

# P71 A Power-Efficient Noise Canceling Technique

## Using Signal-Suppression Feed-forward for Wideband LNAs

Daiki Oki, Satoru Kawauchi, Li CongBing, Masataka Kamiyama,

Seiichi Banba †, Toru Dan †, Nobuo Takahashi †, Koji Sakata †, Haruo Kobayashi, Nobukazu Takai

Department of Electronic Engineering, Gunma University, 1-5-1 Tenjin-cho, Kiryu 365-8515, Japan

† Sanyo Semiconductor Co., Ltd.

### Research Goal

Realize low noise and low power LNA.

Noise Cancelling Technique

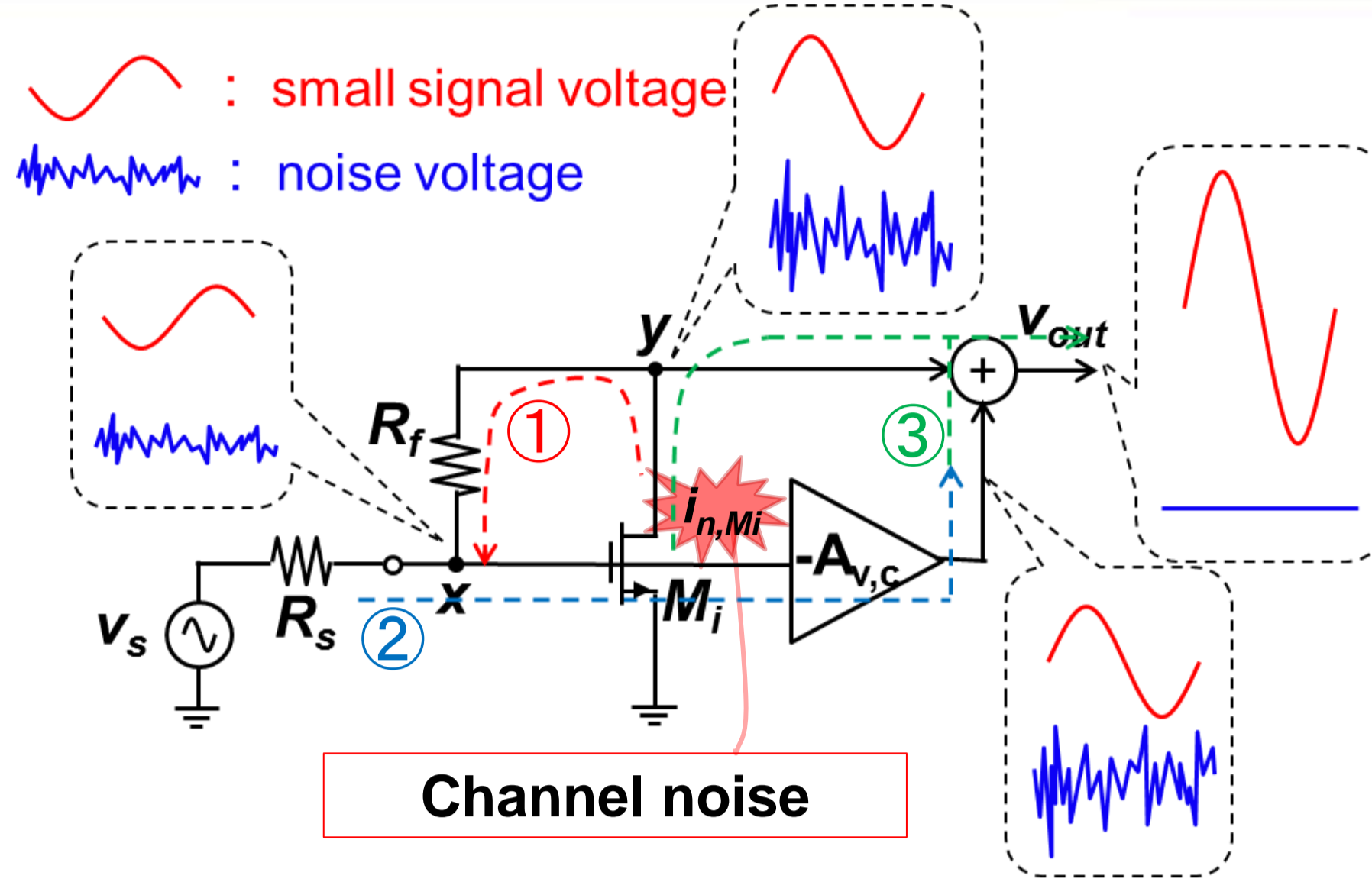
Signal Suppression

Low Noise Amplifier(LNA)

