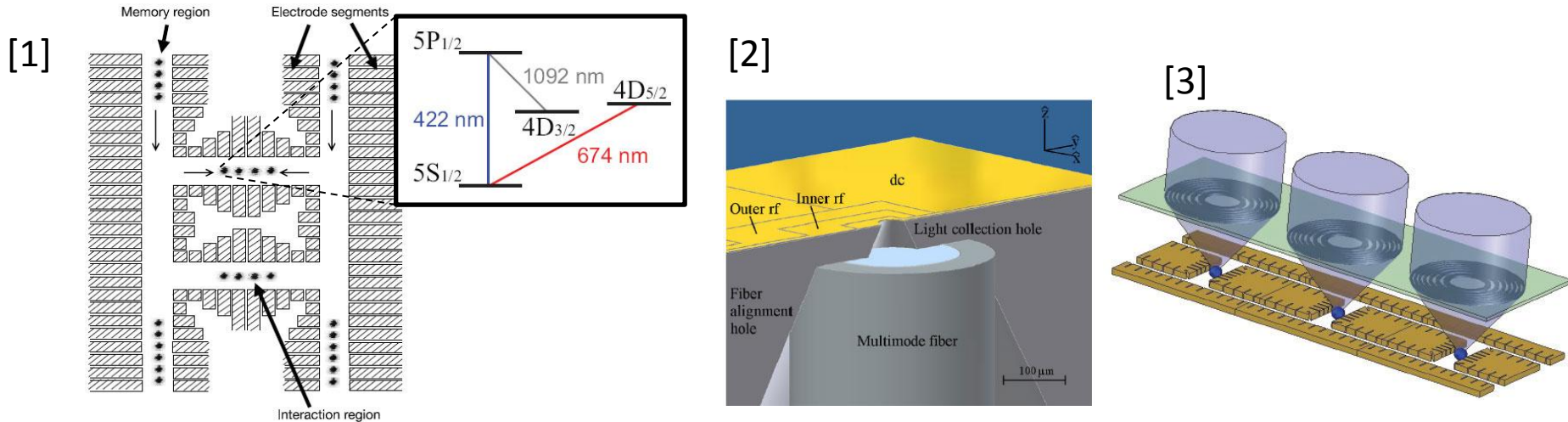


Surface-electrode ion trap with integrated light source

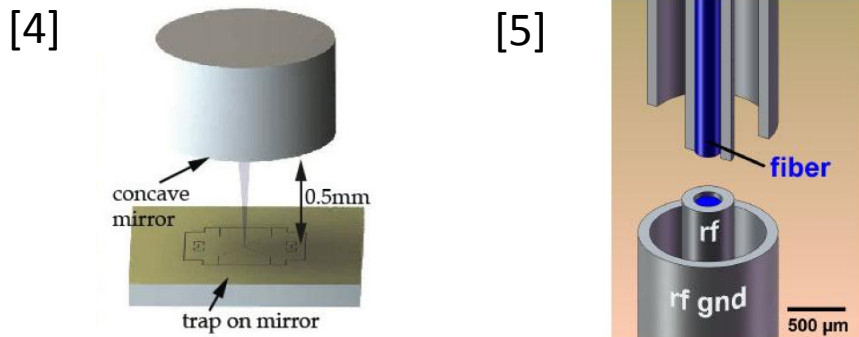
Tony Hyun Kim
Chuang group
2011 April 5

Optics integration in ion traps

- QIP with 10s and 100s of qubits



- Quantum light-matter interface (cQED)



[1] D. Kielpinski, C. Monroe, D.J. Wineland. Nature 6890, 709-771 (2002)

[2] A. VanDevender, Y. Colombe, J. Amini, D. Leibfried, D.J. Wineland. PRL 105, 023001 (2010)

