Improving Supercomputer Usage with Aging Awareness

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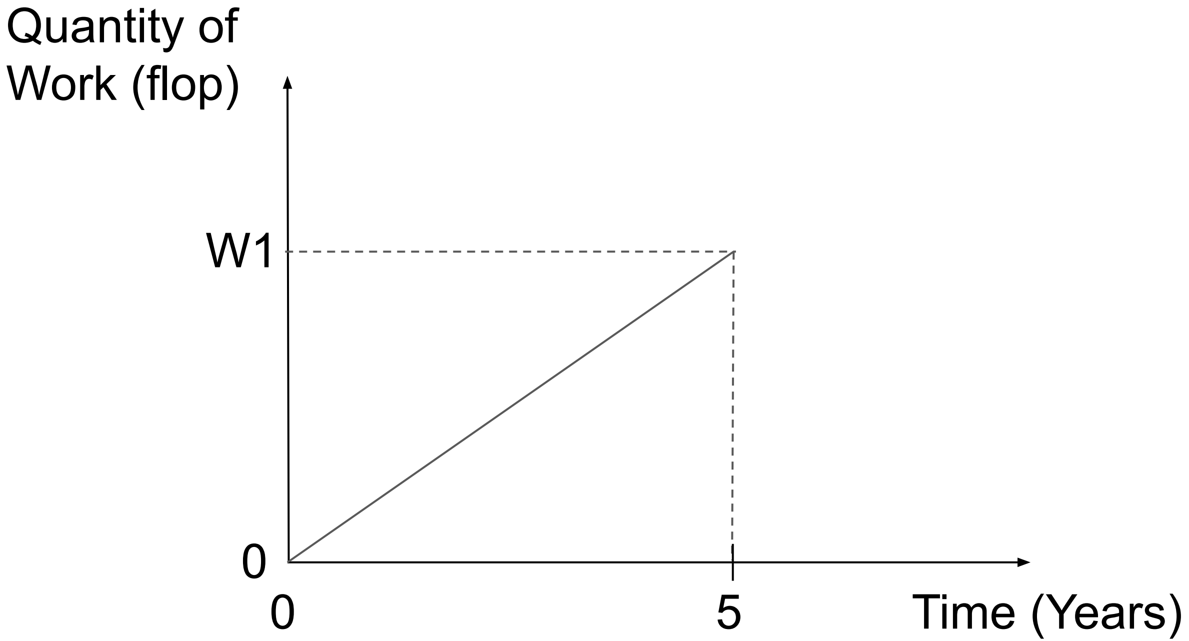
