Sub-task 3.4 and 4.1 Mixer technology development

• Wideband: AlN
• Magnetic field dependence tuning structure
• Low noise at higher frequencies

Work done by:
Shaojiang Zhu, Alwin Brettschneider, Tony Zijlstra, Teun Klapwijk (+ collaborators SRON)
AlN barriers

- $R_n \sim 7\,\Omega$
- $A \sim 0.4\,\mu\text{m}^2$
- $J_c \sim 78\,\text{kA/cm}^2$
Tunnel-detection elements
Band 9 FTS for AlN (blue AlOx RnA=20); different magnetic fields

Note magnetic field dependence
Magnetic field dependent tuning

\[ \frac{\sigma_1}{\sigma_N} = \frac{1}{\hbar \omega} \left( \int_{-\Delta}^{\Delta} g_1(1,2) \tanh\left( \frac{\hbar \omega + \epsilon}{2k_B T} \right) d\epsilon + \int_{-\Delta}^{\Delta} g_2(1,2) \tanh\left( \frac{\hbar \omega + \epsilon}{2k_B T} \right) d\epsilon \right) \]

Here the coherence factors \(g_{1,2}\) are given by

\[ g_1(1,2) = \text{Re}[N(1)]\text{Re}[N(2)] + \text{Re}[P(1)]\text{Re}[P(2)], \]

\[ g_2(1,2) = \text{Im}[N(1)]\text{Re}[N(2)] + \text{Im}[P(1)]\text{Re}[P(2)], \]

Oxford Dec 8th 2009

APL accepted for publ
Proximity-effect in Nb/Al (bottom) and Nb/Nb* (top)
Niobium films on SiOx on Nb

Omid Noroozian
Herschel Space Telescope

Oxford Dec 8th 2009
State of the art: Band 10 Japan (AlOx) and HI FI Band 3 results

A sensitive ALMA Band 10 SIS receiver engineering model

Y Uzawa¹, M Krong¹, T Kojima¹,², M Takeda¹, M Candotti¹, Y Fujii¹, K Kaneko¹, W Shan¹, T Noguchi¹ and Z Wang¹

SST 22, 114002 (2009)
Technology works!

RnA=4
Stable minimum and no glitches required.
Shape-dependence of Fraunhofer: minimizing to be applied field

- Red: Gaussian
- Others: diamond shape

Conclusion: 1st minimum shifts to lower applied fields
Dependence on magnetic field

1. Tuning circuit: proximity-effect layer
2. Uncontrollable jumps: flux-entry?

Preference: operate the device at the smallest possible magnetic field
Predicted response of tuning circuit for CHAMP+: AlN barriers NbTiN/Al striplines

modeled FTS NbTiN-SiOx-Al SIS and AlNx junction

- non-uniform current density modeling
- uniform current density modeling

frequency (GHz)

Transmission

Oxford Dec 8th 2009

Alwin Brettschneider

TUDelft