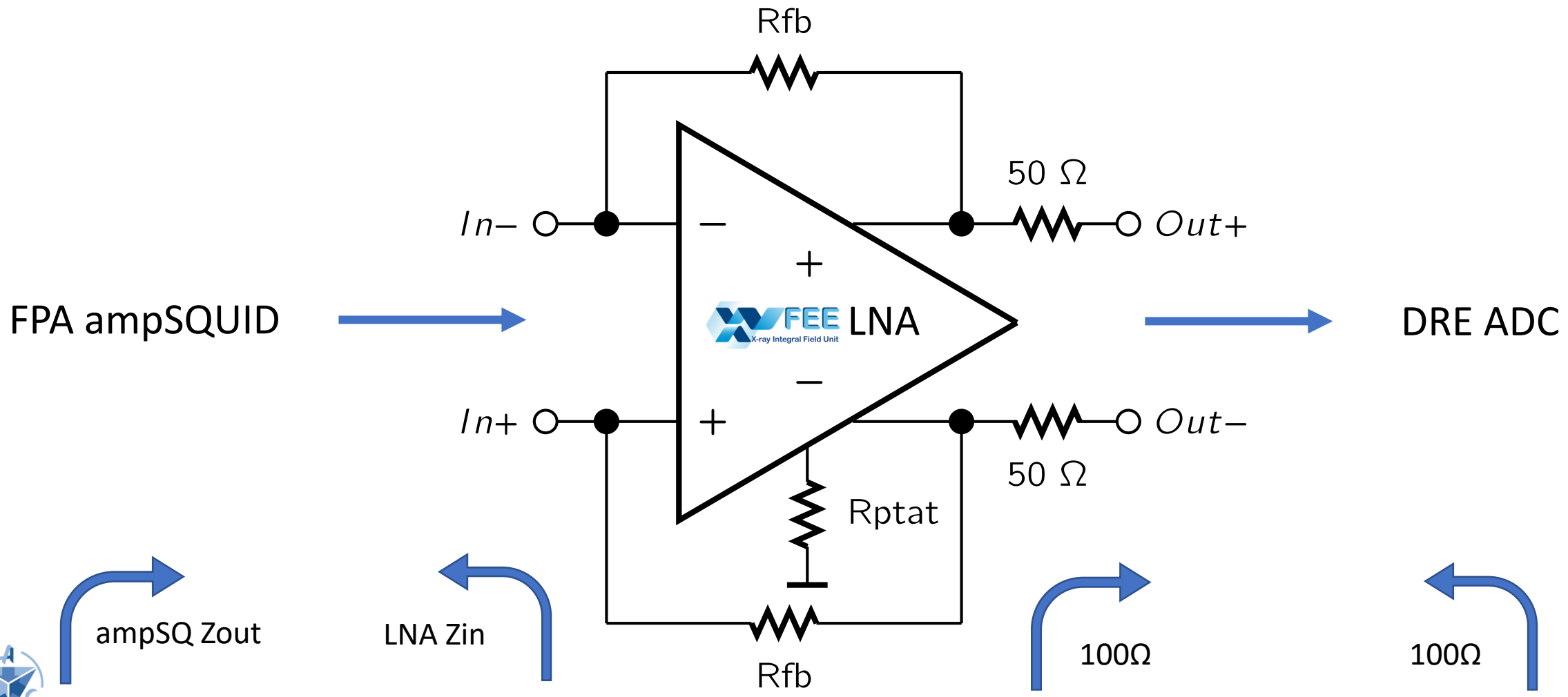
LNA input impedance matching & noise reduction

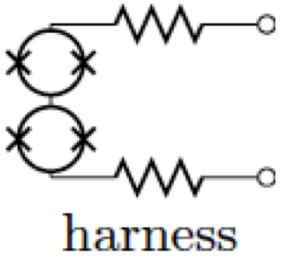
X-IFU CM#13 – Technical Session - Mai 2022 – Damien Prêle for the APC **WFEE** team



Miller effect -> LNA Zin ~ Rfb/(1-LNA_Gain)