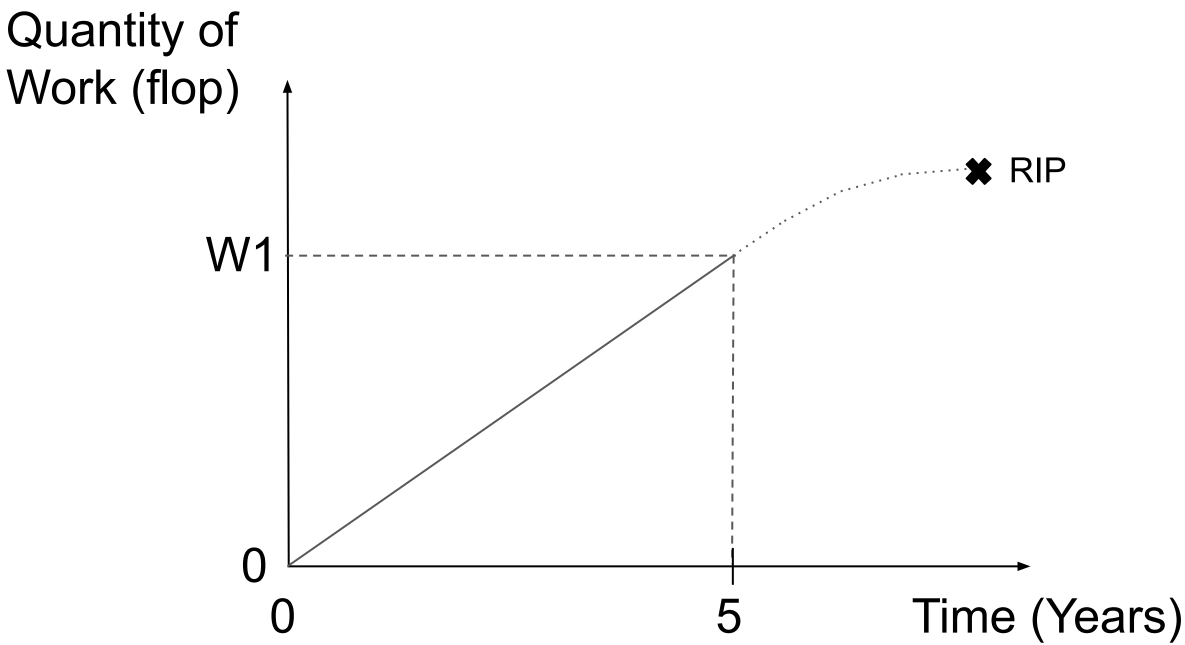
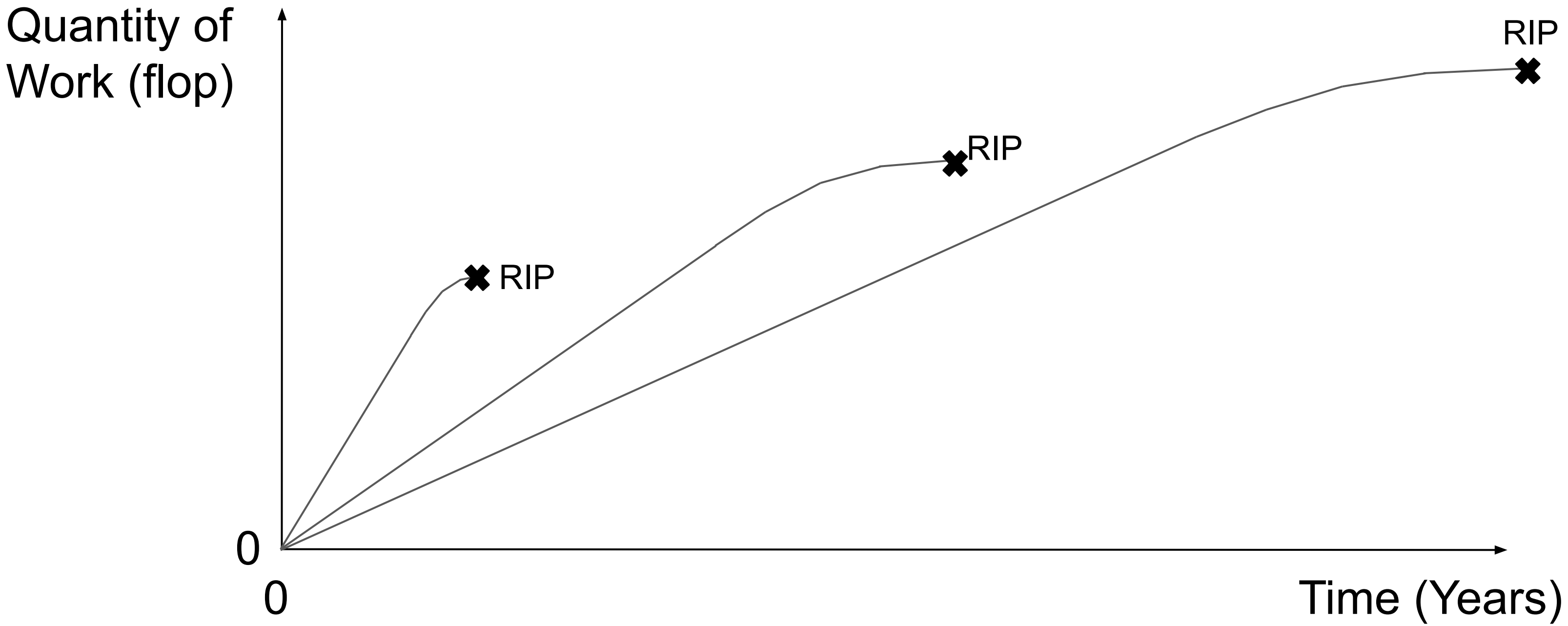
How are supercomputers currently used?



