

Status of the Technical Design Report (TDR) for SAND in the ND complex

Paolo Bernardini

SAND general meeting

March 26, 2024



UNIVERSITÀ
DEL SALENTO
L'Ateneo tra i due mari



The SAND-TDR is organized in 16 sections

Overleaf is used to collect text and figures

I will present:

- status of each section,
- people in charge,
- possible contributions

Am I aware of all available material ?

1.1	Introduction and Overview	1
1.1.1	Physics Motivations	1
1.1.2	Requirements	2
1.1.3	Opportunities for SAND	2
1.1.4	Setup	2
1.1.5	Simulated Performance	2
1.1.6	Background Removal	2

Tentative index + keywords (written by me)

Waiting for the results of the task force

1.2	Lead/Scintillating-Fiber Calorimeter (ECAL)	3
1.2.1	Electromagnetic calorimeter (ECAL) Design and Structure	3
1.2.2	Performance in KLOE and KLOE-2 Experiments	5
1.2.3	Requirements for DUNE near detector (ND)	5
1.2.4	ECAL Calibration and Monitor System	5
1.2.5	ECAL Electronics	5
1.2.6	ECAL Dismounting Procedures	6
1.2.7	ECAL Revamping and Test before SAND Installation	7
1.2.8	ECAL Installation & Integration	7
1.2.9	Commissioning	7
1.2.10	Schedule and Milestones	7

Tentative index + keywords

Written (+ figure) : § 1.2.1, § 1.2.1.1,
 § 1.2.1.2, § 1.2.1.3
 § 1.2.5.3, § 1.2.6

Other texts are ready (not on overleaf)

In charge:

**A. Di Domenico
 D. Domenici**

Present contributions by:

**P. Bernardini
 A. Miccoli
 M. Panareo**

Possible contributions by:

ECAL working group

1.3	The Superconducting Magnet	8
1.3.1	Magnet Specification	8
1.3.2	Magnet Maintenance and Revamping Options	8
1.3.3	Activities at Laboratori Nazionali di Frascati (LNF)	8
1.3.4	Installation & Integration at Fermi National Accelerator Laboratory (Fermilab) .	8

Tentative index + keywords

In charge:

G. Delle Monache

Possible contributions by:

ECAL working group

A. Vannozzi

1.4	LAr Active Target (GRAIN)	10
1.4.1	Introduction and Physics Requirements	10
1.4.2	Mechanical Design	10
1.4.3	Optical Detector	10
1.4.4	Electronics	10
1.4.5	Data Acquisition and Slow Control System	10
1.4.6	Neutrino Event Reconstruction	10
1.4.7	Calibration System	11
1.4.8	Cryogenic System	11
1.4.9	First Commissioning in <u>Laboratori Nazionali di Legnaro (LNL)</u>	11
1.4.10	Integration and Installation in <u>SAND</u>	11

Tentative index + keywords

In charge: **L. Di Noto**
A. Montanari

Overleaf clone

Possible contributions by: **GRAIN working group**

ASIC document is available

1.5	Tracker	12
1.5.1	Straw tube tracker (STT)	12
1.5.2	Drift chamber	13
1.5.3	Gas system	13

Tentative index + keywords

In charge: R. Petti
G. Sirri
S. Di Falco

Possible contributions by: tracker WG

Detail of 1.5.1

- 1.5.1.1 A Compact Modular Design
- 1.5.1.2 Nuclear and "Solid" Hydrogen Targets
- 1.5.1.3 Engineering Model
- 1.5.1.4 Technology and Performance
- 1.5.1.5 System Integration
- 1.5.1.6 Electronic Readout
- 1.5.1.7 Cooling System
- 1.5.1.8 Data Acquisition and Slow Control
- 1.5.1.9 Prototyping and Tests
- 1.5.1.10 Gas System
- 1.5.1.11 Fabrication and Installation
- 1.5.1.12 Commissioning
- 1.5.1.13 Calibration and Monitoring
- 1.5.1.14 Detector Performance

1.6	Data acquisition (DAQ) Architecture	14
1.6.1	DAQ Interfaces	14
1.6.2	Synchronous Interfaces	14
1.7	Detector Control (DCS)	14
1.7.1	DCS Devices	15
1.7.2	DCS Unifying Standards	15
1.7.3	Detector Operation	16
1.7.4	Basic and Advanced Operations	16
1.7.5	DAQ-DCS Interfaces	17
1.8	Detector Safety Systems (DSS)	17
1.8.1	DSS Devices	18
1.8.2	DSS Control Hardware	18
1.8.3	DSS Rack	19

Tentative index + keywords

Written (+ figure) : § 1.6, § 1.6.1, § 1.6.1.2
 § 1.7, § 1.7.1, § 1.7.2, § 1.7.3, § 1.7.4
 § 1.8, § 1.8.1, § 1.8.2, § 1.8.3

