

Nu@FNAL Status and Outlook

Sergio Bertolucci

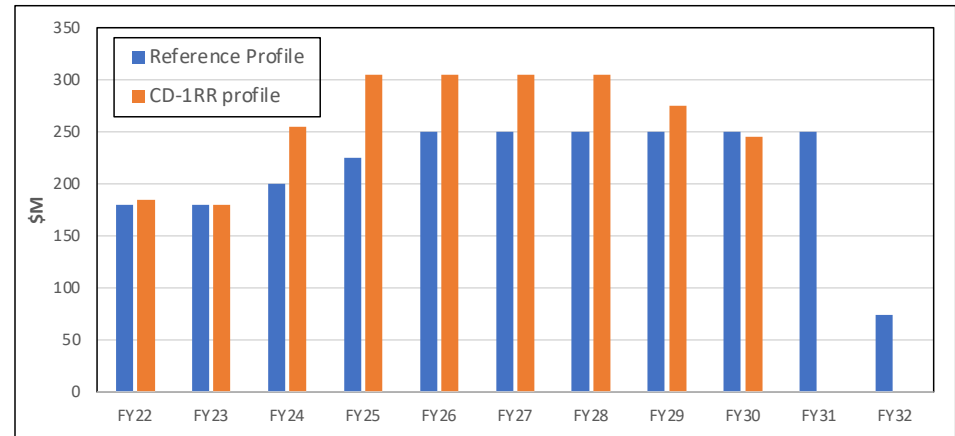
The INC and RRB meetings (Feb, 7, March 31)

Following the concern expressed by several International Funding Agencies, DOE promptly reacted to address the consequences of the funding profile, proposing:

- A new and accelerated funding profile
- A CD1RR in July 2022, to prepare for the baselining of the LBNF/DUNE major components.

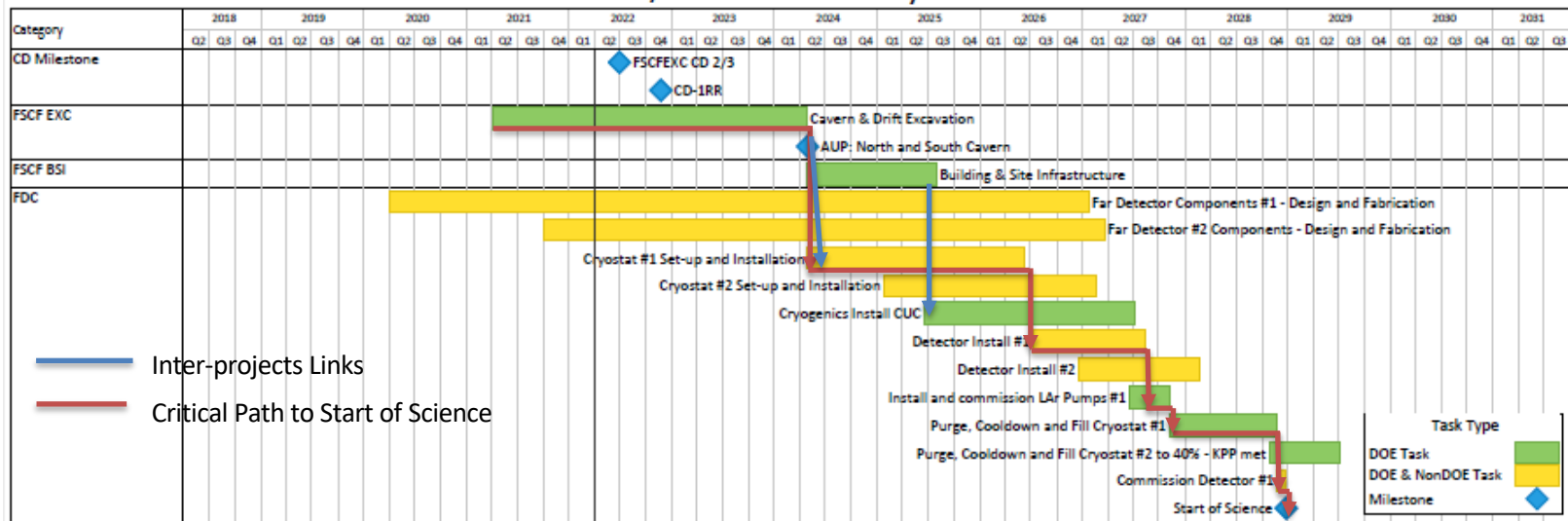
CD-1RR Funding Profile

- Point estimate and Range developed using new CD-1RR profile
- DOE Office of Science committed to this profile
- We continue to look for opportunities to advance Near-site work



