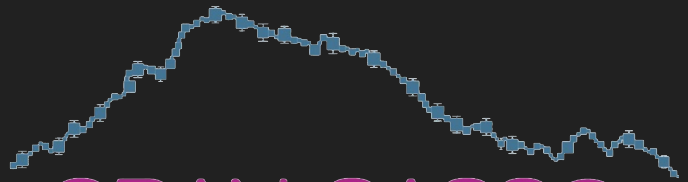
DAQ operation and sync tests

DarkSide-20K



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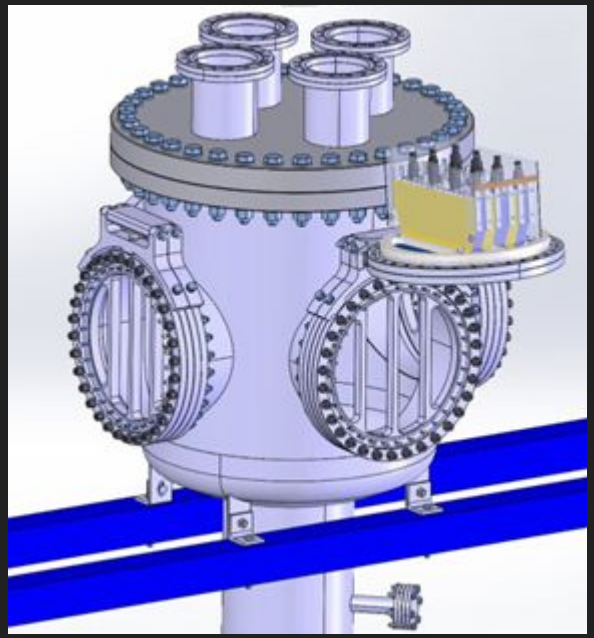
Overview

- Darkside DAQ workflow
- Atomic clock crash-course
- Experimental setup
- Testing with 1 Hz Signal
- GPS signal testing underground
- Summary and outlook

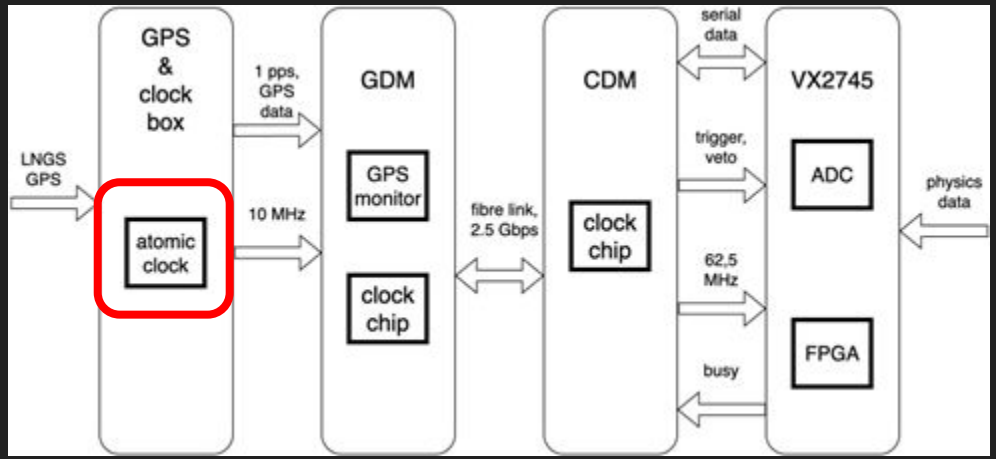
Darkside DAQ workflow

From SiPMs to user



Data flow

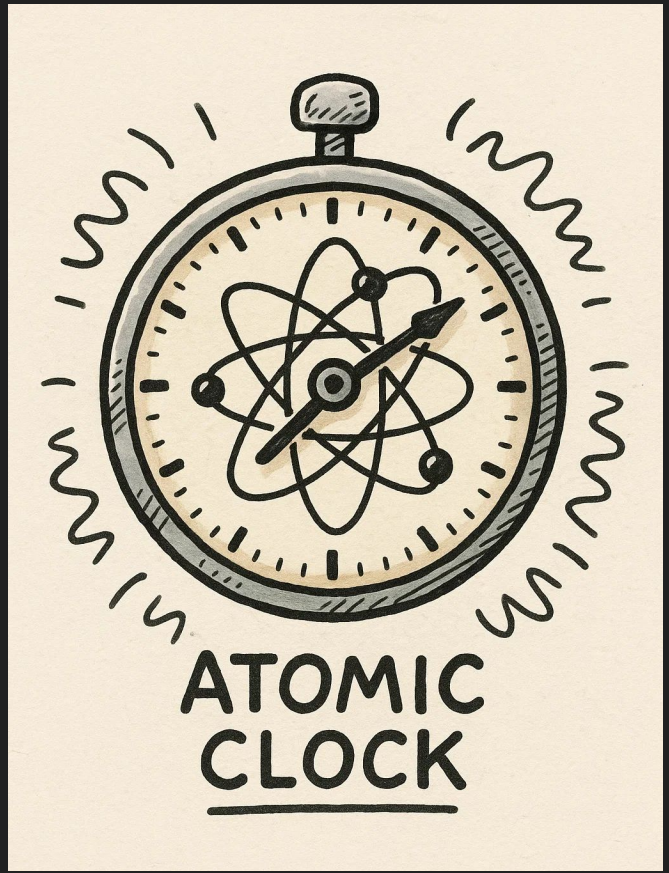
Global Data Manager (GDM)