⇒ Always working

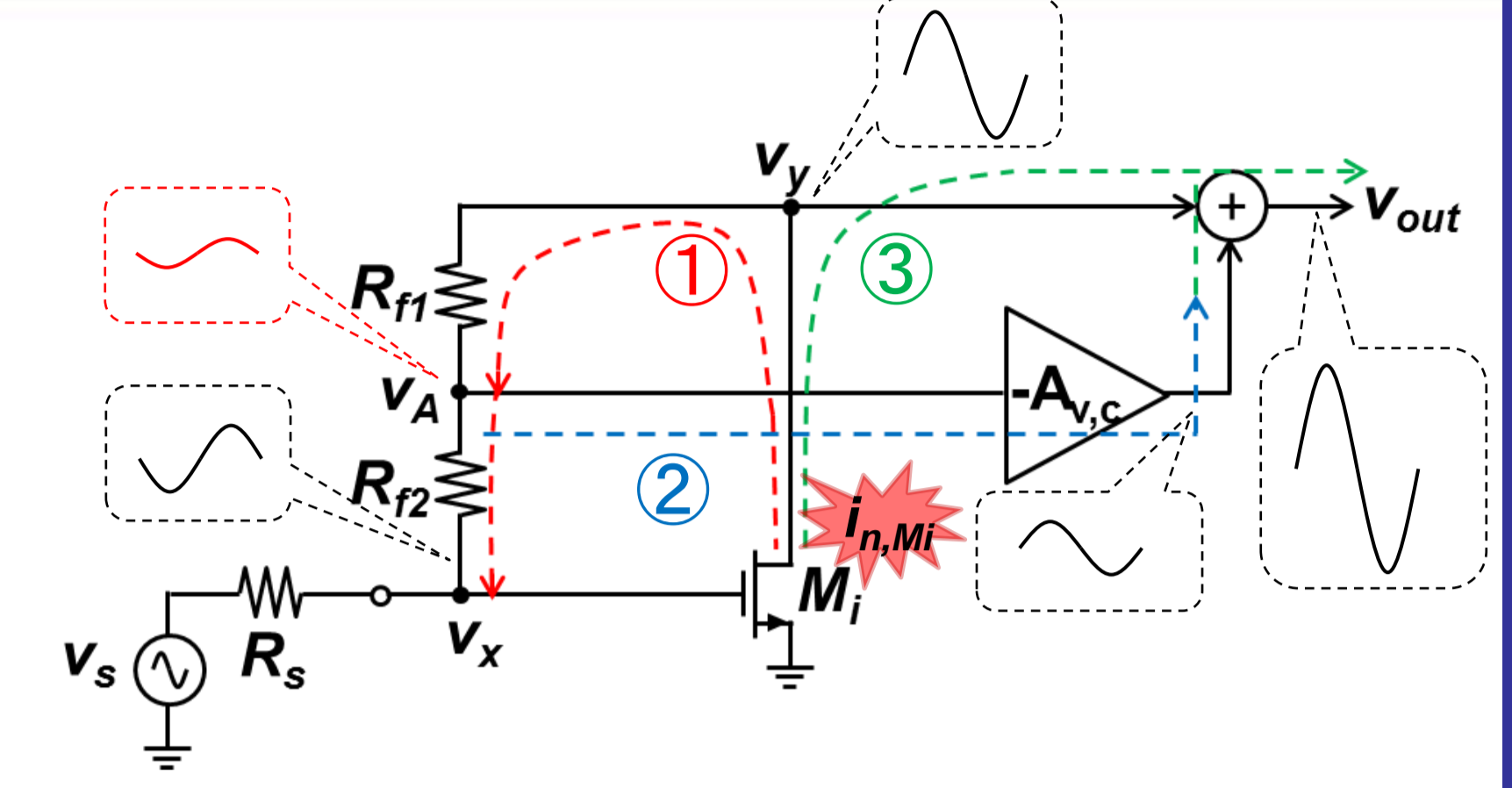
⇒ LNA power reduction is must for low power transceiver

### Basic Noise Cancelling Technique



Power increase by  $A_{v,c}$  operation

### Proposed Solution (Signal Suppression Technique)



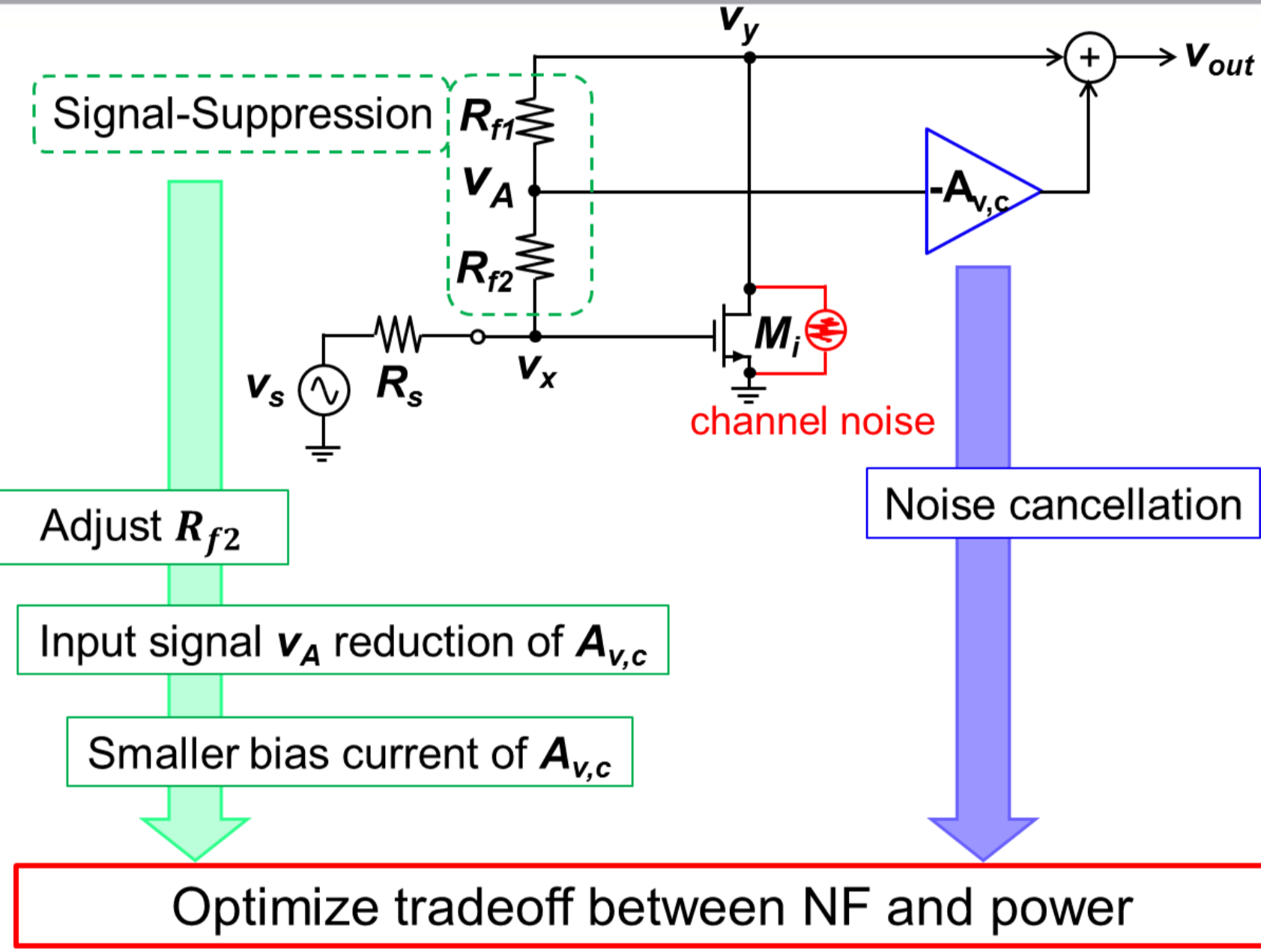
Division of  $R_f$

⇒ Suppress input signal of  $A_{v,c}(v_A)$

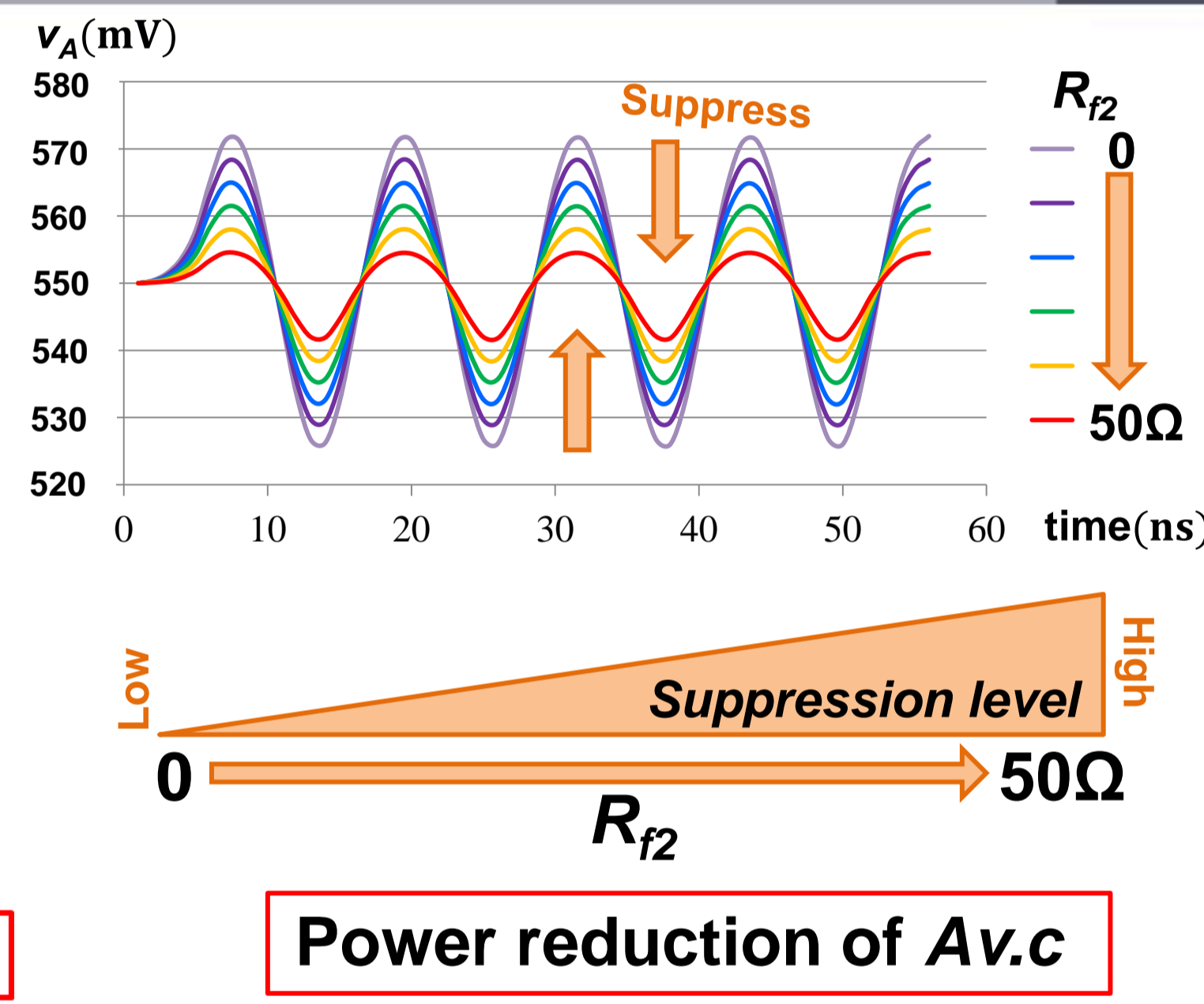
