Several novel applications that rely on high-speed single-photon detectors (SPDs), for example quantum cryptography, have recently emerged. The nanowire SPD consists of a 4-nm-thick, ~100-nm-wide, superconducting NbN wire operating at 4.2 K or below. It reportedly detects single photons at 1550-nm wavelength with a detection efficiency (DE) of ~5%, which is too low to be of use for most applications. Its proposed GHz-counting rate is several orders of magnitudes faster than has been demonstrated by other types of SPDs to date [1]. The aim of our research is to improve the detection efficiency (DE) of the nanowire SPDs and to make devices capable of GHz-counting rates. Figure 1 shows a scanning electron micrograph (SEM) of a nanowire SPD that consists of closely spaced nanowires in a large-area meander. We are working to improve DE by: (1) using thicker and more optically absorptive NbN films, (2) defining even narrower nanowires, (3) improving the linewidth uniformity, (4) increasing the length of the nanowire (and thus the total area of the meander), and (5) identifying and minimizing sources of material damage (such as electro-static discharge, plasma-damage, and thermal damage). We have recently developed a fabrication process using electron-beam lithography and hydrogen-silsesquioxane (HSQ) resist followed by a reactive-ion etch (RIE). This process, combined with an electron-beam proximity-effect correction technique, allows us to fabricate wires 150-µm long and less than 100-nanometer wide with line-width non-uniformity of ~5%, covering an area of ~25 µm² [2]. Figure 2 shows an SEM image of one of the devices we have made using this process that was 25-nm-wide: the narrowest superconducting nanowire ever fabricated for this type of detector.

REFERENCES:
