

Measurement of Nb/Al -STJ
response to photon using VTS at
FNAL (second run)

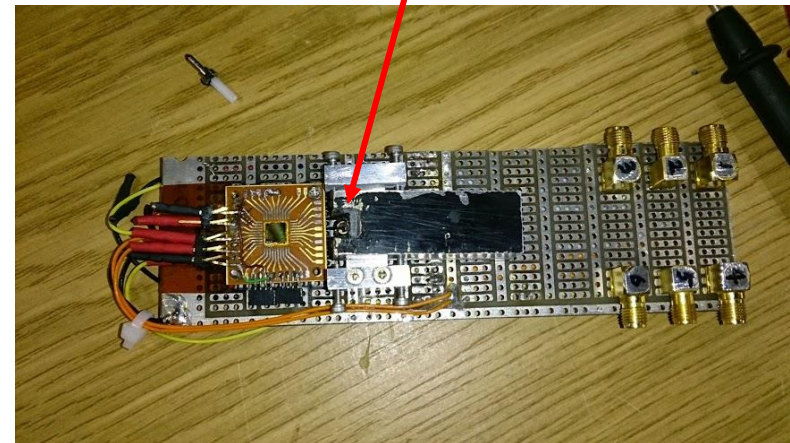
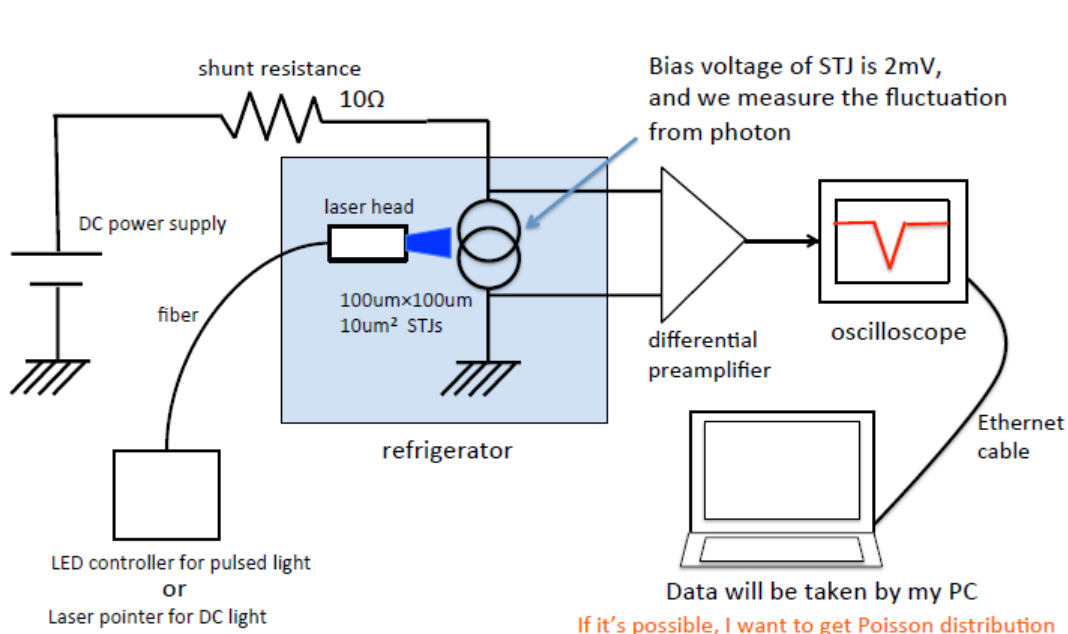
HOU2013 report
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Set up

In the first experiment we didn't see the response to photons. So, we take off the prism and decide to radiate laser directly in the second experiment.

The circuit is same as the first experiment.



Set up

We attached pin photo diode to confirm whether light came to STJ.

Pin photo diode senses light that is reflected by STJ.