Power reduction of  $A_{v,c}$

Introduction

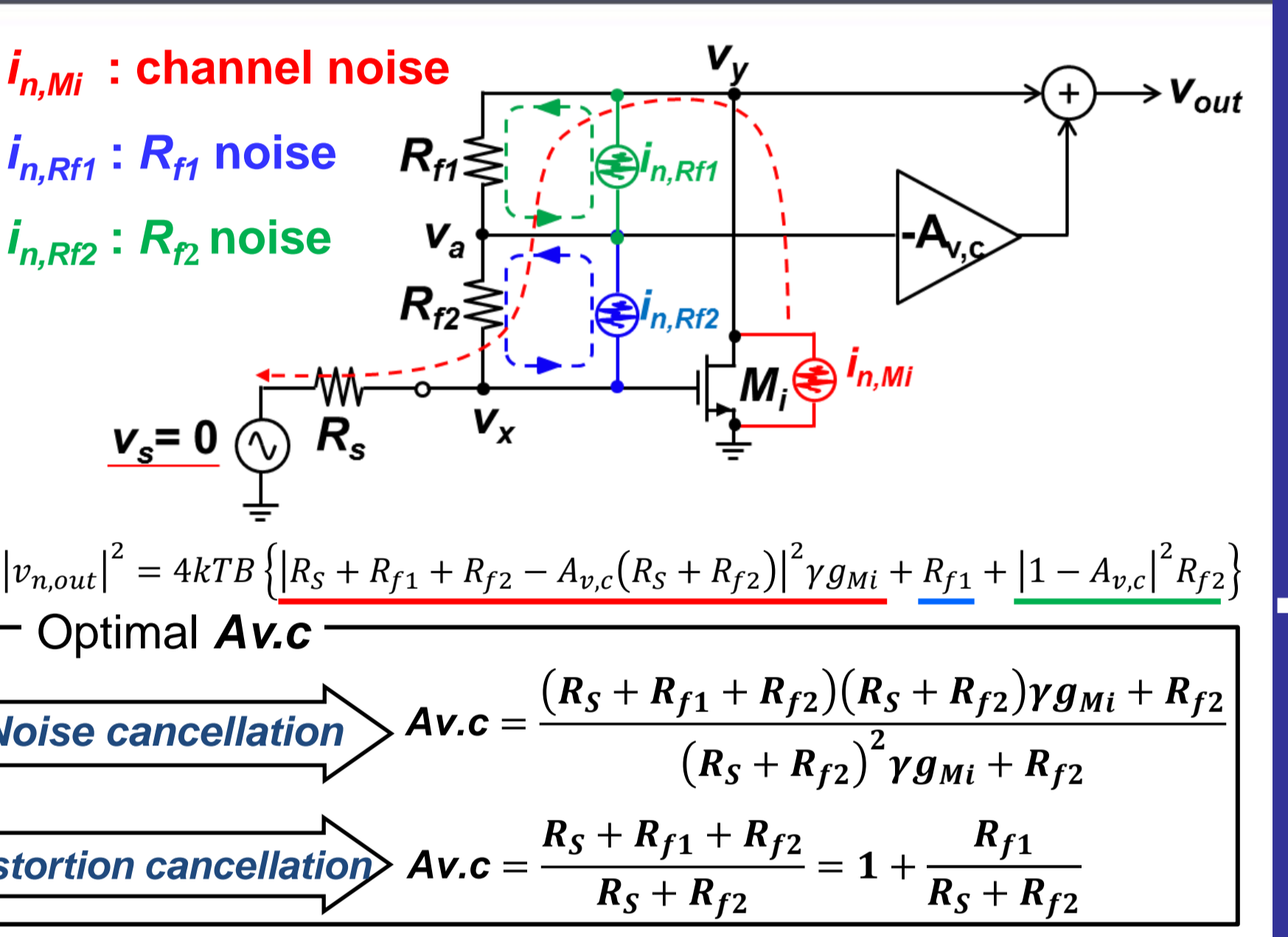
### Proposed Noise Cancelling Technique



### Signal Suppression at Noise