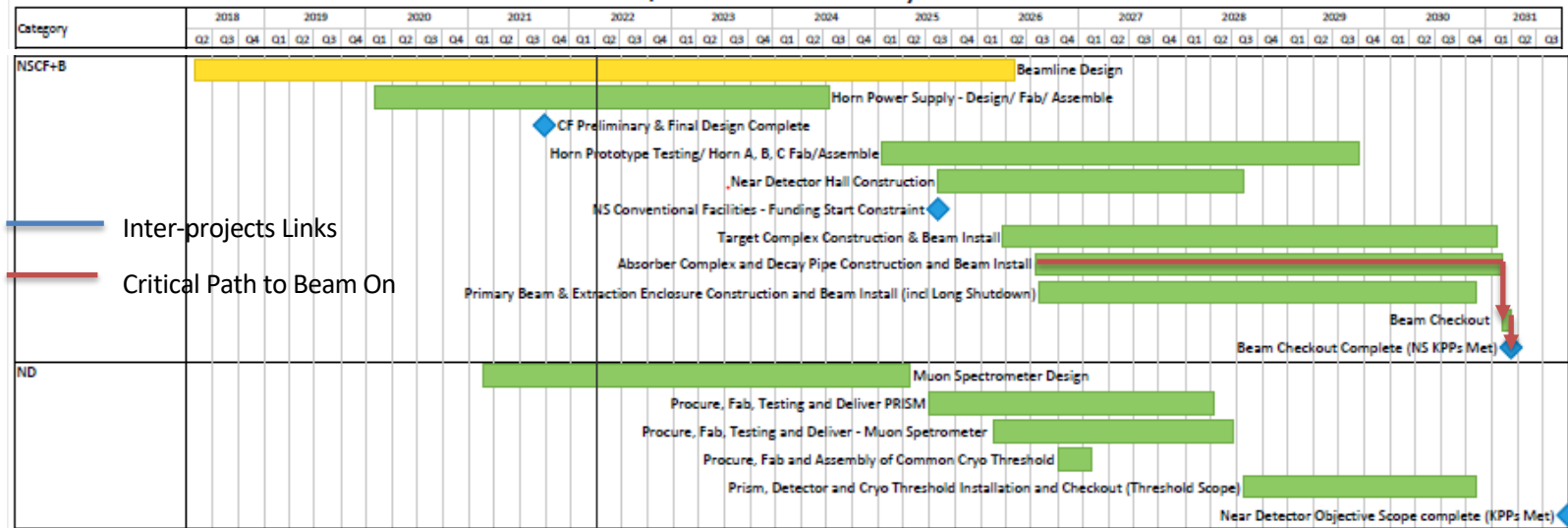
	Prior	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	Total
Reference Profile	772	180	180	200	225	250	250	250	250	250	250	74	3,131
CD-1RR Profile	772	184	180	255	305	305	305	305	275	245	0	0	3,131
Difference	0	4	0	55	80	55	55	55	25	-5	-250	-74	0

Schedule Far Site



- Interproject links between FS subprojects allow for schedule changes in one subproject to reflect impacts to follow-on projects.
- Far Site is technically limited, proceeding to completion of detector #1 (start of science) and the FD2 KPPs as soon as possible.
- The Critical Path is detailed, well understood and has been consistent for the past few years

Schedule Near Site



- Near Site work is funding constrained with Civil Construction work beginning in mid-2025. The ND team continues to work to optimize the installation plan in conjunction with defining the objective scope.
- The Critical Path to Beamline completion is well understood and is funding constrained. To optimize available funding, work has been sequenced so the Target Complex and Absorber Complex complete about the same time.