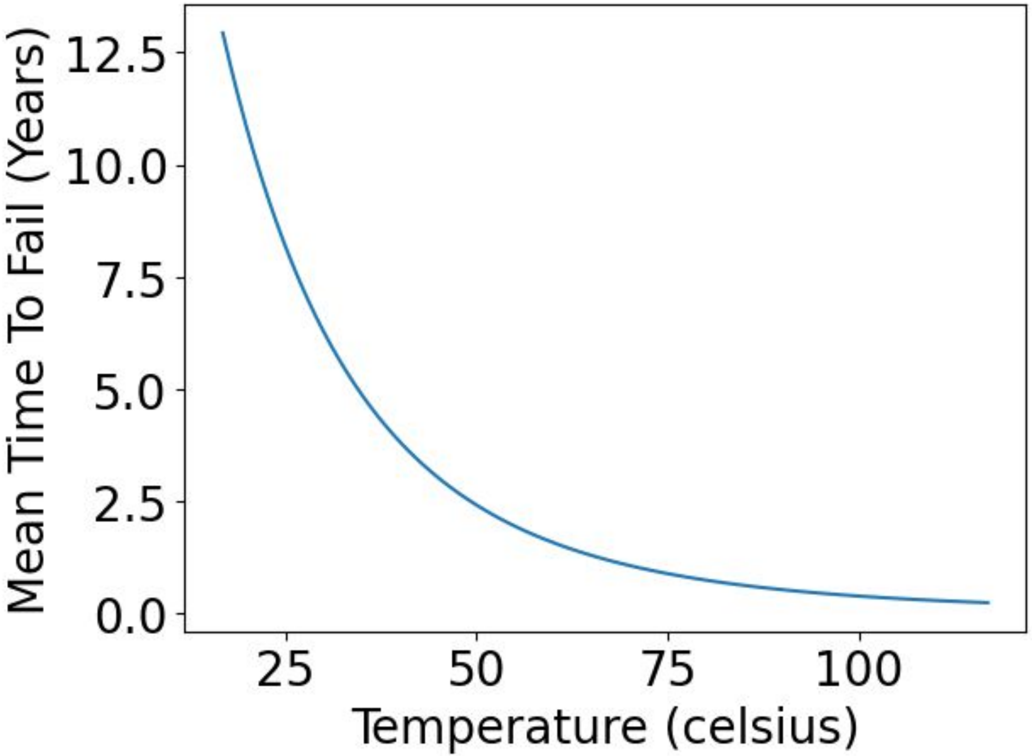
What if we extend the lifetime ?



What if we use the machine differently?



Aging model



Temperature depends on:

- frequency
- cooling parameter

Goal: Demonstrate the usefulness of taking into account aging in resource management