- Atomic clock runs from GPS receiver 1 pps signal
- Provides 10MHz ext. clock to GDM.
- GPS IRIG -B datestamp is decoded in GDM

Rubidium Atomic Clock

- The “clock” is based on the natural frequency of a transition between two hyperfine energy levels in the ground state of the rubidium-87 atom
- very precise frequency: 6,834,682,610.9 Hz (about 6.8 GHz)
- Voltage-controlled crystal oscillator (VCXO). Resonance microwaves absorbed by the vapour cell that has the gas
- Stability: about 1 part in 10^{12} over 1 second
- Can be sync with a GPS signal



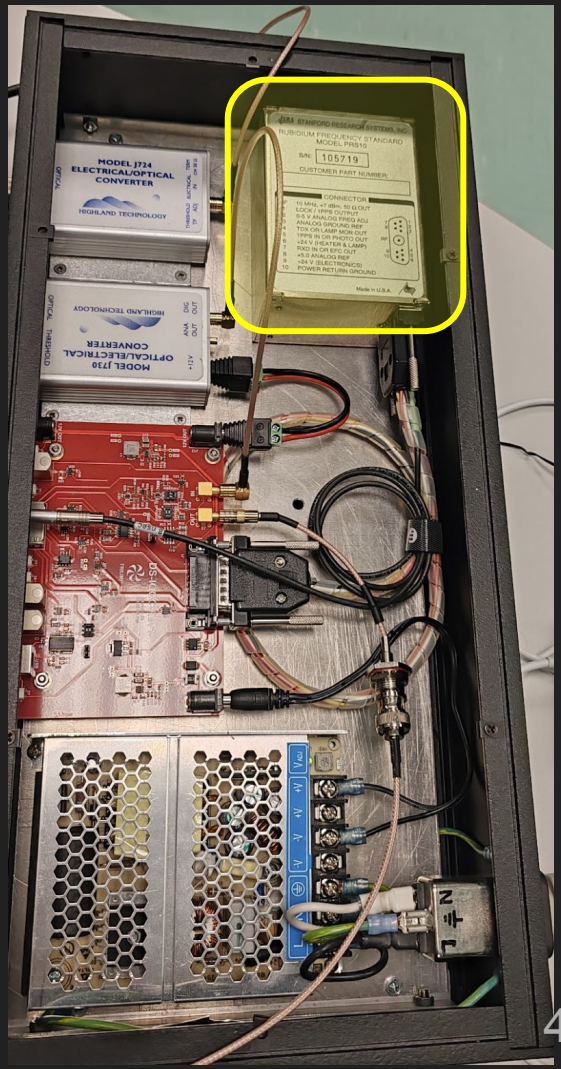
Why do we care about time?

- Supernova Events
- Difference between S1 and S2 inside the detector define the type of event (TPC)
- All SiPM ADCs must be synchronized through the GDM
- The primary "malfunction" in the OPERA experiment was a faulty, loose fiber optic cable connection in the timing system, which incorrectly suggested that neutrinos were traveling faster than light.