CD1-RR July 2022

CD1-RR passed with very positive assessment, opening the baselining of the Far Detector excavation and of the Surface Infrastructure.

Next milestone:

CD2-3A for the Far Detector Horizontal and Vertical Drift Modules

The successful outcome of the CD1-RR contribute a lot in reaffirming the top priority of LBNF/DUNE at Snowmass.

DUNE Current Schedule

Phase I (up to ~200 kt-MW-yrs):

- Two far detectors: FD1-HD (LAr TPC Horizontal Drift), FD2-VD (LAr TPC Vertical Drift)
- Near detector = ND-LAr + TMS (Temporary Muon Spectrometer) + SAND + PRISM movement
- 1.2 MW beam power
- Beneficial occupancy of the Near Detector Hall in Q1-2028
- Data taking at the Far Detector starting in **Q4-2028**
- Data taking on LBNF beam starting by **Q4-2030/Q1-2031**

Phase 1 Physics Goals

Oscillation Physics:

- Definitive resolution of the mass ordering
- Sensitivity to maximal CP violation ($\delta_{CP} \sim \pm \pi/2$)
- World-leading measurement of mass splitting (Δm_{21}^2)

+

- Supernova neutrinos
- Atmospheric neutrinos
- Nucleon decay
- BSM signals (steriles, non standard interactions, etc)

+

- A large number of measurements with the ND complex

Nu_at_FNAL in DUNE

Far Detector- Photon Detection System current and future activities (see Francesco's talk)

- 40 PDS systems for ProtoDUNE Run II ready
- SiPM tender underway
- Assembly of the ProtoDUNE II (Horizontal Drift)
- Start of the SiPM mass test
- Leadership position in the PDS of the Vertical Drift Module
-
-

Nu_at_ FNAL in DUNE

Near Detector- SAND (see Luca's talk)

- Structured the SAND group in formal subgroups
- Started KLOE dismounting
- Magnet systems revamping + test procedures
- Specifications of the calorimeter new FEE
- Design and prototype work on the Straw Tube Target Tracker
- Design and prototype work on GRAIN (LAr read out optically)
- Continue simulation and analysis work
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Nu@FNAL in ICARUS (Bo, Ge, LNS, MiB, Mi, Pd

Activities in 2021-2022)

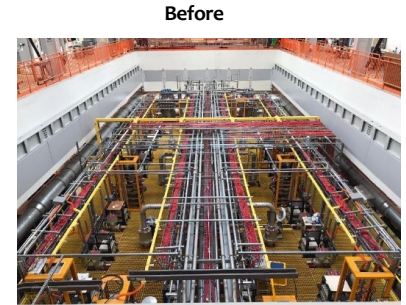
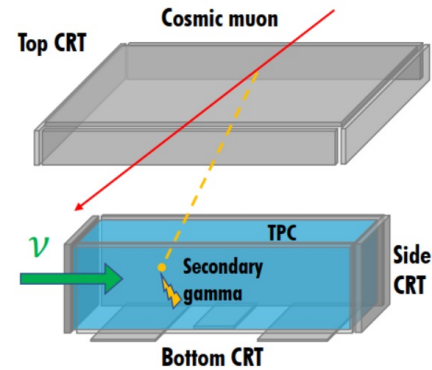
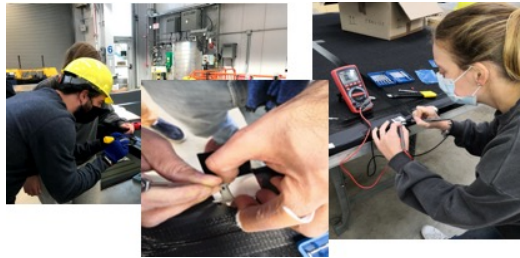
- Installation and commissioning of the Top Cosmic Ray Tagger (CRT);
- Data analysis and software development: CRT-PMT-TPC matching;
- Reconstruction optimization for track and shower by TPC signals;
- Visual TPC Event Scanning;
- Slow Control system (PMT and CRT);
- Data Production and Management;
- DAQ System maintenance and updates;
- Remote shift: 20% of the total;
- Shift support (Top CRT and DAQ experts, shifter help);
- Run coordination;

