The DarkSide-20k experiment at GSSI

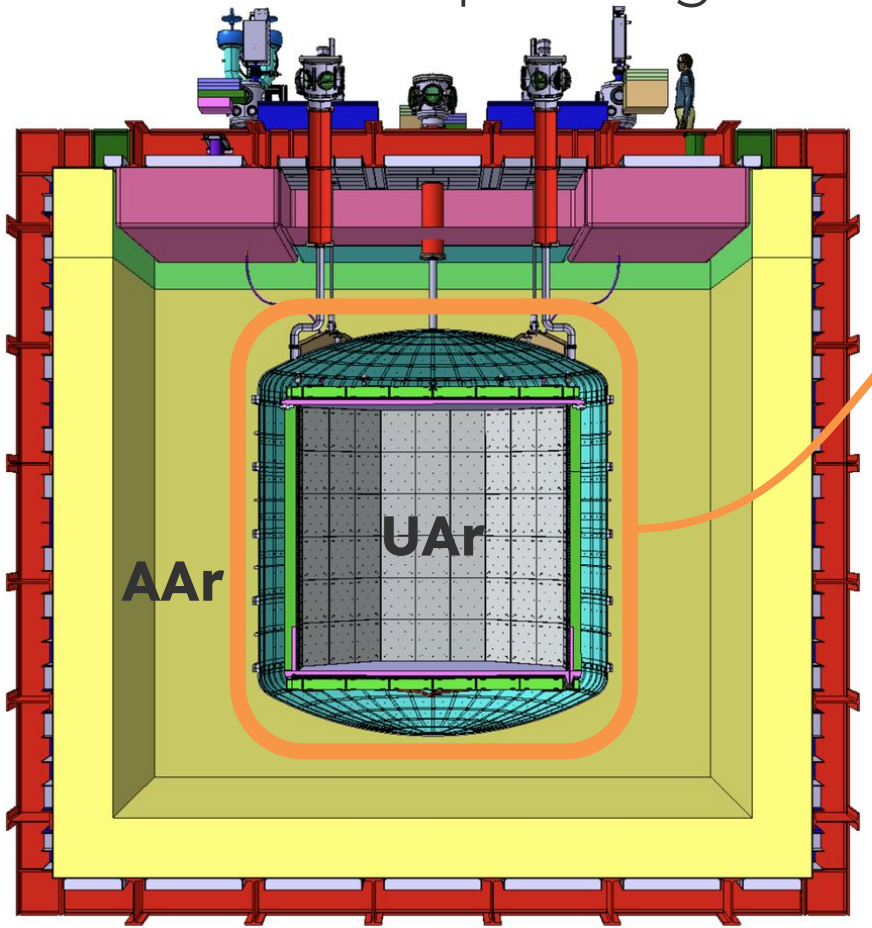
11th Astroparticle Science Fair: Underground Physics
24th February 2025

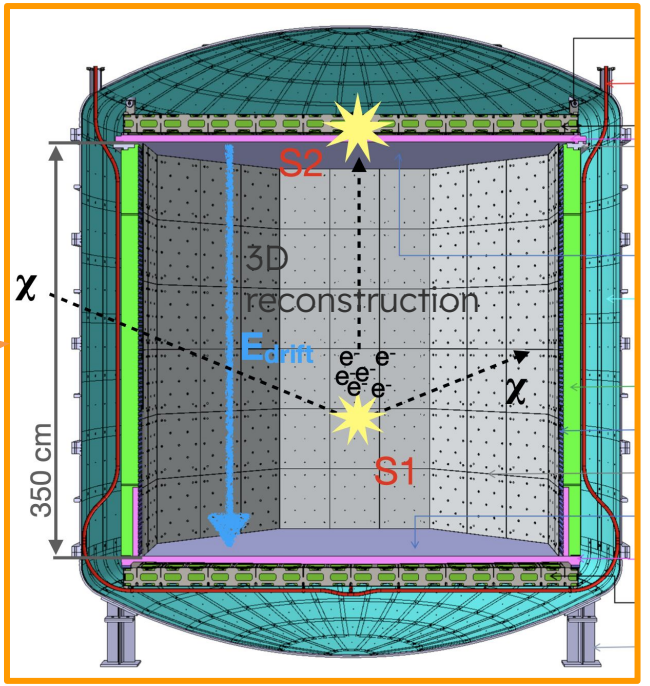
Pablo Kunzé on behalf of the GSSI DarkSide group

(3D model of the detector)

GRAN SASSO SCIENCE INSTITUTE
SCHOOL OF ADVANCED STUDIES
Scuola Universitaria Superiore

Dark matter direct detection with DarkSide-20k:
Dual Phase Liquid Argon TPC





Signal from WIMP

Nuclear recoil in liquid Argon

- S1: Liquid Argon scintillation (128nm) - prompt signal
- S2: Ionization electrons drifting to the top reaching gas phase -> second light signal