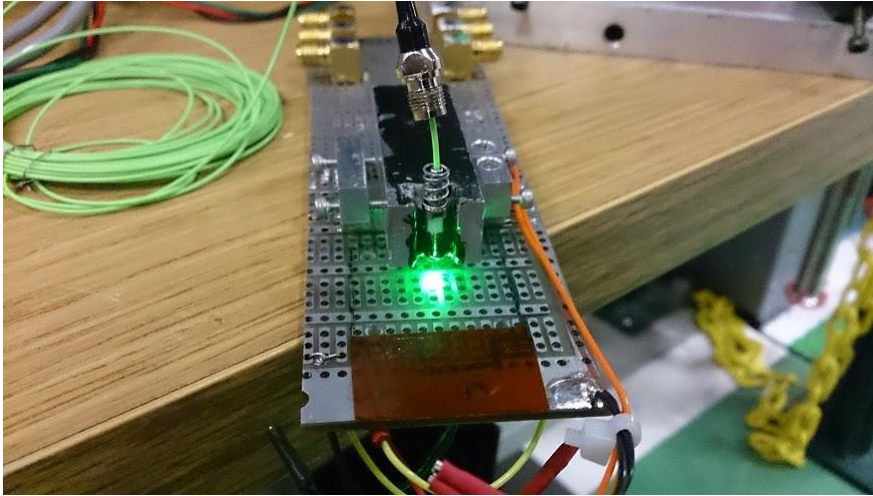
Pin photo diode
 10^7 gain

Laser on: 400mV
Laser off: 5.6mV



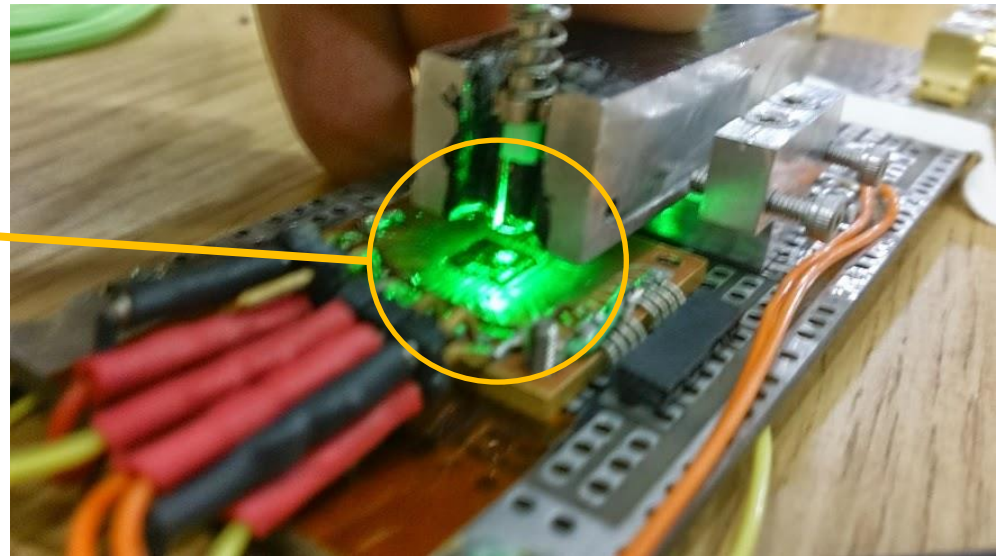
pin photo diode

Set up



We used a 5mW laser pointer

