

# MiniGRAIL

## Progress report 2004

The MiniGRAIL Group

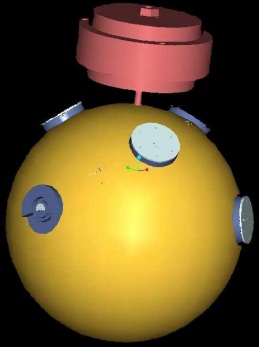
Y. Benzaim, G. Frossati, L. Gottardi, H. van der  
Mark, A. de Waard

*Kamerlingh Onnes Laboratory,  
Leiden University, The Netherlands*

The Low Temperature Division TU Twente

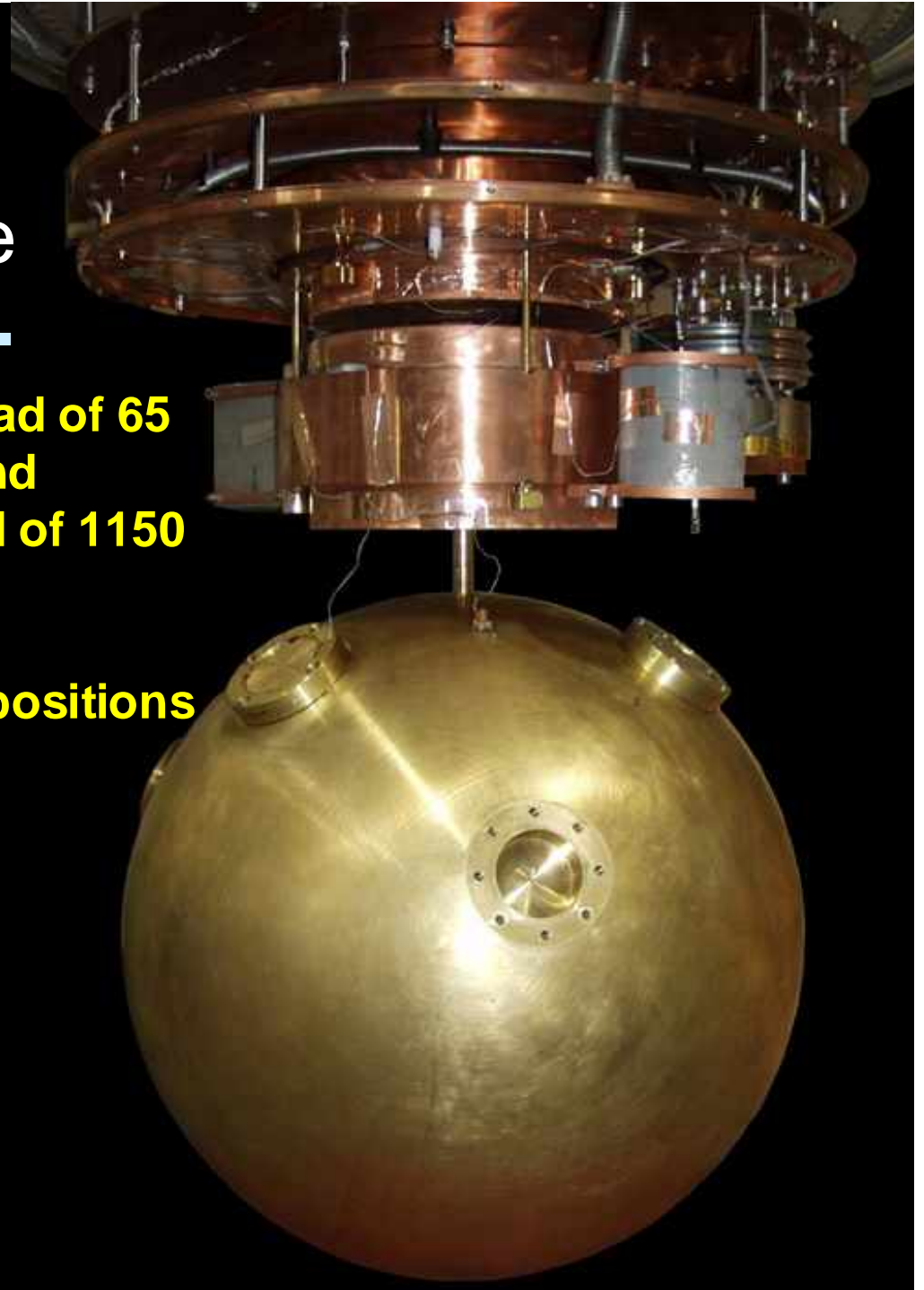
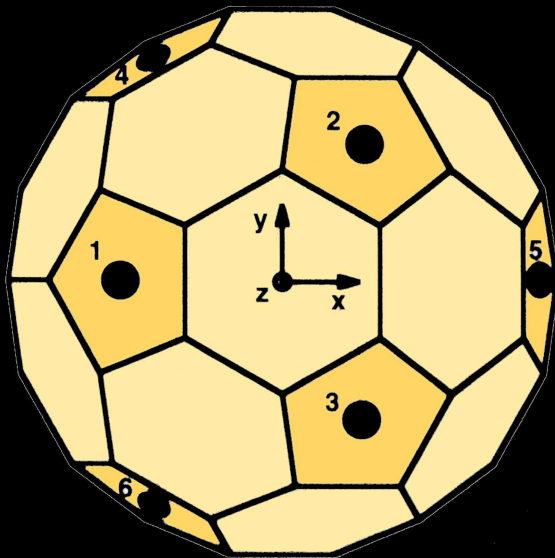
J. Flokstra, M. Podt

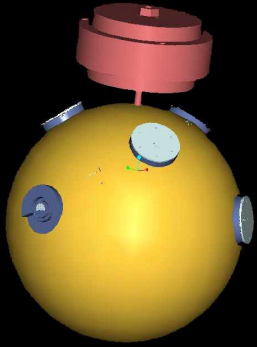
This work has been done in strong collaboration  
with the ROG group and the Auriga group