Cancelling Amp



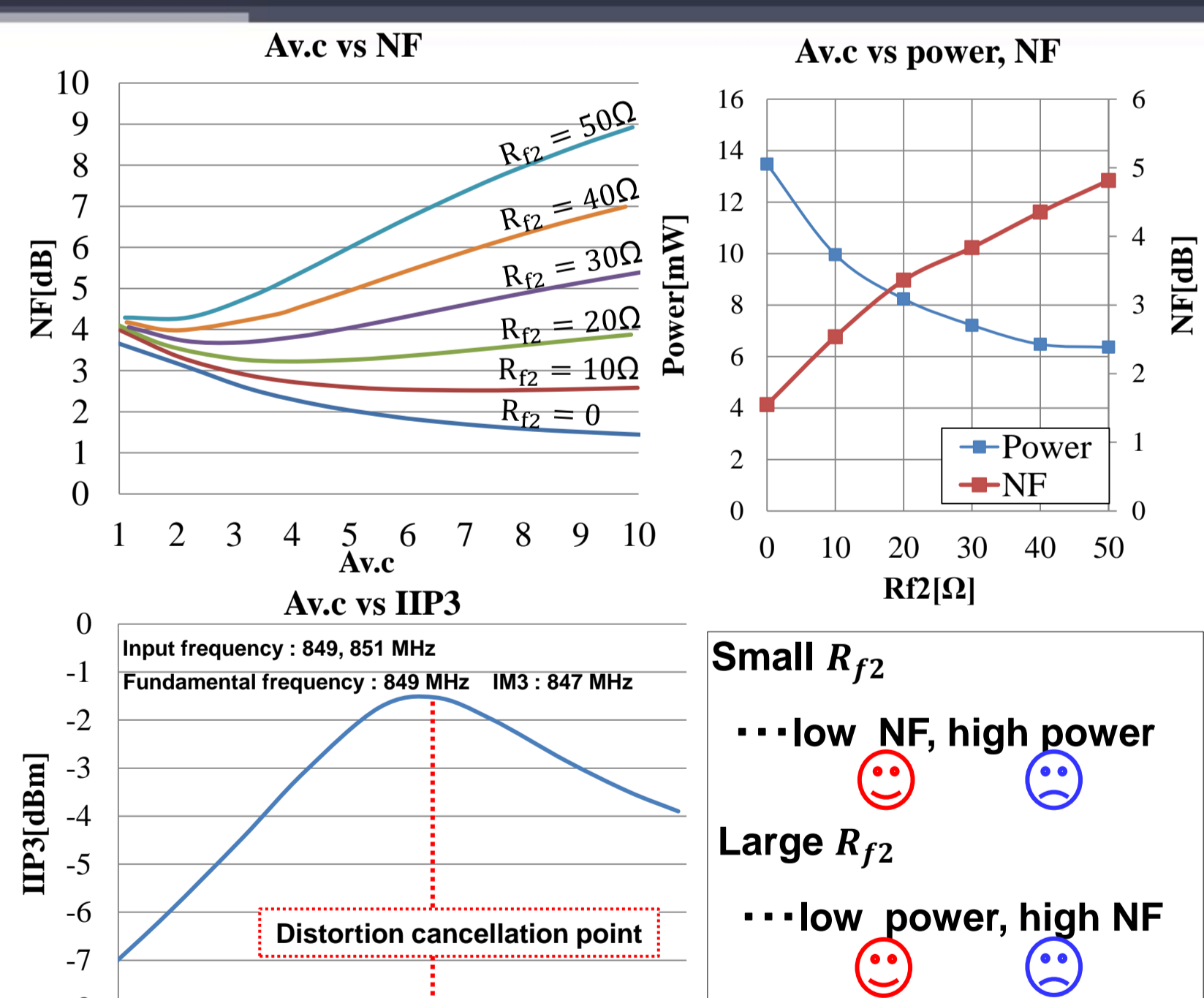
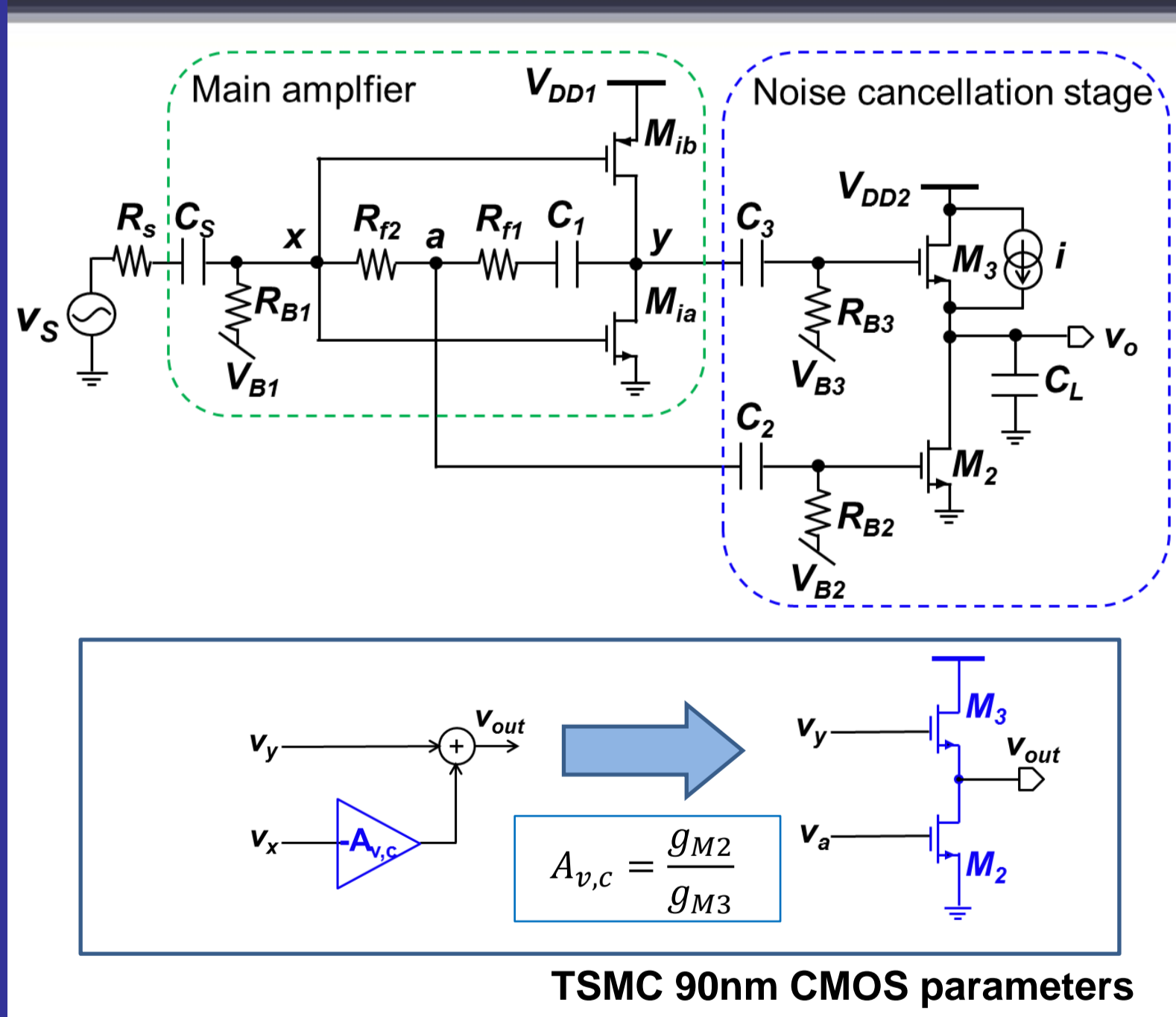
### Noise, Distortion Analysis of Proposed LNA