Light is incident decidedly

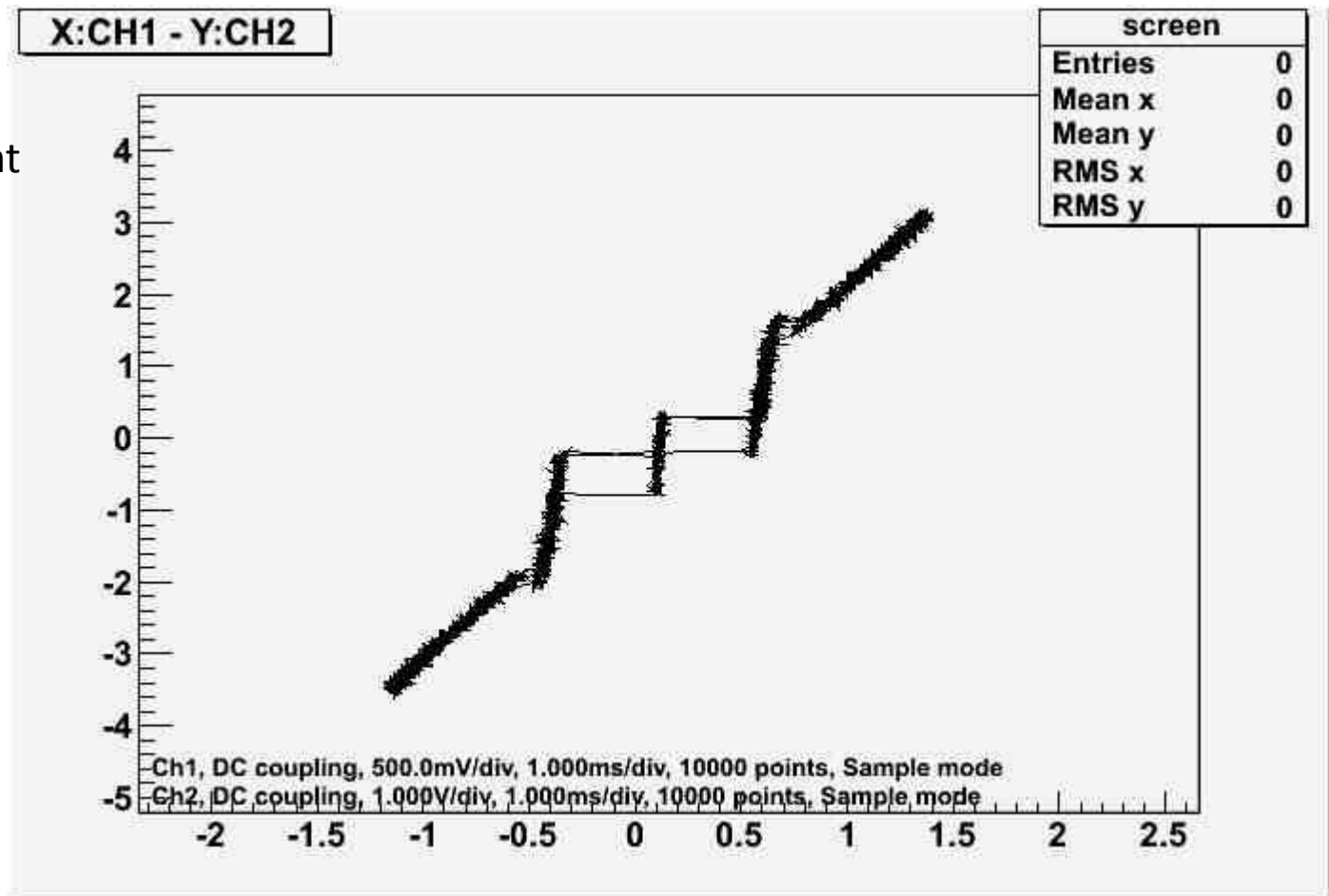


I-V curve

100 μ m \times 100 μ m

No magnetic field

Josephson current
 I_s 24mA

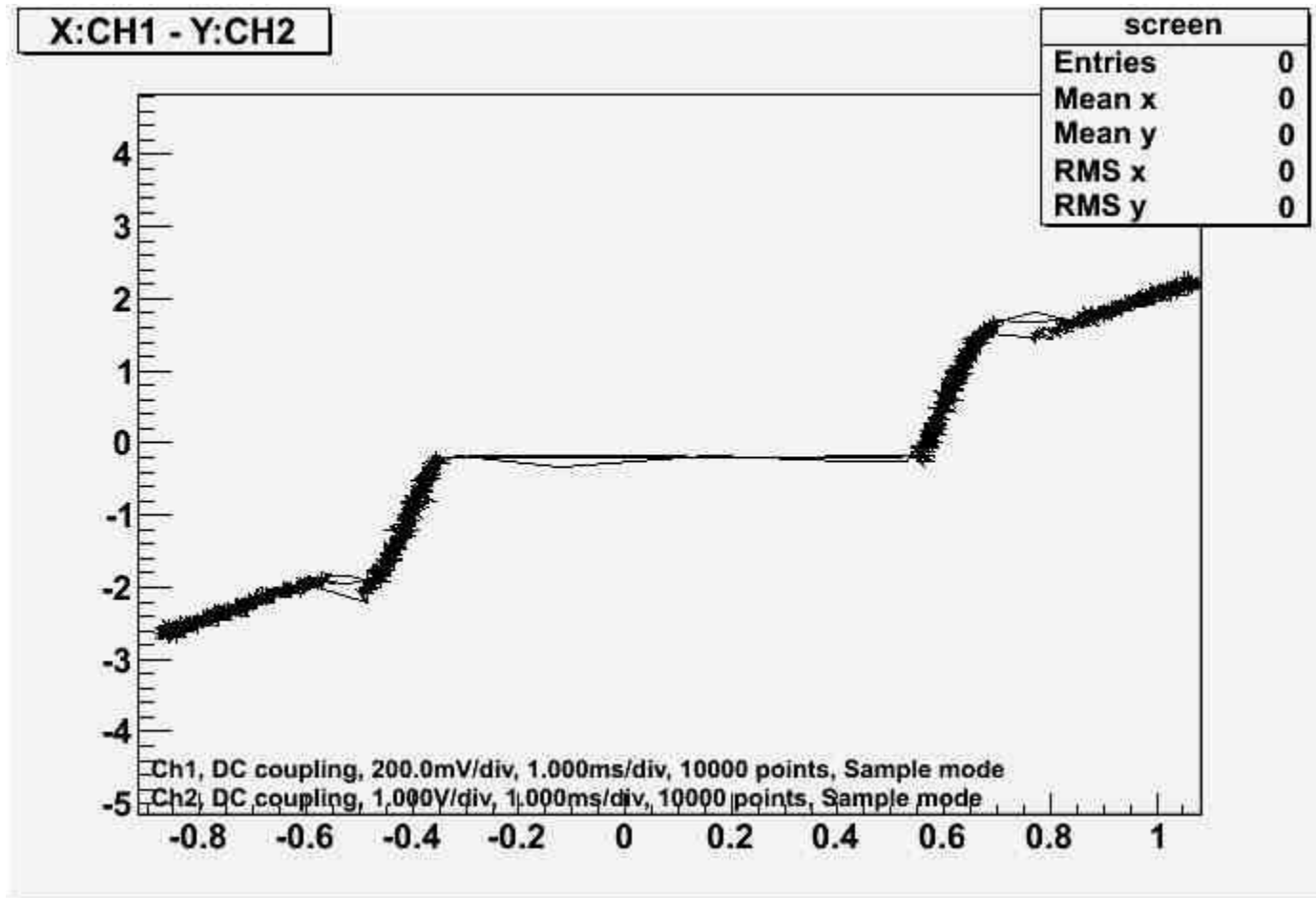