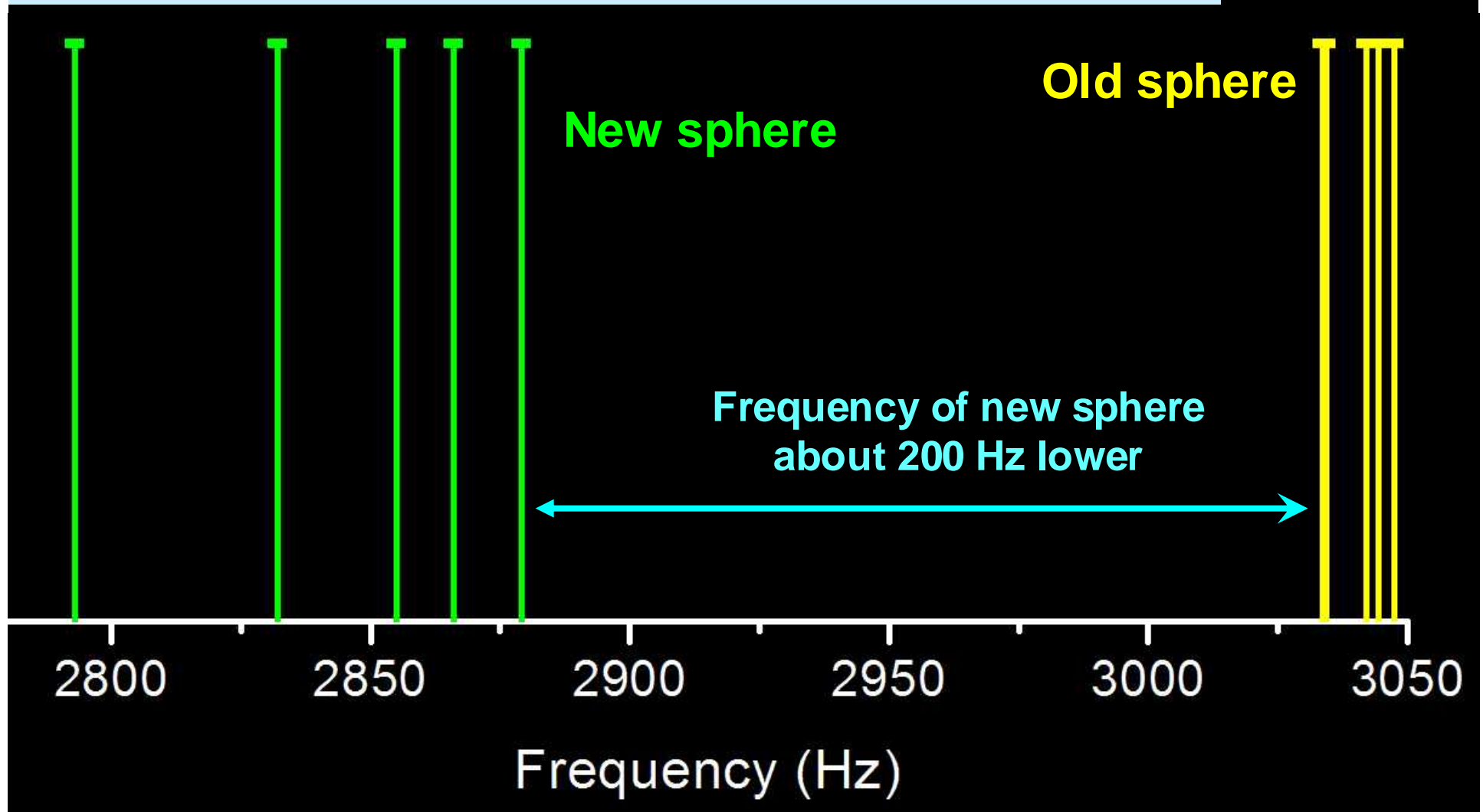
## The new sphere

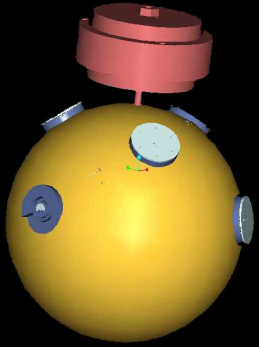
- **Larger diameter (68 cm instead of 65 cm) gives lower frequency and higher mass (1300 kg instead of 1150 kg).**
- **Six holes machined in TIGA positions**