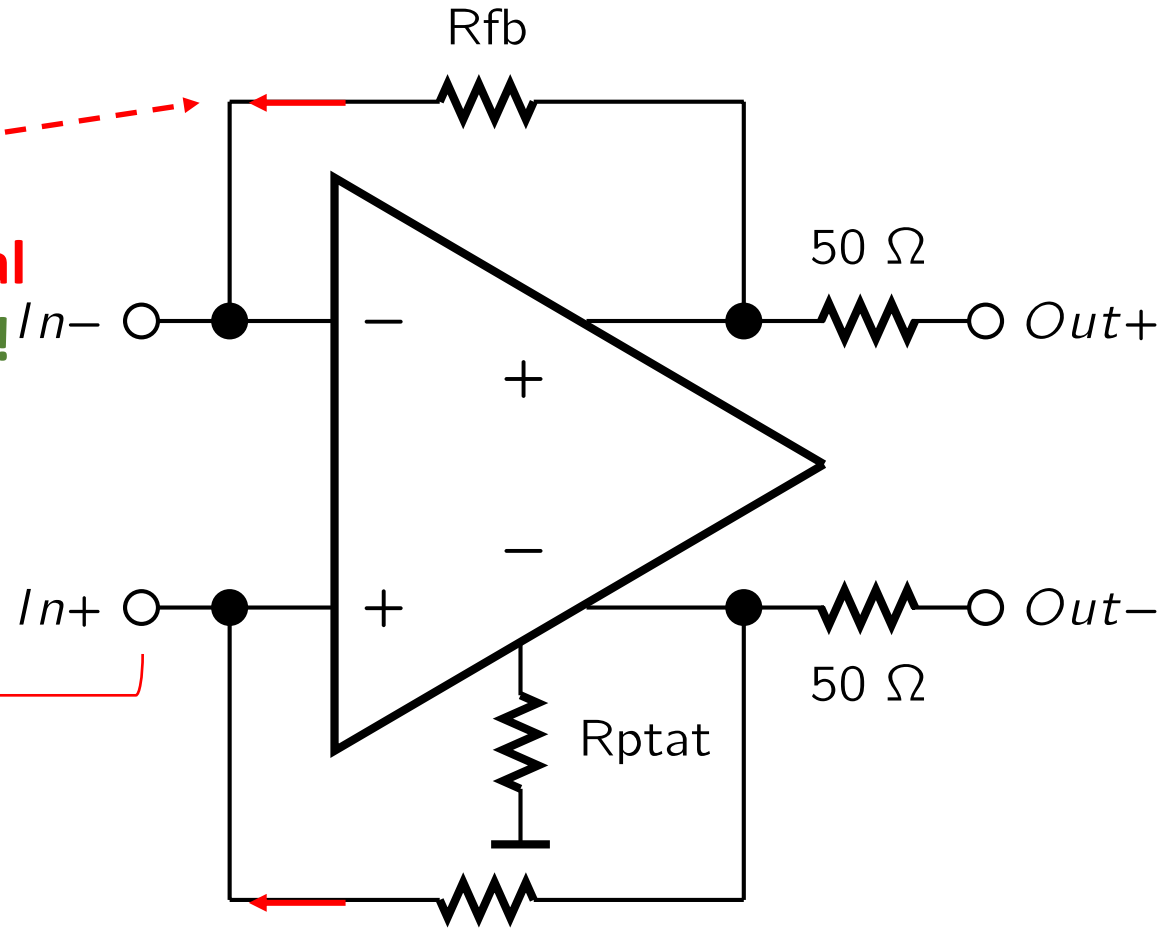
Rdyn in small signal
Rdc in DC

The feedback “subtract”
an **half of the input signal**
and an half of the noise !
Even the intrinsic LNA Noise



Rdyn + harness = LNA Zin

0.5 V/V



ampSQ Zout
+ harness resistances

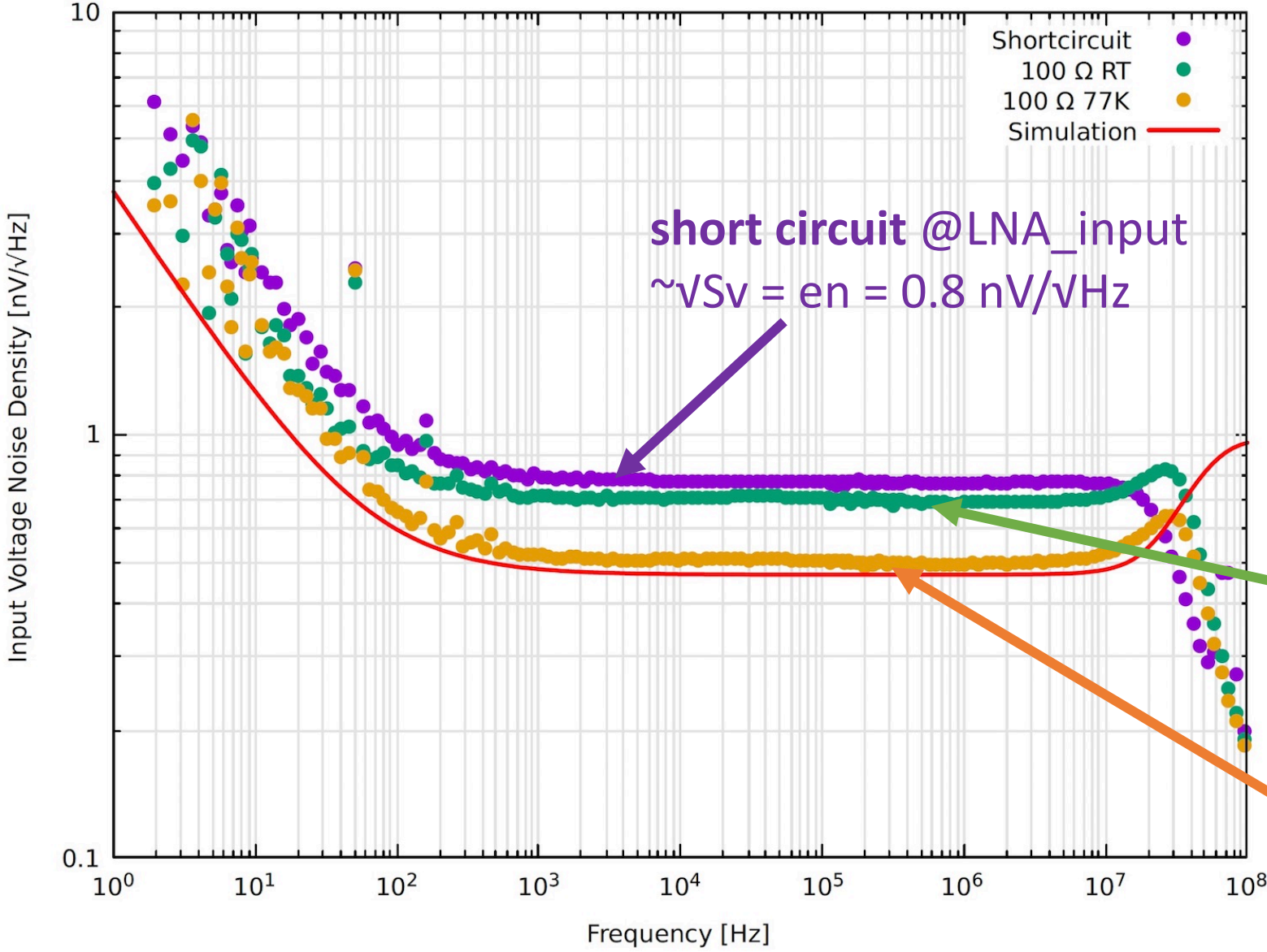
~Rfb/(1-|LNAgain|)

