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Deployable ion trap quantum network node

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Trapped ions provide a promising platform for building a Europe-wide quantum internet where quantum network nodes are separated by several hundreds of kilometres. Coherent ion-photon interfaces, consisting of a linear Paul trap with an integrated cavity, exist for more than a decade [1], and are capable to act as a quantum processor, telecom-wavelength quantum repeater [2] and quantum memory [3]. To pave the way towards a quantum network based on trapped ions, we develop and construct, for the first time, a fully integrated rack-mounted ion-photon interface that we call the "deployable node"which means that the node can in principle be transported to and operated at a remote location, without requiring laboratory conditions, e.g. a data centre. The node will be capable to provide laboratory conditions on its own and can be connected to other nodes via telecom-wavelength fibre. The ion-photon interface is given by a near-concentric 20mm long optical cavity and based on the proven design of Ref. [4]. Here, I present the design and the first results of the characterisation of the new setup.

[1] Stute, A., et al. "Tunable ion–photon entanglement in an optical cavity." Nature 485.7399 (2012): 482-485.
[2] Krutyanskiy, Victor, et al. "Telecom-wavelength quantum repeater node based on a trapped-ion processor." Physical Review Letters 130.21 (2023): 213601.
[3] Drmota, Peter, et al. "Robust quantum memory in a trapped-ion quantum network node." Physical Review Letters 130.9 (2023): 090803.
[4] Schupp, J., et al. "Interface between trapped-ion qubits and traveling photons with close-to-optimal efficiency." PRX quantum 2.2 (2021): 020331.

(For this project, we collaborate with the local company Alpine Quantum Technologies (AQT) with expertise in rack-mounted ion trap systems.)

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