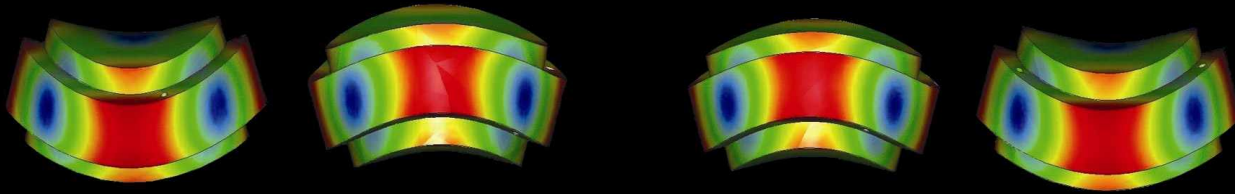


# Resonance frequencies of bare sphere at 300 K

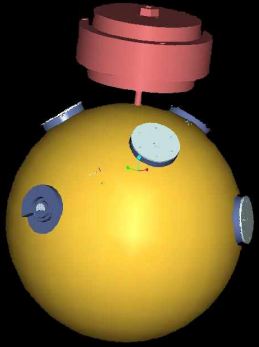




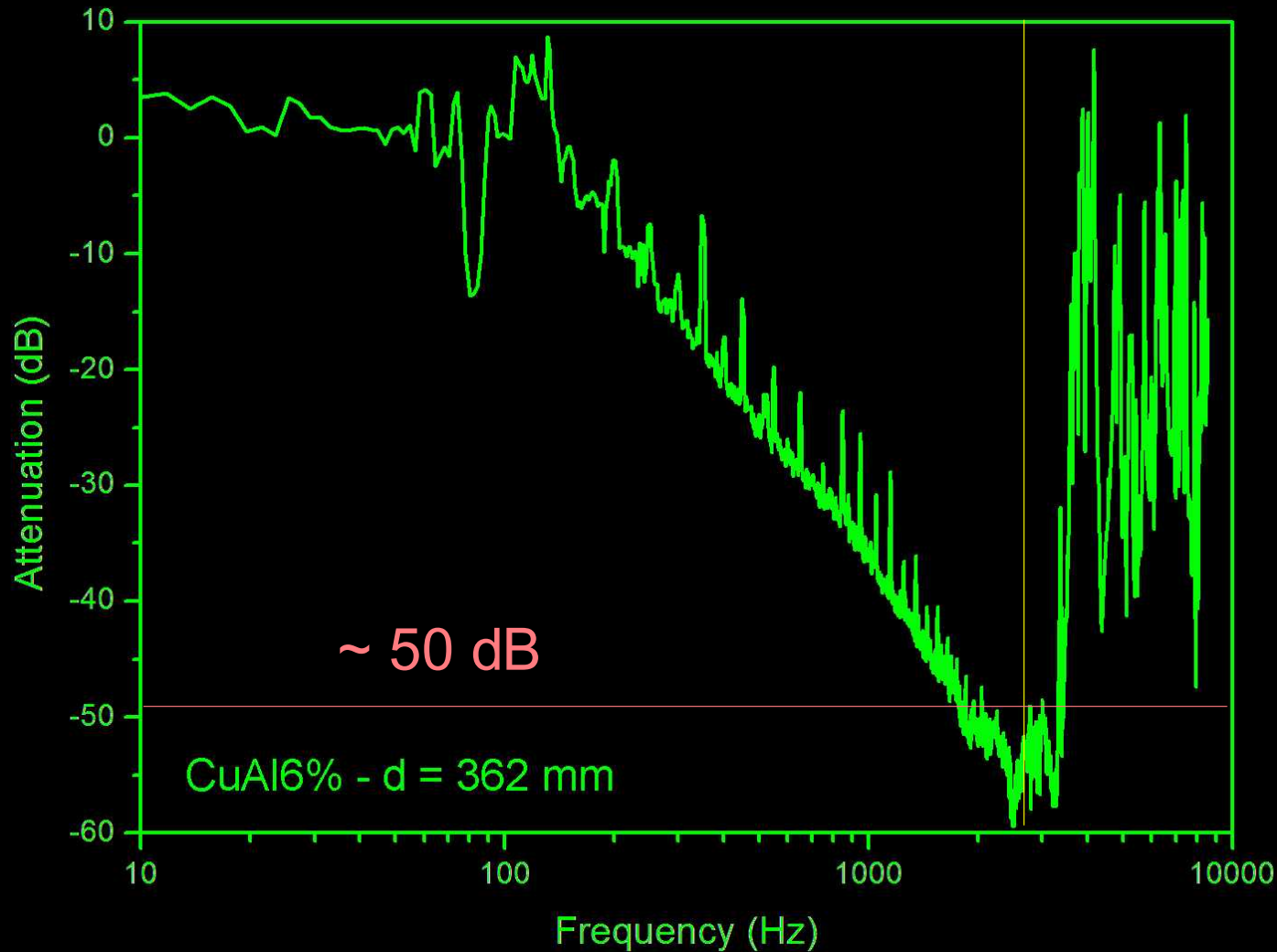
# Improvements on the Vibration Isolation System



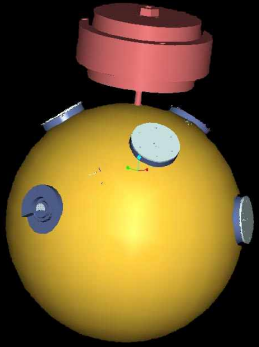
Material	$\downarrow_{\text{before}}$ (mm)	$f_{\text{before}}$ (Hz)	$\downarrow_{\text{after}}$ (mm)	$f_{\text{after}}$ (Hz)
CuAl 1,2	370	3516	370	3516
CuAl 3,4	370	3516	362	3633
Cu 5-7	370	3397	358	3512