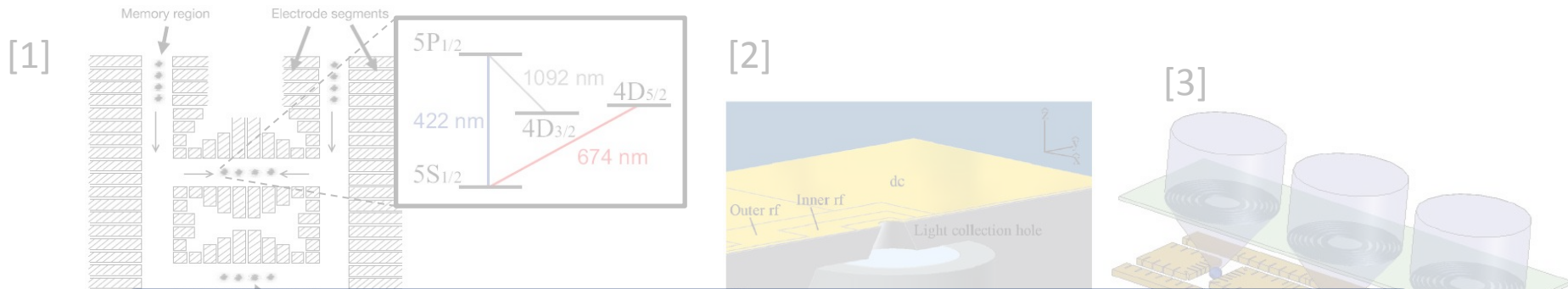
[3] E. Streed, B.G. Norton, A. Jechow, T.J. Weinhold, D. Kielpinski. PRL 106, 010502 (2011)

[4] P.F. Herskind, S.X. Wang, M. Shi, Y. Ge, M. Cetina, I.L. Chuang. arXiv: 1011:5259 (2010)

[5] A. Wilson, *et al.* arXiv: 1101.5877 (2011)

