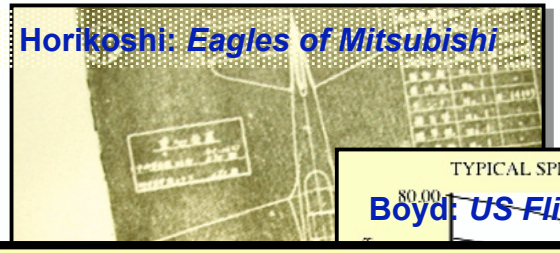
The Quantum System Engineering Roadmap: FAQ

Q3: What is a reliable technical path to practical quantum spin microscopy?

A3: The metric is bits-per-second received from each target spin

- **Jiro Horikoshi and John Boyd**



Single-spin channel capacity is the performance metric that governs spin microscopy

- **Directly reflects the mission, (gain information from spins)**
- **Provides strategic guidance for device design**
- **Establishes fundamental physical bounds on performance**

MRFM performance metrics based on channel capacity

net Shannon-Hartley MRFM capacity:
$$\mathcal{C}^{\text{S-H}} = \mathcal{C}^{\text{QCL}} \times \mathcal{D}^{\text{loss}}$$

quantum capacity limit (QCL):
$$\mathcal{C}^{\text{QCL}} = 0.4758 \times f_{\text{sig}} \left[n_s/(m\omega_0\hbar) \right]^{1/2}$$

loss[b] to excess noise (*i.e.*, $\mathcal{R}^{\text{net}} > 1$) and noise imbalance (*i.e.*, $\mathcal{R}^{\text{bal}} \neq 1$):
$$\mathcal{D}^{\text{loss}} = \frac{1.6413}{(\mathcal{R}^{\text{net}}\mathcal{R}^{\text{bal}})^{1/6}} - \frac{0.5038}{(\mathcal{R}^{\text{bal}})^{1/2}} \times \arctan\left[3.2579 \times \frac{(\mathcal{R}^{\text{bal}})^{1/3}}{(\mathcal{R}^{\text{net}})^{1/6}} \right]$$

approximate capacity, valid for all devices to the left of the $\mathcal{R}$-line[c]:
$$\mathcal{C}^{\text{S-H}} \simeq \mathcal{C}^{f}$$