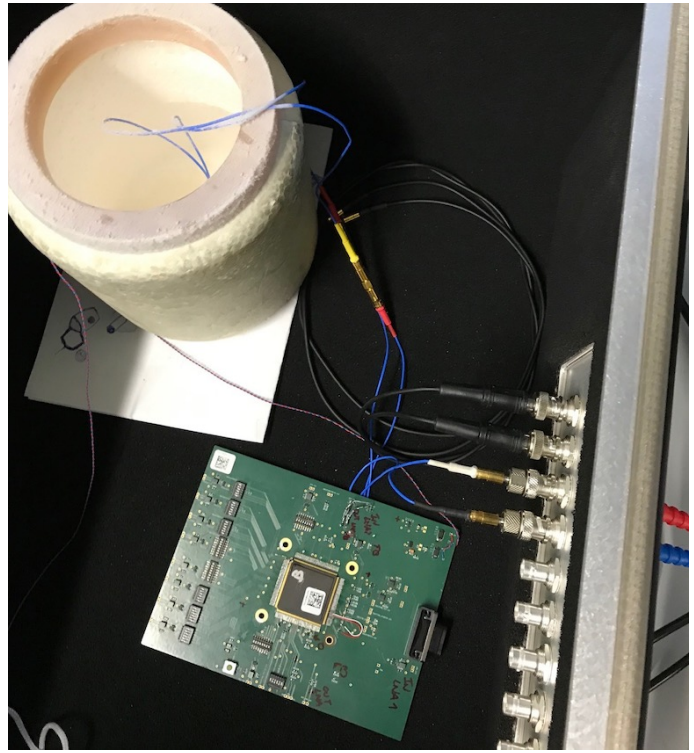
160 V/V

0.5 V/V

LNA noise subtraction

LNA noise (as signal) is "substract"





