

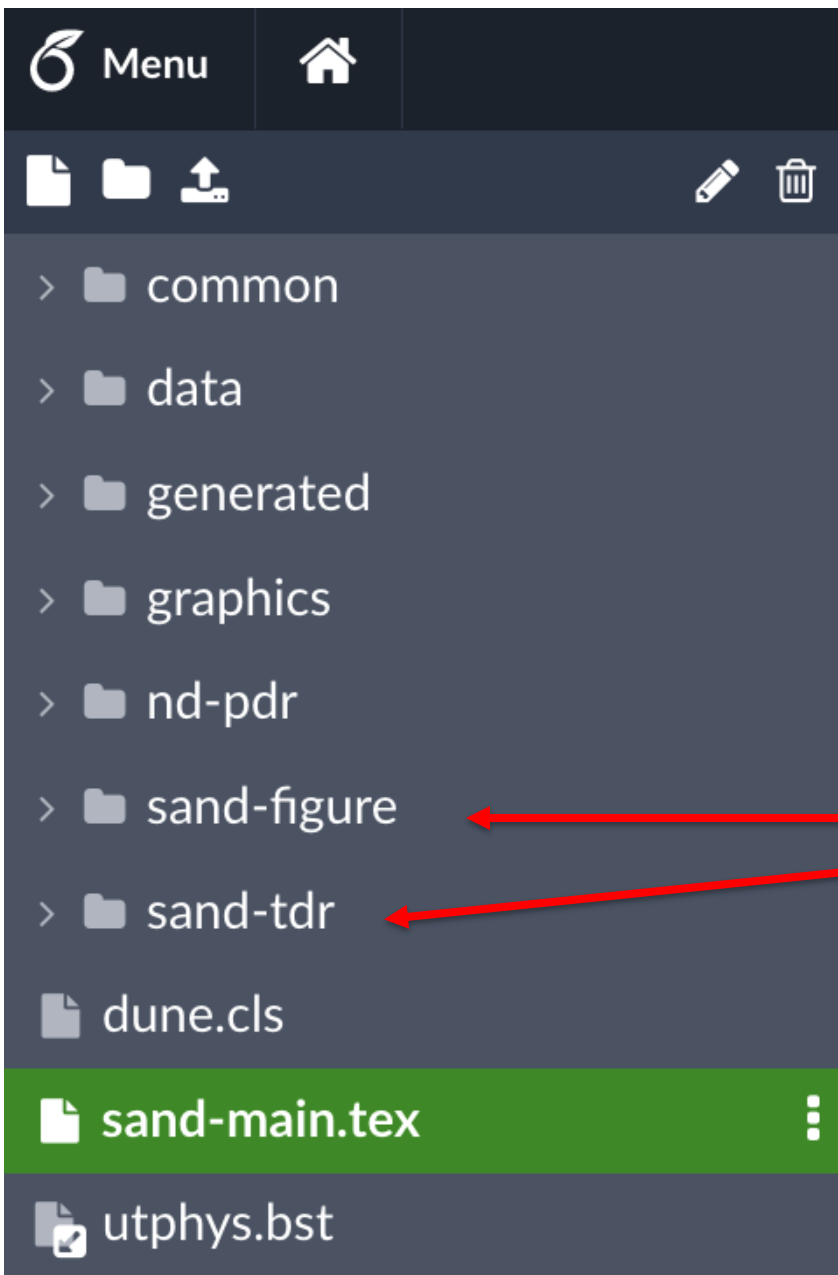
# The Technical Design Report (TDR) for SAND in the ND complex

Paolo Bernardini, Lecce, Italy  
DUNE Collaboration Meeting  
October 1<sup>st</sup>, 2024