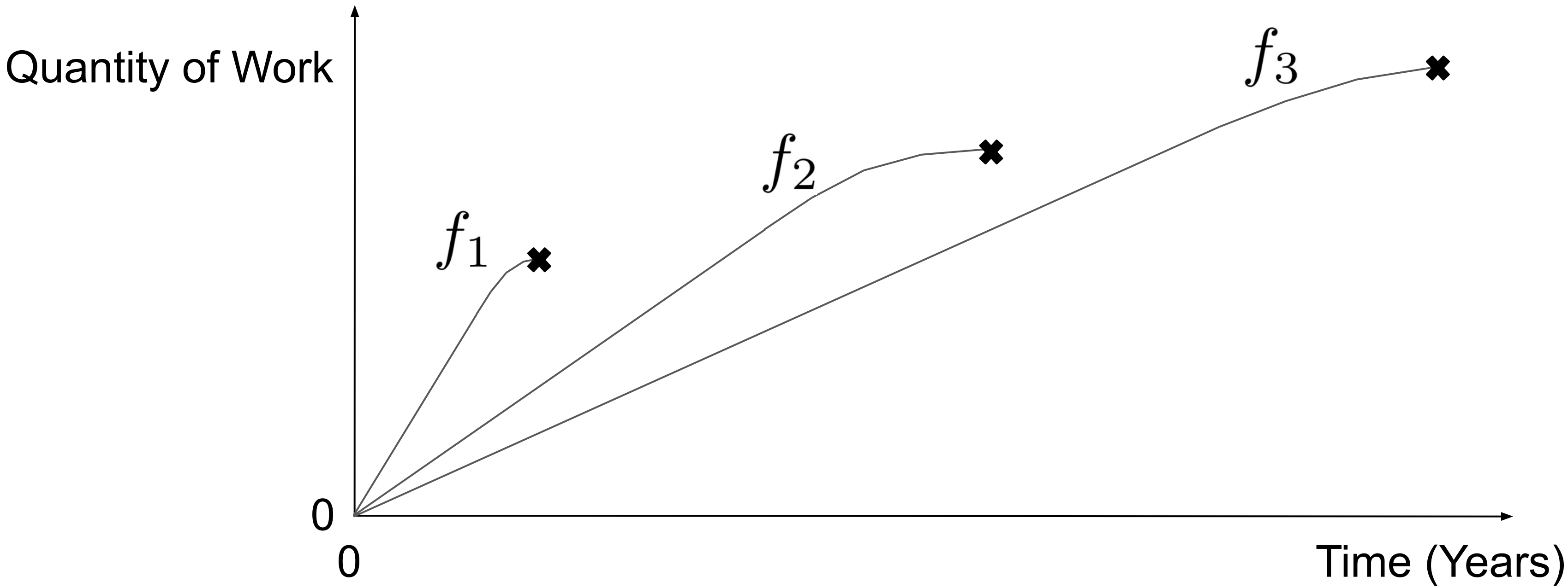
Limit/Challenge: Having accurate aging models

Hard because:

- Lack of accurate Models (i.e. parametrized Equation)
  - currently based on chemical reactions, not on actual aging analysis
- Instantiation of the models also hard
  - too many factors
- Model Validation is challenging

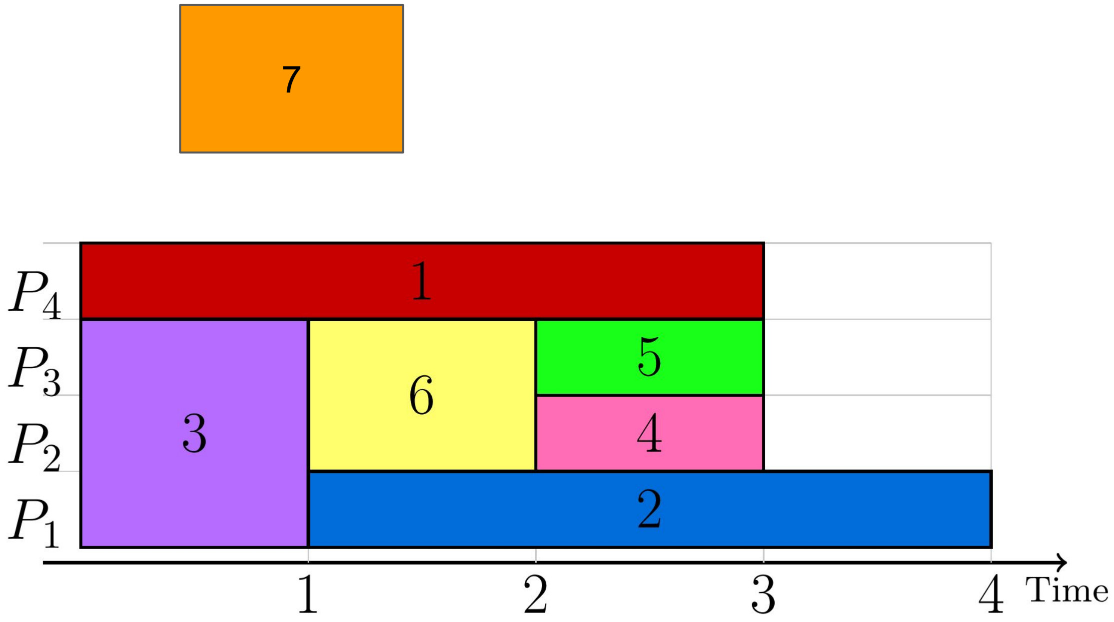
Subgoal: to convince you to make research on hardware aging :), *but* also that we can manage with suboptimal models