I-V curve

100 μ m \times 100 μ m

Add the magnetic field

Magnetic field:30G

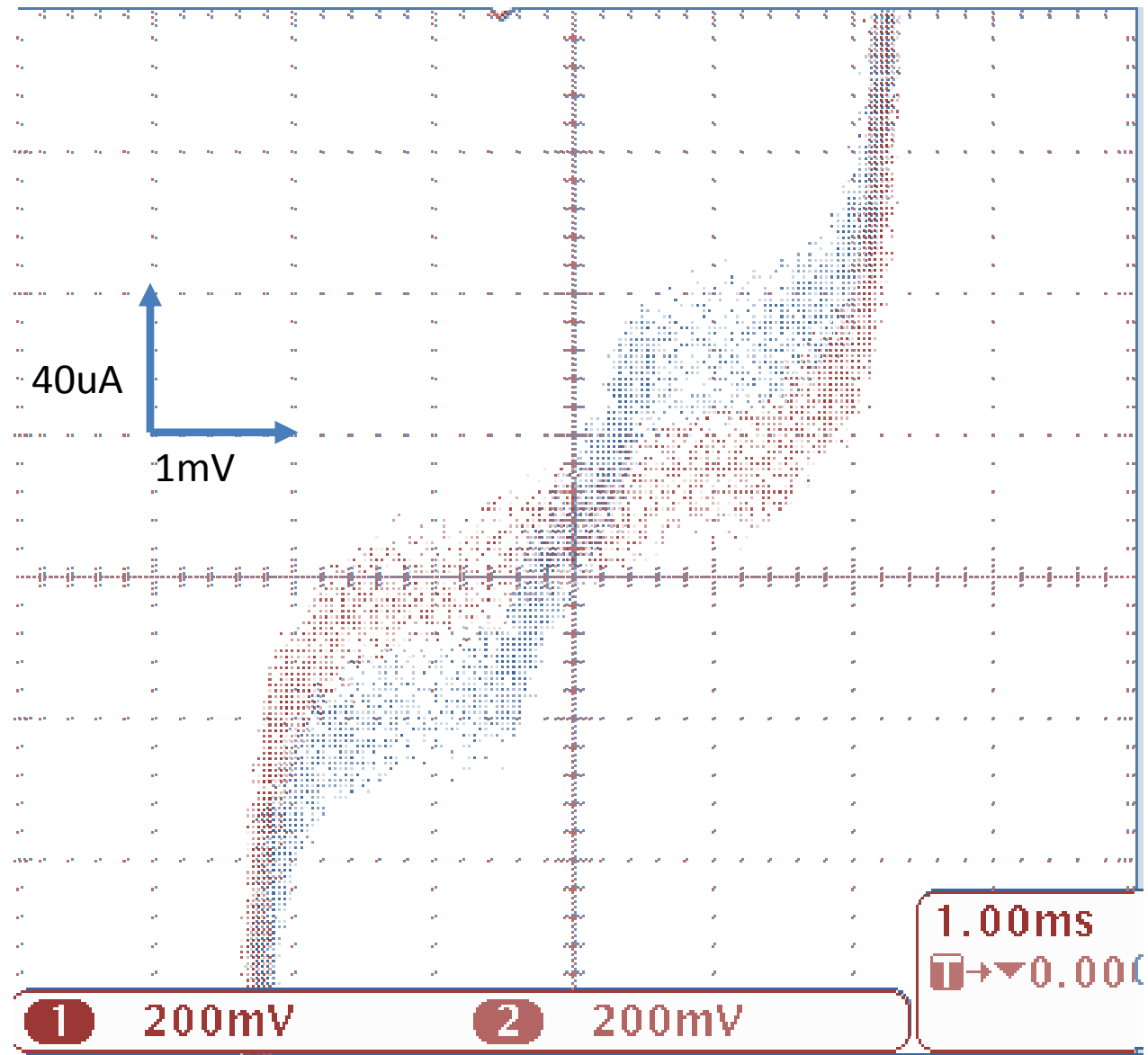


100 μ m \times 100 μ m

Incident
Laser Pointer

Put two graphs of
oscilloscope.

