

Reliability How-To

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Reliability of the PMT-Electronics of JUNO

- Decided last year October in Padova to share reliability 50:50 between Electronics and PMT (incl. base)
 - Overall reliability goal / **requirement**

1% failures in 6 years

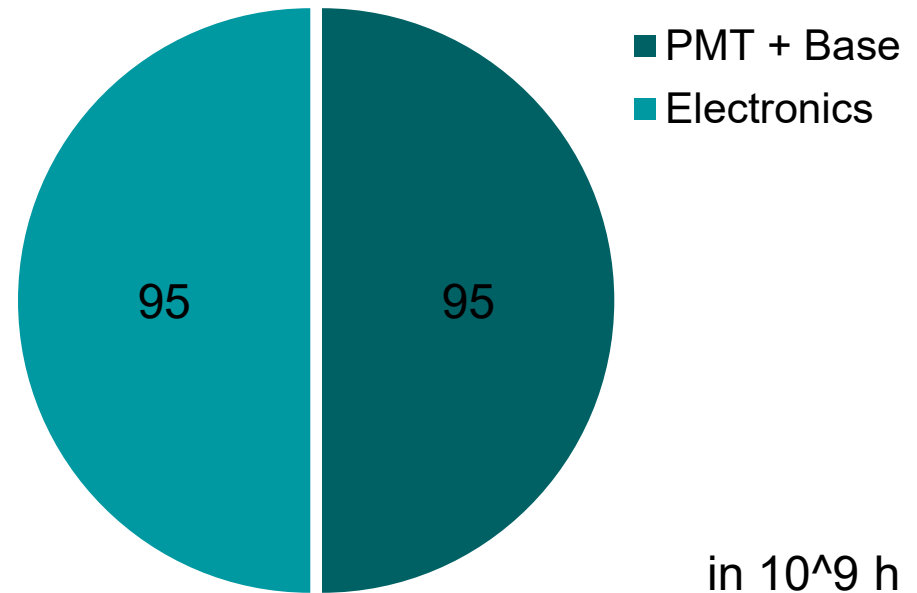


0.5% failures in 6 years

FIT = $95 / 10^9$ h

electronics only

Reliability contribution



How can we meet this goal?

- We need to know the reliability estimate / limit of every board
 1. HV
 2. GCU
 3. Power-Board
 4. Cable (up to surface)
- Common mission goal:

Everything should work the same way it has been installed

- Very conservative estimation of the lifetime
- If something fails, the board may still be good enough for physics
 - Analysis of all failure modes and the possible consequences is too much effort
- **This means, all parts have to be included in the reliability analysis!**

How to calculate the reliability ...

Lessons we learned in Aachen ...

- The data inside the MIL-HDBK is outdated
 - **We are using the data from the manufacturer**
 - If the manufacturer does not provide data, we replaced those with one which does!

- **Important is the part stress**
 - Use the right voltage / power rating
 - This means evaluation of every part in the schematic
 - Critical points are **capacitors**

- **Recipe to calculate the reliability for one part:**
 1. Calculate the part operating conditions
 2. Compare with the rated conditions
 3. Look-up the FIT value

- **Recipe to calculate the reliability for one board:**
 1. Sum all FIT values of the used parts
 2. Add the estimation for the board itself (e.g. from FIDES)

Calculation gives an Limit!
usually 60% CL

Thank you!