Our approach: we allow to modify the node frequencies

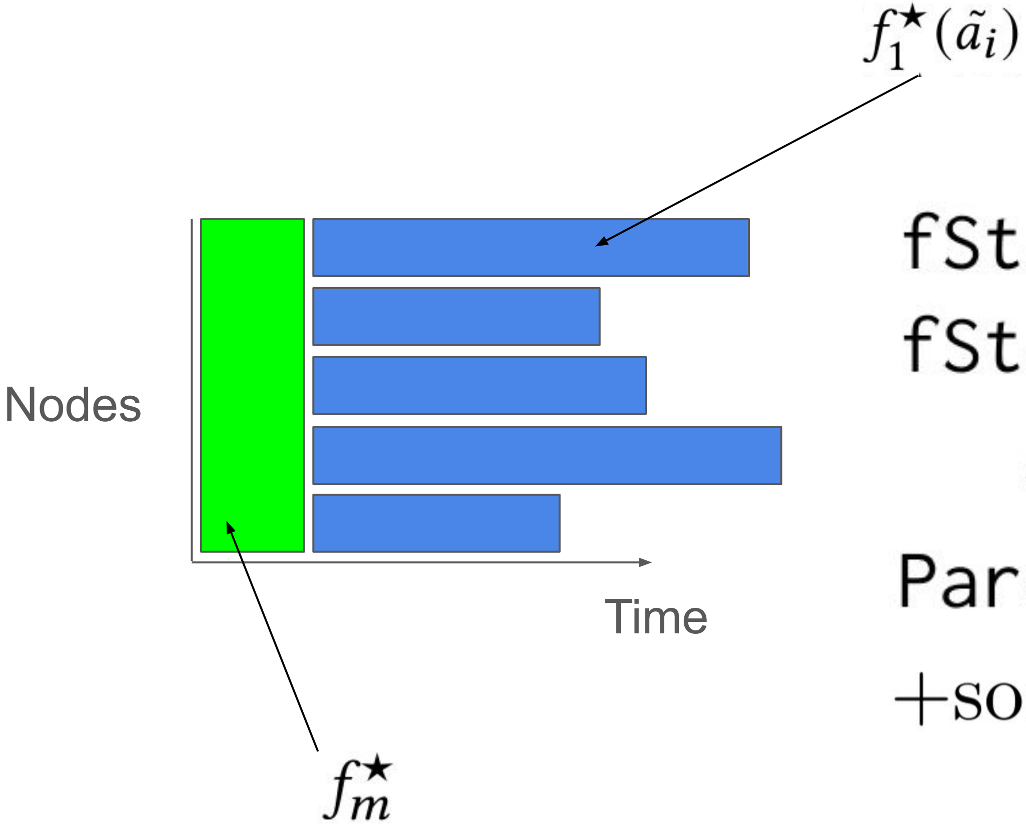


Scheduling problem:

