where conductance terms and noise are to be taken at the same frequency. Eq.(1) is supported by the RF measurements of transconductance and noise and the electronic temperature reported below as function of bias voltage. As electronic temperature depends on current, one can alternatively express thermal noise as $S_I = 2eI_d\tilde{F}$, by introducing a pseudo Fano factor $\tilde{F} \lesssim 1$. The limit $\tilde{F} = 1$ corresponds to a classical shot noise as observed in vacuum diodes. The hot electron regime shows up in our nanotube transistor by a full thermal shot noise with $\tilde{F} \sim 1$ at low bias followed by some reduction ($\tilde{F} \simeq 0.7$) resulting from Pauli principle and the effect of electronic degeneracy which generally shows up at high bias.

The sample (Fig.1(a)) is taken from a batch which was extensively described and characterized in Ref.[5]. A symmetric double gate RF design is used (Fig.1(a)) on high resistivity silicon substrate. The high mobility CVD-grown nanotube (diameter $d \sim 2$ nm) is equipped with a top gate (length $L_g = 0.3\mu$m) deposited on a thin AlO$_x$ oxide (thickness $t_{ox} \simeq 6$ nm). Palladium drain and source metallisations are used for low Schottky barrier contacts. Our high-sensitivity cryogenic setup includes a low noise amplifier fitted to a 200–50 Ohms impedance matching transformer with a 0.8 GHz cutoff. Matched resistors are fitted at the input and output lines to obtain a broad 0.1–0.8 GHz measuring band. The 200 Ohms output load ensures DC voltage bias conditions and serves as an auxiliary white noise source for in-situ calibration. The lumped circuit element description of the nanotube transistor (Fig.1(b)) is used for RF data analysis and the theoretical model below. The gate capacitance, $C_g/L_g \simeq 0.07 \pm 0.02$ fF/μm, is taken from the room temperature RF probe station measurements [5]. With $C_q/L_g = 8e^2/hv_F = 0.4$ fF/μm ($v_F \simeq 8 \times 10^5$ m/s) we deduce $\beta \simeq 0.2$ [5]. We have used negative drain bias, which shows lower $1/f^\alpha$ noise and symmetric gate bias conditions. I_d and S_I are taken by reference to the pinch-off value (at $V_g = +1$ V).

Figure 2 shows the radio frequency transconductance g_m^{RF} deduced from transmission measurements [5] as function of gate voltage for different bias conditions. The DC conductance g_d^{DC} and transconductance g_m^{DC} are obtained from the $I_d(V_g, V_d)$ characteristics (Fig.2-inset). Reflection coefficients, and g_d^{RF}, cannot be accessed with this setup. The sample shows large $g_m^{RF} \simeq 30$ μS, typically 3-times larger than g_m^{DC}, which suggests AC contact coupling. We observe a small temperature dependence of g_m^{RF} (a $\sim 50\%$ decrease between 4K and 300K) which we take as a first indication of a hot electron regime.

In Fig.3 we discuss measurements of the transistor in the open state ($V_g = -0.5$ V) where $g_m^{RF} \simeq 0$. Here the nanotube behaves as a metallic wire with a finite transmission $D \sim 0.1$,