Optics integration in ion traps

- QIP with 10s and 100s of qubits

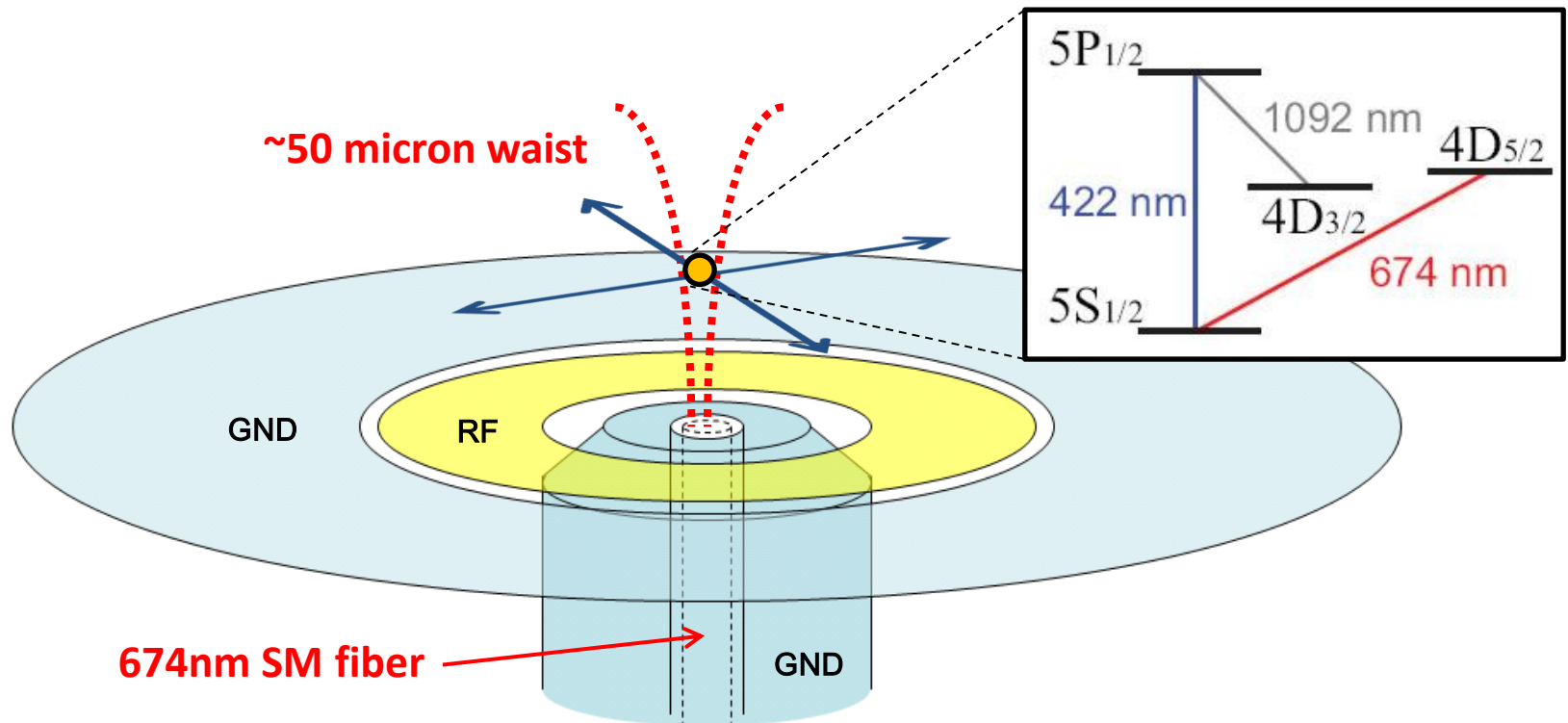


Challenges:

1. Perturbation of trapping fields,
2. Dielectric charging [6],
3. Overlap of ion and mode.

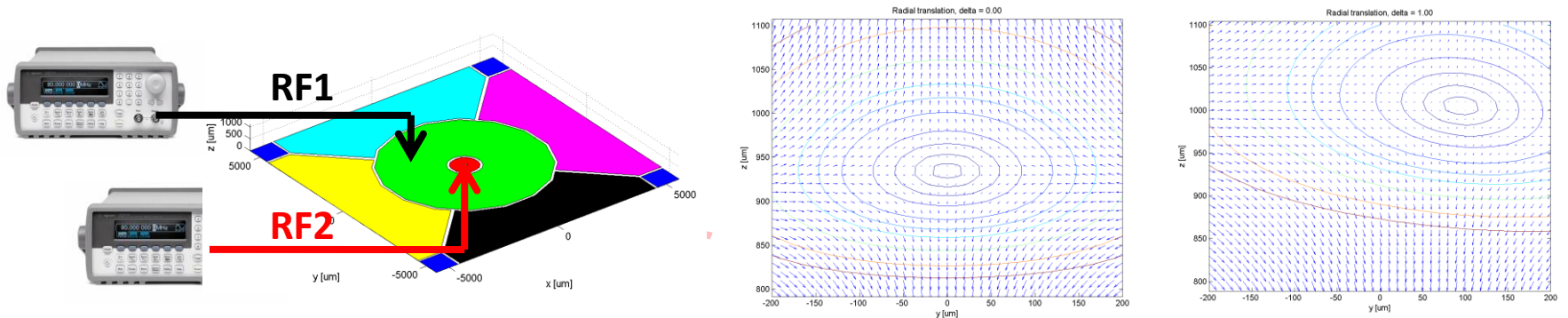
Fiber integration for light delivery

- Single-mode for 674nm (and 422nm)
- Mode waist at ion of ~ 50 micron

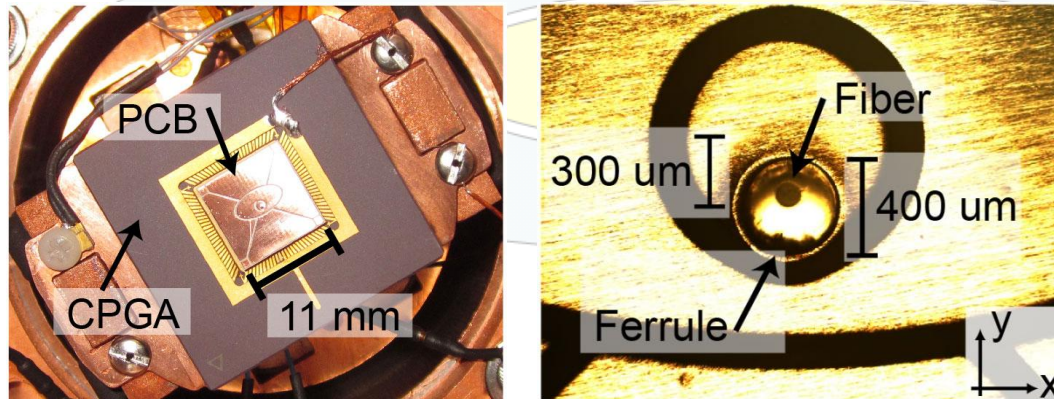


Trap design and fabrication

- Ion translation by multiple RF sources [7]