In charge: S. Di Domizio
 C. Mariani
 N. Tosi

Possible contributions by: DAQ working group

1.9	Software and Computing	21
1.9.1	Code	22
1.9.2	Simulations	22
1.9.3	Reconstruction (Algorithms)	22
1.9.4	Data Formats	22
1.9.5	Computing resources	22
1.9.6	Visualization	23
1.9.7	Integration	23

Tentative index + keywords

In charge: M. Tenti

Possible contributions by: software WG

1.10	Event Reconstruction (Performance)	24
1.10.1	Single Particle Reconstruction	24
1.10.2	Particle Identification	27
1.10.3	Neutrino Interaction Identification in the Spill	28
1.10.4	Event Reconstruction in GRanular Argon for Interactions of Neutrinos (GRAIN)	28
1.10.5	Tracker and ECAL Acceptance for Muons, Protons, Pions	28
1.10.6	Event Reconstruction in STT	28
1.10.7	Neutrino Energy Reconstruction in Inclusive charged current (CC) Events	28

Tentative index + keywords

In charge: **M. Tenti**
A. Surdo

Written (+ figure) : § 1.10.1,
§ 1.10.1.2, § 1.10.1.3,
§ 1.10.1.4, § 1.10.1.5

Possible contributions by: **software WG**

1.11 Analysis	29
1.11.1 Selection of CC Interactions	29
1.11.2 Measurements of $\nu(\bar{\nu})$ -Hydrogen Interactions	29
1.11.3 Determination of Relative and Absolute Fluxes	29
1.11.4 Constraining the Nuclear Smearing in Ar	29
1.11.5 ν -e Elastic Scattering	29
1.11.6 Coherent π^\pm Production	29
1.11.7 ν_e/ν_μ & $\bar{\nu}_e/\bar{\nu}_\mu$ Flux Ratios	29
1.11.8 On-Axis Beam Monitoring	29
1.11.9 External Backgrounds	29

Tentative index + keywords

In charge: **M. Tenti**
A. Surdo

Possible contributions by: **software WG**

1.12	Installation & Integration	30
1.12.1	Organizational Structure and Sharing of Responsibilities	30
1.12.2	Transport and Handling	30
1.12.3	Experimental Hall and Facilities	30
1.12.4	Cryogenics and Gas Distribution	30
1.12.5	Installation Sequence	30
1.12.6	Critical and Special Lifts	30
1.12.7	Commissioning	30
1.12.8	Safety	31
1.12.9	Risk Matrix and Risk Management	31

Tentative index + keywords

In charge: C. Montanari

Possible contributions by:
ECAL, GRAIN, TRACKER ... WGs



1.13 Safety	32
1.13.1 Applicable Codes and Standards	32
1.13.2 Organizational Structure	32
1.13.3 ORC List	32
1.13.4 Risk Matrices	32
1.13.5 Risk Mitigation and Management	32

Tentative index + keywords

In charge: C. Montanari

Looking for an INFN-FNAL person



1.14 Organization & Management	33
1.14.1 Contribution by Fermilab	34

Tentative index + keywords

In charge:
S. Bertolucci
L. Patrizii
L. Stanco

Written: § 1.14

1.15 Time Schedule	35
1.15.1 Resource-Loaded High Level Schedule	35
1.15.2 Working Groups Specific Resource-Loaded Schedules	35
1.15.3 Milestones	35
1.15.4 Schedule-Related Risks	35
1.15.5 Schedule-Related Risk Mitigation and Management	35

Tentative index + keywords

In charge:
S. Bertolucci
C. Montanari
L. Patrizii
L. Stanco



1.16 Possible Upgrades	37
1.16.1 GRAIN Charge Readout	37
1.16.2 New Targets	37

Tentative index + keywords

In charge: **A. Montanari**

Contribution about new targets ?