# Improvements on the Vibration Isolation System

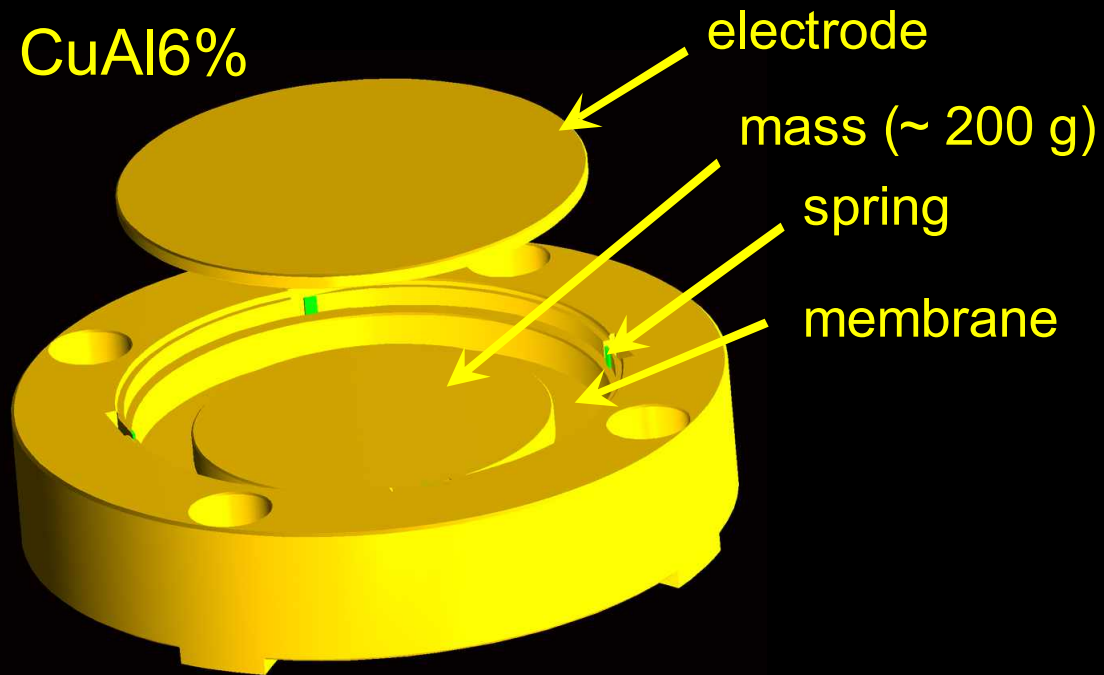






## Closed Membrane Capacitive Transducer

CuAl6%



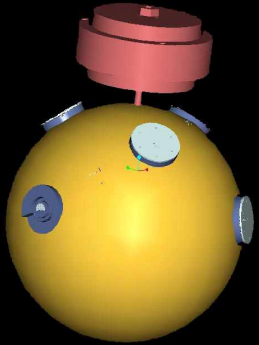
Advantages:

- Compact design
- Easy to make

$d \sim 30$  micro m

$V_{BIAS}$  up to 500 V

# Cryogenic run with 3 capacitive transducers



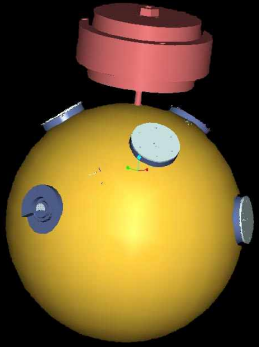
transformer +  
single QD SQUID

transformer + 2-  
stage SQUID

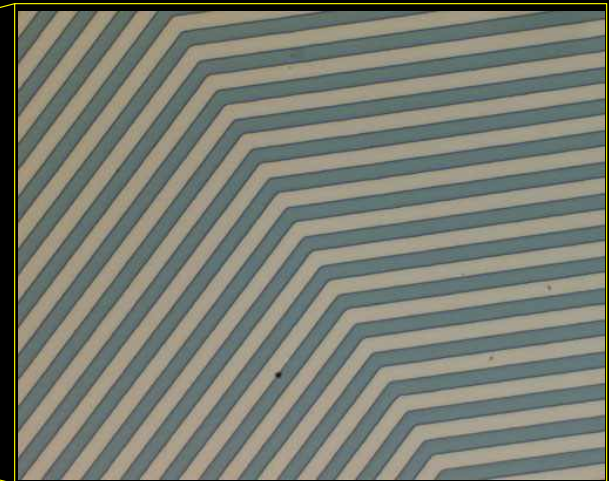
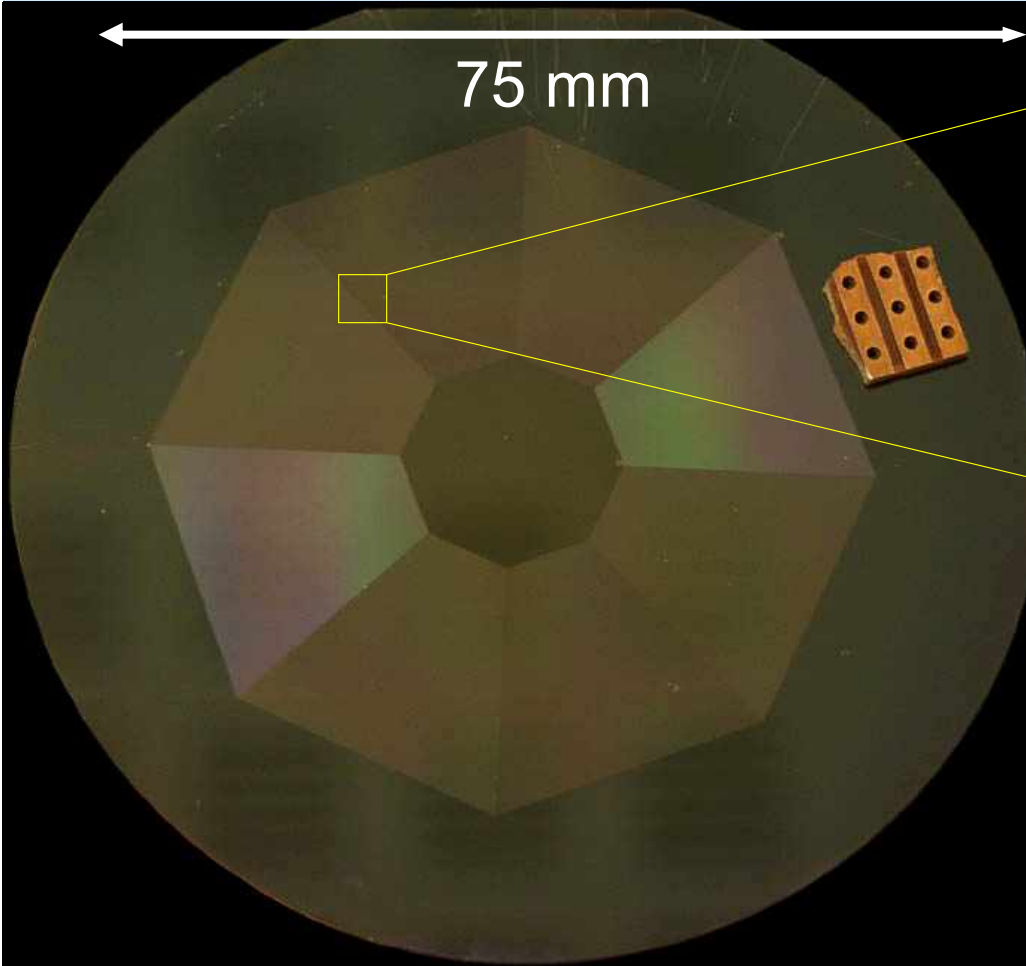


calibrator





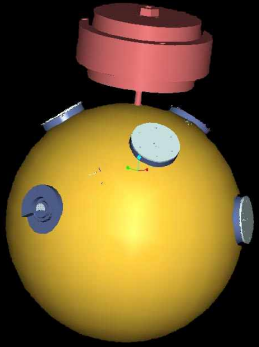
## Future improvements: flat coil



turns = 2170  
line width = 5  $\mu\text{m}$   
 $L \sim 0.5 H$

Next design (3x3 cm):  
5000 turns  
Line width = 0.4  $\mu\text{m}$   
 $L \sim 1 H$

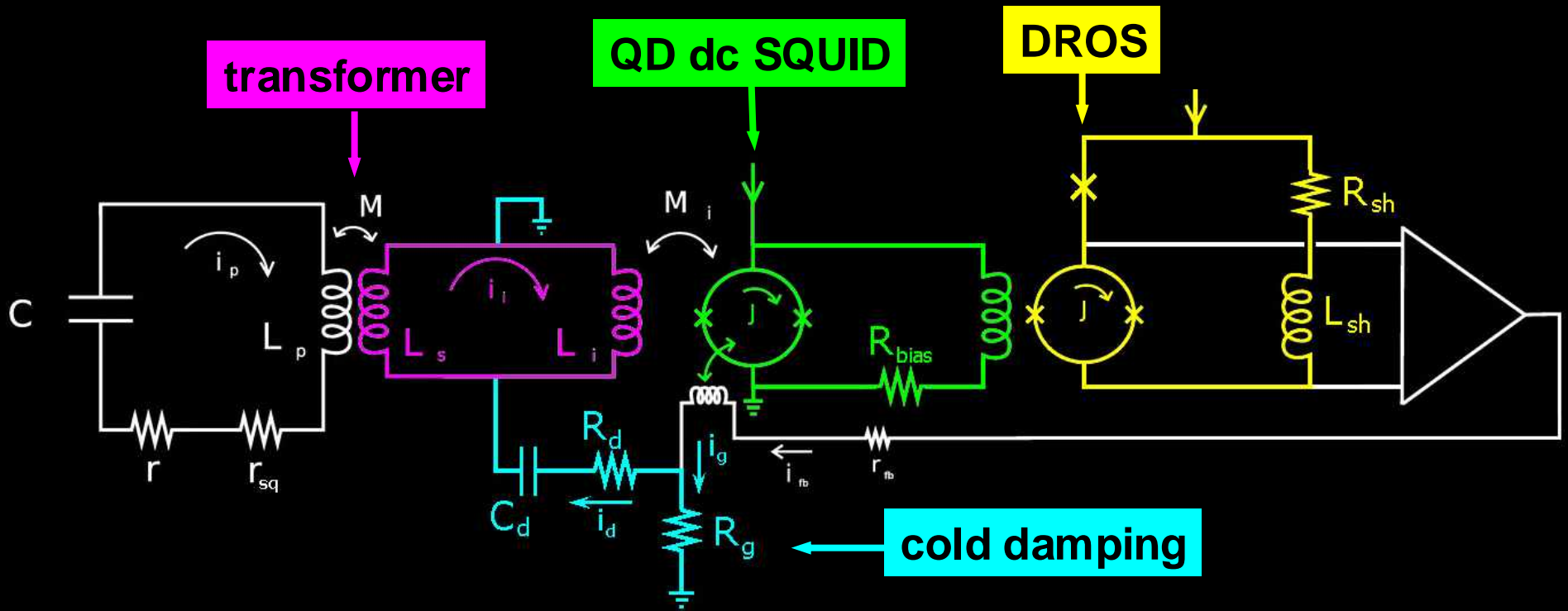


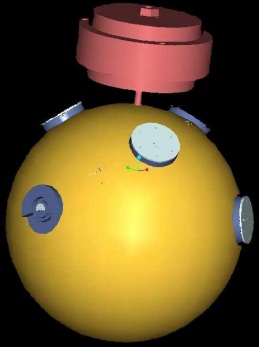


# 2-stage SQUID

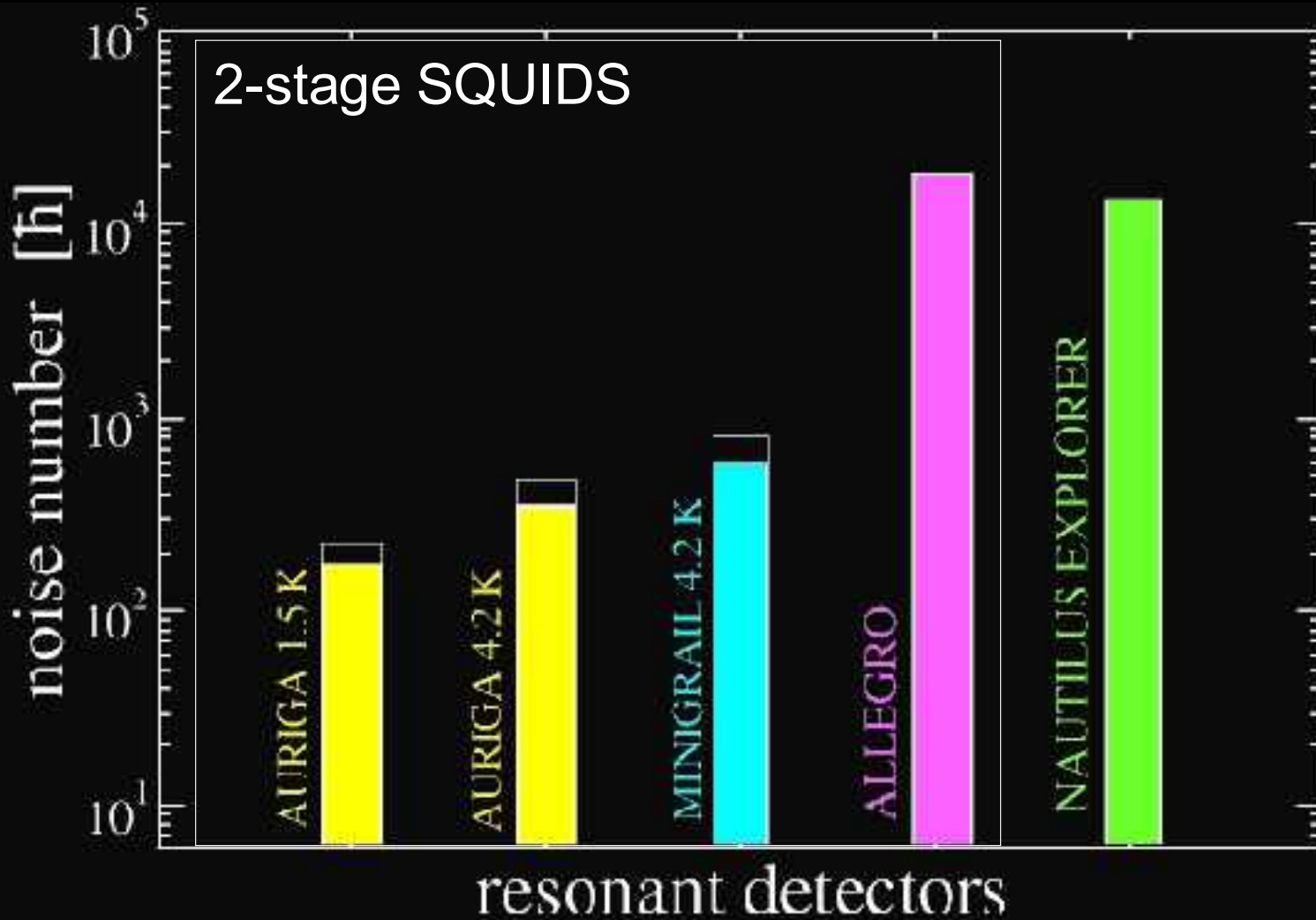


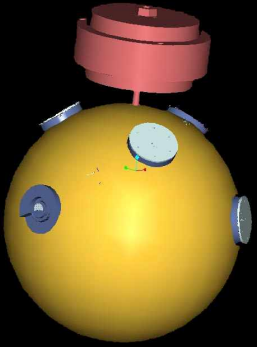
