# A CMOS Direct Sampling Mixer Using Switched Capacitor Filter Technique for Software-Defined Radio

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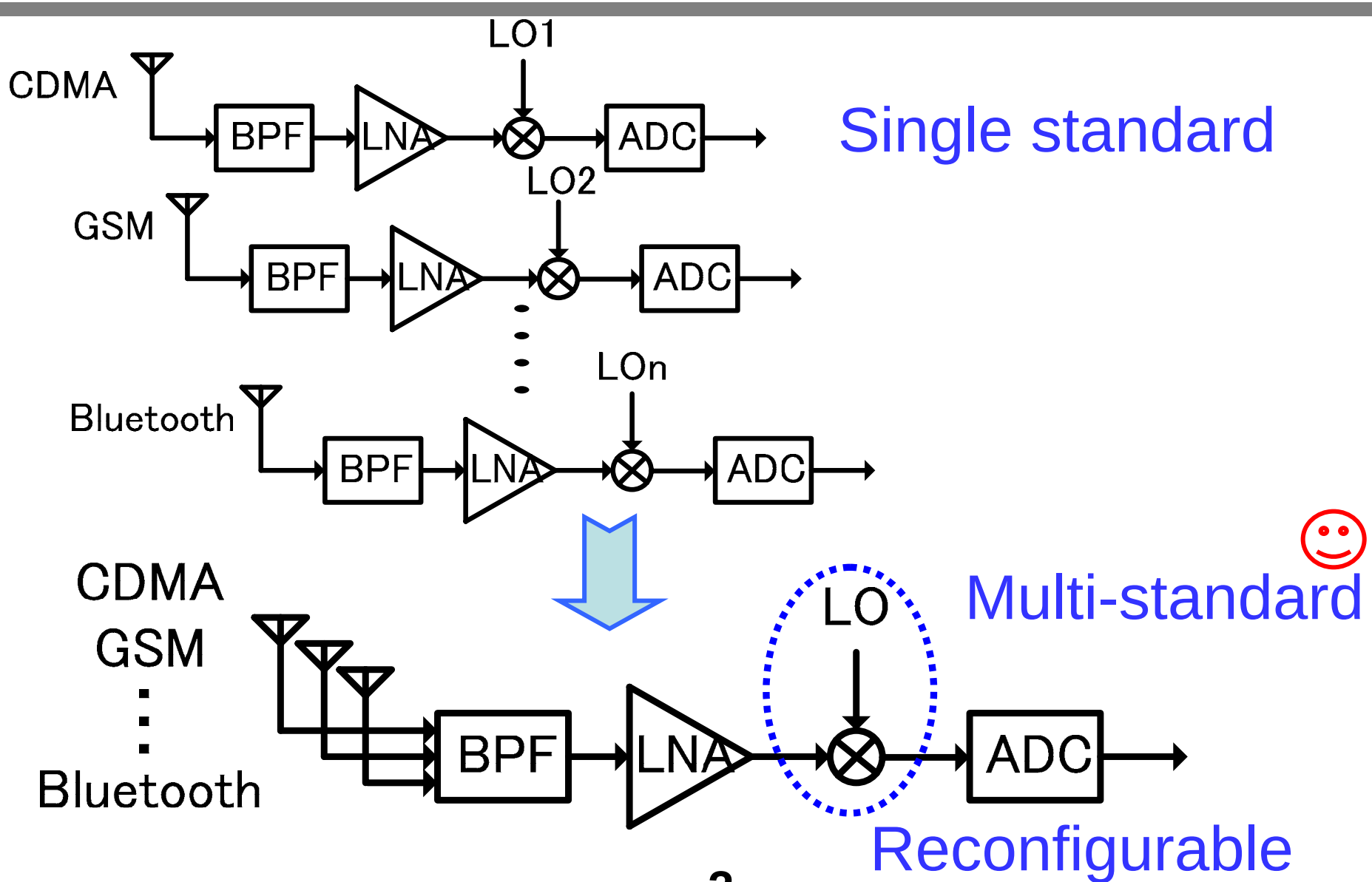
# Outline