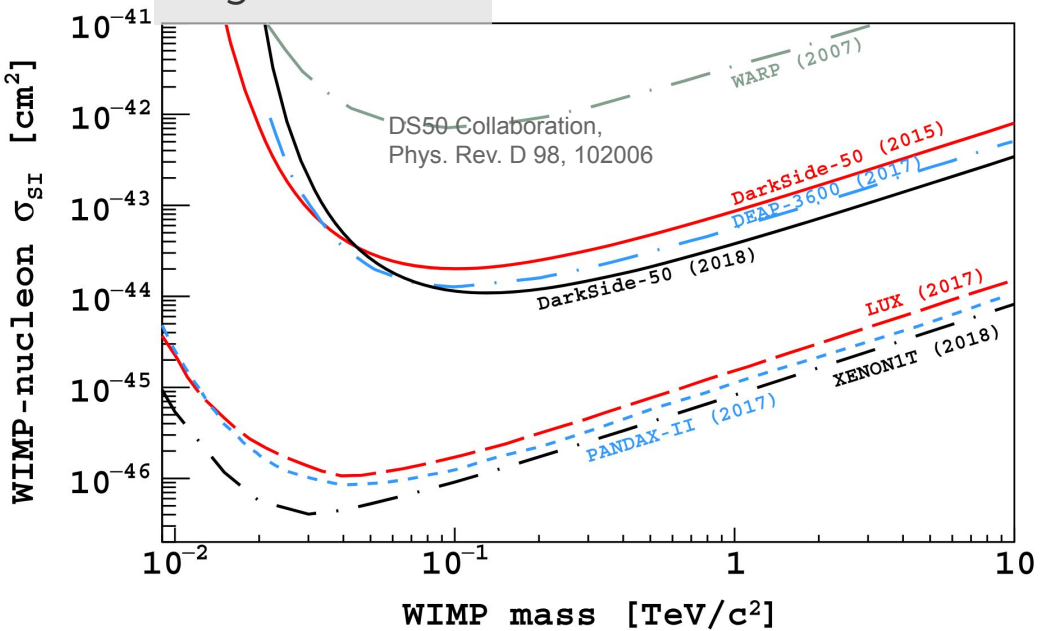
Need background free condition for discovery program

WIMPs Sensitivity with the DarkSide program

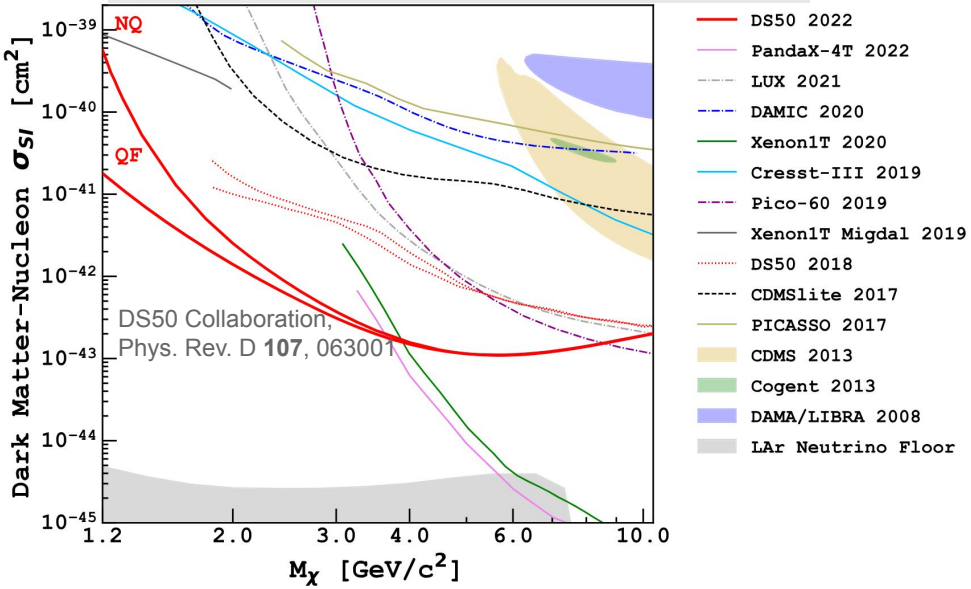
DarkSide 50 (final results)

