



# Cold Electronics Risks and Plans for Risk Mitigation

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# Outline

- Risks
- Conclusions



# DUNE FD Risk RT-131-FD-007

Threat	Open	RT-131-FD-007	Detector performance is impaired by electrical noise	15 %	1	100	0 (N) - negligible technical impact
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- Risk: detector performance is impaired by electrical noise
  - Affects both ProtoDUNE-SP and SBND
    - Both DUNE and SBND TPC detectors require low noise for physics
- Mitigation:
  - Having a well-defined and isolated detector ground, the use of double shielded transformers for detector power, using proper shielding techniques on all conductive cables, validation of the noise performance of all equipment (*e.g.*, variable frequency drives) and careful review and oversight of the installation process.
    - ProtoDUNE-SP ([879](#)) and SBND ([1077](#)) each have well-defined grounding designs
  - Work ongoing to lower intrinsic noise on CE components



# DUNE FD Risk RT-131-FD-028

Threat	Open	RT-131-FD-028	Detector components are damaged during shipment to the far site	15 %	4	275	0 (N) - negligible technical impact
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- Risk: detector components are damaged during shipment to the far site
  - Affects both ProtoDUNE-SP and SBND
    - Cold electronics components will be shipped from BNL to both Fermilab and CERN
- Mitigation
  - Current estimates include building spares for all components, specified in the QA/QC plan ([1809](#)). Developing a documented QA program for shipment packing and method. Review shipping procedures, shipping containers, test in crate after arrival.



# DUNE FD Risk RT-131-FD-035

Threat	Open	RT-131-FD-035	Average component lifetime is less than expected	15 %	3	250	0 (N) - negligible technical impact
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- Risk: average component lifetime is less than expected
  - Does not affect ProtoDUNE-SP or SBND
    - Those detectors have significantly shorter data-taking operations than the DUNE Far Detector
- Mitigation:
  - Ongoing lifetime studies on all components, including accelerated aging tests.
  - Both FPGA and CMOS technology have been validated to operate > 25 years at cryogenic temperature with high confidence. Need to study the lifetime of other components.



# DUNE FD Risk RT-131-FD-076

Threat	Proposed	RT-131-FD-076	More dead channels than expected	25 %	0	0 (N) - negligible technical impact
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- Risk: more dead channels than expected
  - Affects both ProtoDUNE-SP and SBND
    - Loss of channels impacts the ability to identify, reconstruct, and measured neutrino scatters and other events on physics interest. Missing channels will correspond to dead argon volume
- Mitigation:
  - Implementing a design robust against loss of channel information at all points in CE readout chain
  - Developing detailed QC program to identify dead/bad channels during validation ([1809](#))



# DUNE FD Risk RT-131-FD-088

Threat	Open	RT-131-FD-088	Cold ASIC chip set is unavailable	20 %	12	4,000	1 (L) - slightly substandard
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- Risk: Cold ASIC chip set is unavailable
  - Affects both ProtoDUNE-SP and SBND
    - Both detector designs have FE and ADC ASICs at cryogenic temperature
- Mitigation
  - If improved prototype versions are not available, both detectors can be instrumented with existing ASIC designs:
    - FE ASIC from MicroBooNE/35-ton demonstrated low noise in MicroBooNE with a known loss of channels (~4%) seen in both detectors
    - ADC ASIC and FPGA from 35-ton achieved digitization and transmission in LAr at 2 MHz and 1 Gbps with known issue of DNL “stuck codes”
  - Increase resources to improve chance of success with current designs of ASICs



# ProtoDUNE-SP Risk RT-131-FD-120

Threat	Proposed	RT-131-FD-120	ProtoDUNE-SP: Resource competition with other experiments (e.g., SBN)	50 %	0	0 0 (?) - Not yet defined
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- Risk: ProtoDUNE-SP: Resource competition with other experiments (e.g., SBN)
  - Affects both ProtoDUNE-SP and SBND
    - Both detectors use the same critical designers
    - If ProtoDUNE-SP is delayed, both experiments will be attempting to produce, test, and install concurrently
- Mitigation:
  - Increase effort from collaborators:
    - Fermilab, MSU, UTA, Boston, UC Davis, LSU, Penn
  - Design choices selected to make components as similar as possible: FEMB, CE flange, warm electronics
  - SBND installation is approximately 6 months after ProtoDUNE-SP as shown in ([1809](#))
    - Allows for a subsequent production of ASIC/FEMBs





# Conclusions

Are the technical risks associated with the development and implementation of the CE systems recognized and understood and is there a plan for managing and mitigating these risks?

- Risks for the cold electronics system have been documented for the DUNE far detector
  - All threats for the cold electronics except for long lifetime in LAr apply to both SBND and ProtoDUNE-SP
- Plans to mitigate each risk are ongoing