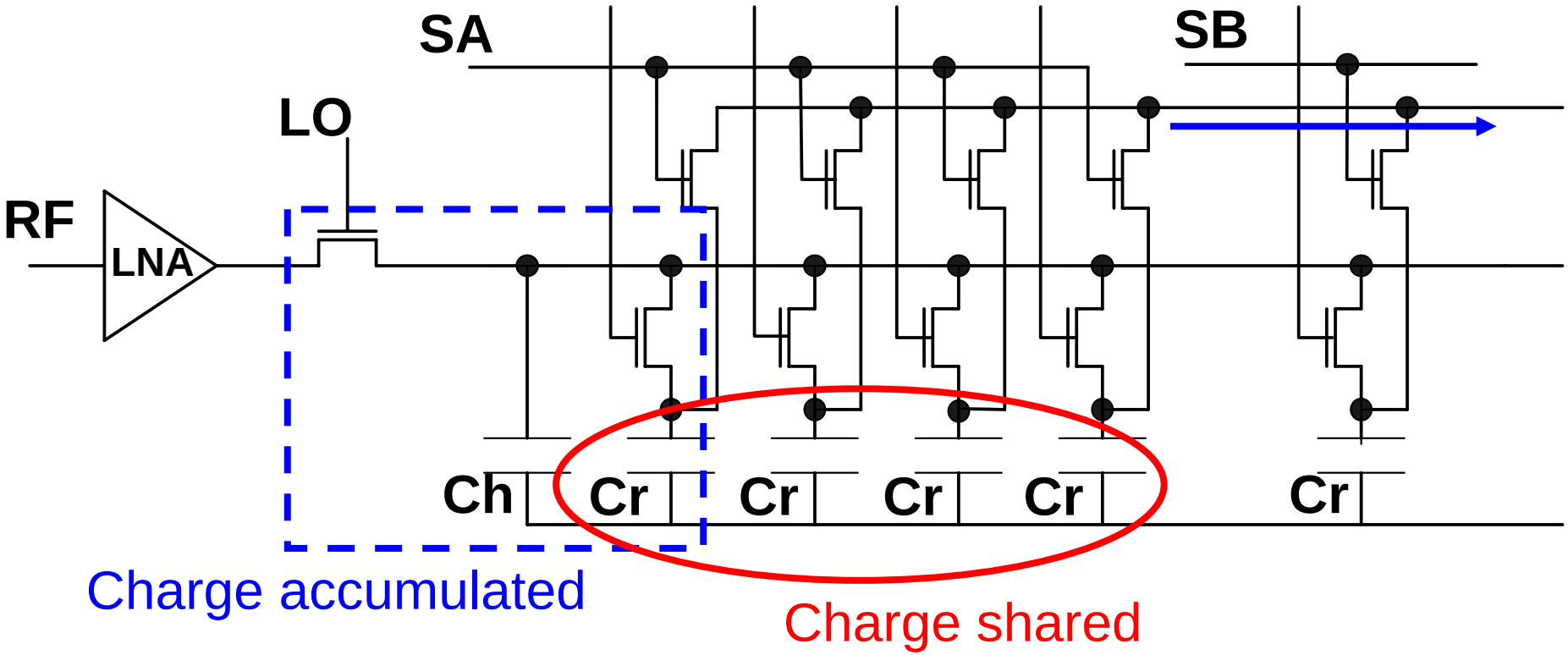
- **Background**
- **Proposed circuit**
- **Measurement results**
- **Conclusion**

# Background


LO1
CDMA
BPF
LNA
ADC
LO2
GSM
BPF
LNA
ADC
LOn
Bluetooth
BPF
LNA
ADC
Single standard
CDMA
GSM
Bluetooth
LO
BPF
LNA
ADC
Multi-standard
Reconfigurable

# Previous work

## Multi-Tap Direct Sampling Mixer(MTDSM)




R. B. Staszewski(TI) et al, “All-Digital TX Frequency Synthesizer and Discrete-Time Receiver for Bluetooth Radio in 130-nm CMOS”, JSSC Vol.39, No.12, pp. 2278-2291, Dec. 2004.

# Problems of previous work

MTDSM's issues

- **Poor variability of filter characteristic**
  - **Low order of the filter**
- **Bad Noise Figure**
  - **Effect of flicker noise**
- **Not good for wideband**
  - **Pass-bands appear at multiples of LO**