DROS ↑  
sensor SQUID ↑



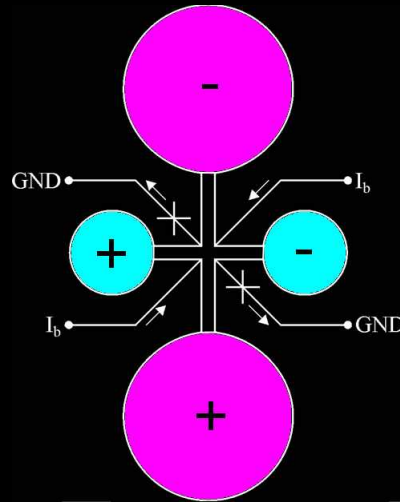
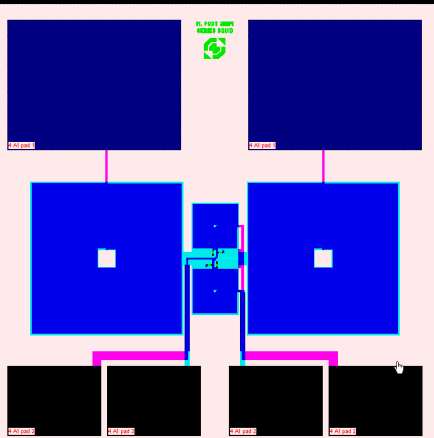
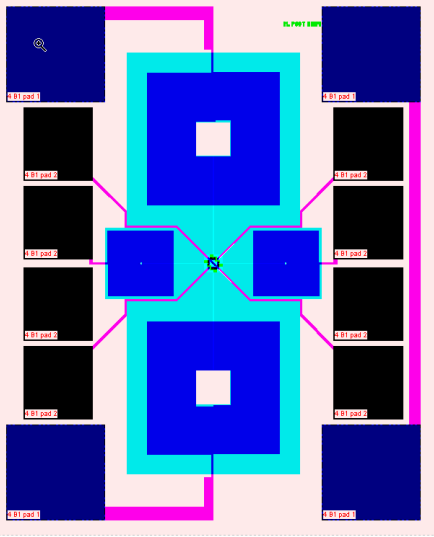