46kg Ar target mass

Bkg-free result



Ionization signal only study:
World leading lowmass WIMPs limit

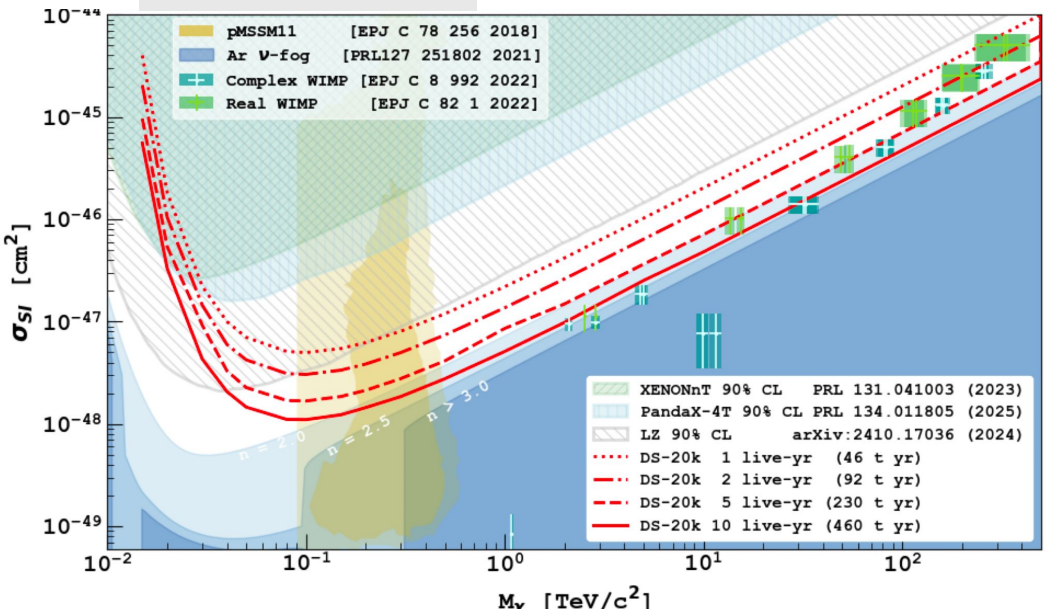


WIMPs Sensitivity with the DarkSide program

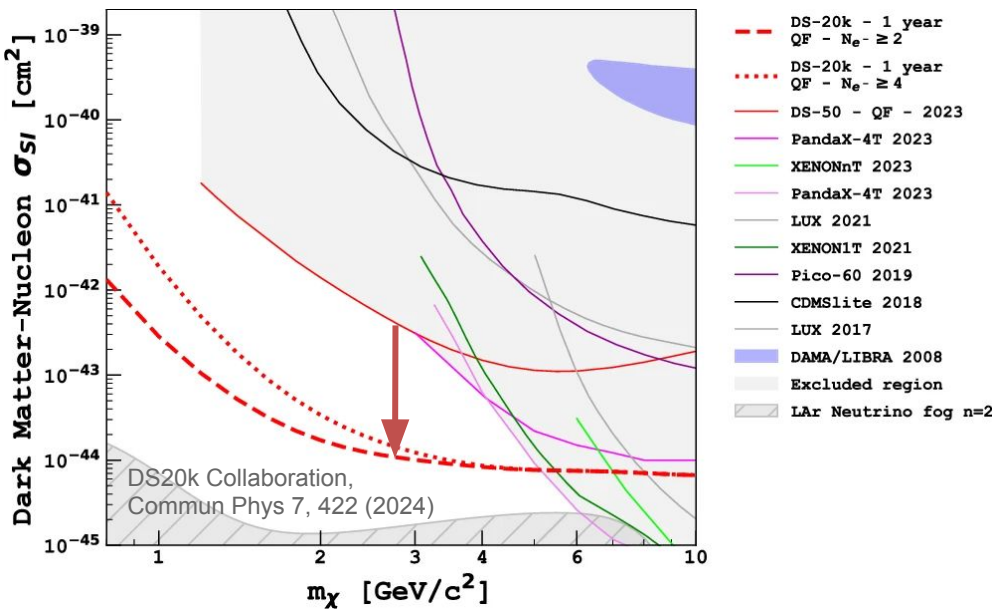
DarkSide-20k
(expected sensitivity)

20 tonne Ar
fiducial

Bkg-free result



Ionization signal only study:
~x100 improved sensitivity



DarkSide-20k construction

LNGS Hall C

Nuova Officina Assergi Clean room

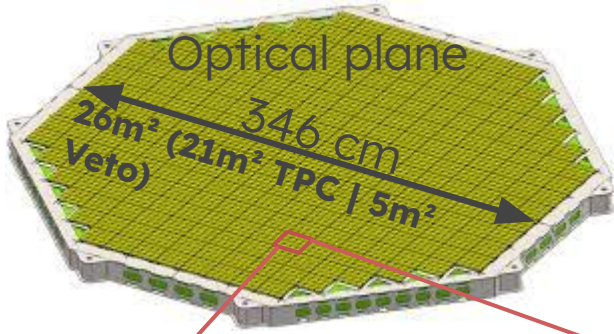
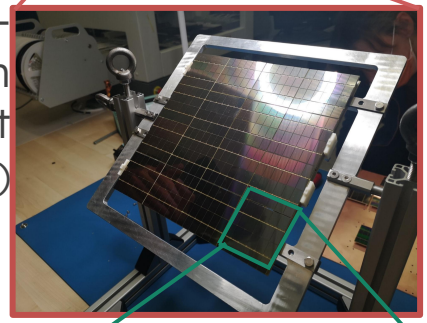
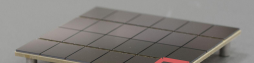
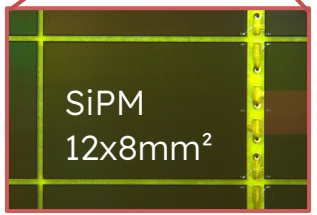