T=**300K 100Ω** @LNA input

Sv = (en/2)^2+(1.3nV/√Hz/2)^2

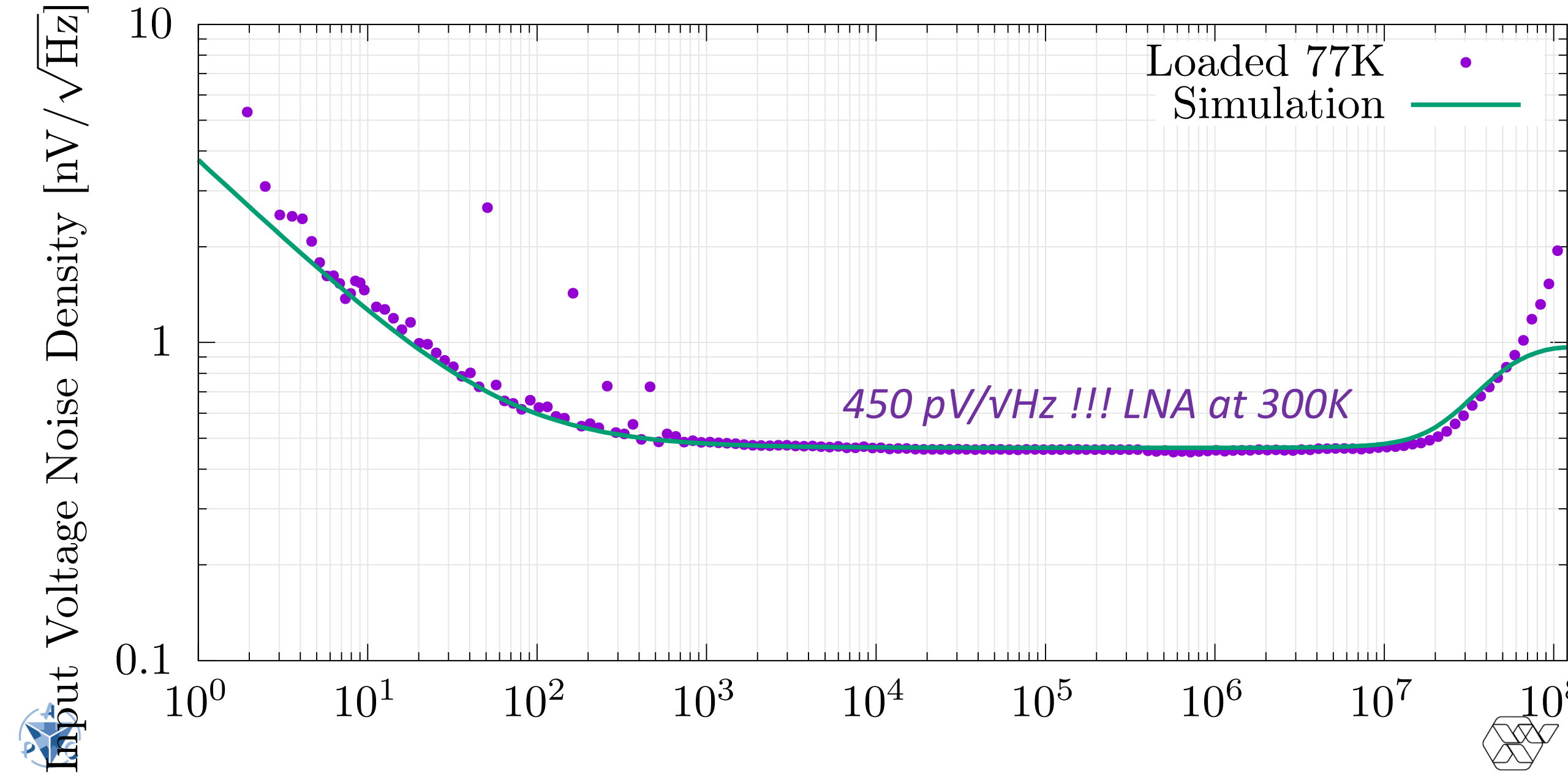
√Sv = 0.75 nV/√Hz

T=**77K 100Ω** @LNA input

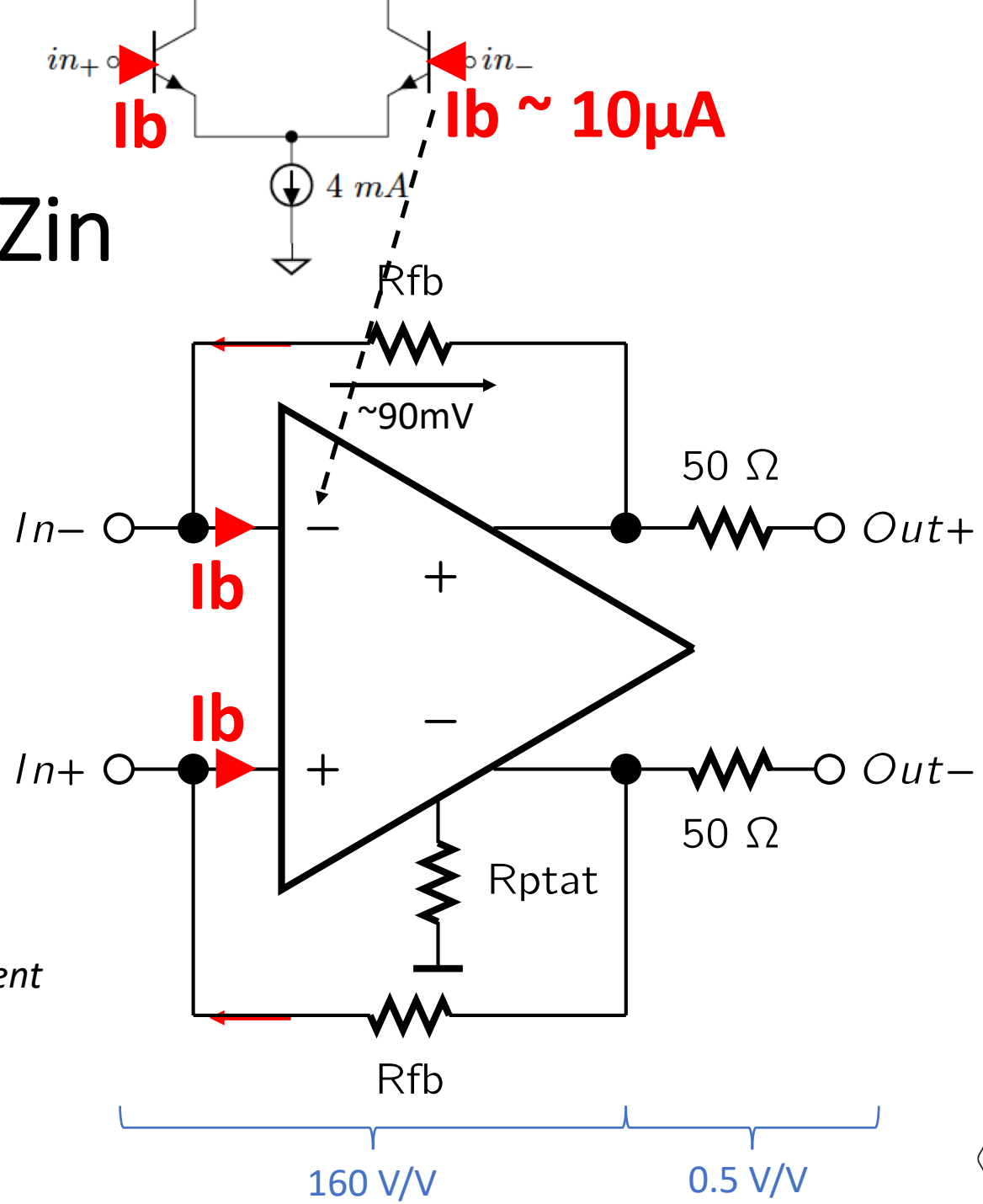
Sv = (en/2)^2+(0.65nV/√Hz/2)^2

√Sv = 0.5 nV/√Hz

One of the last measured LNA noise (with gain(f) correction)



More details about LNA Zin



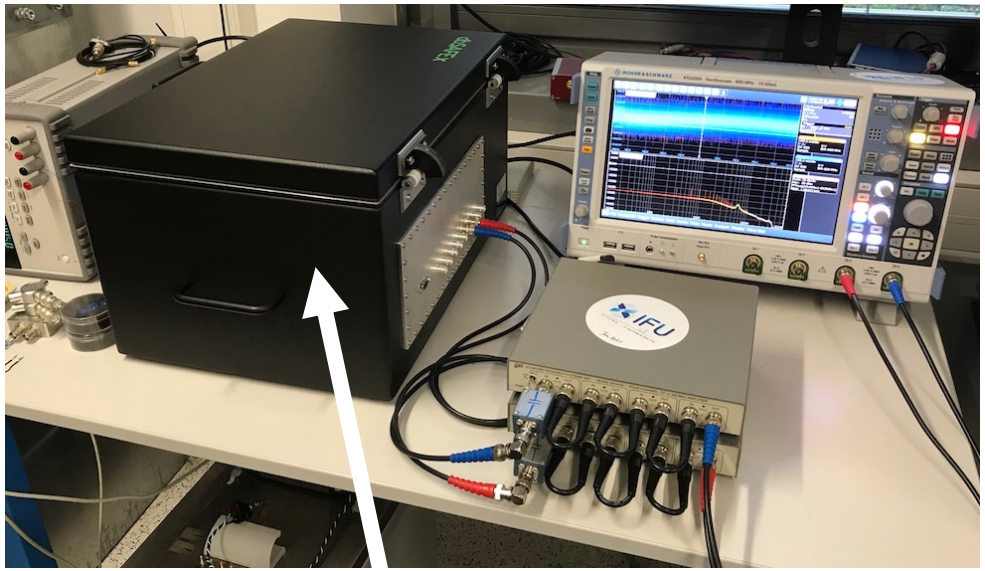
Intrinsic small signal LNA input:

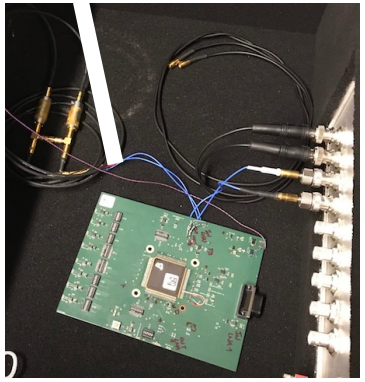
2kT/(q Ib) = 5 kΩ

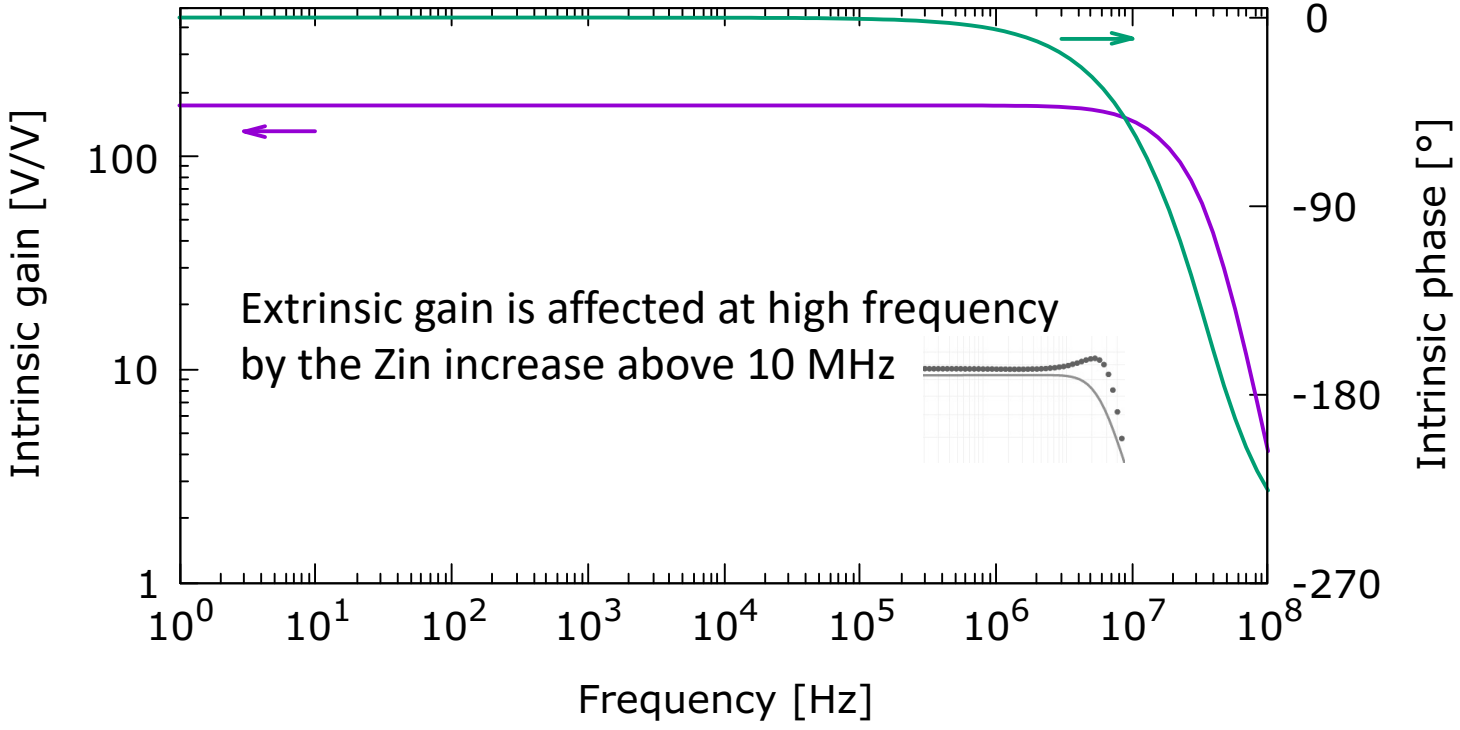
+ in // Rfb/(1-LNAGain)

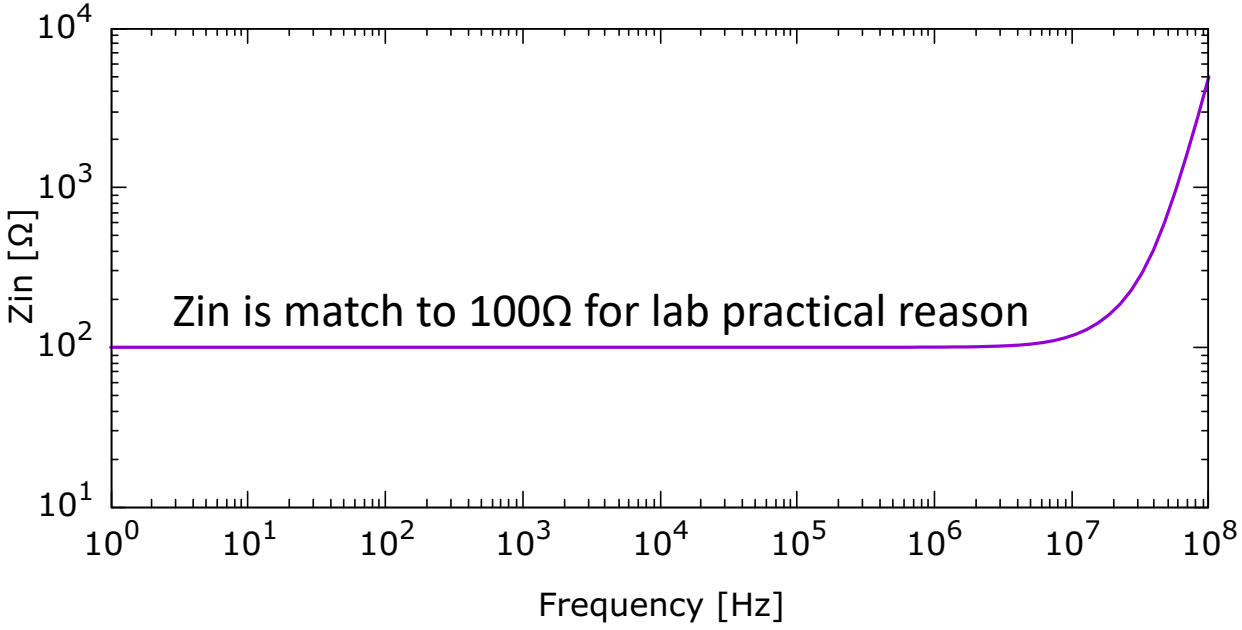
The feedback is also very useful to provide the ++Ib current of the "push-push" LNA input stage

LNA
Gain, Phase and
Zin measurement









More details about ampSQUID Zout ?