- Where to place jobs
- At which frequency to run them



Frequency heuristic



fStarMin: $\min_i\{f_1^\star(\tilde{a}_i)\}$

fStarMax: $\max_i\{f_1^\star(\tilde{a}_i)\}$

Arith: $\frac{1}{m}\sum_i\{f_1^\star(\tilde{a}_i)\}$

Parallel: $f_m^\star$

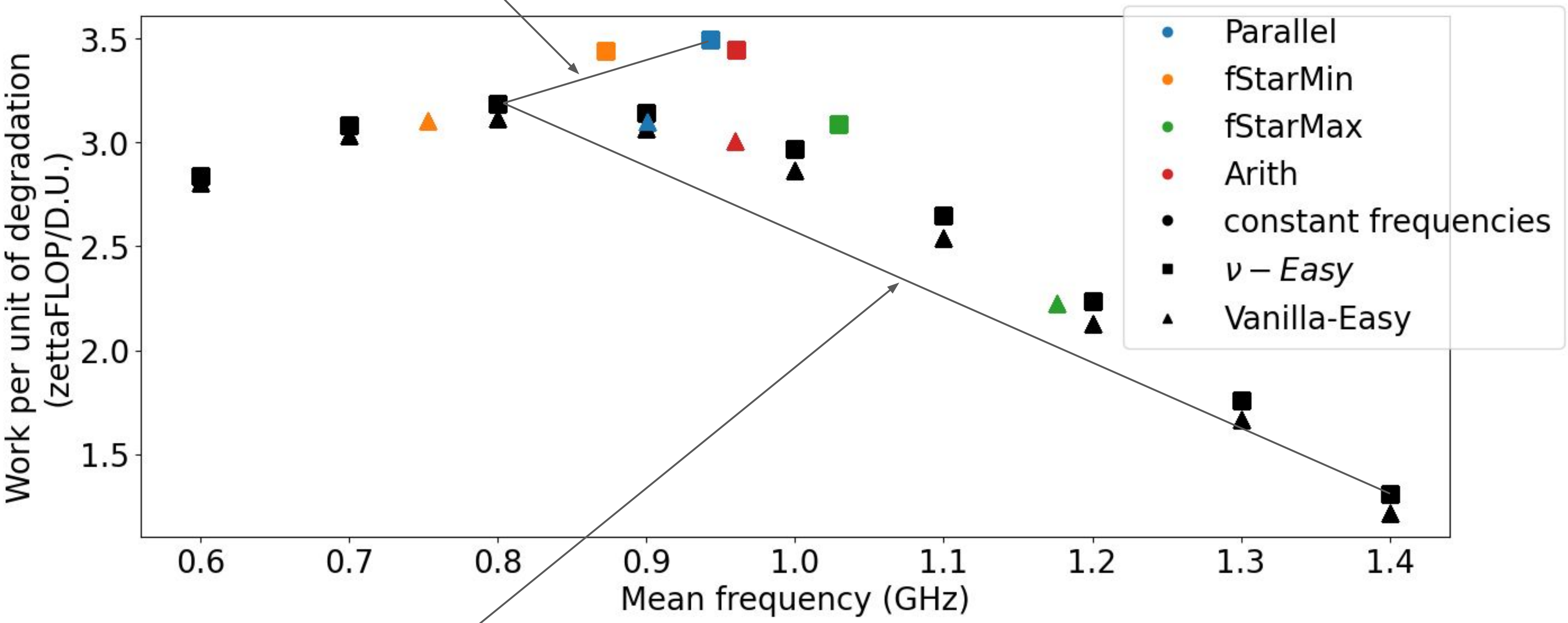
+some constant frequencies

Placement heuristics

We used Easy-Backfilling with nodes ordered by :