There is a difference
of 40 μ A



Blue: irradiate laser
pointer

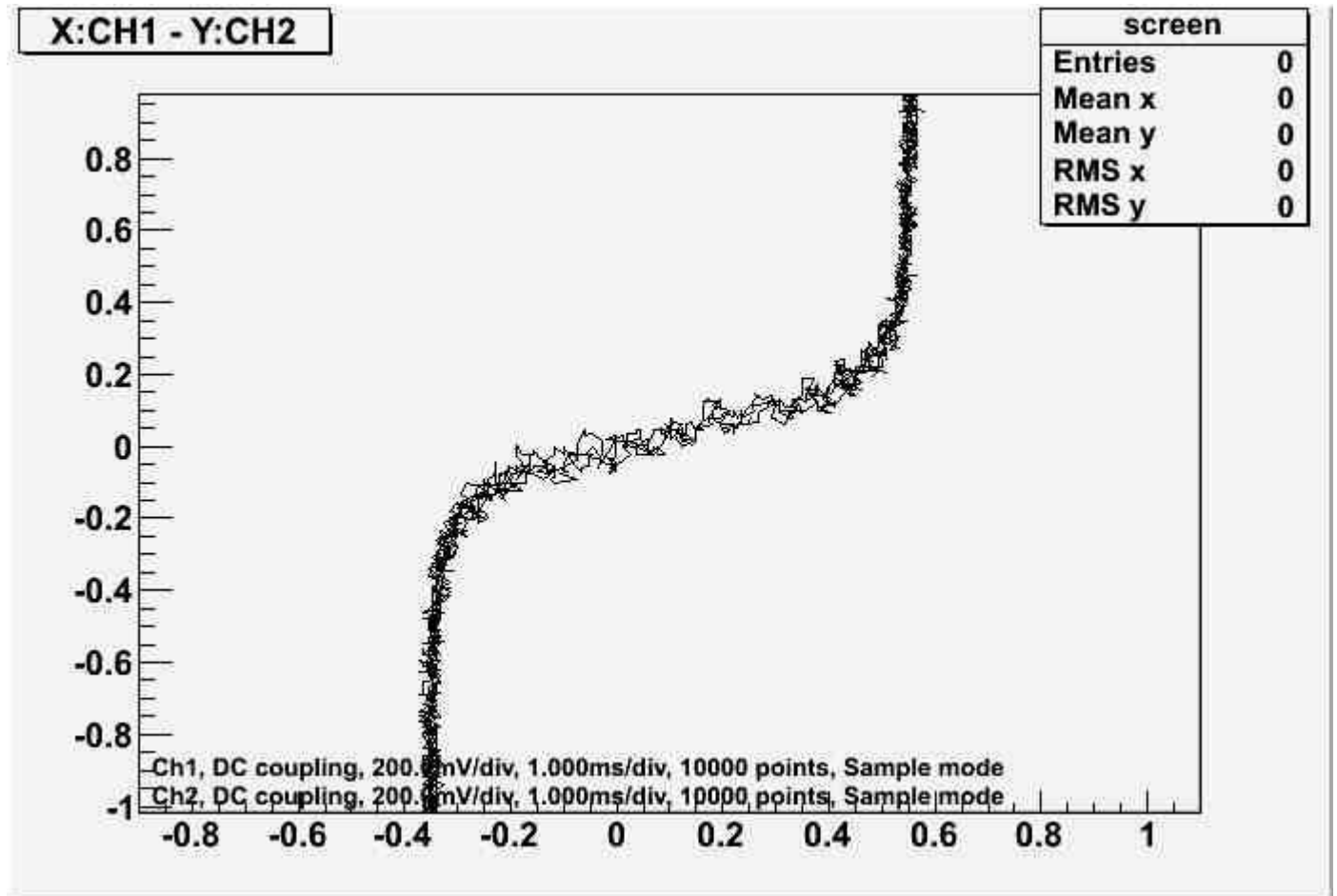
Red: no laser pointer

I-V curve

100 μ m \times 100 μ m

magnetic field :30G

No
Laser pointer

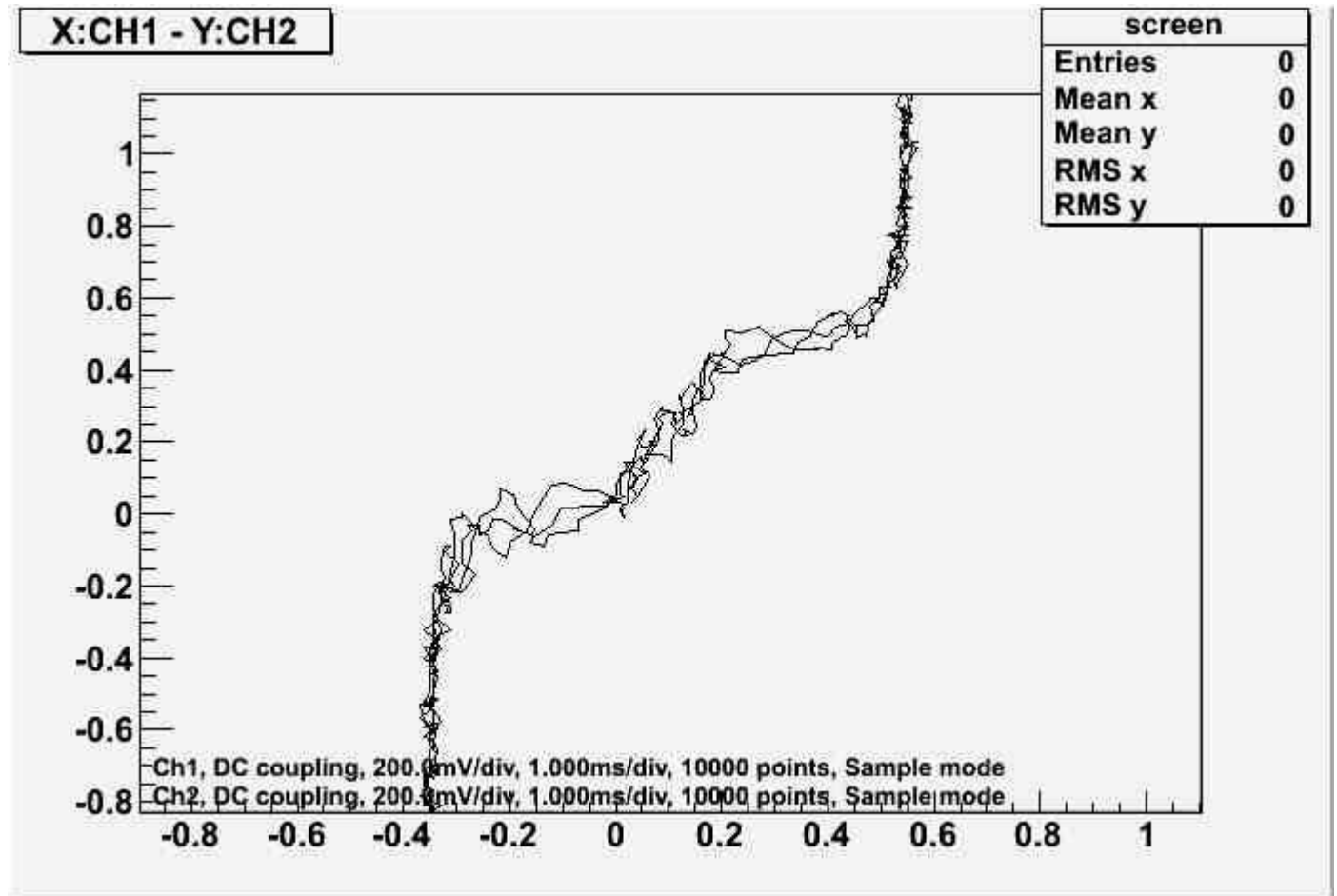


I-V curve

100 μ m \times 100 μ m

magnetic field :30G

Irradiate the
Laser pointer



Electric charge

Calculate the electric charge per 1us.

$$\begin{aligned} Q &= 40 \times 10^{-6} \text{ A} \times 1 \times 10^{-6} \text{ s} \\ &= 40 \times 10^{-12} \text{ C} \\ &= 2.50 \times 10^8 e \end{aligned}$$