# Proposed solution

Realize MTDSM using Switched Capacitor Filter (SCF) Technique

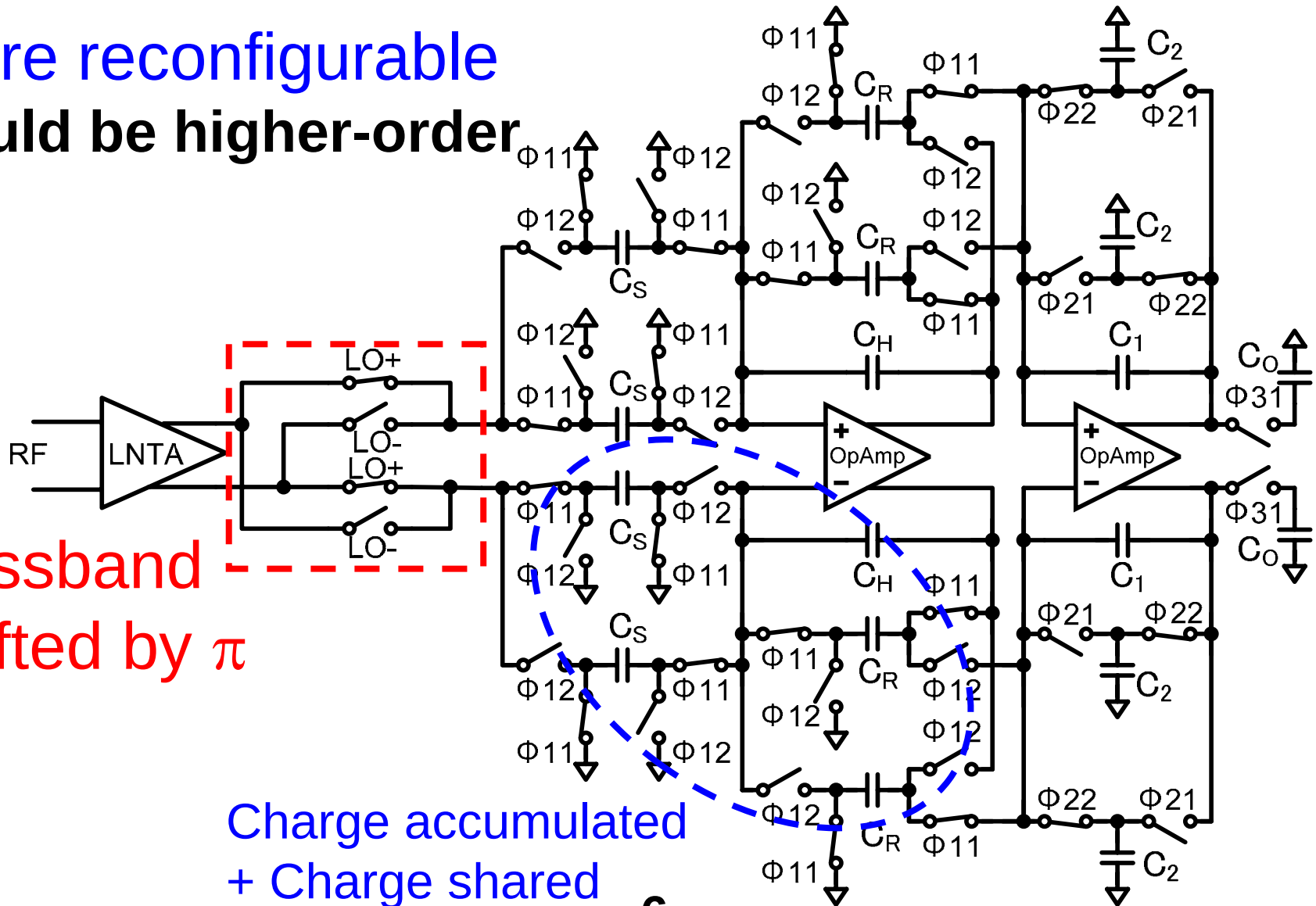
## Features

- **Filter characteristic is reconfigurable**
- **Promise higher-order filtering**
- **NF improvement (pass-band is shifted)**
- **Better for wideband (pass-band is shifted)**