Glossary	38
References	42
Editing in order to respect the DUNE-TDR template	

In progress,
when new material is
available on overleaf

In charge: **P. Bernardini**

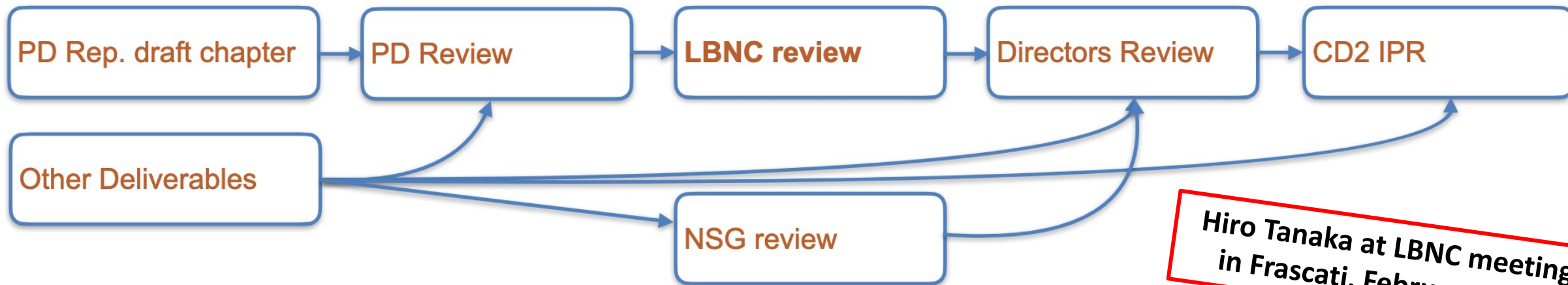


SUMMARY

- ~ 1.5 month since the start of the TDR activity
- Present TDR draft in the indico site of this meeting
- Some text and some plot in few sections: ECAL
DAQ-DCS-DSS
Event Reconstruction
Management
- Only preliminary index and keywords in the other sections
- Other text and figures in preparation ? Not in overleaf ?
- The overall status is worrying
- A strong commitment is needed

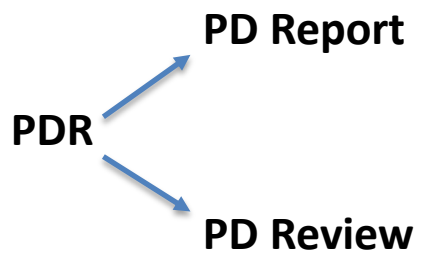
REMIND
June, first review (ECAL+magnet)
December, first TDR draft

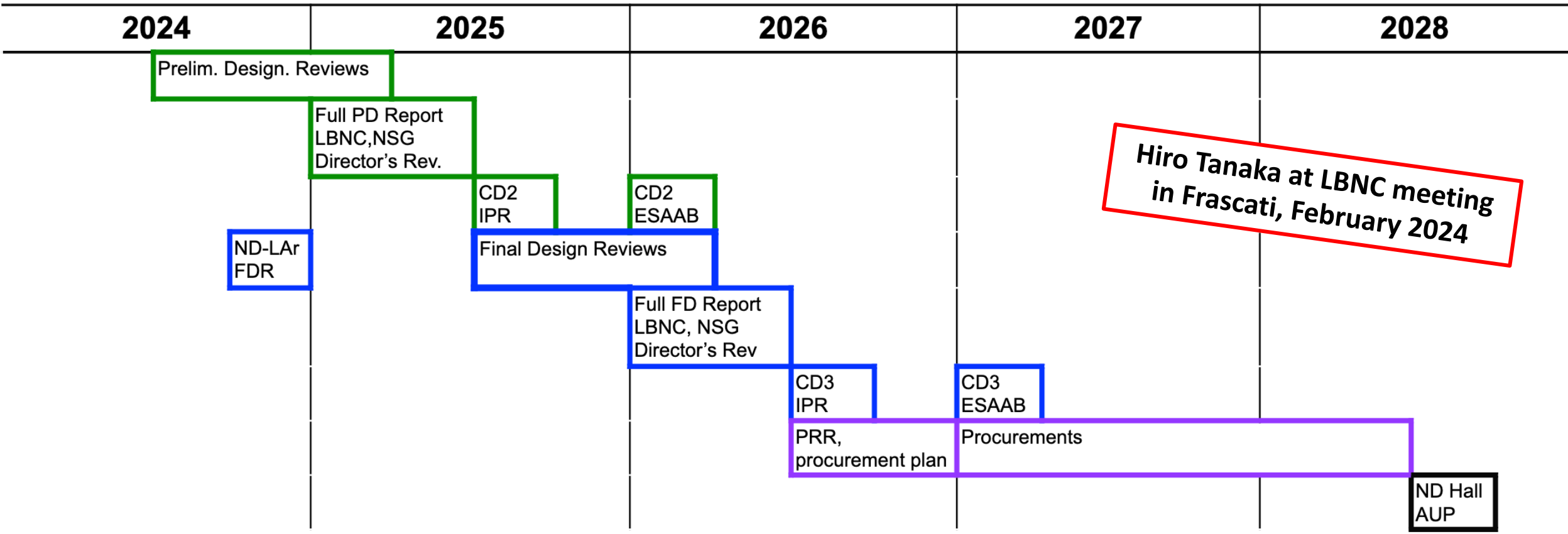
OLD SLIDES



**Hiro Tanaka at LBNC meeting
in Frascati, February 2024**

Preliminary design report is “preliminary” version of the technical design report
 The technical design report is finalized in the final design/CD3 process as a “final design report”





