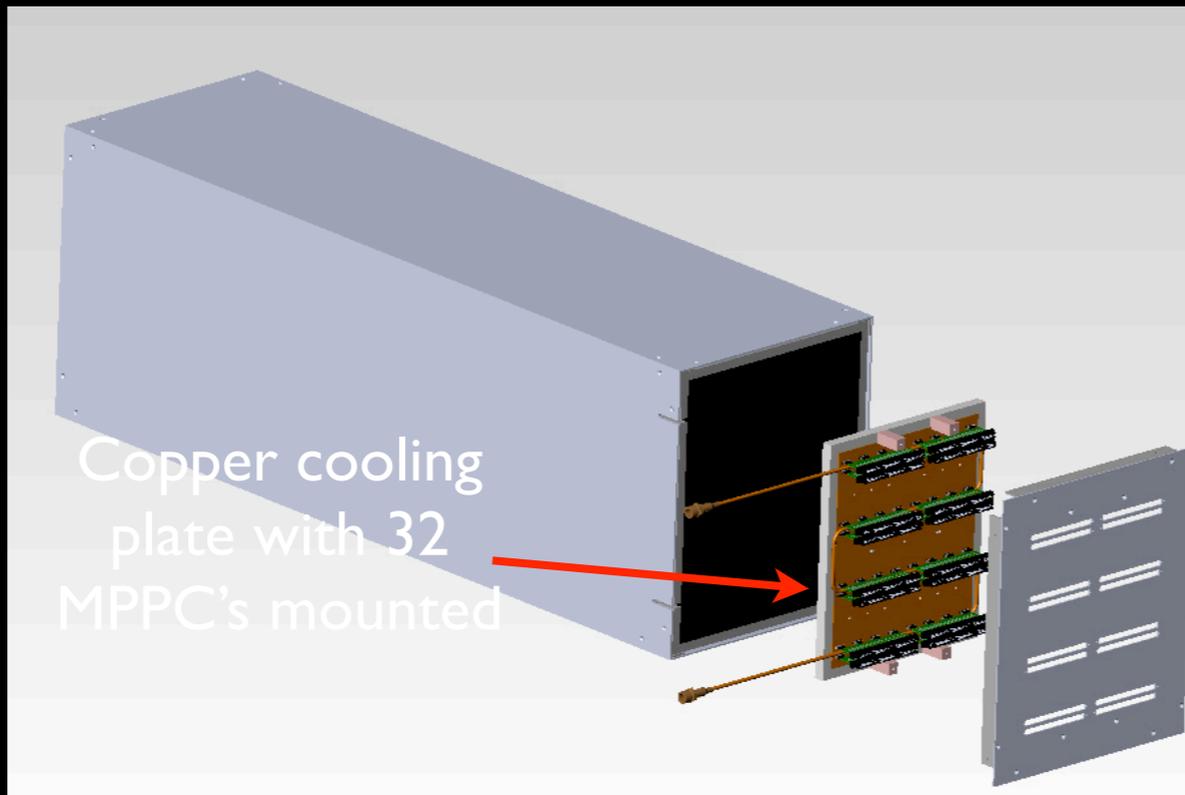
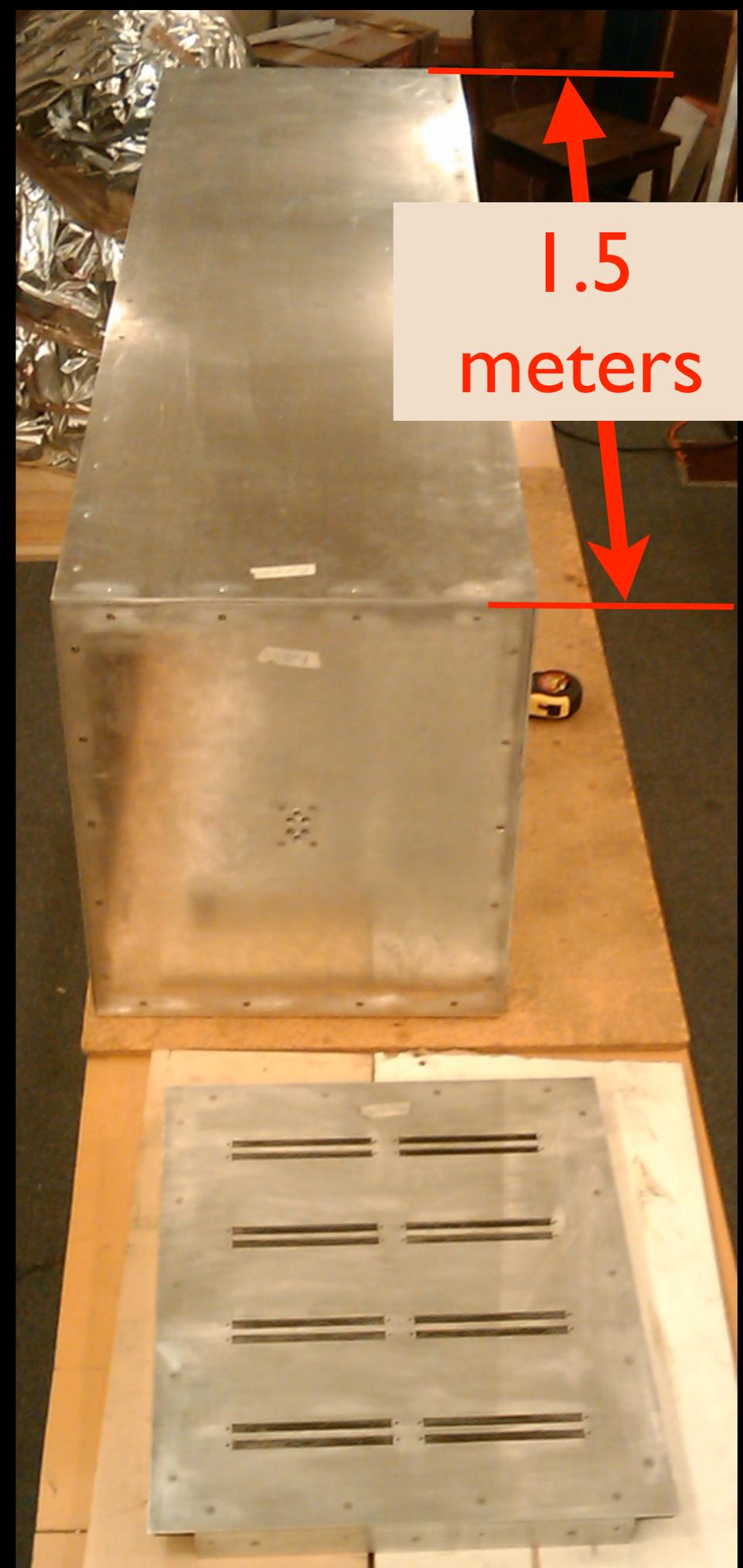