Experimental Setup

Experimental setup

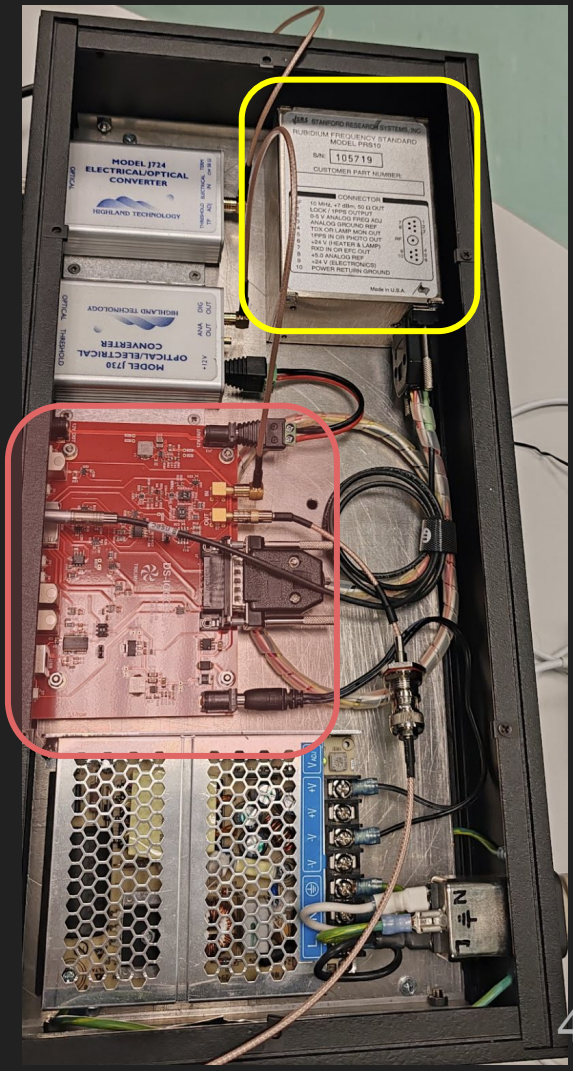
Rubidium Clock: SRS PRS10



Experimental setup

Rubidium Clock: SRS PRS10

DS-IOGC-Rev1 (Input Output GPS Clock and GDM interface) board developed in TRIUMF



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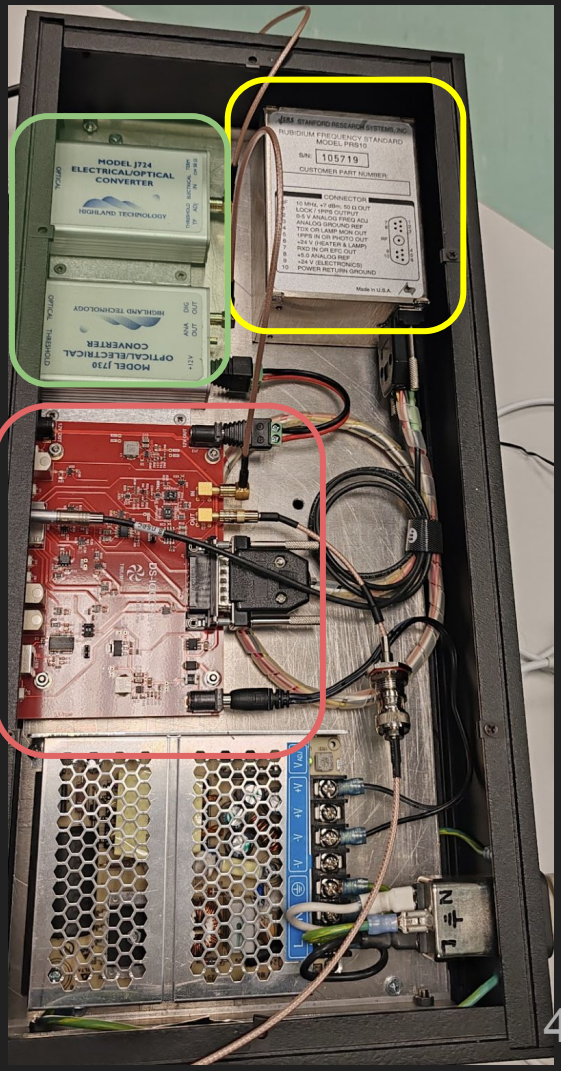
ELECTRICAL ↔ OPTICAL converters