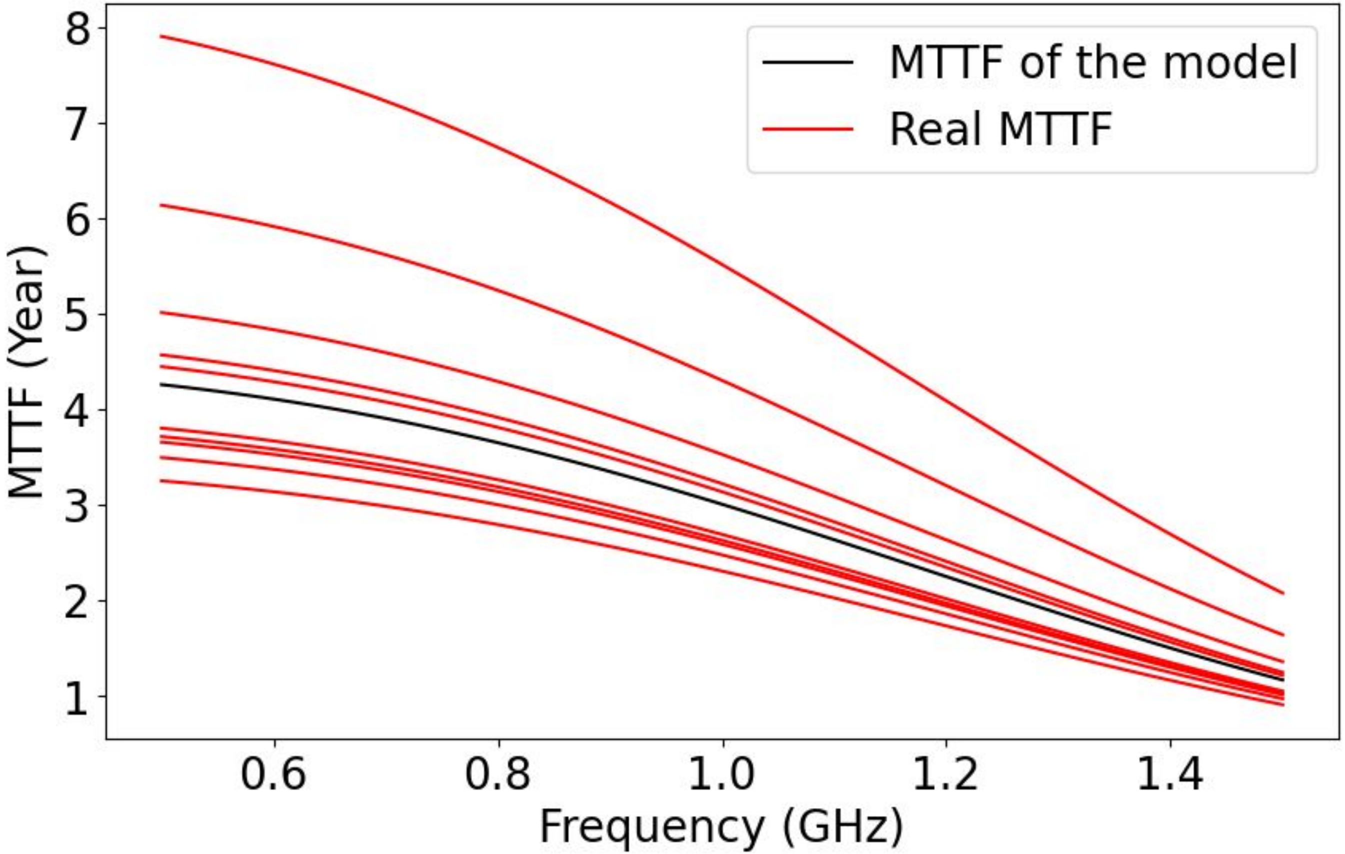
- Random order: $\mathtt{Vanilla\text{-}Easy}$
- By cooling parameter: $\nu - \mathtt{Easy}$