# Fermilab-MINERvA

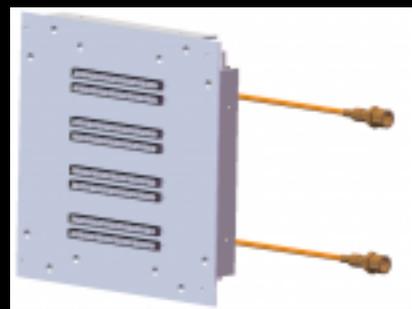
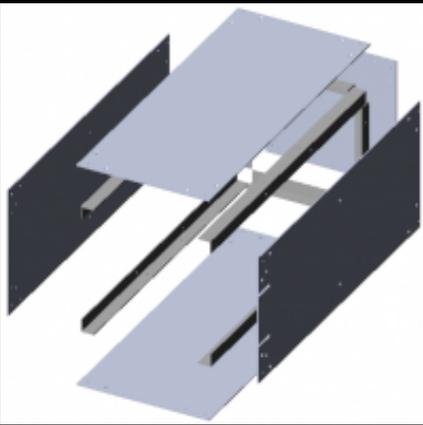
- Neutrino-nucleus scattering, few-GeV now, up to 20-25 later
- Understand neutrino oscillation data at a detailed level, including nuclear effects that can be very large
- USM effort involves Irina Potashnikova, Cristian Peña, Giuliano Maggi, Fedor Prokoshin, Edson Carquin, W.B. in:
  - database redesign (time-dependent constants for 30,000+ channels)
  - calibration constant validation for 30,000+ channels
  - study of resonant and coherent pion production
  - data-taking, including on-site at USM