Using ATHENA SQUID TN5.1 Test Report FAB1 (ATH-SQ-VTT-TN-5.1) 27.03.2020

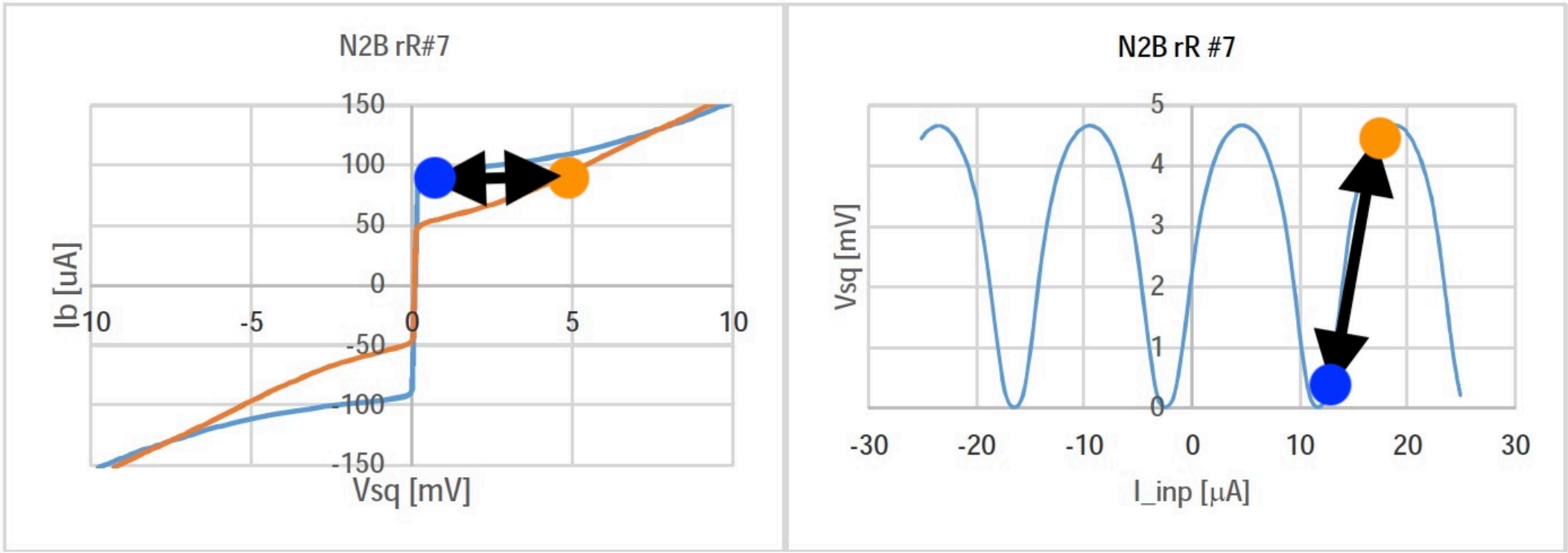
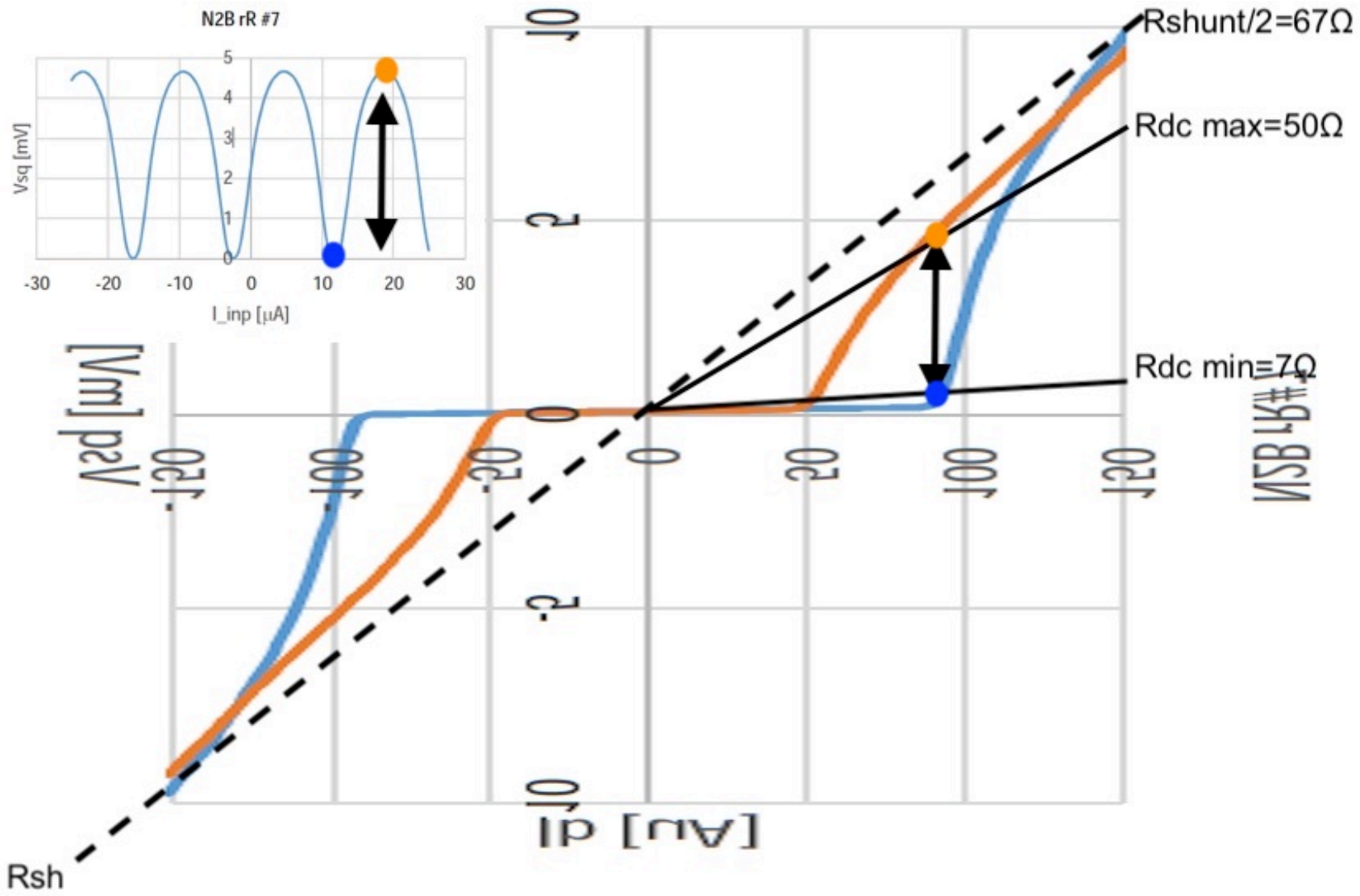