# Proposed circuit

More reconfigurable

**Could be higher-order**

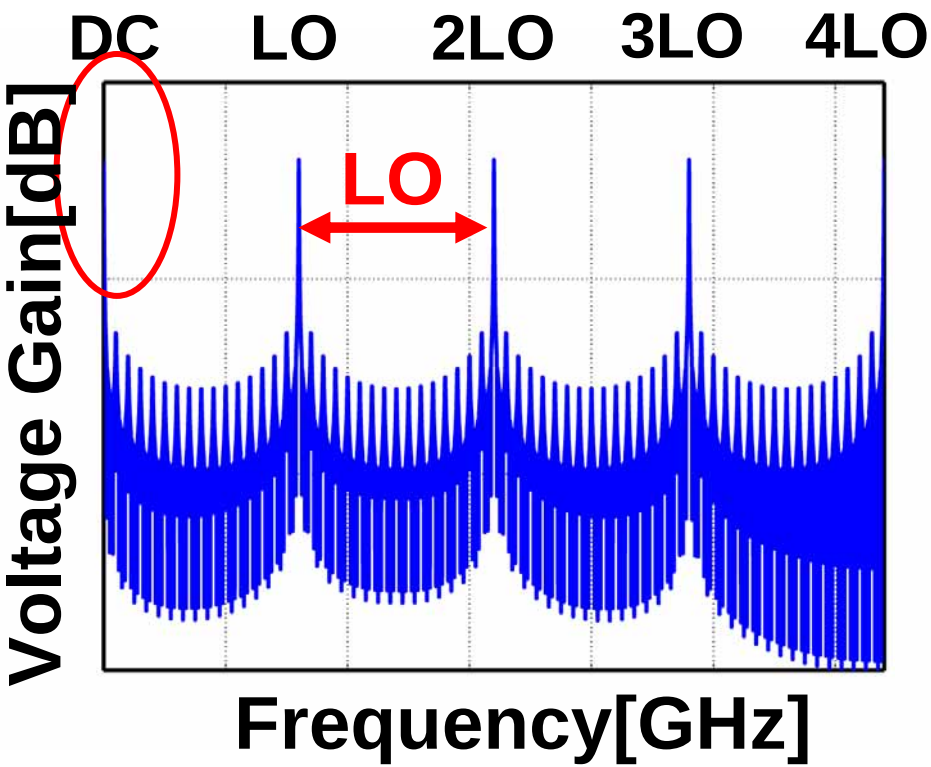



Passband shifted by $\pi$

Charge accumulated + Charge shared

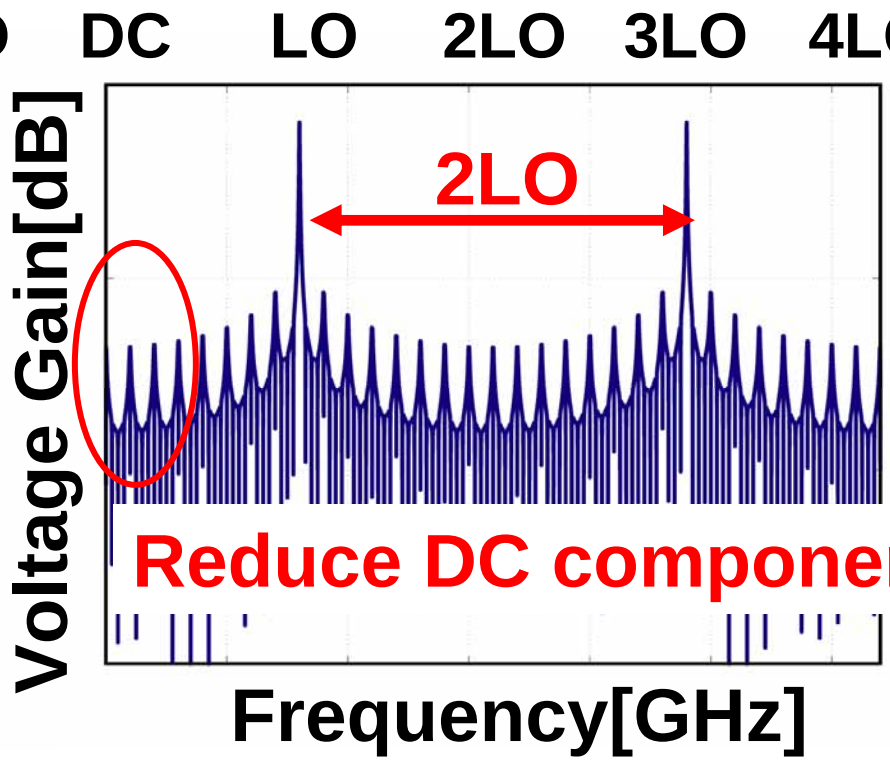
# NF improvement (pass-band shifted)