- Preliminary design reviews to be carried out in mid 2024-early 2025
 - Requires draft PDR chapters as input
 - Revised PDR chapters following review submitted to LBNC for review

PROCESS: REQUIREMENTS

- It all starts with the physics . . .
 - Articulated as requirements for the Near Detector
- Revamp/articulate requirements for the DUNE Near Detector
 - Joint activity between DUNE near detector consortia and physics working group
- Needs:
 - Further refinement of long-baseline requirements
 - Extension to cover cross section and exotic physics
 - Role of SAND beyond “beam monitoring”
- Goals:
 - Revised requirements to be approved at May 2024 DUNE collaboration meeting by Executive Board
 - Present to LBNC at next meeting (June 2024)

Chair: Mike Kordosky

• Physics Working Groups

- Long Baseline: L. Pickering
- Cross Sections: L. Muntenau
- Exotics: J. Justo-Albo
- Computing/Software: M. Muether

• ND consortia:

- ND-LAr: P. Ochoa Ricoux
- TMS: D. Naples
- SAND: M. Tenti

**Hiro Tanaka at LBNC meeting
in Frascati, February 2024**

Hiro Tanaka at LBNC meeting
in Frascati, February 2024

	Chapter Draft	Design Review	Ready for LBNC
Intro/Physics	Jun 24	N/A	Jul 24
ND-LAr (final)	Nov 24	Dec 24	Feb 25
TMS	Nov 24	Jan 25	Feb 25
SAND*	Jun 24-Feb 25	Jul 24-Mar 25	Apr 25
ND-LAr Cryostat	Jun 24	Jul 24	Aug 24
NS Cryogenics	Jun 24	N/A	Aug 24
DUNE-PRISM	Nov 24	Dec 24	Jan 25
ND DAQ	Nov 24	Jan 25	Feb 25
ND Slow Control			Feb 25
ND I&I	Nov 24	Dec 24	Jan 24