UNIVERSITÀ  
DEL SALENTO  
L'Ateneo tra i due mari



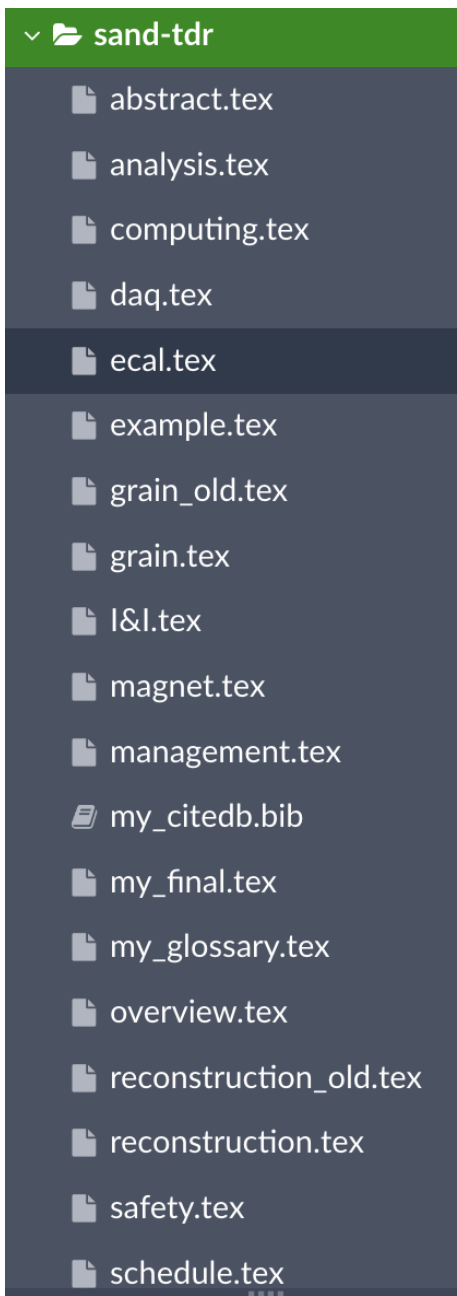


An overleaf is adopted according to  
LATEX conventions for LBNF/DUNE documents

shared with SAND people  
H.A. Tanaka (ND tech. coordinator)  
A.E. Heavey (scientific editor)

The figures in `sand-figure` and the files in `sand-tdr`  
are input for `sand-main.tex`

Dedicated overleaf for GRAIN  
and SOFTWARE Working Groups,  
periodically copied in main overleaf



# Sections in the SAND chapter

1. Overview (requirements & opportunities)
2. Lead/Scintillating-Fiber Calorimeter (ECAL)
3. Superconducting Magnet
4. Liquid Argon Active Target (GRAIN)
5. Tracker
6. Data Acquisition (DAQ) Architecture
7. Detector Control (DCS)
8. Detector Safety System (DSS)
9. Software & Computing
10. Event Reconstruction
11. Analysis
12. Installation & Integration
13. Safety
14. Organization & Management
15. Time Schedule
16. Possible Upgrades

my\_glossary.tex ← New DUNE words and new references in evidence (at the file end)  
my\_citedb.bib ←

1.1	Overview . . . . .		<u>1</u>
1.1.1	Requirements and SAND Role . . . . .		<u>2</u>
1.1.2	The Overall Design of SAND . . . . .	6 pages	<u>3</u>
1.1.3	Derived SAND Capabilities . . . . .		<u>4</u>
1.1.4	Opportunities for SAND . . . . .		<u>6</u>

Updated according to the task-force document  
(approved in DUNE general meeting, May 2024)

To do: careful reading and corrections (volunteers ?)

Possible improvements (mainly in Sec. 1.1.4)

1.2	Lead/Scintillating-Fiber Calorimeter (ECAL)	7
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1.2.5	ECAL Electronics	18
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1.2.7	ECAL Revamping and Test before SAND Installation	65
1.2.8	ECAL Installation & Integration	68
1.2.9	Risk Management	69
1.2.10	Schedule and Milestones	71