To suppose
trapping gain $G_{Al}=10$

Electric charge

$$Q = G_{Al} \frac{\varepsilon}{1.7 \Delta_{Nb}} N$$

G_{Al} : trapping gain

Δ_{Nb} : energy gap

ε : energy of light

$$2.50 \times 10^8 = 10 \frac{4.0 \times 10^{-19}}{1.7 \times 0.75 \times 10^{-3} \times 1.6 \times 10^{-19}} \times N$$

$$\begin{aligned} 2\Delta_{Nb} &= 1.5 \text{ meV} \\ \varepsilon &= 4.0 \times 10^{-19} \text{ J} \end{aligned}$$

$$N = 1.28 \times 10^4 / \text{us}$$

Accept number of photons for STJ is $1.28 \times 10^4 / \text{us}$

Output number of photons from laser pointer is $1.25 \times 10^{10} / \text{us}$

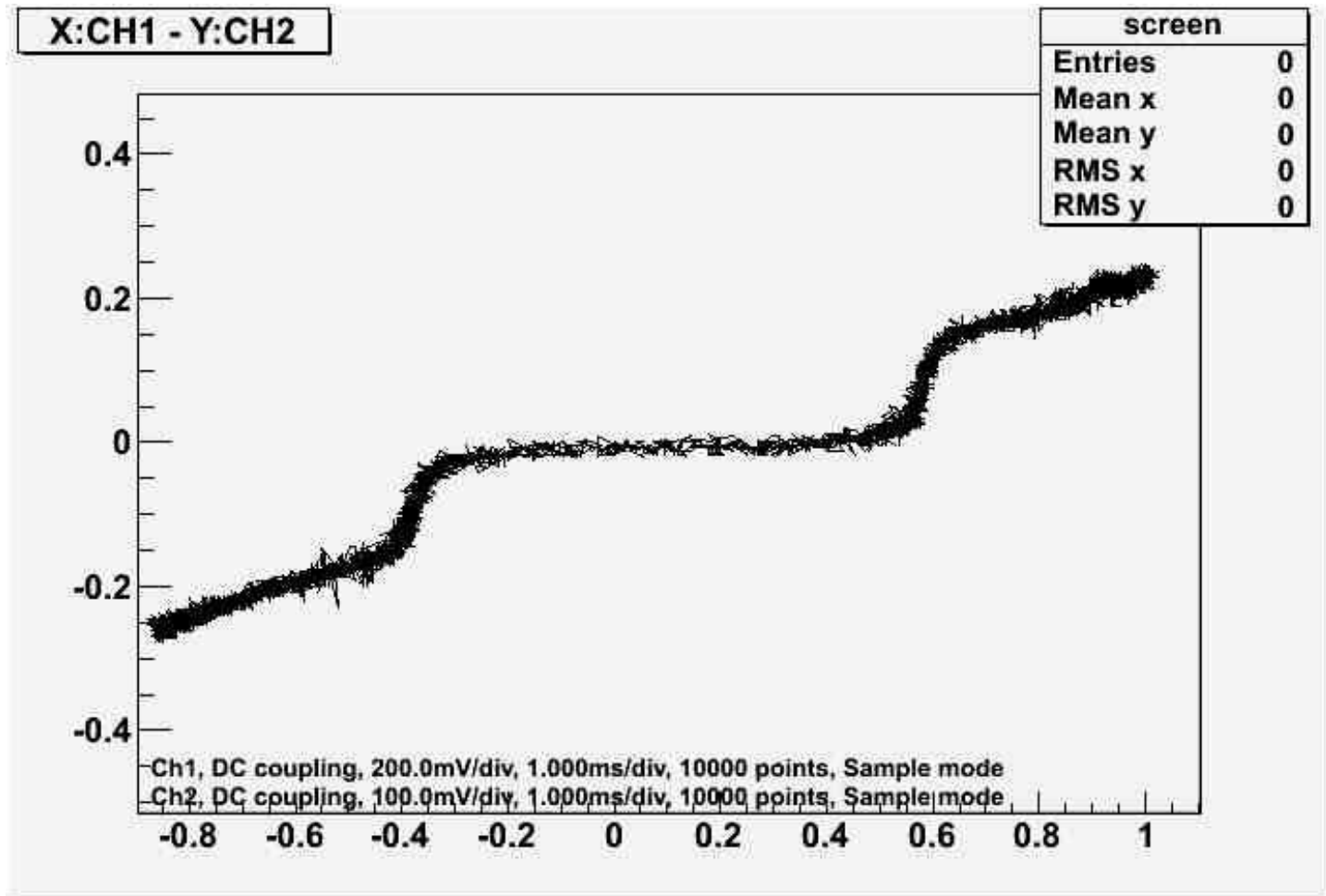
Acceptance 10^{-6} (this include acceptance of fiber injection, geometrical acceptance of STJ, quantum efficiency and charge collection efficiency)