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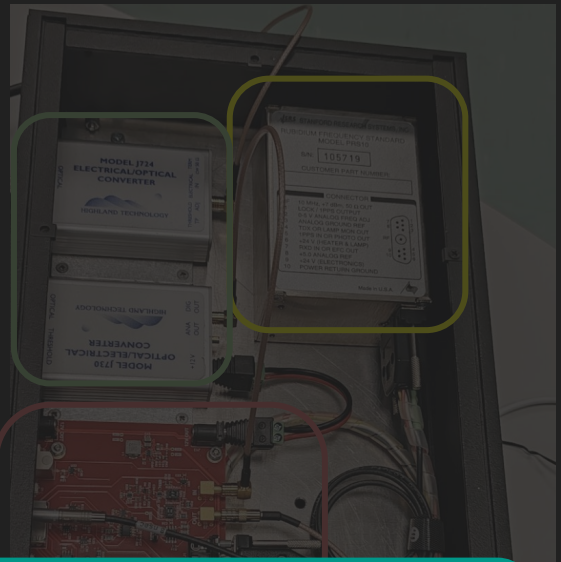
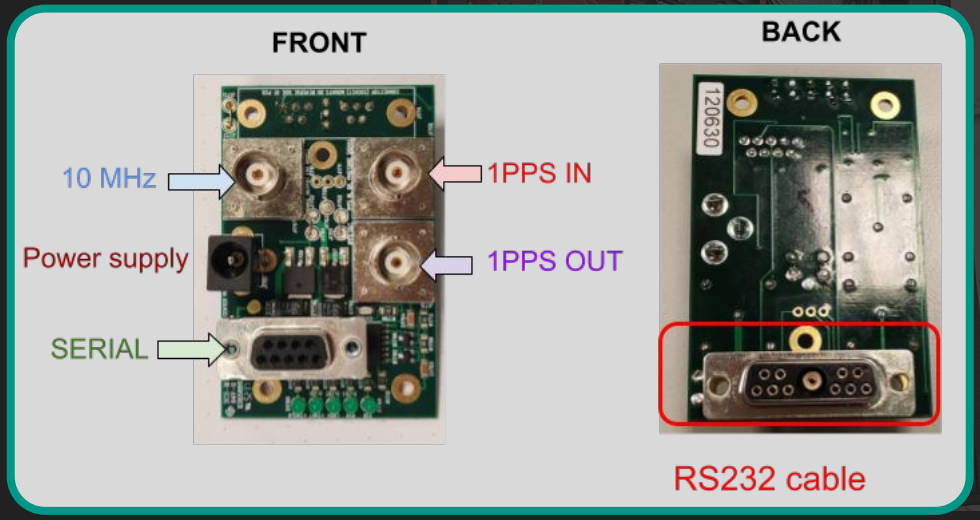
Breakout board: PRBB Breakout Connector Interface Board





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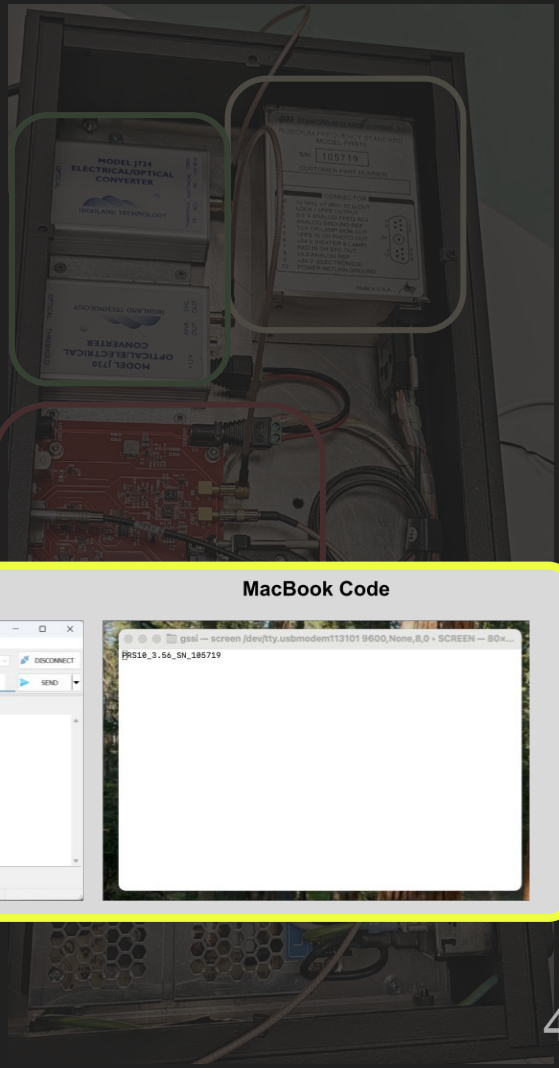

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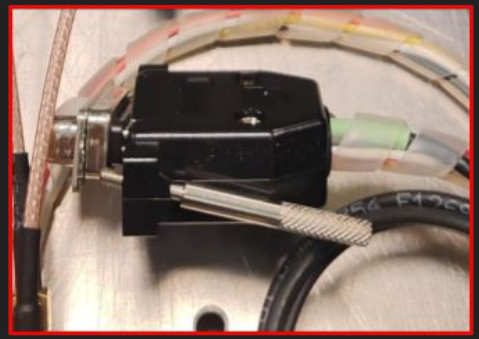
Oscilloscope: RIGOL DHO924S (for 1 Hz test GPS signal generation and measurements)

Care about the the cable !

The breakout connector from the PRS10 must be removed carefully. The black case does not secure the metal sleeve, which can lead to damage if pulled incorrectly.

We suggest using a flat screwdriver to take it out safely!