Coordination Roles:

- Run Coordinators (F. Poppi Feb-May 2022, V. Pia Jun-Sept 2022)
- DAQ Coordinator (L. Pasqualini)
- TPC Reconstruction Working Group co-convener (L. Stanco, A. Campani)
- CRT Working Group co-convener (L. Patrizzii, G. Sirri)
- ICARUS Data Management at CNAF (M. Tenti)

Top CRT Installation and Commissioning

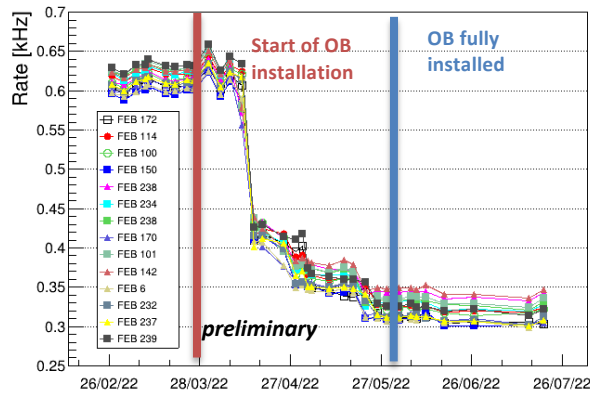
- Top CRT: 123 modules $\sim 2 \times 2 \text{ m}^2$
(84 horizontal modules and 39 vertical modules)
- Installation at Fermilab: September – December 2021



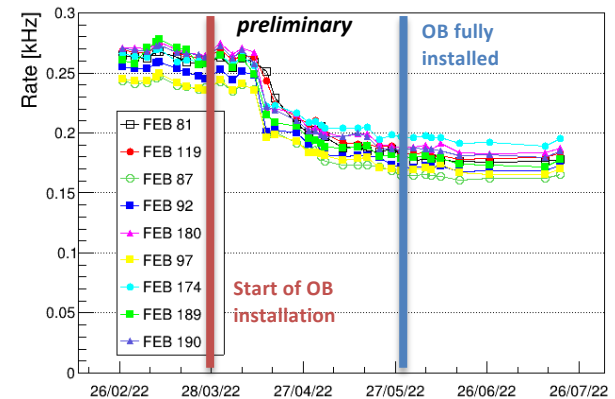
- Team at FNAL:
L. Degli Esposti, D. Di Ferdinando, L. Pasqualini, G. Pellegrini, V. Pia, F. Poppi, V. Togo, D. Casazza, M. Vicenzi, L. Di Noto
support from remote: S. Bertolucci, A. Montanari, L. Patrizii, M. Pozzato, G. Sirri

Commissioning/1

- Integration in the common Data Taking: February 2022
- Rate monitoring (before and after $\sim 3\text{m}$ concrete overburden installation): horizontal/vertical Top CRT rates decreased from 600/250 Hz to 330/180 Hz, in agreement with the expected cosmic rate