* SAND will divide process into KLOE-2-SAND, Tracker, GRAIN, Integration

More details

Preliminary Design Review

Jul 2024
Nov 2024
Dec 2024/Jan 2025
Mar 2025

topics

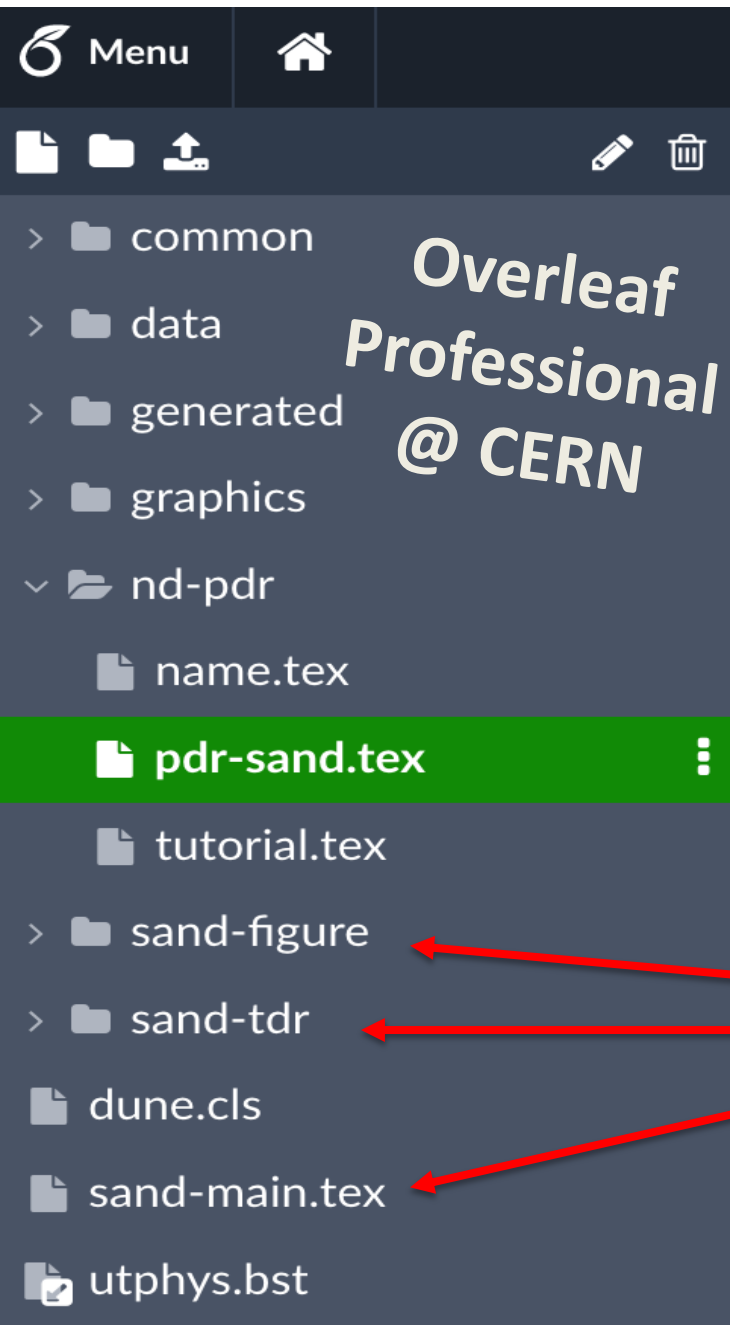
ECAL + magnet
I & I
GRAIN
Tracker

Review of TDR chapter draft

Jan 2025
Feb 2025
Mar 2025

reviewer

SAND consortium
DUNE collaboration
LBNC



Overleaf
Professional
@ CERN

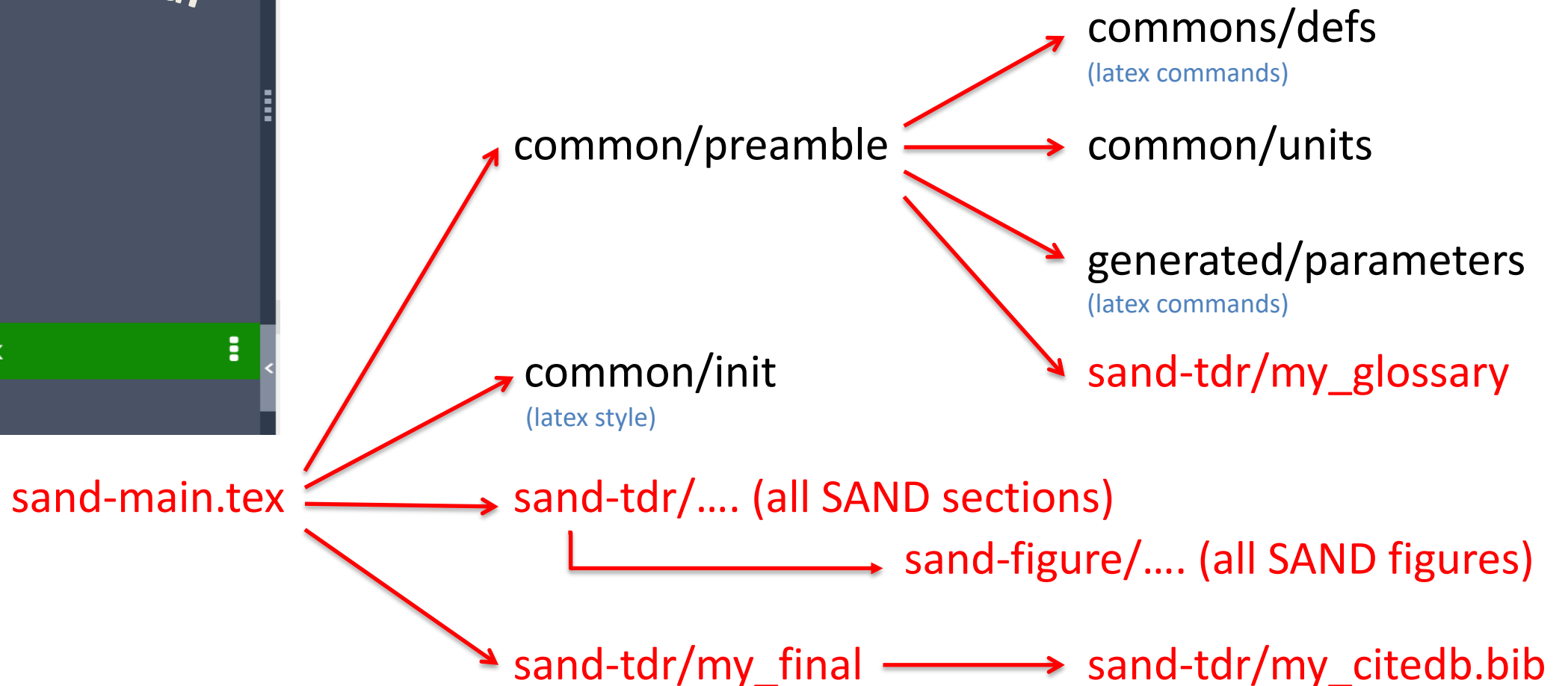
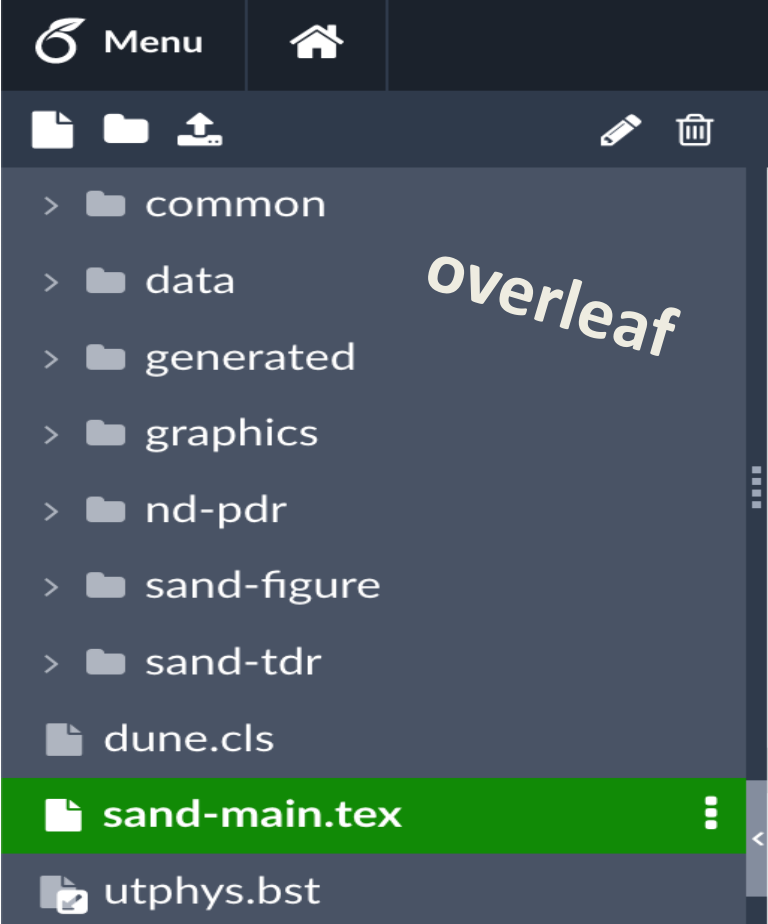
Neutrino Experiment (DUNE) Near
Detector Conceptual Design Report.
Instruments **2021**, 5, 31.
[https://doi.org/10.3390/
instruments5040031](https://doi.org/10.3390/instruments5040031)