1 Hz Test Signal (GPS replacement)

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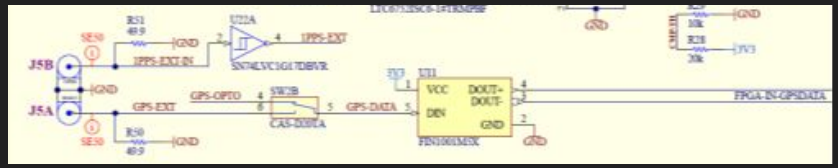
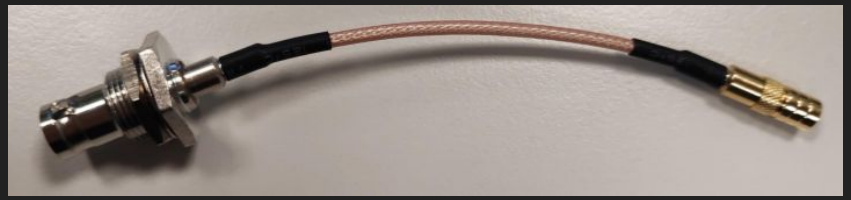
We generated a 1Hz square pulse (5 V) was generated using the RIGOL oscilloscope -Built-in wave generator- to simulate the GPS 1PPS signal to drive the clock.

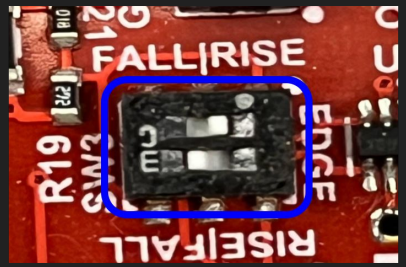


A better function generator is suggested to avoid most of the problem we faced using an unstable one.



The signal was injected through different inputs:

- J5A (LEMO) → did not work
  (will it work with GDM connected?)
- Opto input (via adapter) → worked correctly in a **specific latch** configuration **(rising/falling, strange but fixed with GPS signal)**

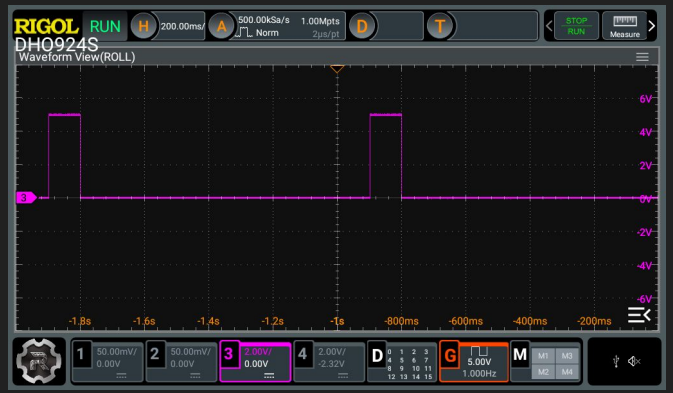


1 Hz Test Signal (GPS replacement)

1Hz square pulse

(5 V, 50 % duty)

Resulting PRS10 1PPS output.

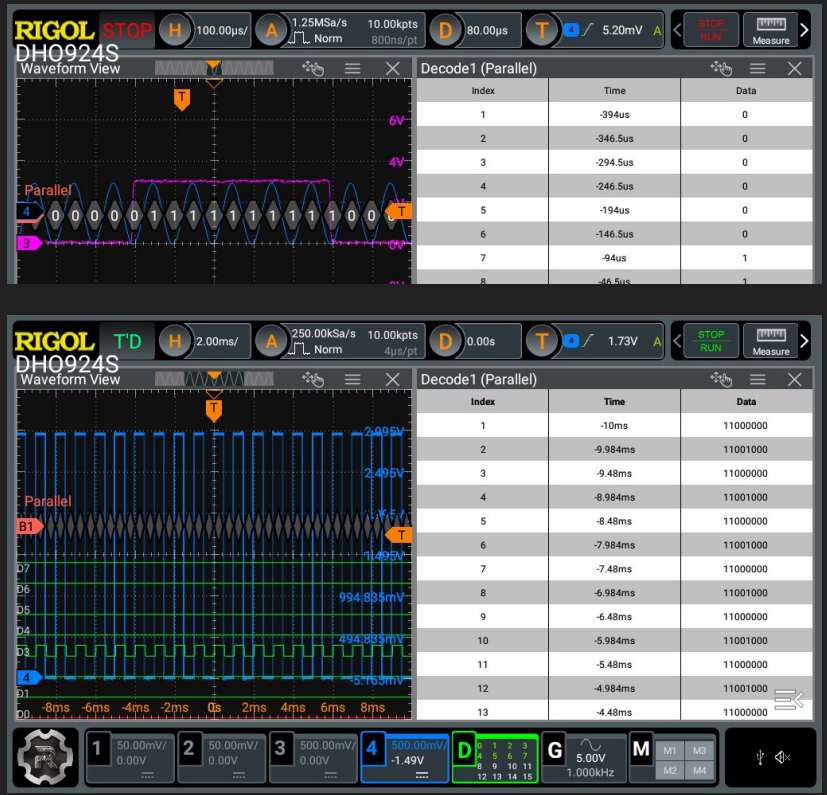


1 Hz Test Signal (GPS replacement) - DECODING

RIGOL oscilloscope has a built-in decoder function that will be helpful to decode the GPS signal and get how it is packed.