Fig. 7: Voltage-current characteristics and flux response of a N2B-type booster SQUID at $T = 4.2$ K. The device has close-to nominal upper critical current in the IV characteristics.

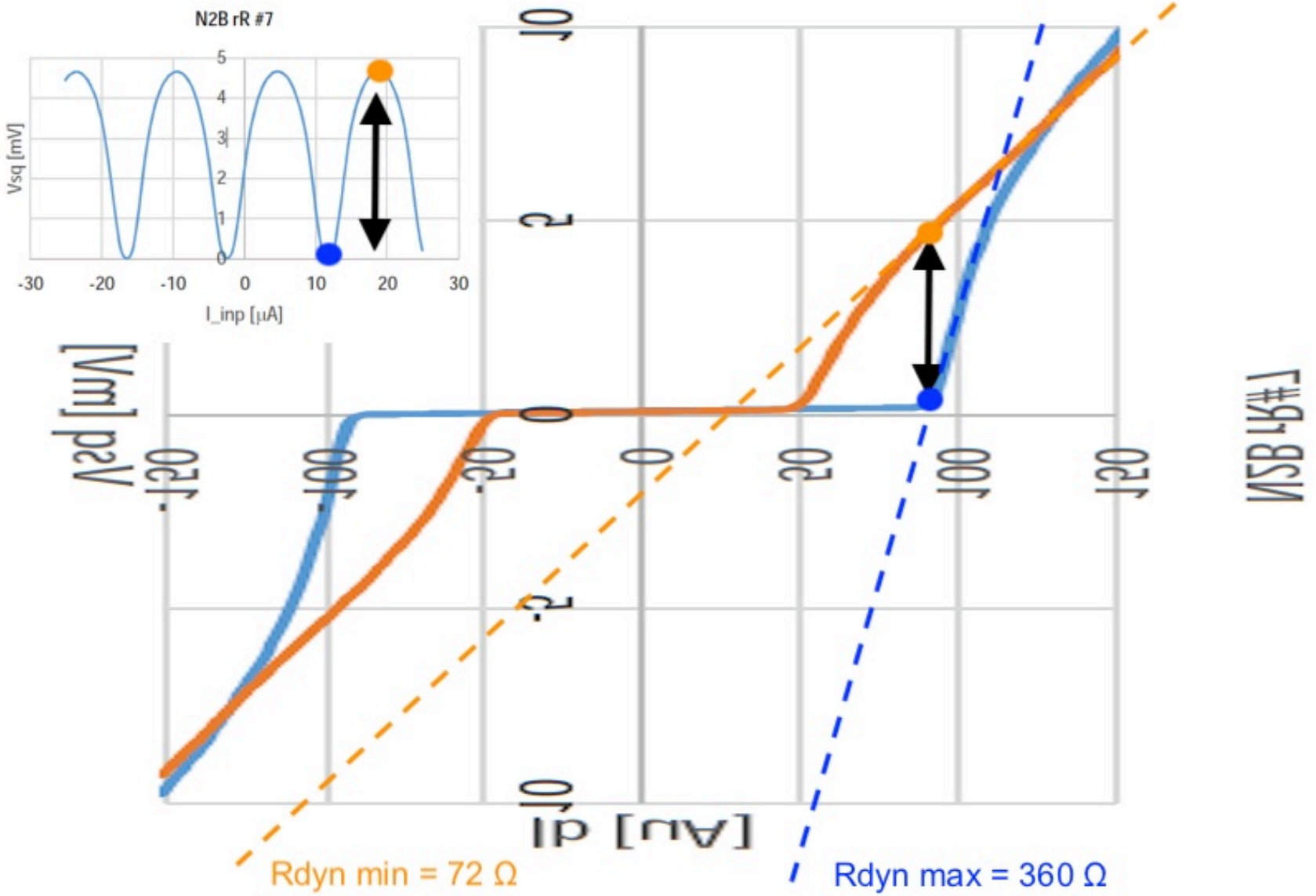
More details about ampSQUID Zout

SQUID output charac V(I)
-> V/I=**Rdc** [7Ω-50Ω]