Photo-Detection Unit (20x20cm²)

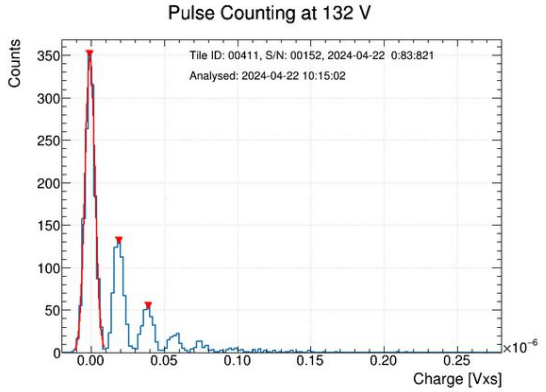


Tile (5x5cm²)

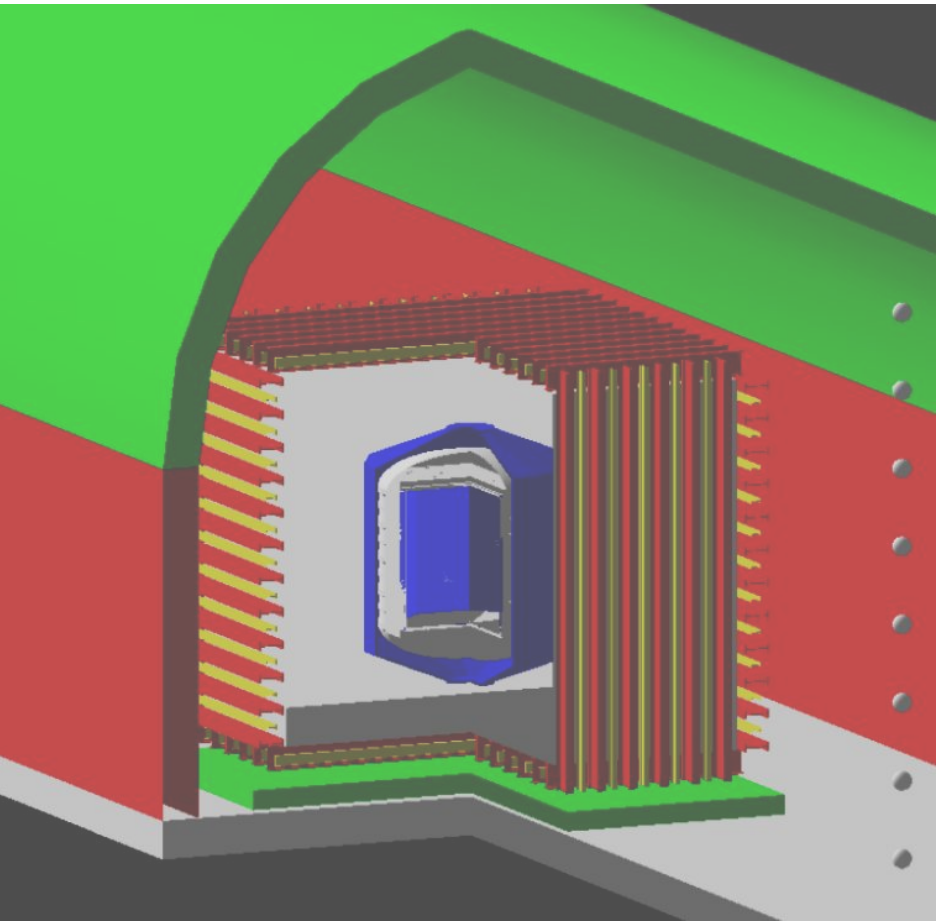


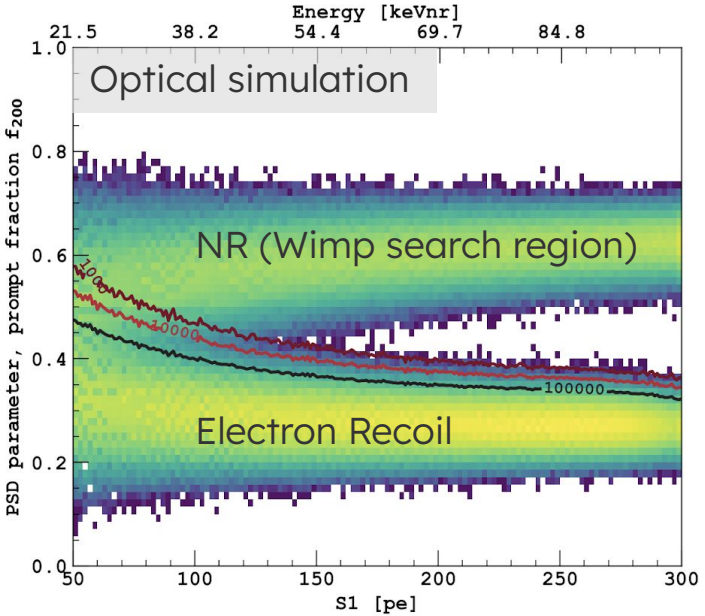



Test setup at NOA



Activities at GSSI: Geant4 Simulation





Pulse Shape Discrimination

- Liquid Argon response allows discrimination between ER and NR
- Evaluate impact of SiPM parameters on PSD