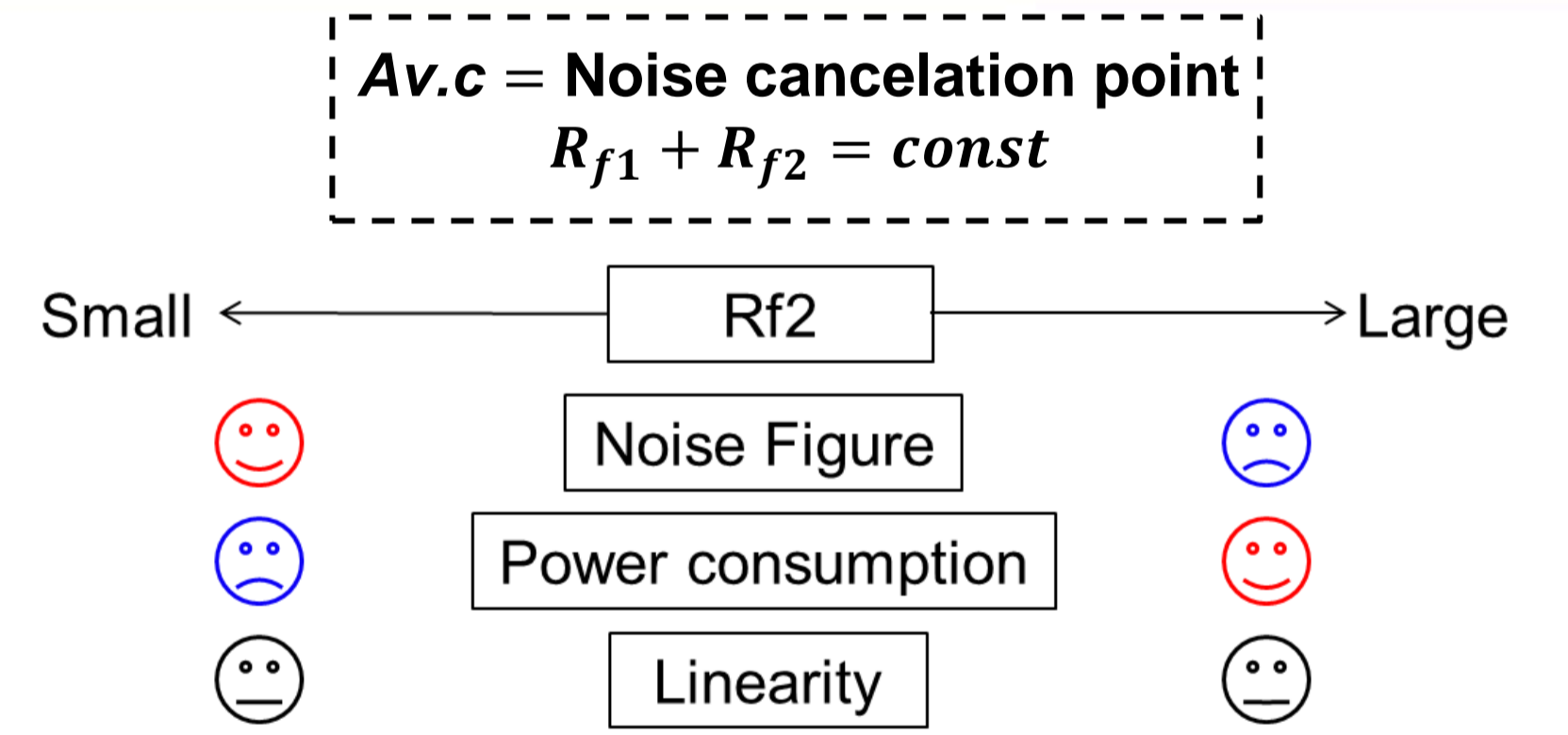
Proposed Circuit

### Proposed Circuit for Simulation

### Performance Tradeoff



### Performance Tradeoff



### Summary

- This work provides optimal tradeoff in between NF and power in wide-band LNA.
- ⇒ By adjusting feedback resistor  $R_{f2}$ .
- SPECTRE simulation with 90nm CMOS has proved
  - noise cancelling.
  - low power.
  - distortion cancelling.
  - good frequency characteristics with  $R_{f2}=20\Omega$

### References

[1] F. Bruccoleri, E. A. M. Klumperink, B. Nauta "Wide-Band CMOS Low-Noise Amplifier Exploiting Thermal Noise Cancelling" IEEE Journal of Solid-State Circuits, (Feb. 2004).

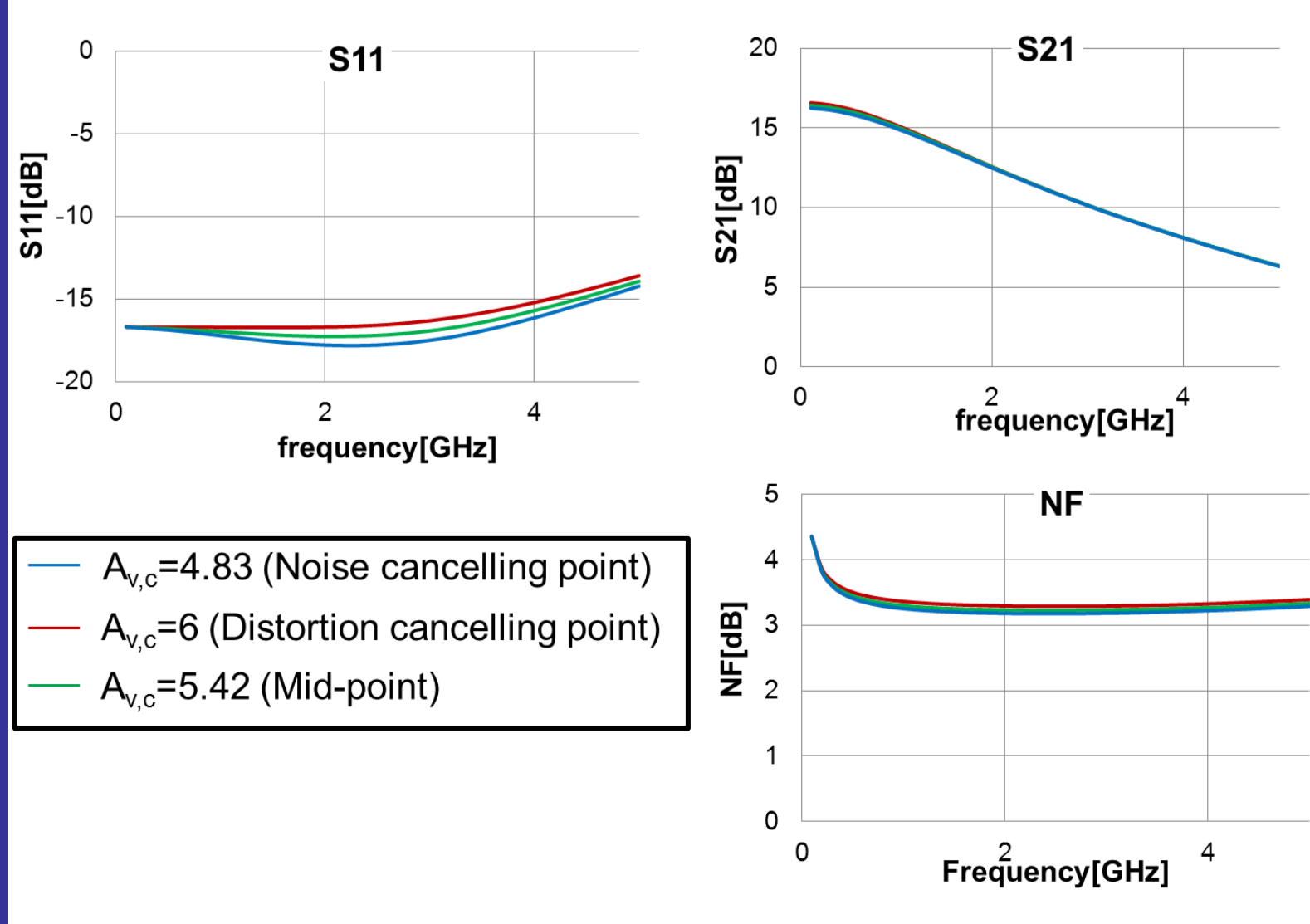
[2] C.-F. Li, S.-C. Chou, G.-H. Ke, P.-C. Huang "A Power-Efficient Noise Suppression Technique Using Signal-Nullled Feedback for Low-Noise Wideband Amplifiers" IEEE Trans on Circuits and Systems (Jan. 2012).