## Close




Before

## Far, easy to choose

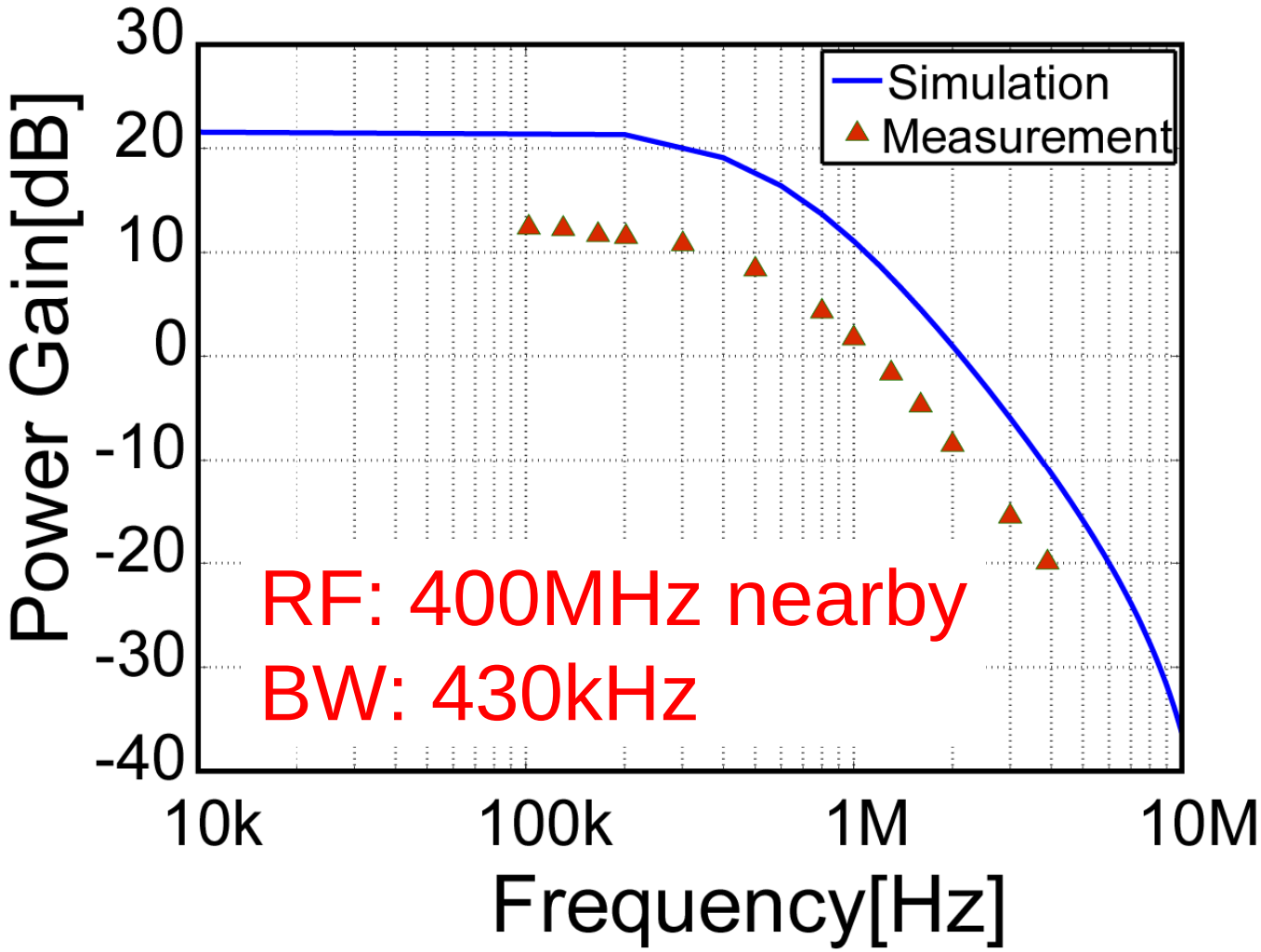



After shifted

- Better NF (about 25dB)
- Better for wideband

# Measurement results

MTDSM for Digital Terrestrial Television (ISDB-T) 1-segment was fabricated.



# Measurement results (2)

| | |
|---|---|
| Technology | 0.18μm CMOS process |
| Local Oscillator | 800 MHz |
| Bandwidth | 430 kHz |
| Power Gain @ 400.1 MHz input | 12.4 dB |
| Attenuation @ 3MHz offset | 27.3 dB |
| Supply Voltage VDD | 1.8 V |
| LNTA + DSM core current | 18 ~ 20 mA |
| Power consumption | 32.4 ~ 36 mW |
| Chip area | 1150μm x 750μm |

| | Previous work | SCF |
|---|---|---|
| Reconfigurability | Medium | Better |
| NF | Medium | Better |
| Gain | Bad | Better |
| Power | Better | Bad |
| Area | Medium | Medium |

# Conclusion

- **A direct sampling mixer using switched capacitor filter technique is proposed.**

- **It improves the reconfigurability while not increasing the power, area so much.**

SCF's Features

- **Easier to reconfigure**
- **Promise higher-order filtering**
- **NF improvement (pass-band shifted)**
- **Better for wideband (pass-band is shifted)**

# Thank you for your interest!

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