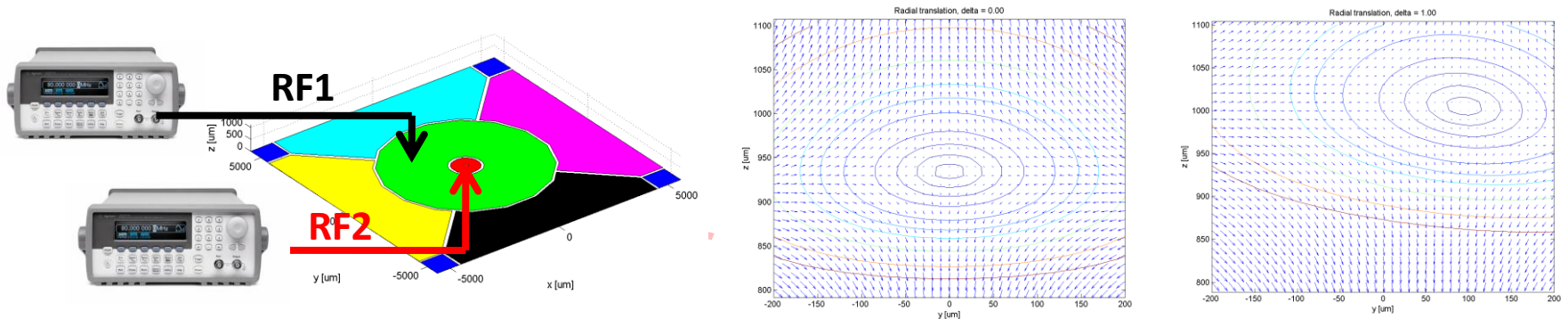


- Coarse alignment under microscope

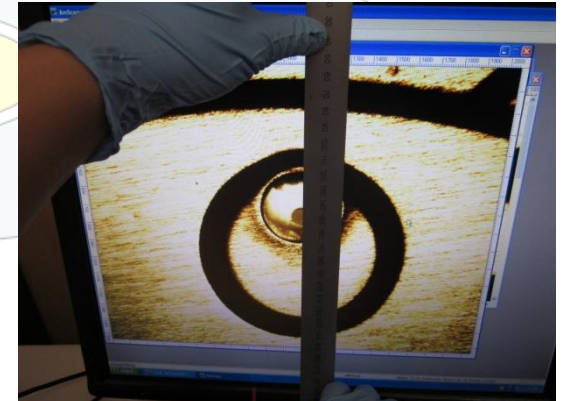
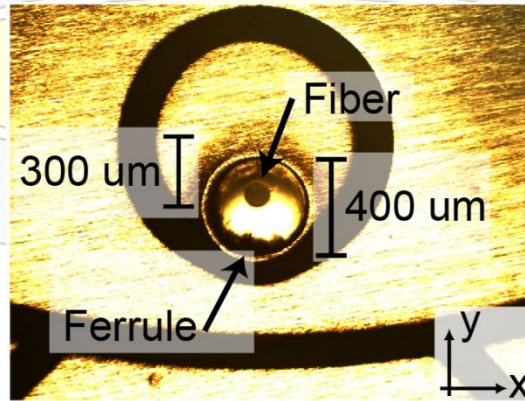
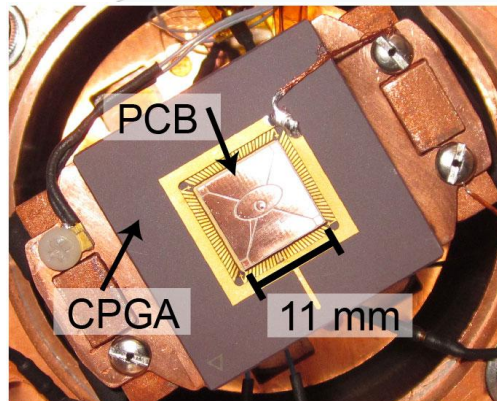