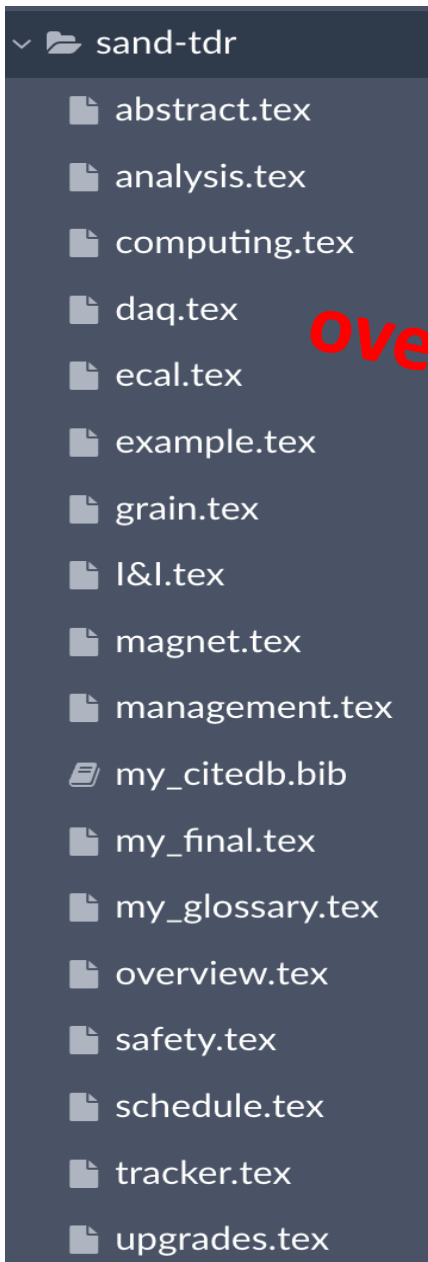
old CDR text

new for SAND TDR

Overleaf owner P.B.

**Other colleagues share
(or will share) this overleaf**





Present: index + key words (+ also some text)

sand-tdr/overview

sand-tdr/ecal

sand-tdr/magnet

sand-tdr/grain

sand-tdr/tracker

sand-tdr/daq (3 sections)

sand-tdr/computing

sand-tdr/analysis (2 sections)

sand-tdr/I&I

sand-tdr/safety

sand-tdr/management

sand-tdr/schedule

sand-tdr/upgrades

?? task force

A. Di Domenico + D. Domenici

G. Delle Monache

L. Di Noto + A. Montanari

R. Petti + G. Sirri + S. Di Falco

C. Mariani + S. Di Domizio + N. Tosi

M. Tenti + A. Surdo

M. Tenti + A. Surdo

C. Montanari

C. Montanari + ?? INFN-FNAL people

L. Stanco + S. Bertolucci + L. Patrizii

C. Montanari + L. Stanco + S. Bertolucci

??