10 KHz signal was used as clock for the decoding of the signal

as in [10.1088/1748-0221/14/04/P04001]



GPS signal testing underground

Follow us into the underground…

GPS signal testing underground

We tested the GPS signal from underground telephone room (GS1) taking it from the optical fiber splitter.

The clock locked in automatically **without any problem** in ~ 4 min

(integration time constant **TO** was set to 2 [default value], the clock manual suggest it to have **TO 10** ~ 72h integration time if locking to 1pps GPS signals)

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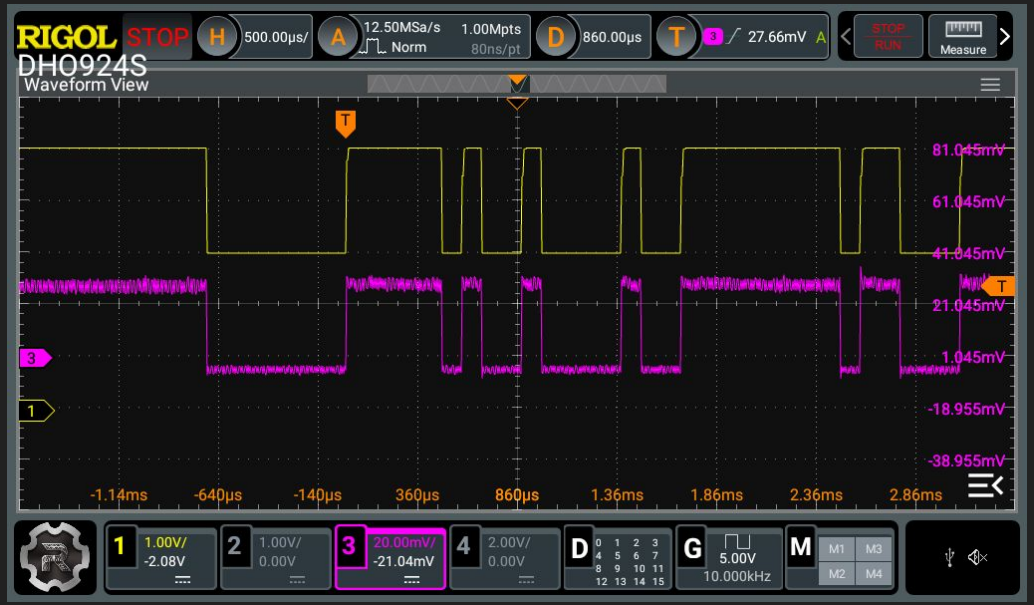
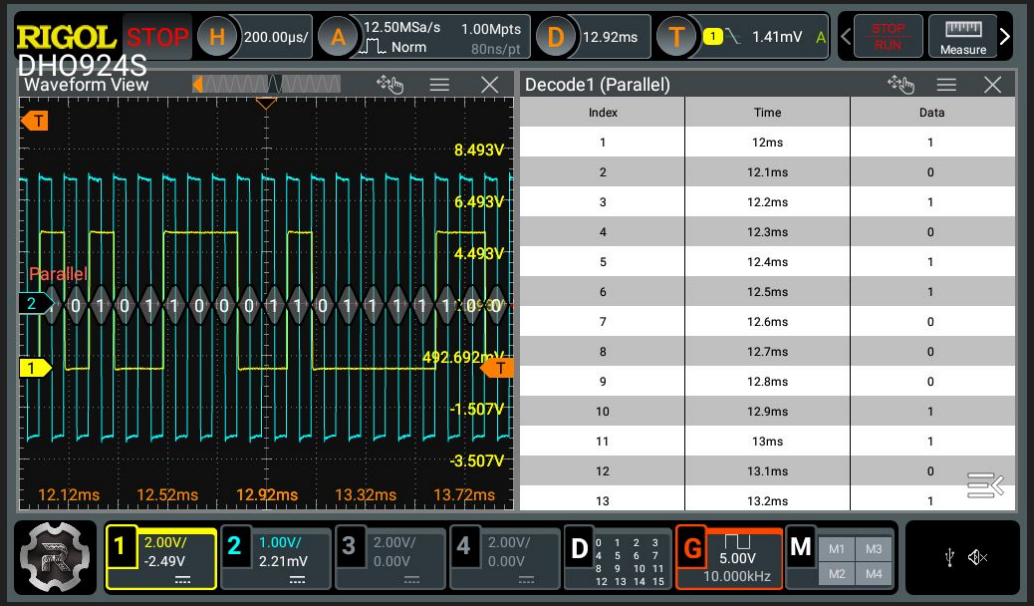
GPS signal testing underground