## Comparison between SQUID-based read-out

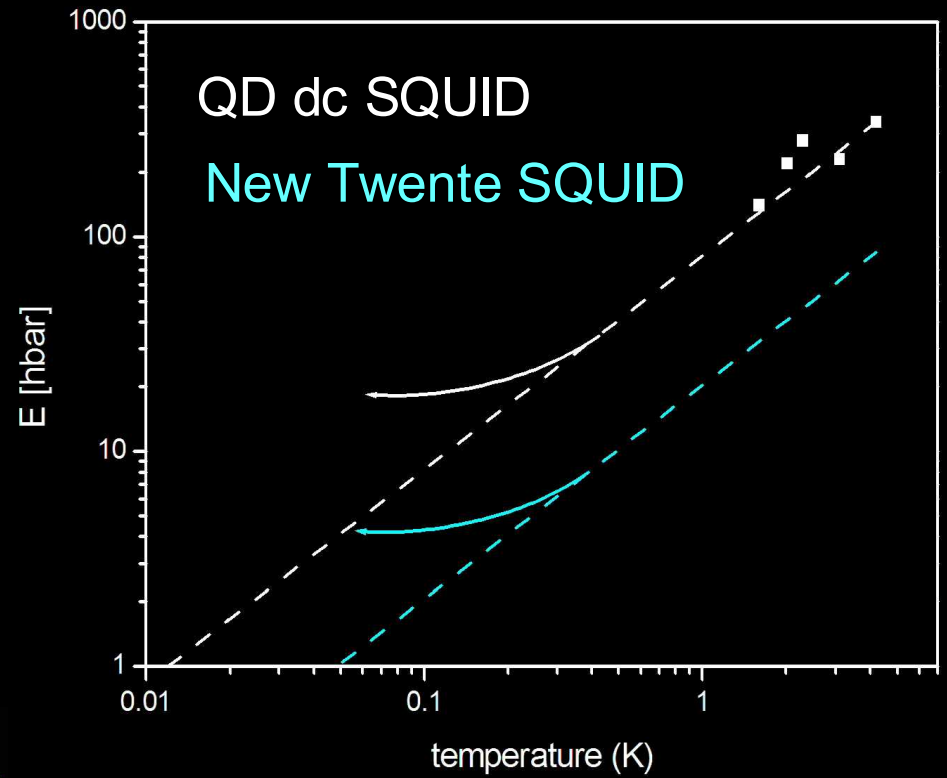
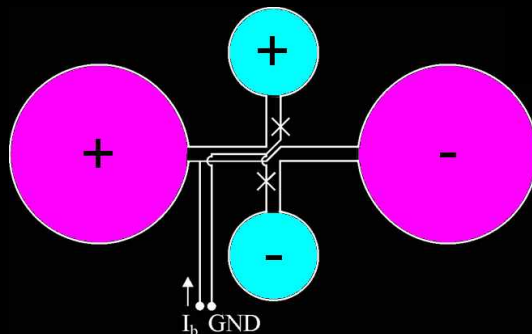




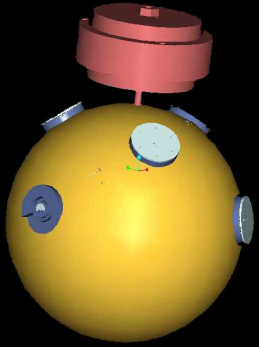
# Future improvements: Advanced sensor SQUIDs