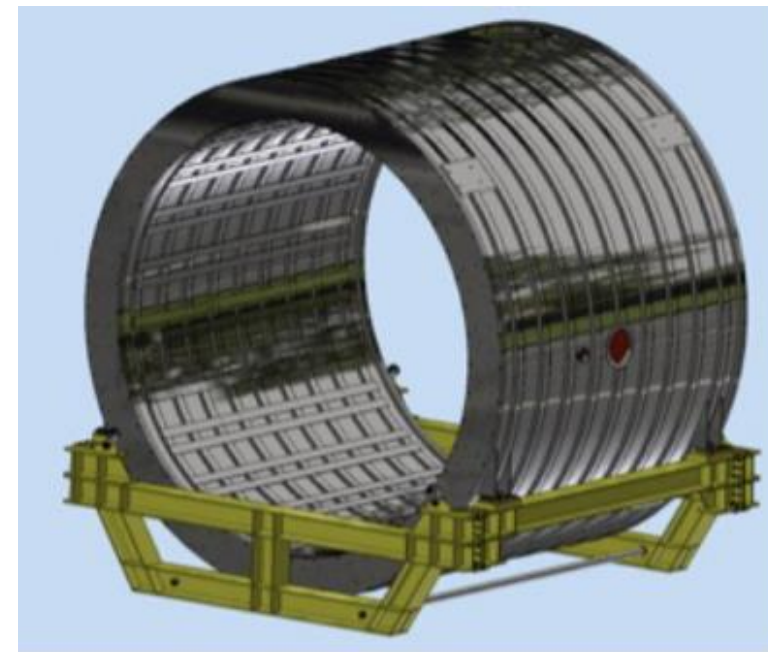
66 pages



- ✓ Draft available in time
- ✓ July 22-23, 2024 - Preliminary Design Review (PDR)
- To be updated according to recommendations
- Possible improvements (mainly in Sec.s 1.2.8, 1.2.9)
- Refinements expected within ~ 15 October

1.3	The Superconducting Magnet	73
1.3.1	Magnet Specification	73
1.3.2	Magnet Maintenance and Revamping Options	77
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1.3.4	Installation & Integration at Fermilab	90
1.3.5	Risk Management	93

25 pages

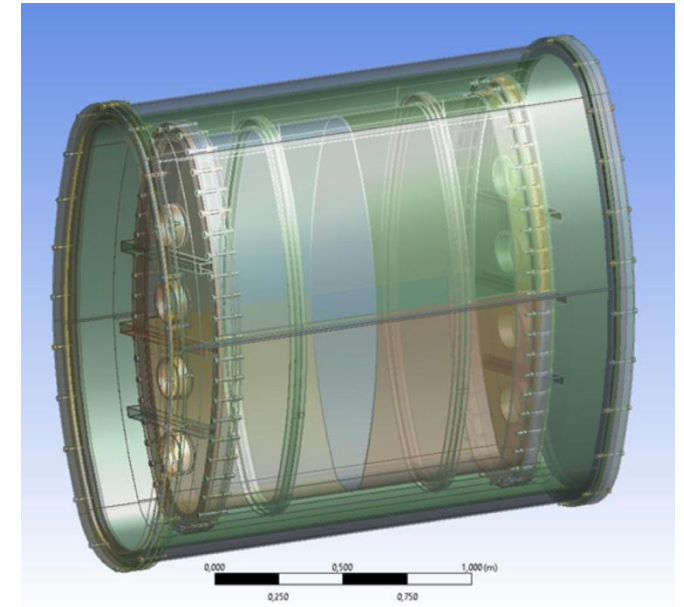


- ✓ Draft available in time
- ✓ July 22-23, 2024 - Preliminary Design Review (PDR)
- To be updated according to recommendations
- Possible improvements (mainly in Sec.s 1.3.4, 1.3.5)
- Refinements expected within ~ 15 October



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1.4.8	Cryogenic System	124
1.4.9	First Commissioning in Laboratori Nazionali di Legnaro	124
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27 pages



**Present text and figures about**

- physics requirements
- lens description
- ASIC requirements
- mechanics
- SiPM arrays
- 3D reconstruction

**To be completed**

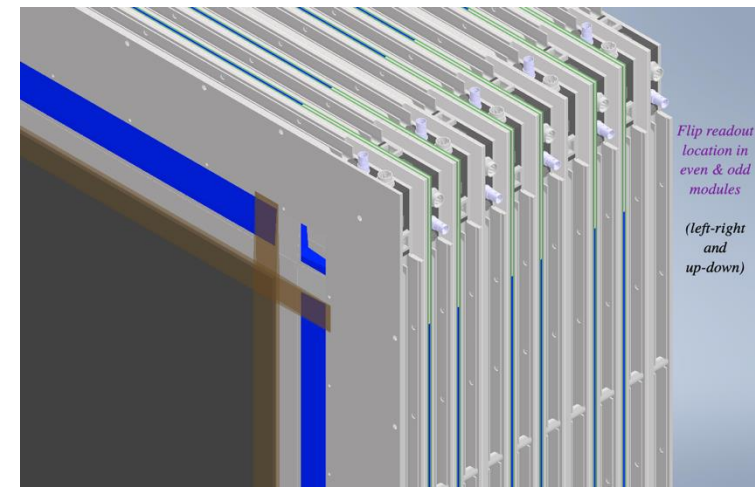
- coded mask description
- simulation & results
- reconstruction with voxels