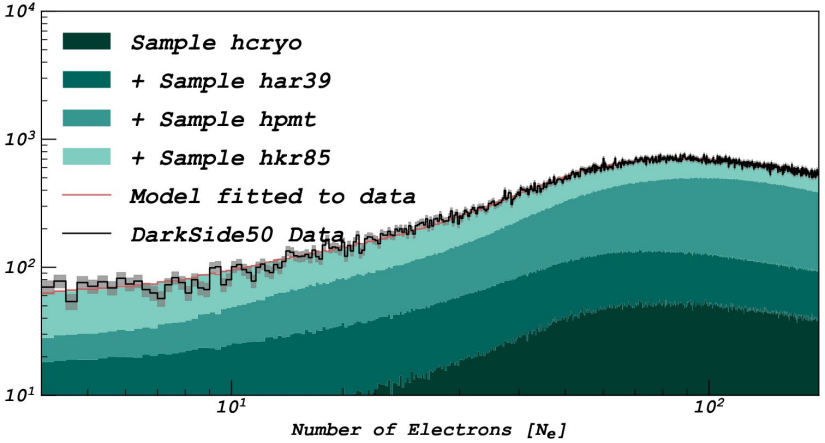
Full detector simulation

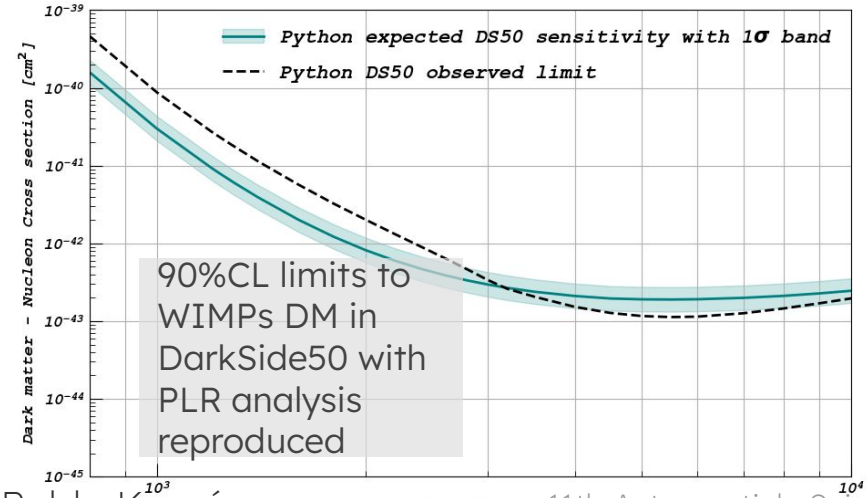
- Background levels (NR and ER) from the detector materials, the Hall C, cosmic rays
- Use for detector design
- Bases for sensitivity analysis

Activities at GSSI: Sensitivity studies

New python framework to compute sensitivity (no dependance on ROOT and RooFit)