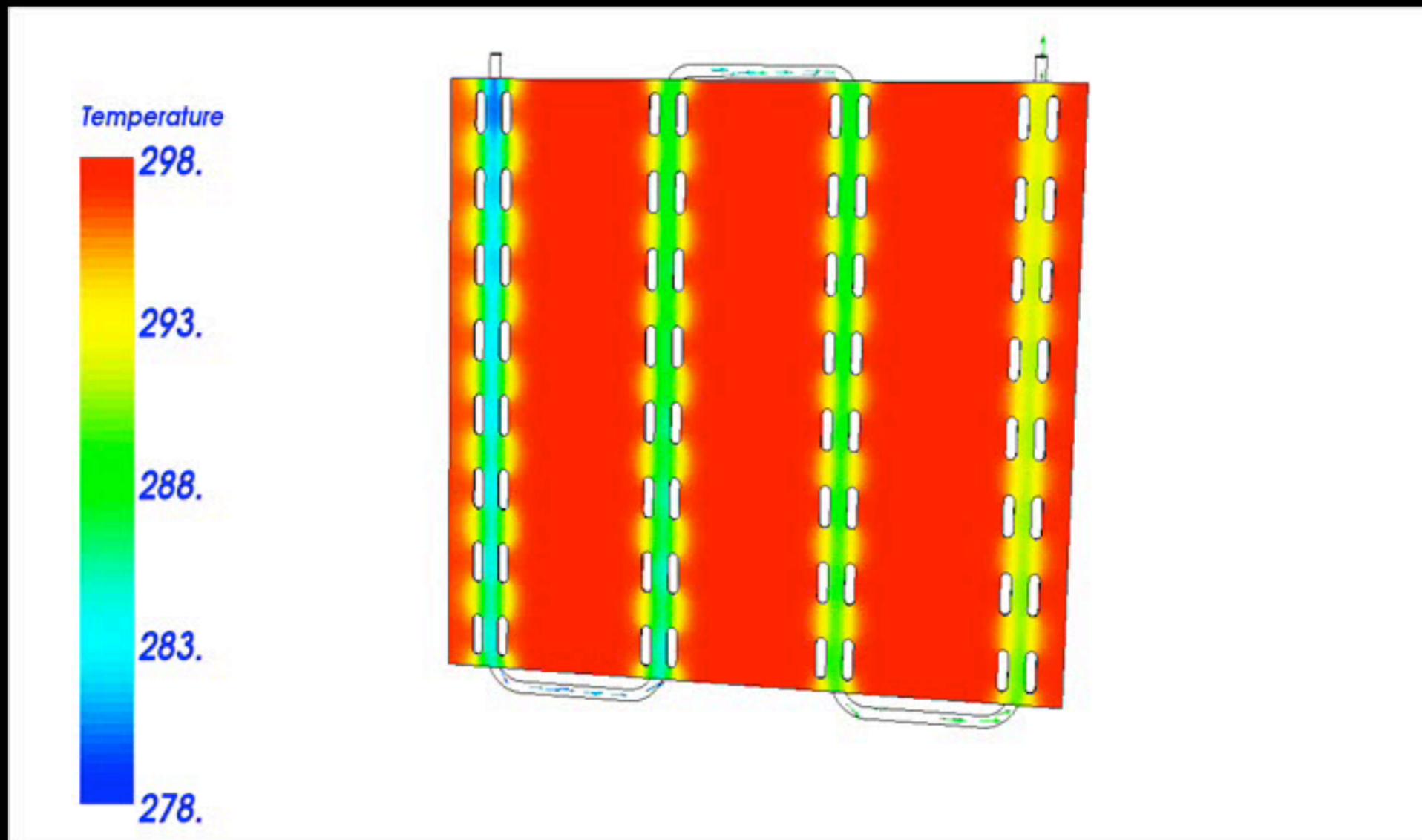
# Temperature-dependent Tests: Dark box enclosure