We compared analog and digital output of the opto-electrical converter



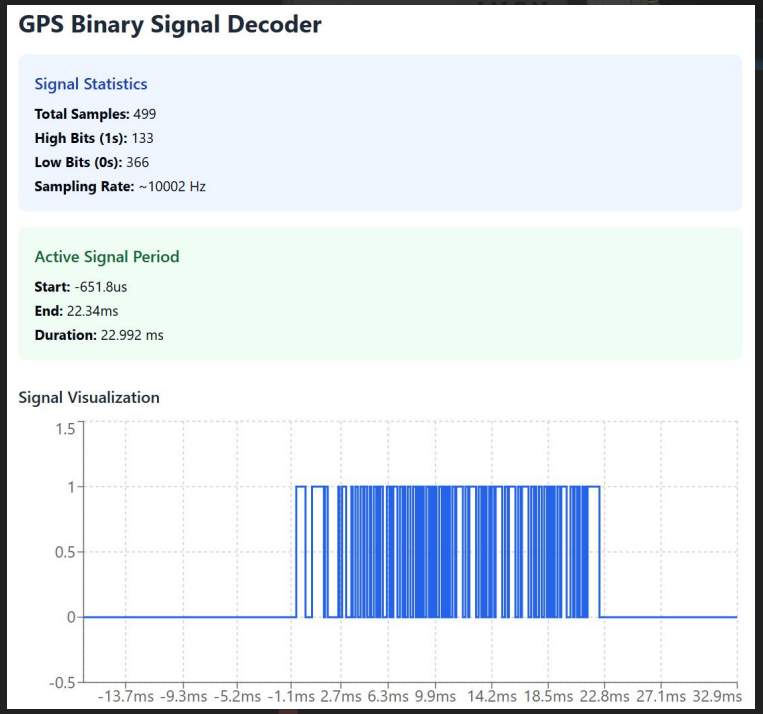
GPS signal testing underground - DECODING

We compared analog and digital output of the opto-electrical converter and decoded them



GPS signal testing underground - DECODING

We have a clear GPS signal sampled from the RIGOL oscilloscope.
We have a clear binary signal, we can identify the “**start of data**”.




```
00111111000001100010110110000000010011100001001100110110010011010110001101011100110100110011010100110100110101001101010011010110001101011111001101010010110111110011011111100110111111001101001100110101010011011110001101011001110100101001
```

Now we need to understand what the GPS is giving us and how to convert it in UTC (*Coordinated Universal Time*)

Summary and outlook

- We tested the **exact hardware** that will be used to provide time to the Darkside experiment.
- PRS10 Rubidium clock was successfully interfaced via RS232 (Mac and Windows) and via DS-IOGC board USB.
- 1 Hz test signal helped us to understand the behavior of the clock
- GPS signal connected and tested, it worked seamlessly.

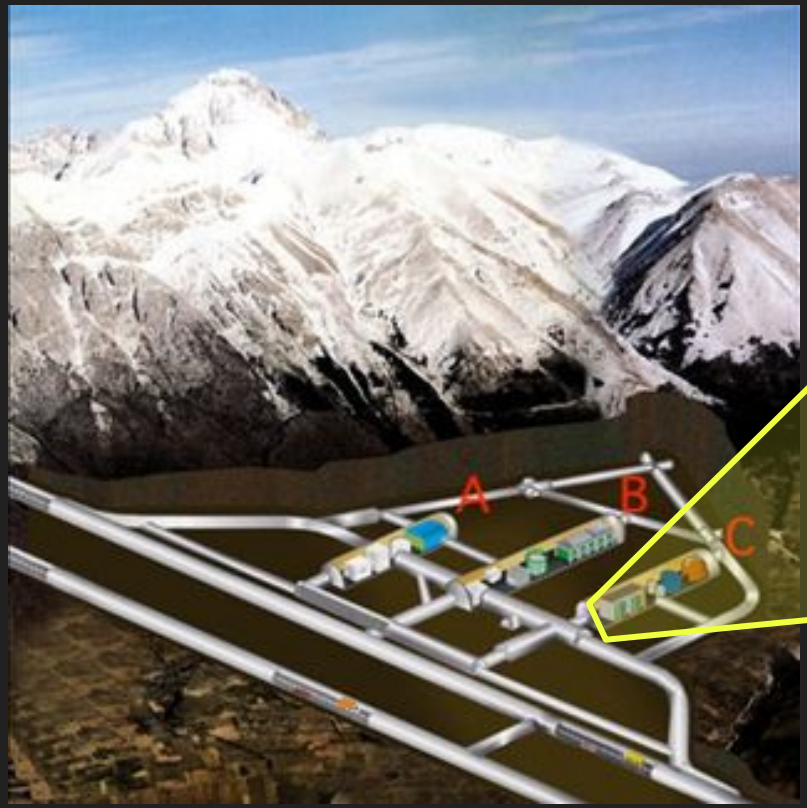
- We are writing the report of these operation for the Darkside group.