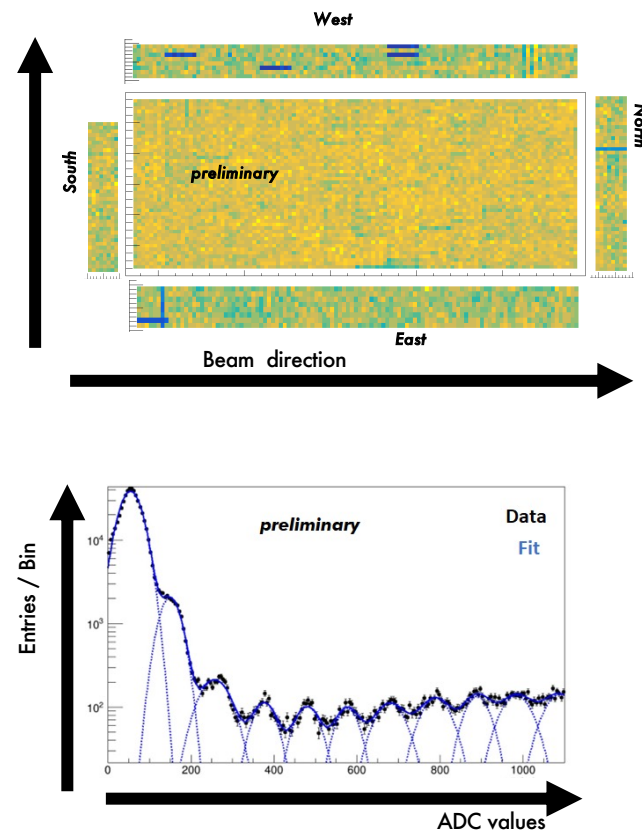
horizontal modules



vertical modules

Commissioning/2

- CRT Hit reconstruction: position, timing and charge amplitude for the CRT Hits
- Channel to channel calibration of the Top CRT to extract pedestal and gain values

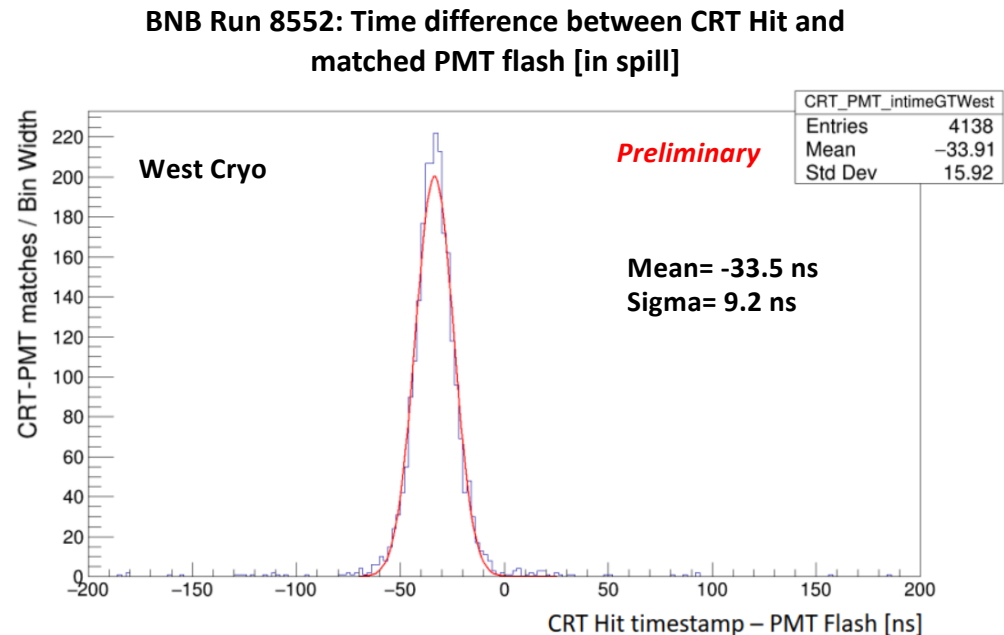


CRT-PMT matching

- CRT timing calibration:
Global Trigger is used as common time reference for CRT Hits and PMT flashes.

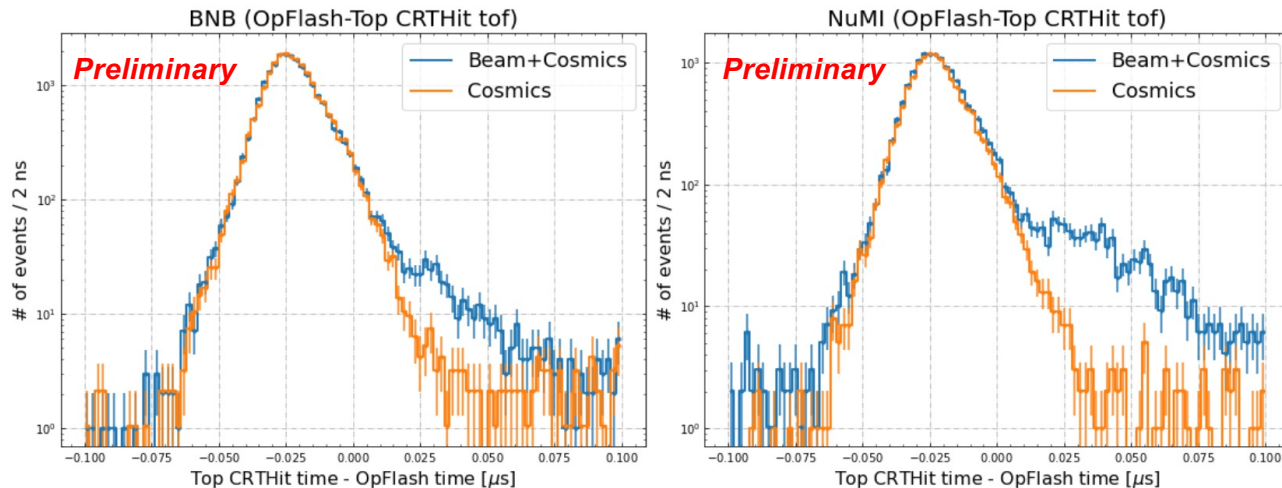
This is achieved by:

- Accurate measurement of the time delay along the CRT signal acquisition and timing distribution lines (cable delays, light propagation in the scintillator fibre)
- PMT optical flashes delay measurement



CRT-PMT Matching: Time of Flight Measurement

- CRT-PMT matching performed on BNB, NuMI and OffBeam data samples.
- Improved timing evaluation by additional corrections on PMT flashes.



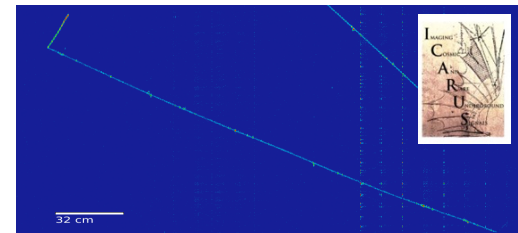
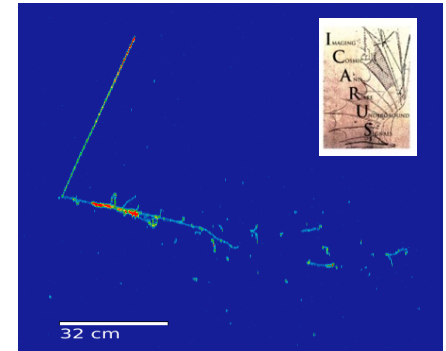
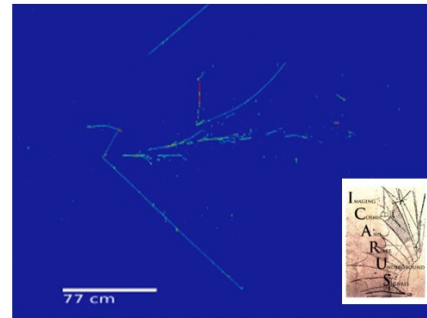
TPC reconstruction Working Group

(A.Campani co-chair, S. Di Domizio, L. Di Noto)

- Development and optimization of the reconstruction chain from the TPC signal to the neutrino event
- study of track and shower reconstruction efficiency in MC and data
- identification of the pathologies in the track and shower reconstruction
- improvement of Pandora algorithms for track and shower reconstruction
- tuning of Boosted Decision Tree algorithm in Pandora for the track/shower identification

Event scanning

- A visual event scanning campaign performed to create a neutrino candidates dataset to tune reconstruction algorithms.
- Visual scanners:
D. Di Ferdinando (Bo), L. Pasqualini (Bo), F. Poppi (Bo), V. Togo (Bo), B. Bottino (Ge), A. Campani (Ge), S. Copello (Ge), L. Di Noto (Ge), M. Vicenzi (Ge)



Slow Control system

Slow control interface for CRT Front End Boards power supply monitoring/control.