Fans for air cooling of electronics

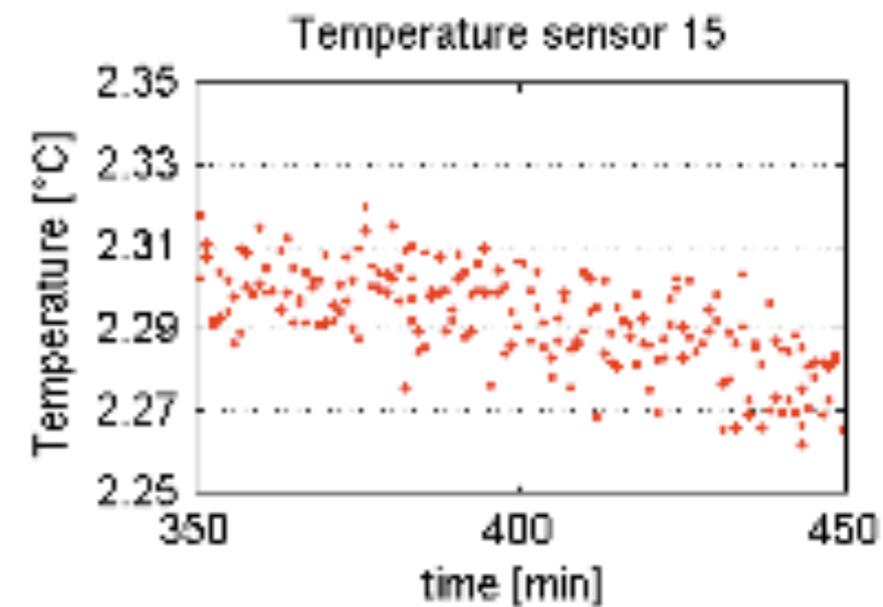
