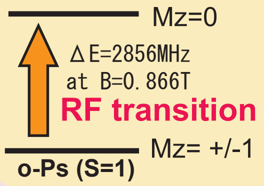
Precise measurement of hyperfine structure of positronium using Zeeman Effect -experimental set up and RF system

G. Akimoto, A. Ishida, Y. Sasaki, A. Miyazaki, K. Kato, T. Suehara, T. Namba, S. Asai, T. Kobayashi, H. Saito, M. Yoshida, K. Tanaka, A. Yamamoto, Y. Urushizaki, I. Ogawa, T. Idehara

Department of Physics, Graduate School of Science, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-0033, Japan

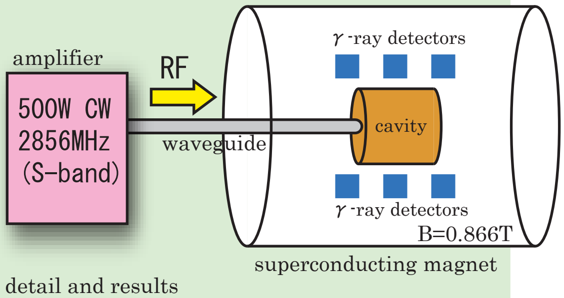
Introduction

Zeeman splitting of positronium



ΔE is a function of Ps-HFS and B

Experimental arrangement of Prototype Run



detail and results
Session F, Nov 11, 0-12, **Ishida**

Required performance

1. sufficient Ps transition

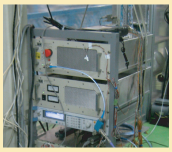
Lifetime of o-Ps is very short (142ns), so **high-power RF source** is required for transition.
S-band RF source meets this requirement. (the field strength of the superconducting magnet is adjusted to 0.866T)

2. stable transition probability

We stabilize RF power in the cavity with an accuracy of less than 0.1% for the O(1ppm) measurement of Ps-HFS.

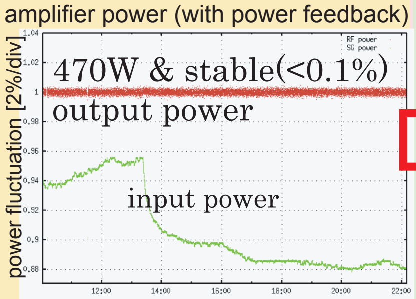
RF system and its performance

High power and stable RF source



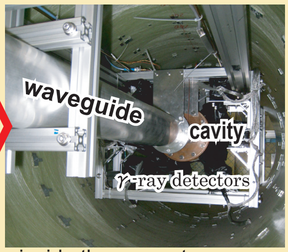
GaN amplifier and signal generator

amplifier power (with power feedback)



waveguide (low-loss)

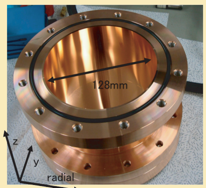
transmission loss2.5dB → 0.6dB improved



inside the magnet

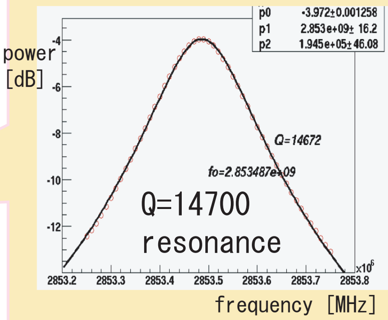
RF-power
470W at AMP
409W at the cavity

cavity Q-value = 14700

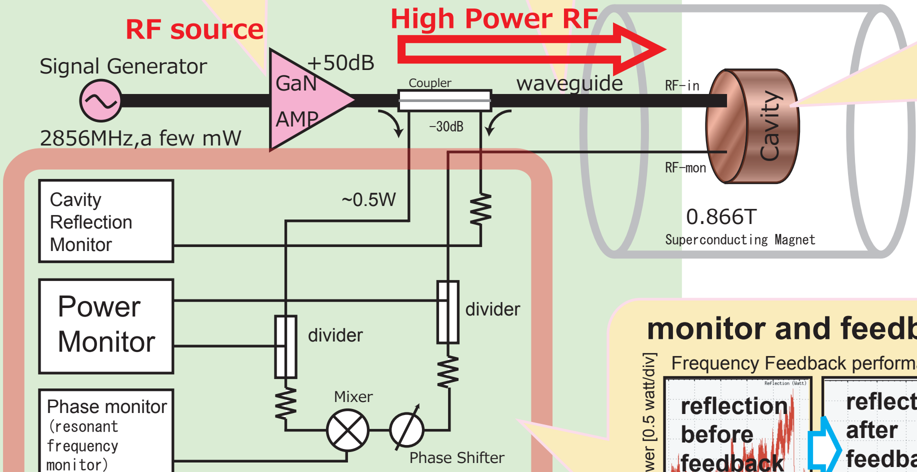


RF cavity
TM_{110}-mode
2856MHz (peak)
Dia. =128mm

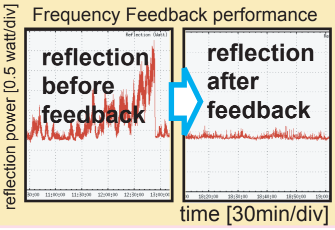
resonance peak of the cavity (2856MHz)



Ps transition ~29%
(3γ-decay to 2γ-decay)



monitor and feedback circuit works

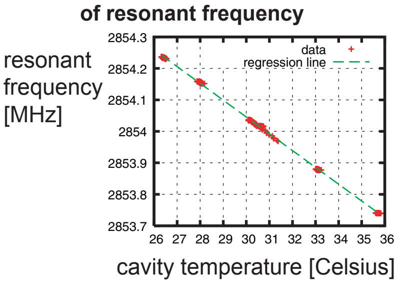


* **Frequency Feedback**
[following resonant frequency] against excessive reflection wave from the cavity breaking down the circuit
* **power Feedback**
Lock in AMP power (AMP gain drift)

stability of the cavity

Though AMP power is stable and the cavity is cooled to a constant temperature by a water chiller, the resonant frequency of the cavity still drifts 6ppm [goal O(1ppm)] with thermal expansion of the cavity (-18ppm/K , right figure).
We will stabilize temperature inside the magnet.

Cavity Temperature dependence of resonant frequency



Conclusion and Update

Experiments to measure Ps-HFS using Zeeman effect require high-power and stable RF.

This RF system successfully supplies the cavity with high-power RF.(power=409W,Q-value=14700) AMP power is stable (power feedback works). We will update RF system about stability of resonant frequency and Q-value