**To be written**

- prototypes
- calibration
- cryogenics
- integration & installation

1.5	Tracker	125
1.5.1	STT	125
1.5.2	Drift Chamber	129
1.5.3	Gas System	130

6 pages



Present - figures and tables about STT geometry

- Missing - subsubsections about STT
- subsection about Drift Chamber
  - subsection about Gas System

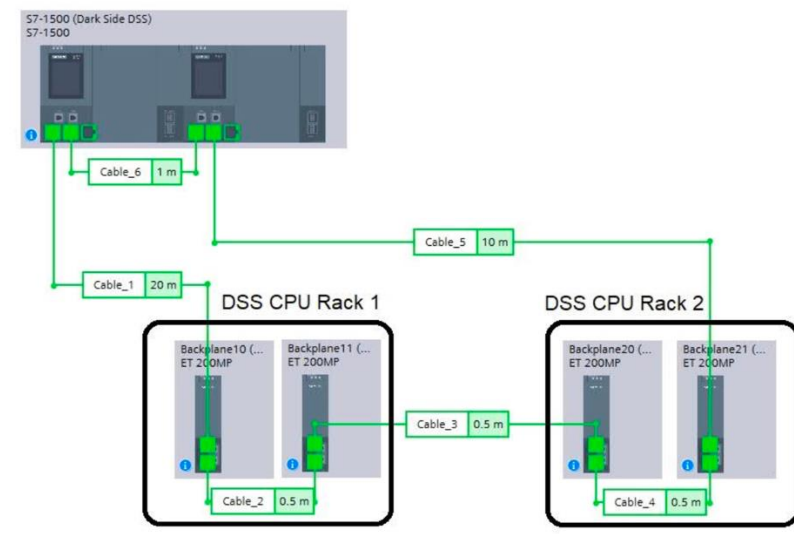


1.6	DAQ Architecture . . . . .	131
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8 pages

Ready draft - DSS

To be completed - DAQ  
- DCS



1.9	Software and Computing . . . . .	139
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24 pages

- Present**
- GRAIN simulation
  - ECAL simulation & clustering
  - Kalman filter
  - edep-sim output

- Missing**
- computing resources

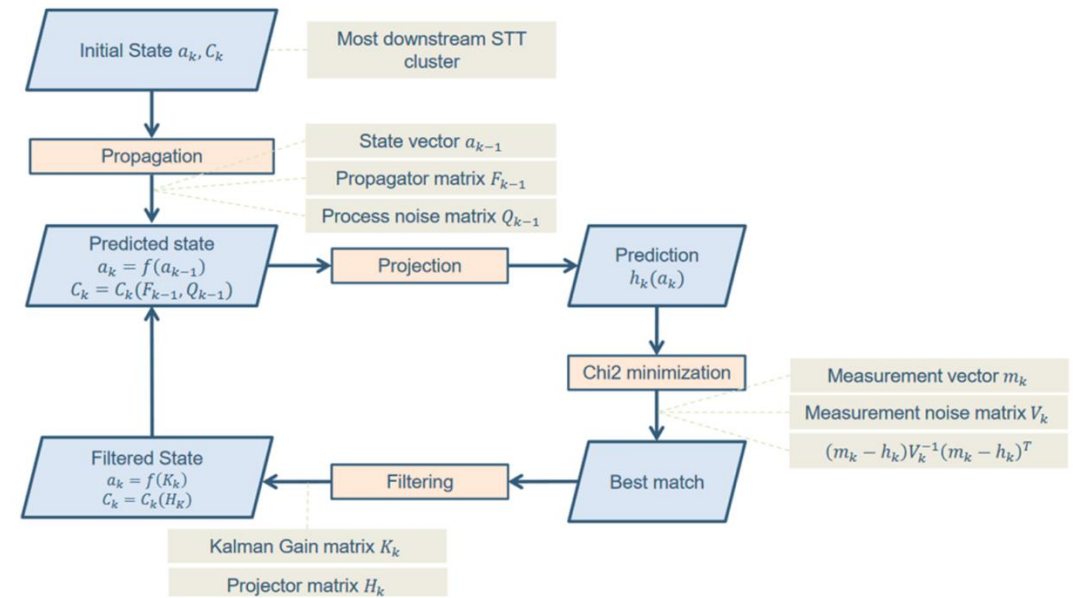
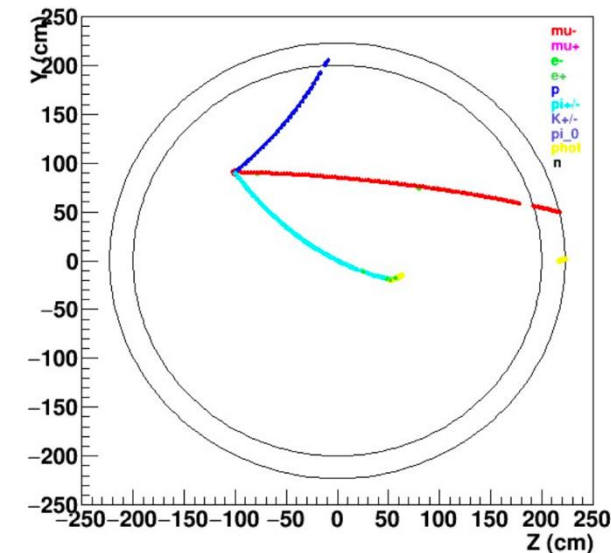