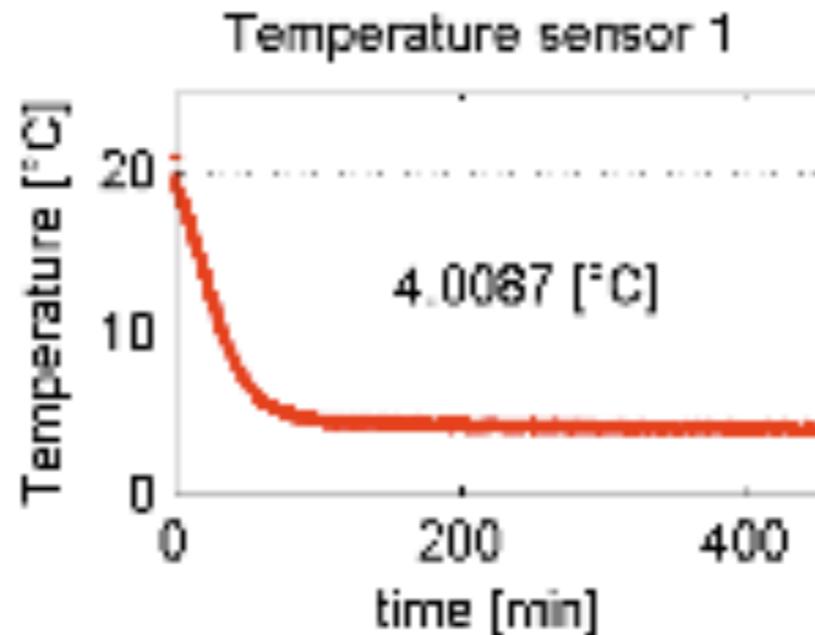
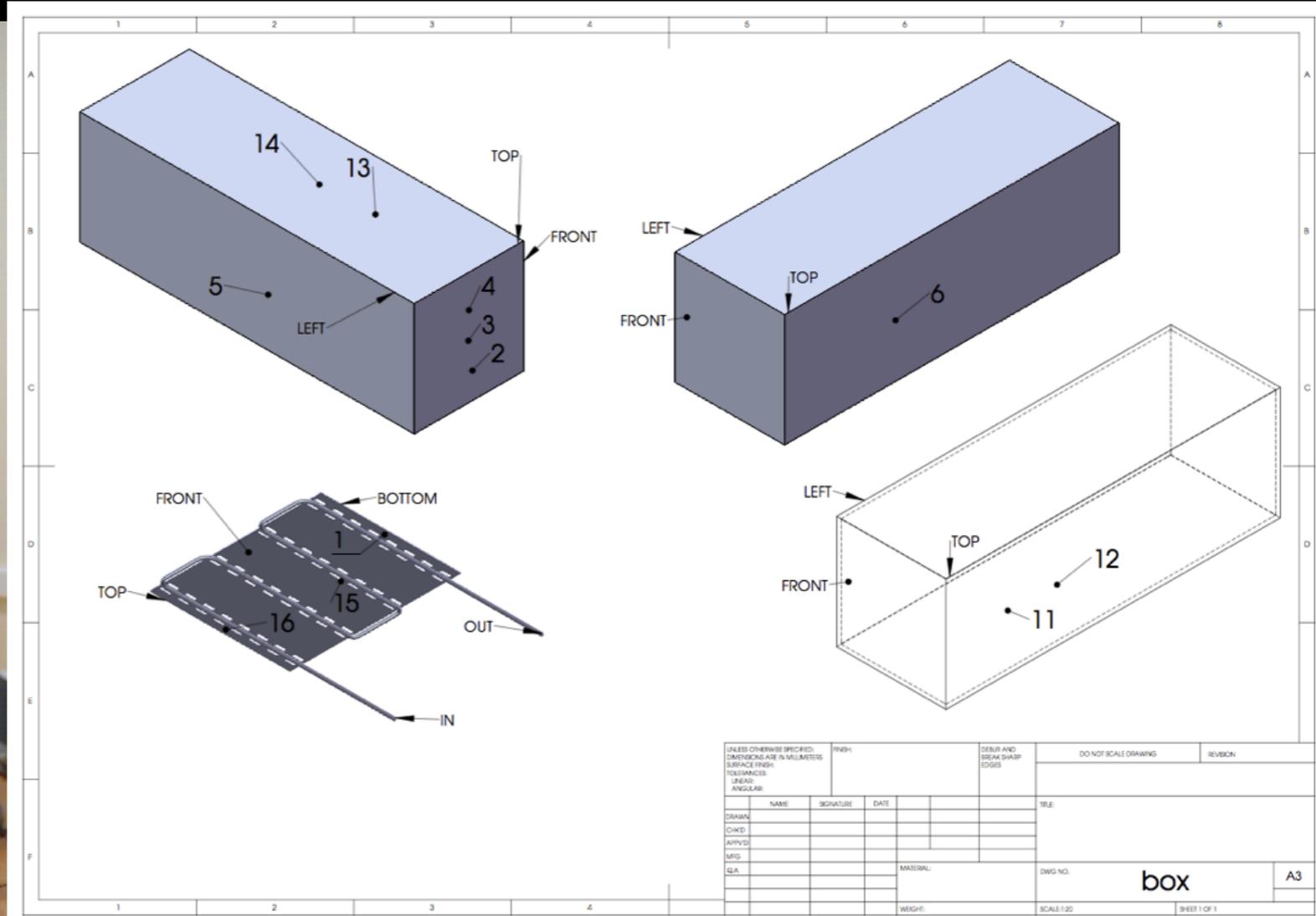