Trap design and fabrication

- Ion translation by multiple RF sources [7]



- Coarse alignment under microscope



Cryogenic experiment

4x RF

„Conventional“
beam delivery

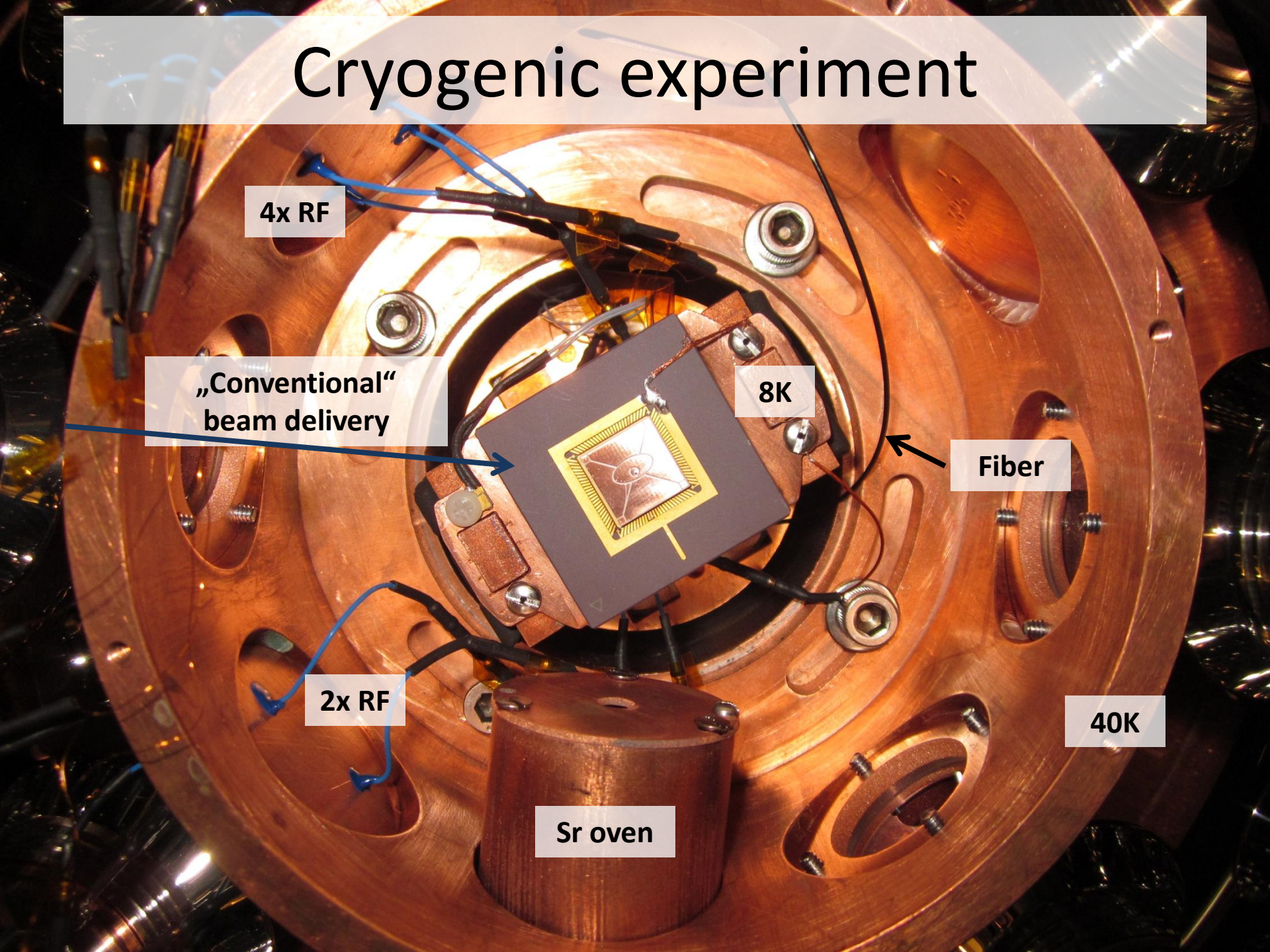
8K

Fiber

2x RF

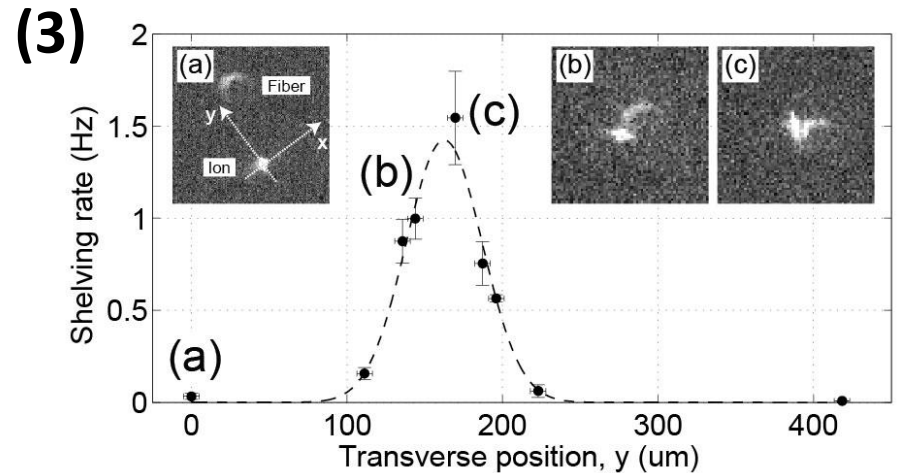
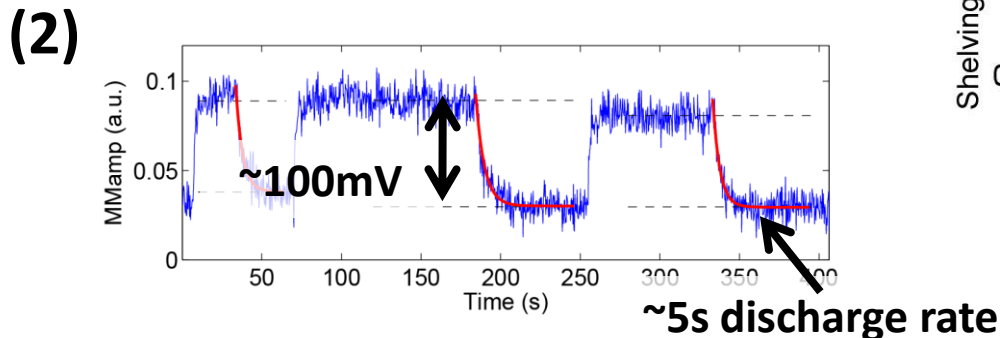
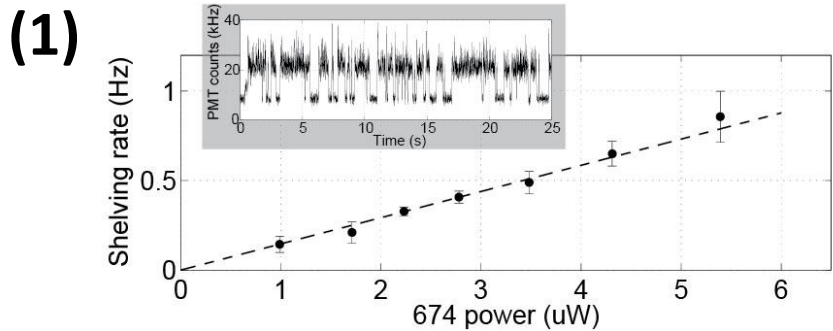
40K

Sr oven



Results

1. Stable trapping and ion-fiber interaction
2. Fiber-induced charging dynamics
3. Measured fiber mode using ion as a probe



Summary

1. Demonstration of integrated (SM) fiber-trap:
 - No dramatic charge buildup during trap operation
2. Quantified fiber-induced stray fields:
 - Large (10~100mV) but slow (seconds)
3. Micromotion-free RF translation of ion:
 - Significant range; tuned to mode $\sim 150\mu\text{m}$ away
 - General technique for tuning ion-mode overlap, use of ion as sensor