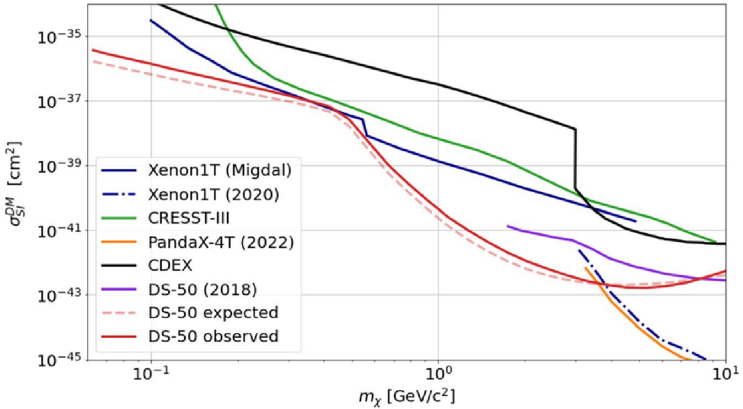
Background only fit



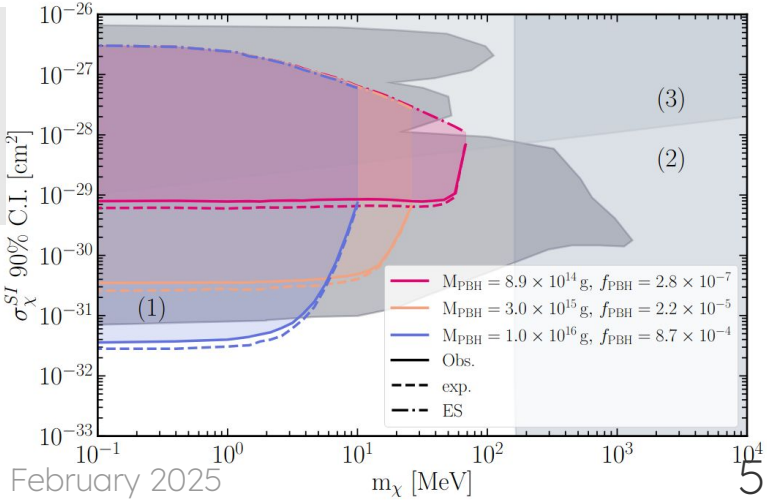


90%CL limits to WIMPs DM in DarkSide50 with PLR analysis reproduced

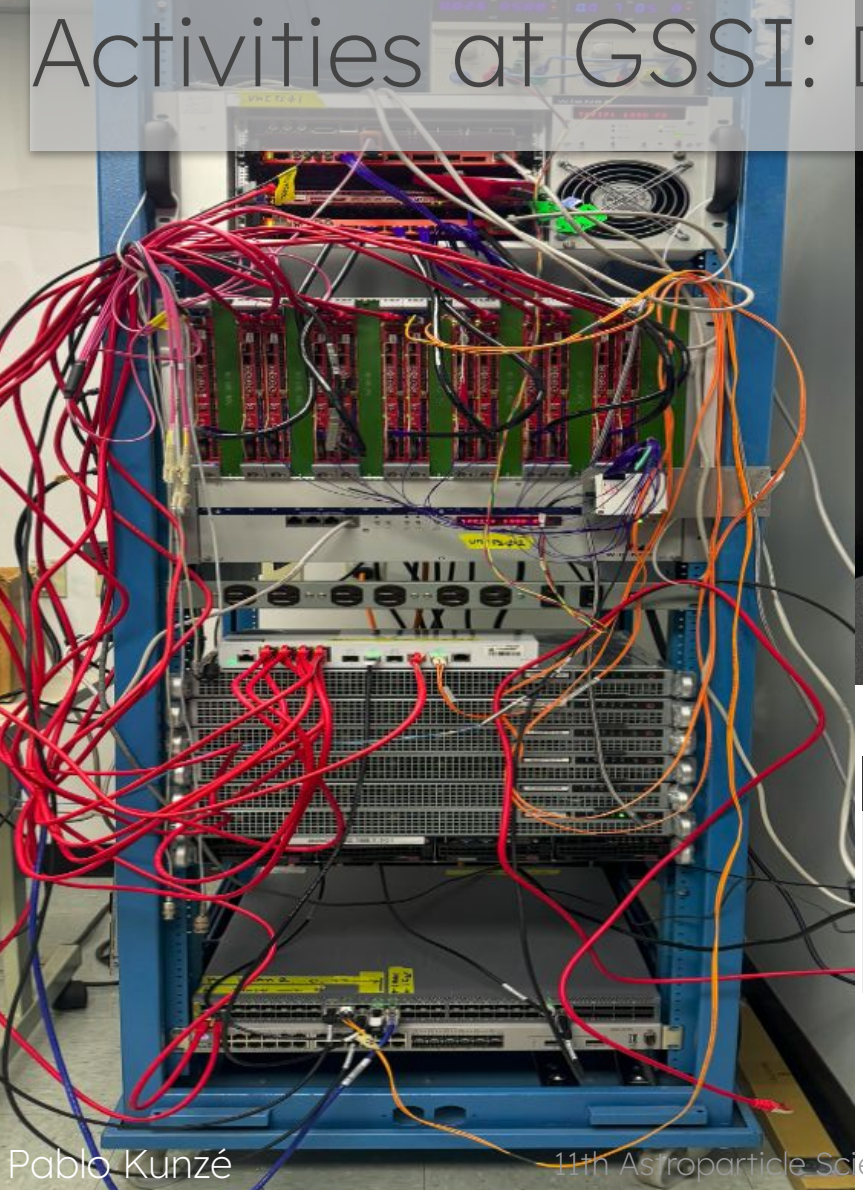
90%CL limits to WIMPs DM with Bayesian approach in DarkSide50 ->