Figure 1.108: Flow chart of the EKF algorithm.

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1.10.1 Single Particle Reconstruction	163
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1.10.3 Neutrino Interaction Identification in the Spill	203
1.10.4 Event Reconstruction in GRAIN	203
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1.10.6 Event Reconstruction in STT	203
1.10.7 Neutrino Energy Reconstruction in Inclusive CC Events	206

52 pages



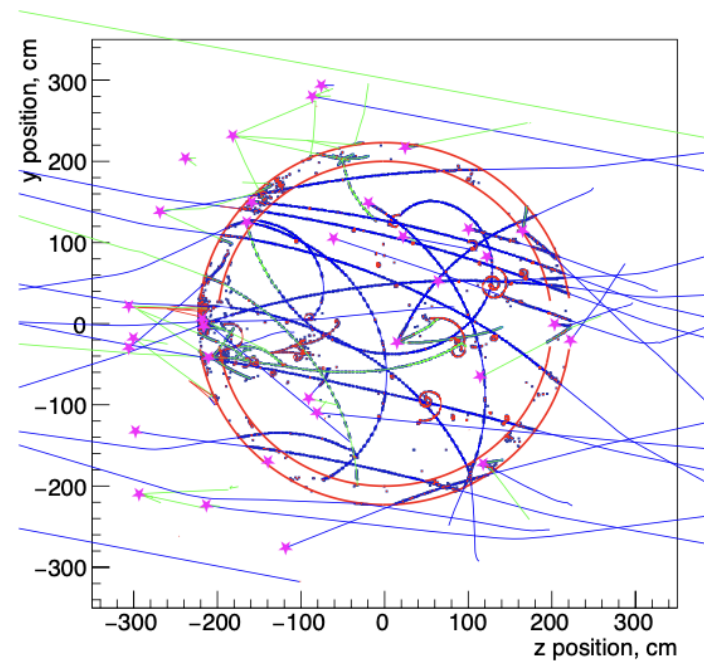
- Present**
  - single particle reconstruction (GEANT & FLUKA)
  - particle ID
  - event reconstruction in STT
  - neutrino energy reconstruction
- To write**
  - identification of neutrino event in the spill
- To do**
  - careful reading and corrections (volunteers ?)

Mainly from the document  
DUNE-doc-13262-v7

"A Proposal to Enhance  
the DUNE Near-Detector  
Complex"

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1.11.8 On-Axis Beam Monitoring	254
1.11.9 External Backgrounds	263

80 pages



- |  |  |  |
|--|--|--|
| <p><b>Present</b></p> <p><b>Ar</b></p> | <ul style="list-style-type: none"> <li>- selection of CC interactions</li> <li>- measurement of fluxes</li> </ul>                                    | <ul style="list-style-type: none"> <li>- <math>\nu</math>-H interactions</li> <li>- nuclear smearing in</li> </ul>                   |
| <p><b>To do</b></p>                    | <ul style="list-style-type: none"> <li>- <math>\nu</math>-e scattering</li> <li>- on-axis beam monitoring</li> <li>- external backgrounds</li> </ul> | <ul style="list-style-type: none"> <li>- coherent <math>\pi</math> production</li> <li>- <math>\nu_e/\nu_\mu</math> ratio</li> </ul> |
|  | <ul style="list-style-type: none"> <li>- careful reading and corrections (volunteers ?)</li> <li>- possible new topics</li> </ul>                    |  |