I-V curve

$10\mu m^2$

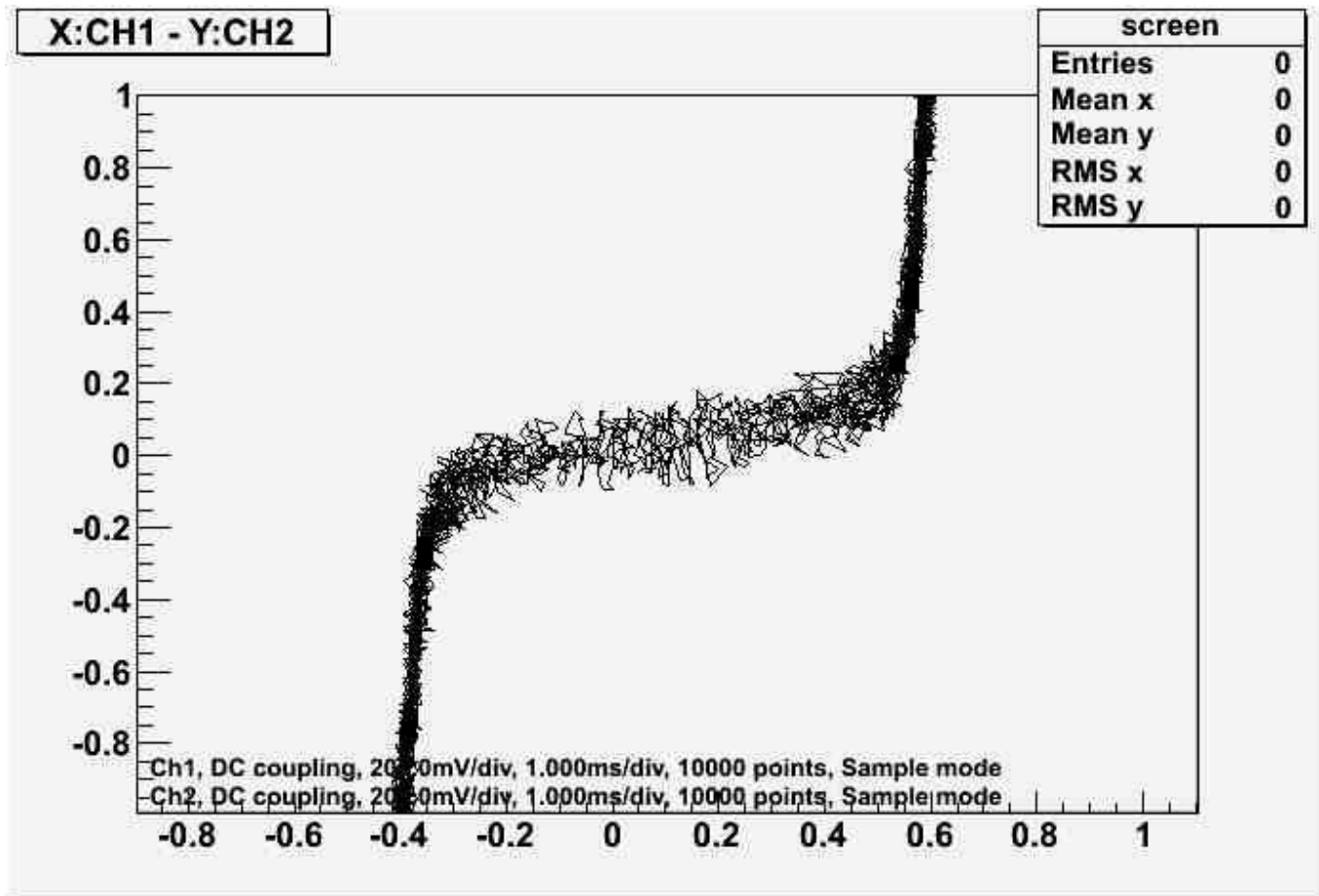
No magnetic field

No IC



I-V curve $10\mu m^2$

magnetic field:30G



STJ of $10\mu m^2$ did not react for Laser Pointer

summary

- We saw the response from 100x100 STJ.
- But no response from an LED.
- $10\mu m^2$ STJ didn't react to photons.
 - ➡ A small signal was overwhelmed for the noise of STJ?

We can extract relative collection efficiency as a function of bias voltage from I-V curves with and without laser illumination, I plan to make this analysis.