- Decoding of converted GPS signal ongoing.
- Measurement of the signal delay inside the opto-fiber cable up to DS hall.

Question?

Some backup, just in case

Where in LNG



DarkSide-20k will be installed in LNGS in Hall-C

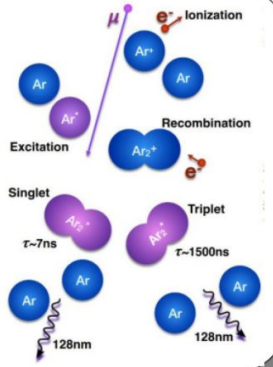
DarkSide-20K Time projection chamber

Argon and Time Projection Chamber (TPC)

Why Argon?

- Effective chemical and cryogenic purification
- Good scintillator, high ionization
- Powerful discrimination against background via pulse shape

Two de-excitation times:
Singlet ~7 *ns* ; Triplet ~1.5 μs

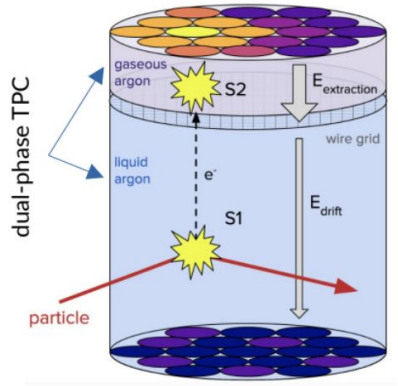


Nuclear recoil (NR): Large probability to populate singlet state

Electron recoil (ER): Mostly populate the triplet state

Neutrons generate NRs while **β and γ** generate ERs

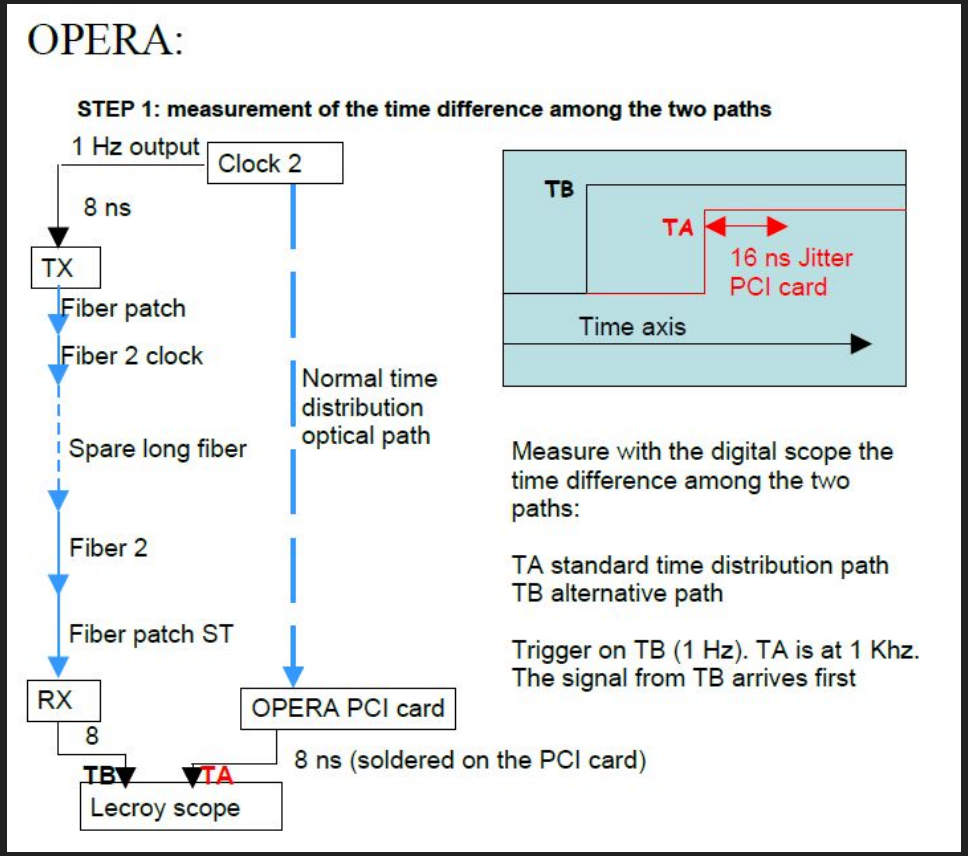
WIMPs generate NRs



S1: primary scintillation in LAr (energy information and pulse shape discrimination)

S2: secondary scintillation from electroluminescence of electrons in gaseous Ar (energy information and position reconstruction)

Delays for the GPS signal underground distribution



We need to have the cable in Darkside hall to do this measurement