+10% work and +18% speed

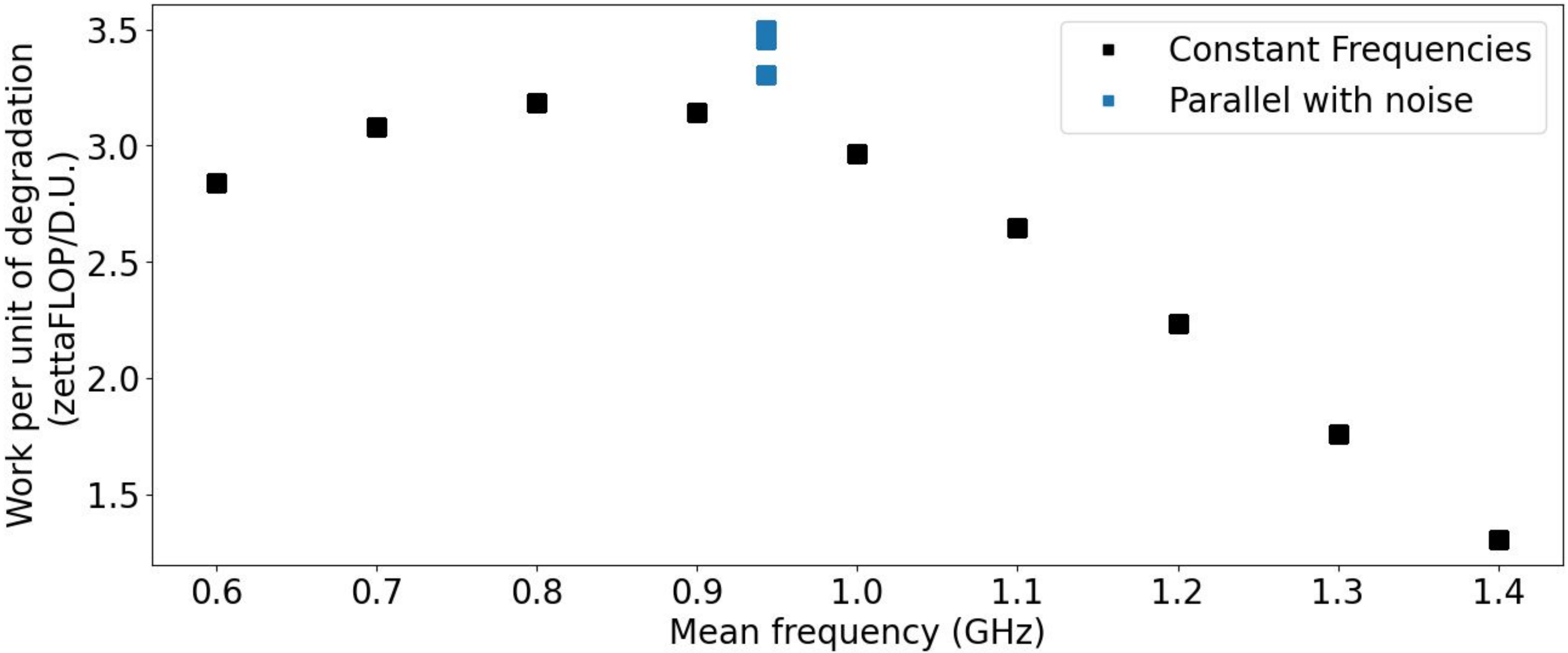


+165% work but -43% speed

Importance of Model Unreliability (I)



Model Unreliability (II)



Conclusion

With our model:

- Huge (more than x2) increase in total quantity of work if choosing the best constant frequency compared to the worst while -43% speed
- 10% work and 18% speed by using Parallel over the best constant frequency

We do not claim our model to be the ground true, but on the contrary we challenge you to come up with better ones !

Paper to be released soon on HAL !

Changing the constraint from ""The machine has to last XX Years" to
"The machine has to produce the maximum quantity of work during its lifetime"