# Cooldown model of copper cooling plate (representing 180 seconds of real-time cooling)

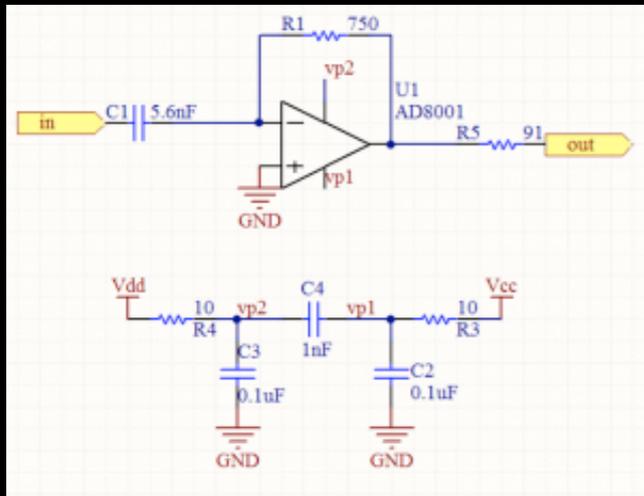


Thermal calculation by USM engineering student Orlando Soto

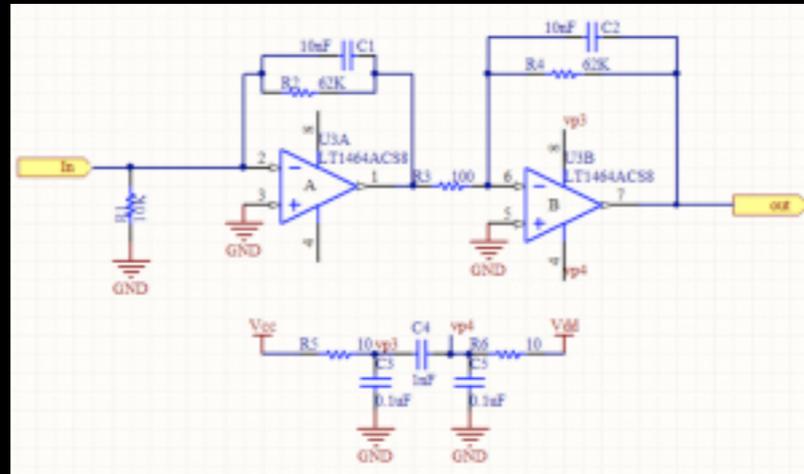
# Temperature-dependent Tests: USM Cooldown Tests