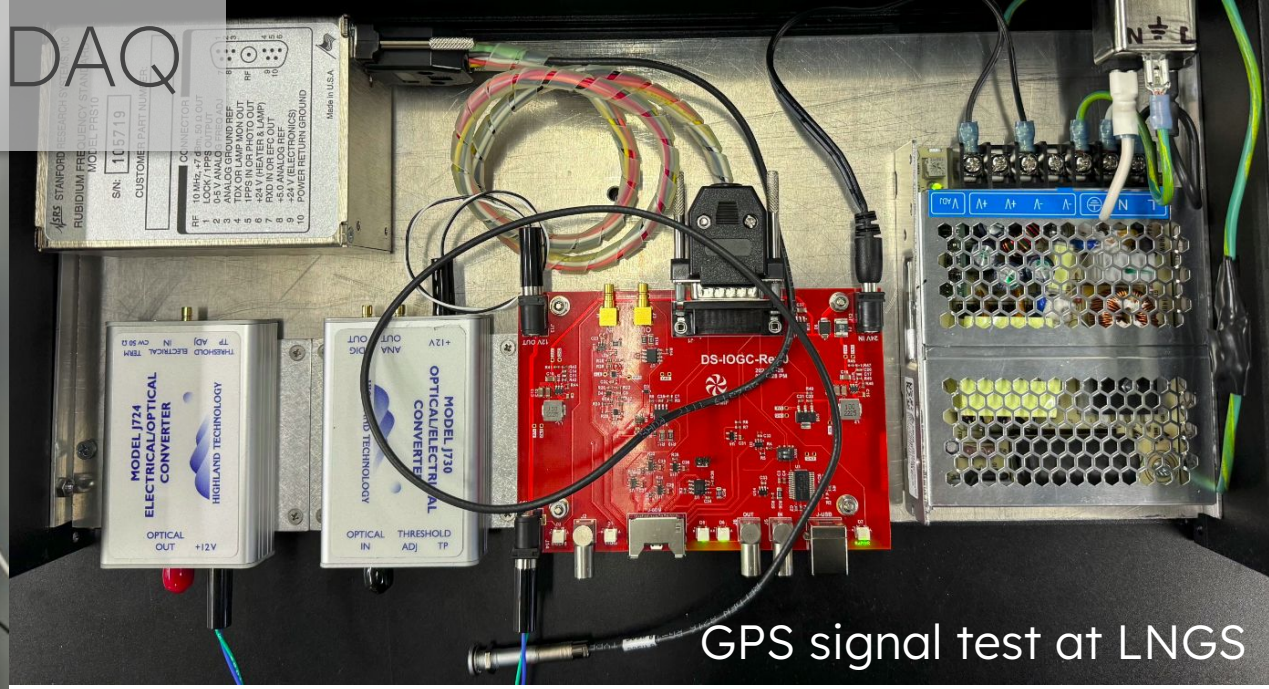


90%CL limits to DM from Primordial black holes with DS50->



Activities at GSSI: DAQ





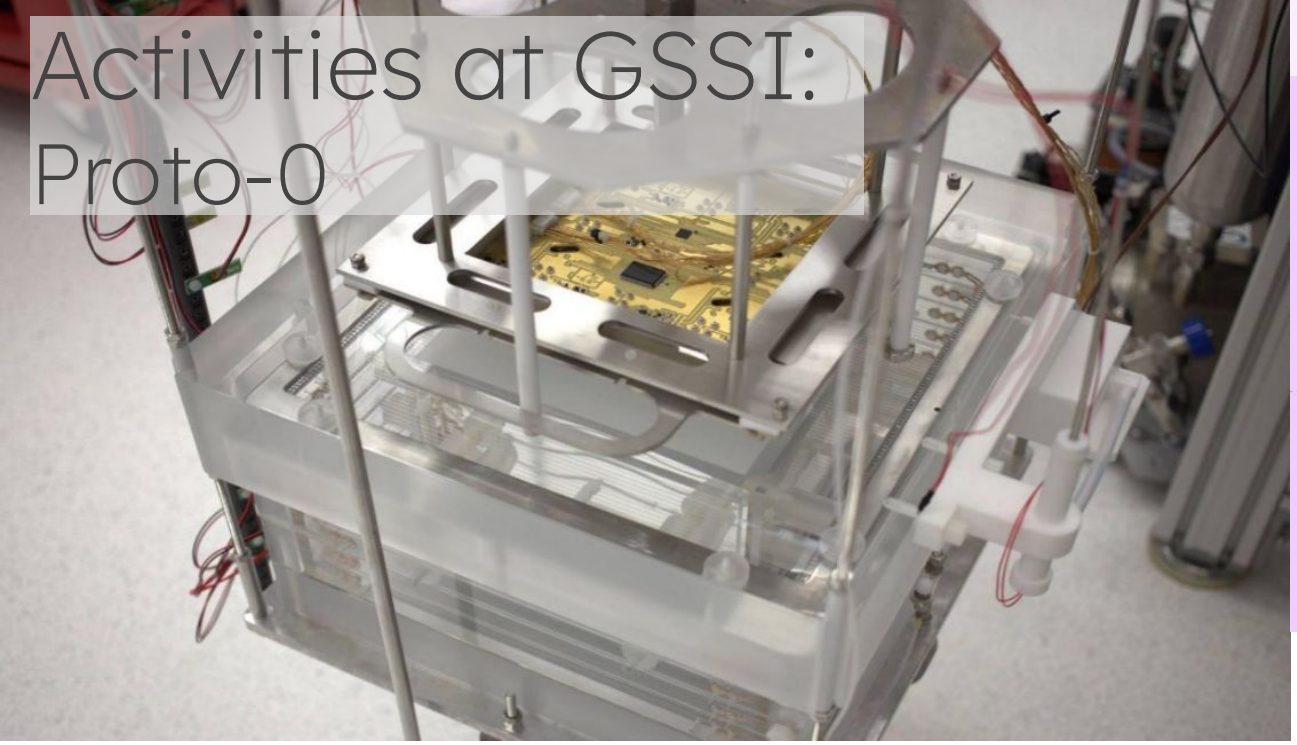
GPS signal test at LNGS

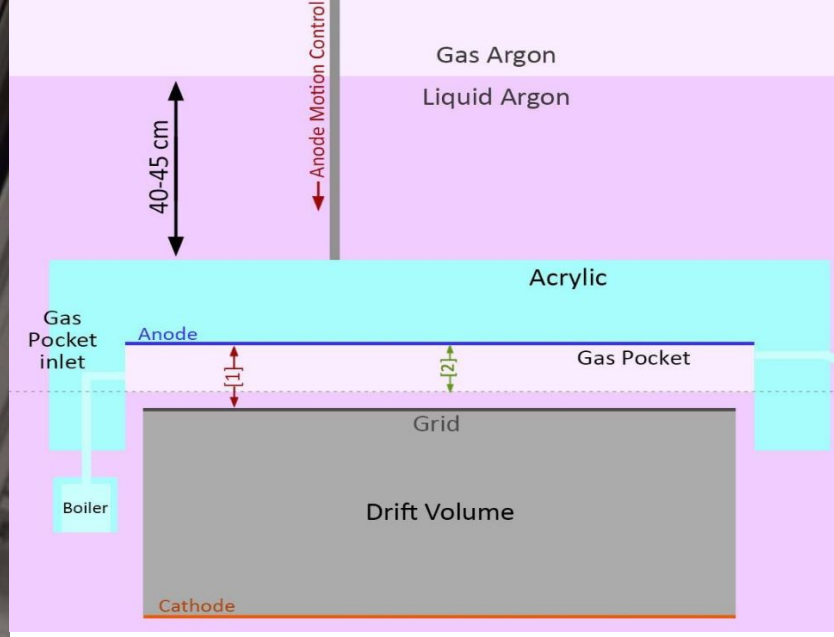
DAQ challenges

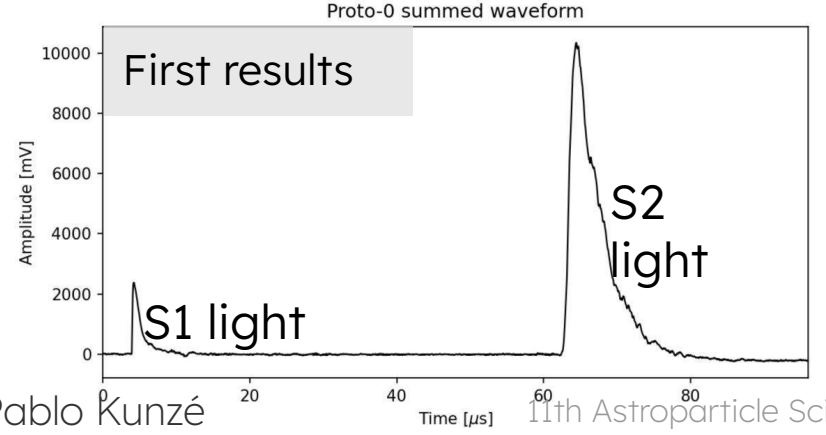
More than 2700 channels
Gbits of data per second
Precise timing

Responsible of DarkSide-20k DAQ implementation in collaboration with Triumf in Canada

Activities at GSSI: Proto-0







Detector

Small Dual Phase LAr TPC (12cm drift)
Operated in Napoli
First results very recent and analysis on going
First working TPC with DarkSide PDUs !

DarkSide people at GSSI

Paolo Agnes

Mauro Caravati

Michele Angiolilli

Stefano Piacentini

Oscar Taborda

Marek Walczak

Pablo Kunzé

Celín Hidalgo

And more to come !

Thanks for your attention !