From the document  
DUNE-doc-13262-v7

"A Proposal to Enhance  
the DUNE Near-Detector  
Complex"

# To be written

Present: tables about sizes, weights and storage @ FNAL of yoke, coil and calorimeter

<b>1.12</b>	<b>I &amp; I</b>
<b>1.13</b>	<b>Safety</b>
<b>1.14</b>	<b>Management</b>
<b>1.15</b>	<b>Time Schedule</b>
<b>1.16</b>	<b>Possible Upgrades</b>

**Present:  
315 pages**

**256 figures  
64 tables**

1. Overview 6 pages - to be checked
2. Lead/Scintillating-Fiber Calorimeter (ECAL) } 91 pages - to be updated
3. Superconducting Magnet
4. Liquid Argon Active Target (GRAIN) 27 pages - in progress
5. Tracker 6 pages - at the beginning
6. Data Acquisition (DAQ) Architecture } 8 pages - to be completed
7. Detector Control (DCS)
8. Detector Safety System (DSS)
9. Software & Computing 24 pages - at the beginning
10. Event Reconstruction } 132 pages - to be completed
11. Analysis
12. Installation & Integration } At the very beginning (some tables)
13. Safety } 1-2 pages for each section
14. Organization & Management } Indexes and keywords are defined
15. Time Schedule
16. Possible Upgrades





complete the sentence . . . . .	64
an example of the relevant safety standards at Fermilab . . . . .	69
per o for ?? . . . . .	92
reference ? . . . . .	100
figure 4.7 ? . . . . .	101
BOLOGNA now . . . . .	102
reference ? . . . . .	103
equation ? . . . . .	110
unita di misura nella figura? . . . . .	120
what section for ASIC ? . . . . .	124
to be completed ? . . . . .	133
to be completed ? . . . . .	133
to be completed ? . . . . .	133
insert a reference . . . . .	144
insert a reference . . . . .	144
insert a reference . . . . .	144

# Instructions for the authors

- Insert the reference in the bibliography (bibitex format)
- Check if some word is present in the glossary and use it
- Insert new words in the glossary
- Check the reference to equations, figures, tables
- Write your name in the text     %% author ?
- Take into account the DUNE editing rules

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



# Glossary

 my\_glossary.tex

**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  $\text{SI}_{10}$  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**

## DUNE Words from the [glossary](#)

<code>\dfirst{fnal}</code>	first time	<u>Fermi National Accelerator Laboratory (Fermilab)</u>
<code>\dword{fnal}</code>	following times	<u>Fermilab</u>

### 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](#)

<code>\dfirst{nd}</code>	near detector (ND)	<i>with link</i>
<code>\dword{nd}</code>	ND	<i>with link</i>
<code>\dlong{nd}</code>	near detector	<i>w/o link</i>
<code>\dshort{nd}</code>	ND	<i>w/o link</i>

<code>\dword</code>	singular	<code>\dwords</code>	lower case & plural
<code>\Dword</code>	capital	<code>\Dwords</code>	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}`.

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

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

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

**numbers and units**

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

# 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.”

# Final remarks

- ❖ Write-up of SAND-TDR has started (February 2024) and is going on
- ❖ Main part of data are available, it's just a matter of writing
- ❖ First review about ECAL+magnet in July 2024
- ❖ What measurement to evaluate the TDR progress ?

Number of pages: 315 !  
Text quality ? Difficult answer

- ❖ To do:
  - Some sections to be written and completed
  - Editing according to DUNE rules
  - SAND internal reading to "measure" the text quality



# Backup slides

**Hiro Tanaka, September 9, 2024  
Collaboration Meeting**

	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 LAr 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 25

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

## More details for SAND

### Preliminary Design Review

✓ Jul 2024	topics
Nov 2024	ECAL + magnet
Dec 2024/Jan 2025	I & I
Mar 2025	GRAIN
	Tracker

### Review of TDR chapter draft

	reviewer
Jan 2025	SAND consortium
Feb 2025	DUNE collaboration
Mar 2025	LBNC

## 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