CRT power
supply channels



CRT Power Monitor Open Power Control

TOP Invalid index : -1 must Updated: 2022-04-13 09:09:25

Channel	Location	Power	V read [V]	I read [A]	Temp [C]	Status	V set [V]	Ramp Rate [V/s] Up Down	Current Limit [A]	Current Superv. Limit [A]
00	pl01	<input type="checkbox"/>	5.202	6.193	30	On	5.200	1000.0 100.0	9.00	10.00
01	pl02	<input type="checkbox"/>	5.201	6.316	27	On	5.200	1000.0 100.0	9.00	10.00
02	pl03	<input type="checkbox"/>	5.202	6.208	29	On	5.200	1000.0 100.0	9.00	10.00
03	pl04	<input type="checkbox"/>	5.199	6.246	25	On	5.200	1000.0 100.0	9.00	10.00
04	pl05	<input type="checkbox"/>	5.202	6.218	29	On	5.200	1000.0 100.0	9.00	10.00
05	pl06	<input type="checkbox"/>	5.201	6.854	26	On	5.200	1000.0 100.0	9.00	10.00
06	pl07	<input type="checkbox"/>	5.201	6.756	28	On	5.200	1000.0 100.0	9.00	10.00
07	pl08	<input type="checkbox"/>	5.217	6.254	26	On	5.220	1000.0 100.0	9.00	10.00
08	pl09	<input type="checkbox"/>	5.201	6.200	28	On	5.200	1000.0 100.0	9.00	10.00
09	pl10	<input type="checkbox"/>	5.201	6.276	26	On	5.200	1000.0 100.0	9.00	10.00
10	unused	<input type="checkbox"/>	0.035	0.052	25	Over Current				
11	pl11	<input type="checkbox"/>	5.201	6.269	26	On	5.200	1000.0 100.0	9.00	10.00

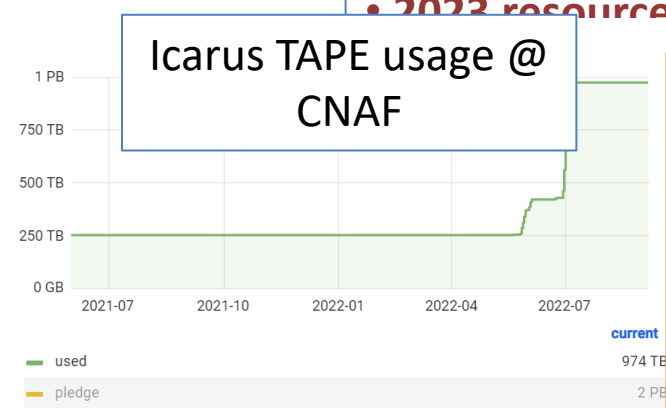
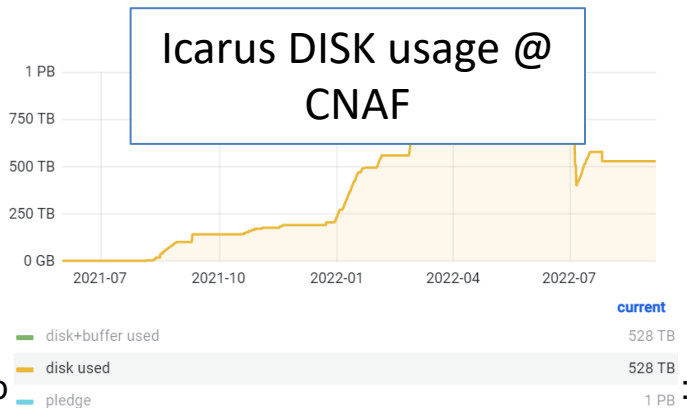
Data Production and Management

- Active contribution to official ICARUS MC production in the context of the ICARUS Production Team's activities
- Responsibility of the FNAL -> CNAF data transfer and CNAF data management

- Transfer tool: [rucio-uploader](#)

CNAF

- **2022 computing resources:**
4000 HS; 1 PB (DISK); 2 PB (TAPE)
- **2023 resources increment:**



All **NuMi** and **BNB** raw data of 2021 and 2022 runs have been transferred to CNAF

- Setup
 - Documentation: wiki.infn.it/progetti/icarus/home

In Summary

- **Nu_at_FNAL is undergoing its phase transition from the design phase to construction**
- **The group continues to grow in term of participating INFN sections and in FTE**
- **The spending profile is globally stable (see progress report)**
- **We will have a very busy 2023, the interaction with of our referees and with CSN II will play a key role for our progress**

THANK YOU