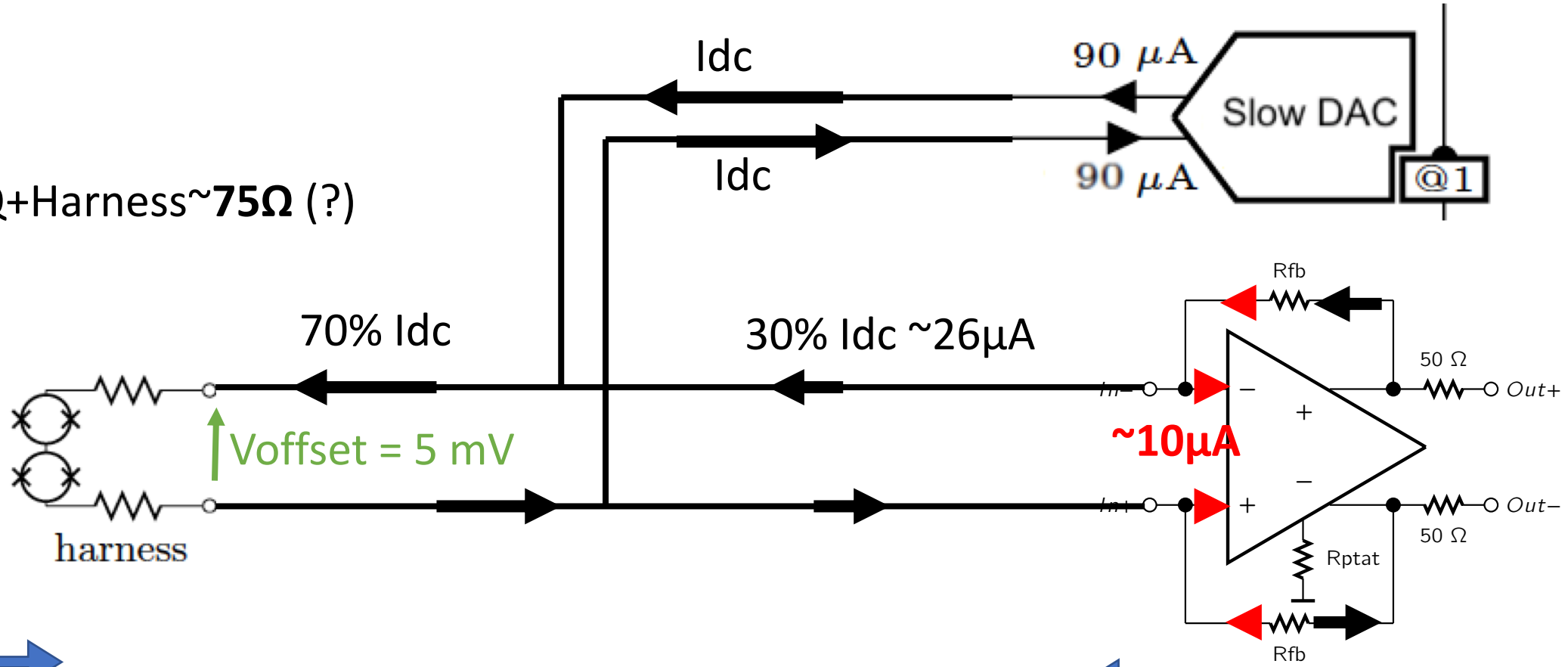
More details about ampSQUID Zout

SQUID output charac V(I)
-> V/I=**Rdyn** [72Ω-360Ω]



Where the SQUID biasing current will go ?

In DC
ZampSQ+Harness~**75Ω** (?)



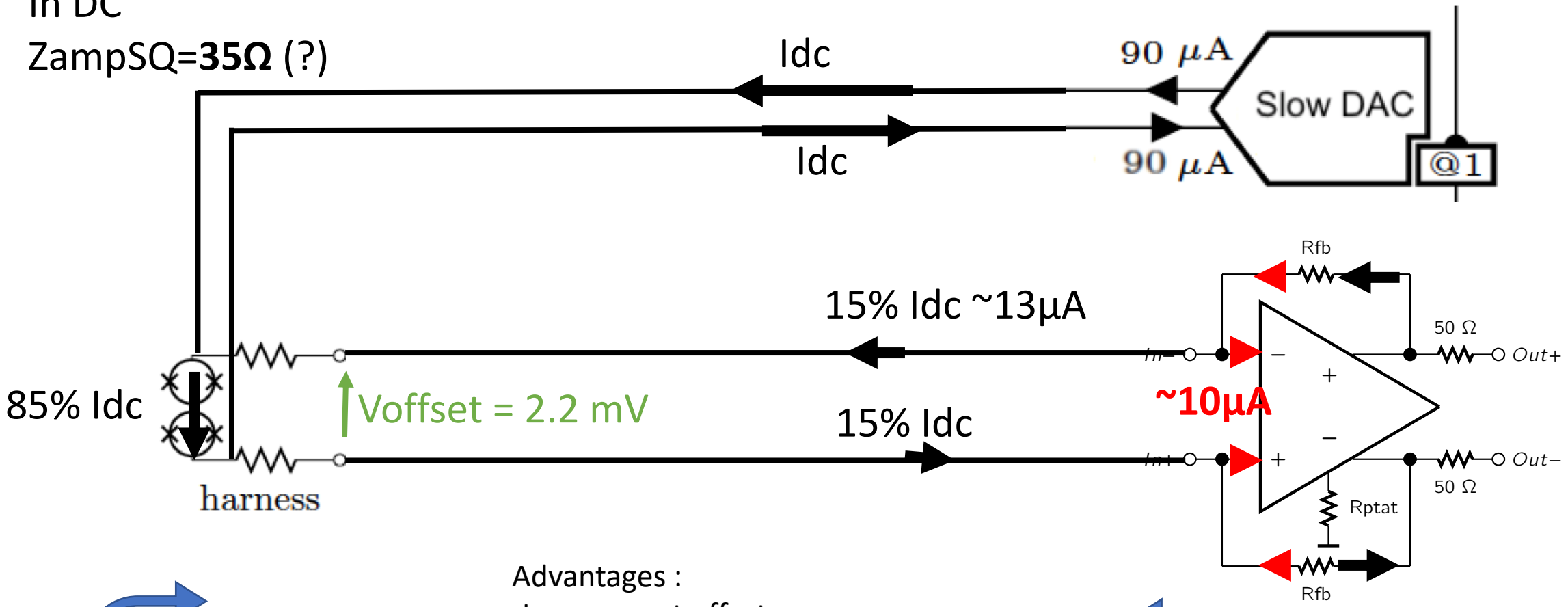
Rdyn ~200 + 40Ω
Rdc ~35Ω + 40Ω

~200 Ω

Possible use of a separate line for the bias ?

In DC

ZampSQ=**35Ω** (?)



Rdyn ~200 + 40Ω

Rdc ~35Ω + 40Ω

Advantages :

-Less current offset

-Less voltage offset

-Ease the SlowDAC filtering

~200 Ω

Possible use of capacitors in series with Rfb?