Possible other sections:

- mechanics (ECAL + GRAIN + tracker)

- muon catcher

Many many rules/instructions in the writing of DUNE documents :

<https://github.com/DUNE/document-guidance/releases/>

Latex structure

<https://ctan.mirror.garr.it/mirrors/ctan/macros/latex/contrib/siunitx/siunitx.pdf>

units

<https://dune.bnl.gov/docs/technical-proposal/dune-words.pdf>

DUNE words

<https://ctan.mirror.garr.it/mirrors/ctan/macros/latex/contrib/glossaries/glossaries-user.pdf>

glossary

An almost synthetic guidance (49 pages)

<https://dune.bnl.gov/docs/guidance.pdf>

Help by Anne Heavey, scientific editor at FNAL



Anne Heavey

Scientific editor
Fermilab, United States

Instruction 1

Labels to identify a section

Examples

chapter	1	<code>\label{ch:sand}</code>
section	1.4	<code>\label{sec:sand-grain}</code>
subsection	1.4.3	<code>\label{sec:sand-grain-detect}</code>
subsubsection	1.4.3.1	<code>\label{sec:sand-grain-detect-mask}</code>
subsubsection	1.4.3.2	<code>\label{sec:sand-grain-detect-lens}</code>



3.9.1.1 A Subsubsection

This is a subsubsection.

3.9.1.2 A Second Subsubsection



Remember, if you have one, you need at least one more.

Avoid sub-sub-sub-section (when possible)

Instruction 2



- 1.9.2 Simulations**
- 1.9.2.1 Neutrino Fluxes**
- 1.9.2.2 Geometry**
- 1.9.2.3 Event Generator**
- 1.9.2.4 Overlays**
- 1.9.2.5 Particle Propagation**
- 1.9.2.6 Detector Simulation**
- 1.9.2.6.1 ECAL**
- 1.9.2.6.2 GRAIN**
- 1.9.2.6.3 Tracker**



- 1.9.2 Simulations**
- 1.9.2.1 Neutrino Fluxes**
- 1.9.2.2 Geometry**
- 1.9.2.3 Event Generator**
- 1.9.2.4 Overlays**
- 1.9.2.5 Particle Propagation**
- ~~**1.9.2.6 Detector Simulation**~~
- 1.9.2. 6 ECAL simulation**
- 1.9.2. 7 GRAIN simulation**
- 1.9.2. 8 Tracker simulation**

Instruction 3

The string of percent signs just makes it easier to spot where new sections (or subsections) start

%%%%%%%%%

```
\subsection{Magnet Specification}\label{sec:sand-magn-specif}
- Experimental requirements ...\\
- Coil parameters (operation current, stored energy ...)\
- Nominal magnetic field map ...
```

%%%%%%%%%

```
\subsection{Magnet Maintenance and Revamping Options}\label{sec:sand-magn-revamp}
- Status\\
- Subsystems and components maintenance\\
- Obsolete or aged subsystems and components to be replaced\\
- New power supply (CAEN ELS)\
- Power Electronics (OCEM)\
- Quench detector (?)\
- Control system
```

%%%%%%%%%

```
\subsection{Activities at LNF}\label{sec:sand-magn-activ}
- Procurement of the cryogenic systems and materials for magnet cool down\\
- Magnet full operational test (full support for test/dismount/remount by ASG ?)\
- Coil cool-down\\
- Magnet energizing test\\
- Coil Cryostat extraction\\
- Magnet turret removal\\
- Dismounting of Iron Yoke\\
- Tools, Packaging \& Shipping to \gls{fnal}
```

Instruction 4

All the main words in headings
are capitalized



- 1.4.5 Data acquisition and slow control system
- 1.4.6 Neutrino event reconstruction
- 1.4.6.1 Algorithms for track reconstruction with lens images



- 1.4.5 Data Acquisition and Slow Control System
- 1.4.6 Neutrino Event Reconstruction
- 1.4.6.1 Algorithms for Track Reconstruction with Lens Images

Glossary

 my_glossary.tex

Instruction 5

**Insert new DUNE words and new DUNE abbreviations
at the end of this file**

Check if the word is already present

To define a DUNE term that has no abbreviation use:

```
\newduneword{label}{term}{description}
```