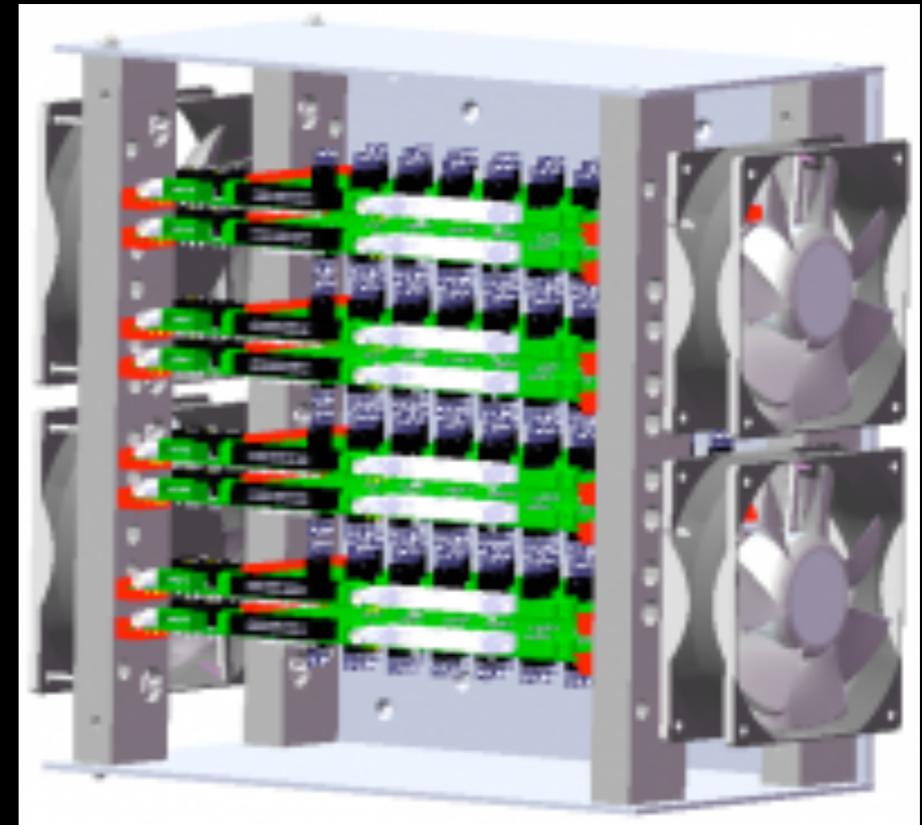
# MPPC Testing: signal board design



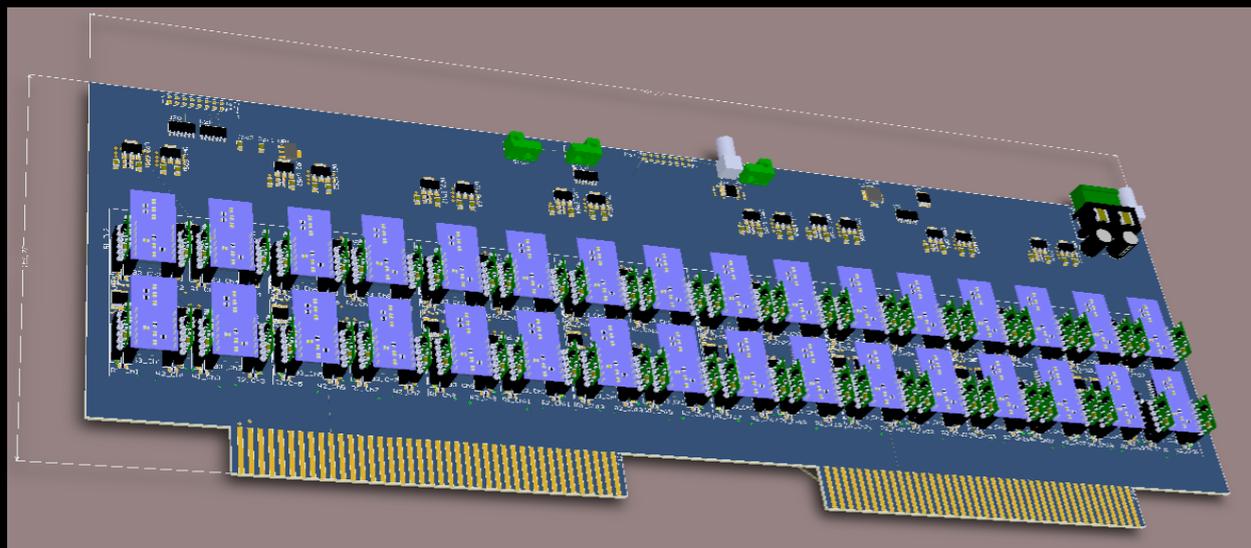
Pulse measurement amplifier



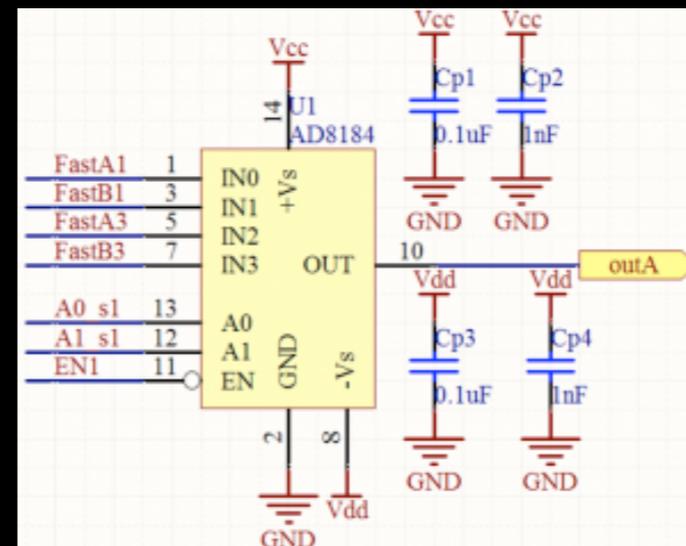
Dark current measurement amplifier



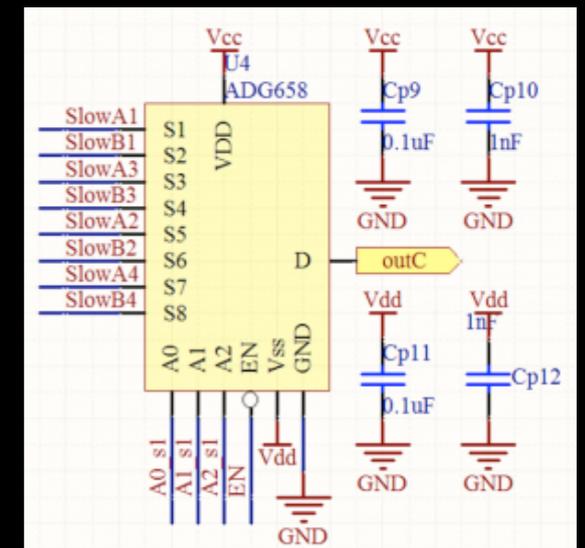
8 boards mounted in end of dark box



Second-generation prototype board design



Pulse measurement multiplexer



Dark current multiplexer

# SiPM Test Boards

Detailed Design by Alam Toro, USM