[3] C.-F. Li, S.-C. Chou, P.-C. Huang "A Noise-Suppressed Amplifier with a Signal-Nullled Feedback for Wideband Applications" IEEE Asian Solid-State Circuits Conference, (Nov. 2008).

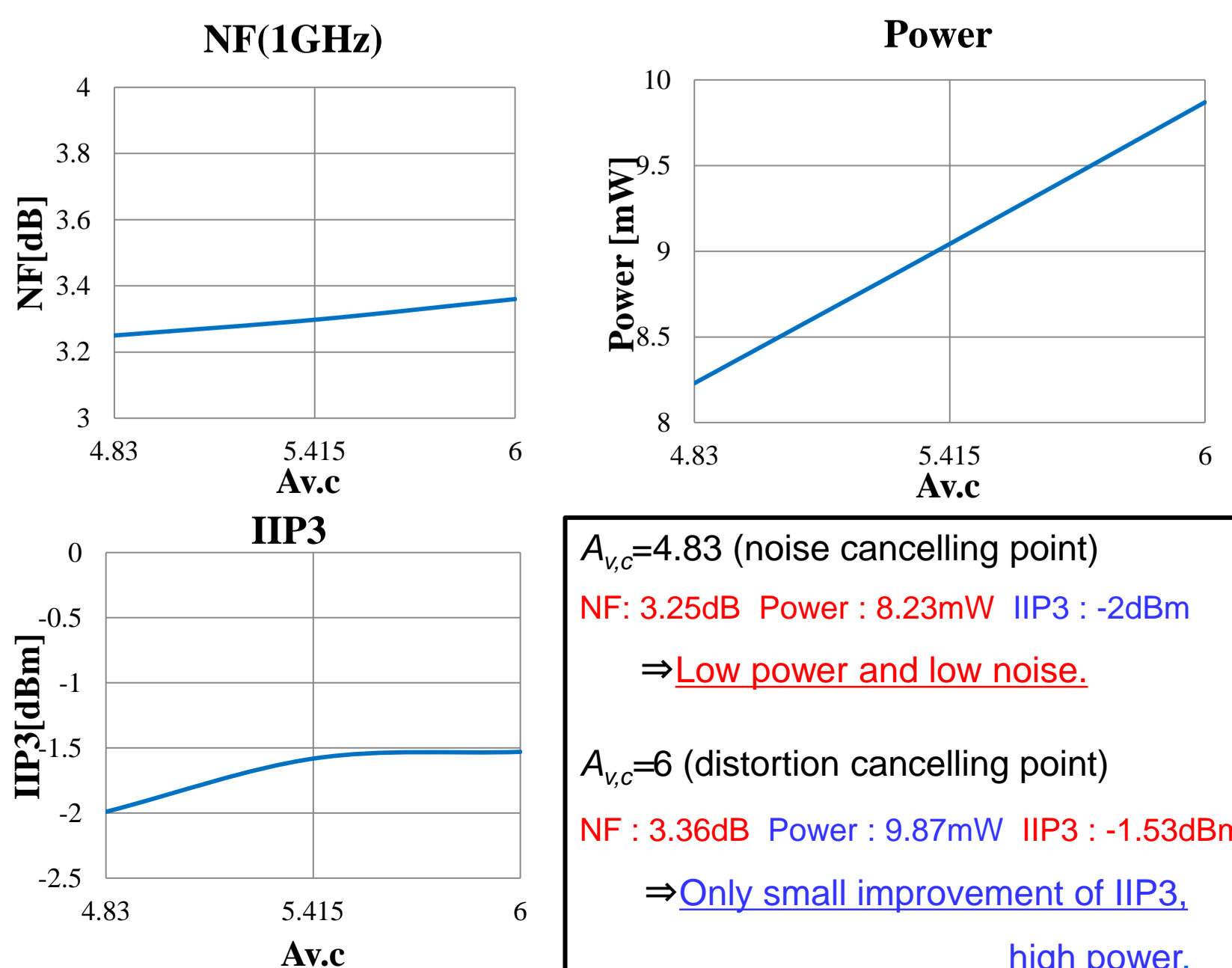
Simulation

### LNA frequency characteristics

Little influence by  $A_{v,c}$



### Performance change by $A_{v,c}$



$A_{v,c}=4.83$  (noise cancelling point)  
 NF: 3.25dB Power: 8.23mW IIP3: -2dBm  
 ⇒ Low power and low noise.

$A_{v,c}=6$  (distortion cancelling point)  
 NF: 3.36dB Power: 9.87mW IIP3: -1.53dBm  
 ⇒ Only small improvement of IIP3, high power.