To define a DUNE term with an abbreviation use:

```
\newduneabbrev{label}{abbrev}{term}{description}
```

Examples

```
\newduneword{detmodule}{detector module}{The entire DUNE far detector is segmented into four modules, each with a nominal  $\SI{10}{\kton}$  fiducial mass}
```

```
\newduneabbrev{adc}{ADC}{Analog Digital Converter}{A sampling of a voltage resulting in a discrete integer count corresponding in some way to the input}
```

Bibliography

 my_citedb.bib

Insert references (bibtex format) at the end of this file

Check if the reference is already present

`\dfirst{fnal}` first time Fermi National Accelerator Laboratory (Fermilab)

`\dword{fnal}` following times Fermilab

More informations in the glossary

Fermi National Accelerator Laboratory (Fermilab) U.S. national laboratory in Batavia, IL. It is the laboratory that hosts Deep Underground Neutrino Experiment (DUNE) and serves as its near site. [1](#)

`\dfirst{nd}` near detector (ND) *with link*

`\dword{nd}` ND *with link*

`\dlong{nd}` near detector *w/o link*

`\dshort{nd}` ND *w/o link*

`\dword` singular `\dwords` lower case & plural

`\Dword` capital `\Dwords` capital & plural

`common/units.tex` to define commands for units

Examples

“m” is written `\si{\meter}`

bare units

“V” is written `\si{\volt}`.

“123.456” is written as `\num{123.456}`.

bare numbers

“ $1 \pm 2i$ ” is written as `\num{1+-2i}`.

“ 3×10^{45} ” is written as `\num{3e45}`.

“ 0.3×10^{45} ” is written as `\num{.3e45}`

“120 GeV” is written as `\SI{120}{\GeV}`,

numbers and units

“4850 ft” is written as `\SI{4850}{\ft}`,

`common/defs.tex` to define new commands

Examples

$\bar{\nu}_e$ is written as `\anue`,

Δm_{21}^2 is written as `\dm{21}`,

$\sin^2 \theta_{13}$ is written as `\sinst{13}`,

$\nu_\mu \rightarrow \nu_\mu$ is written as `\numutonumu`,

$p \rightarrow K^+ \bar{\nu}$ is written as `\ptoknubar`,

Instruction 9

Figures

JPEG use for photographs

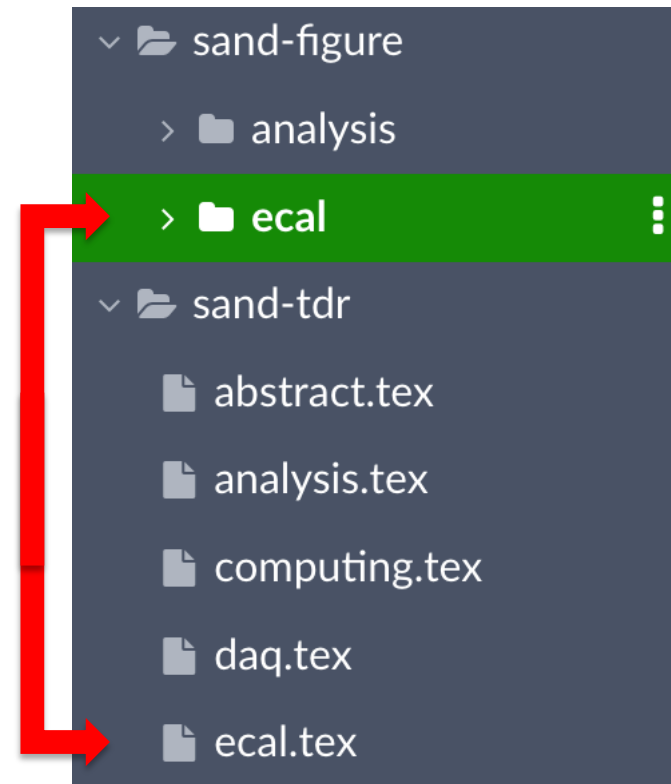
PDF use of any line drawings, plots, illustrations

PNG use due to some inability to produce proper JPEG or PDF (contact editors)

English

- Use American spelling: e.g., ionization (not ionisation), flavor (not flavour) and so on.
- In general, avoid use of first person (e.g., I, we, our). “We” may appear in introductory sections.
- Avoid use of second person, i.e., “you.”

folder for the figures
associated to each topic



SUMMARY

- A preliminary TDR index is available
(almost all sections have been implemented)
- An overleaf structure is ready
- The writing responsables have been appointed
(dedicated mailing list sand-tdr-mail@fnal.gov)
- Next steps
 - complete the index with tasks
 - begin to write
 - first review (ECAL+magnet) at June 2024 (4 months)
 - first TDR draft within December 2024 (10 months)
- Suggestions and contributions are welcome