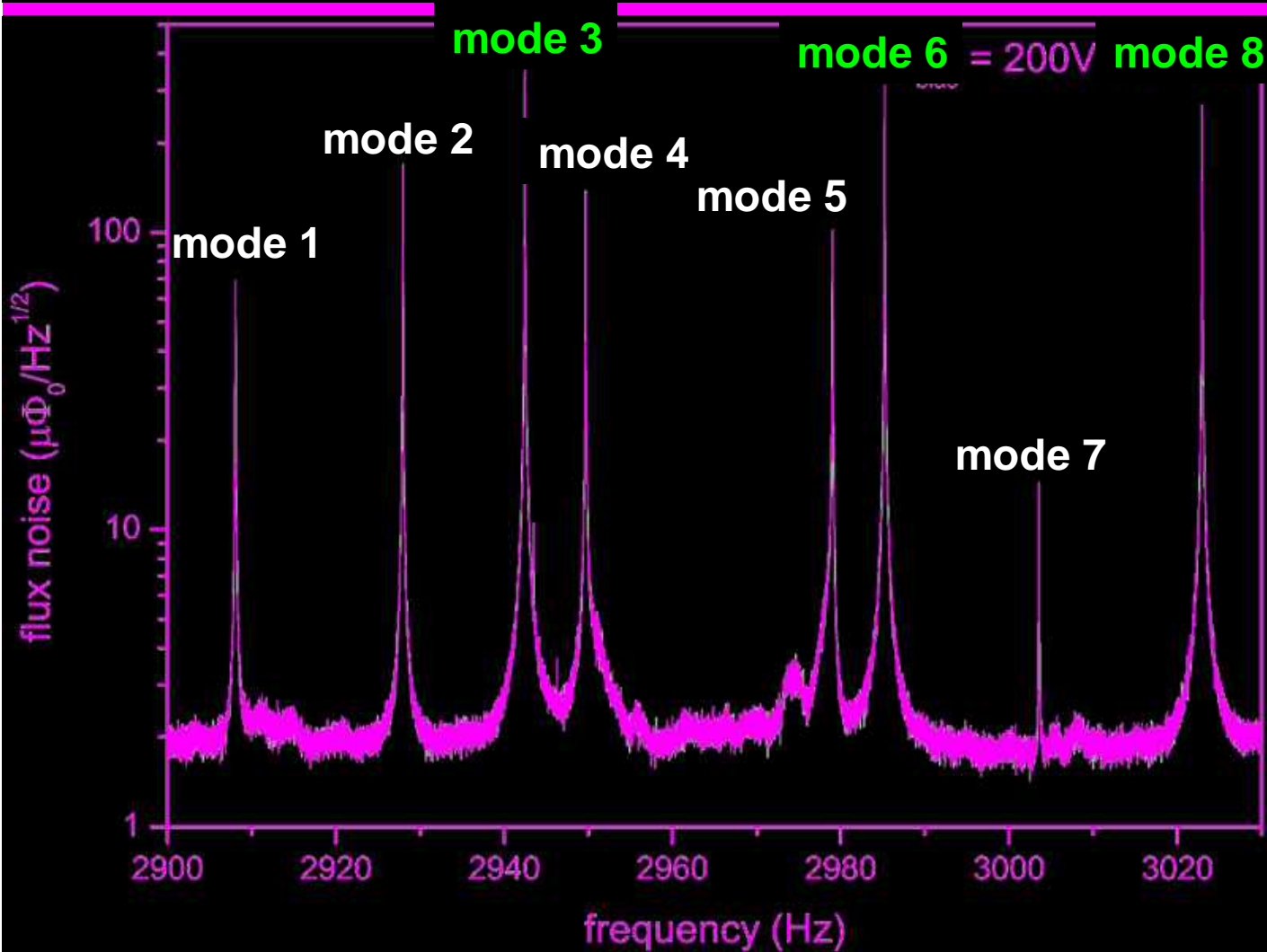
input  
feedback



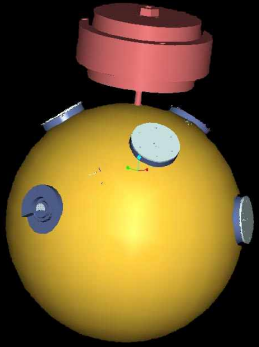
$$L_{in} = 1.7 \mu\text{H}$$



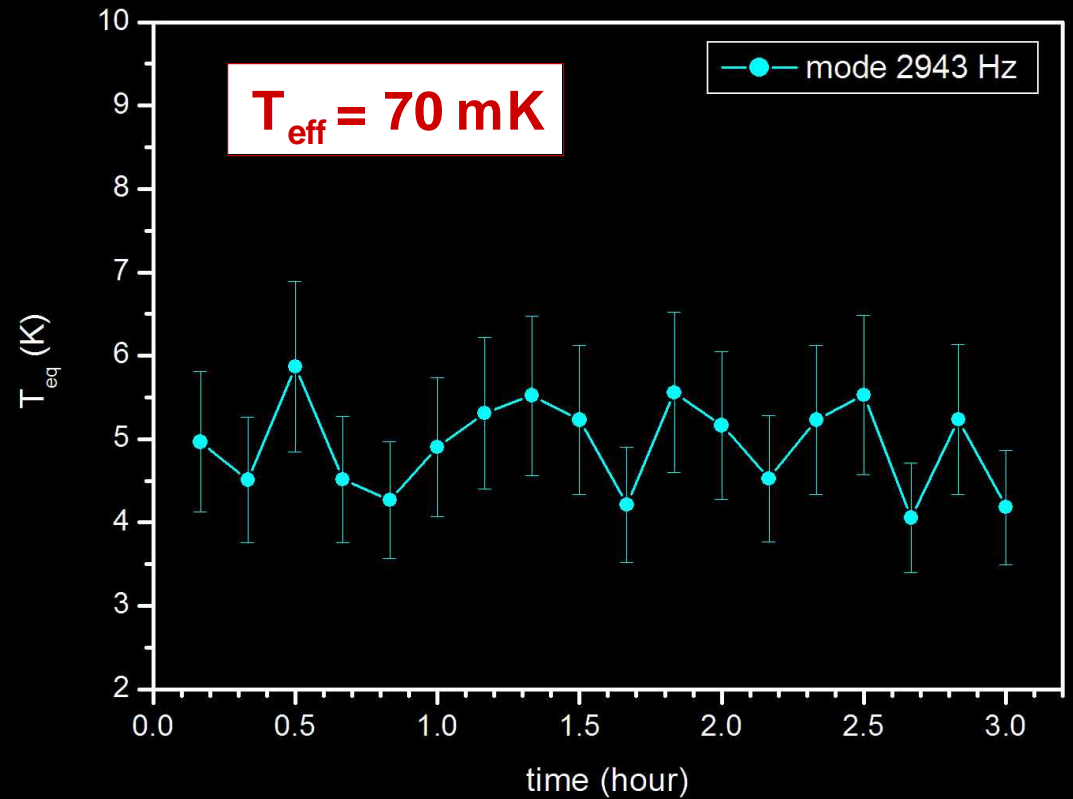
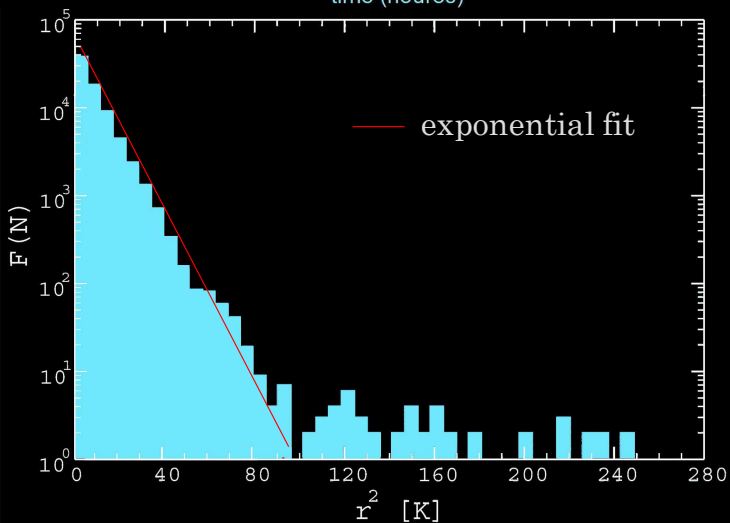
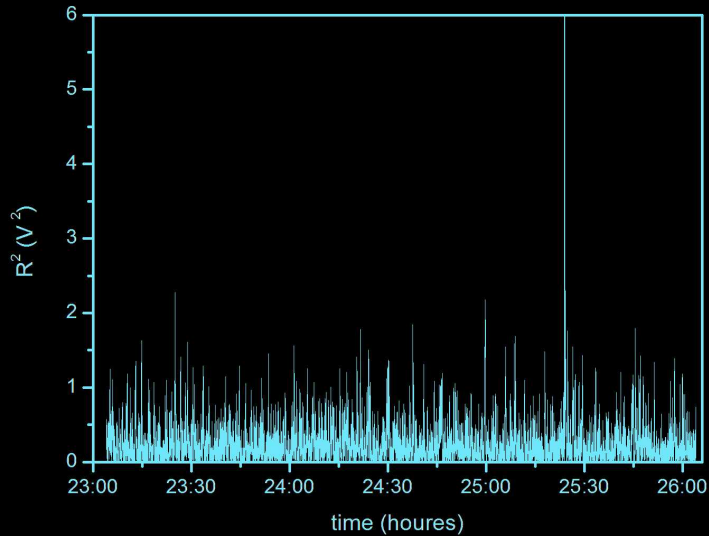
# Flux noise 2-stage SQUID @ 5K

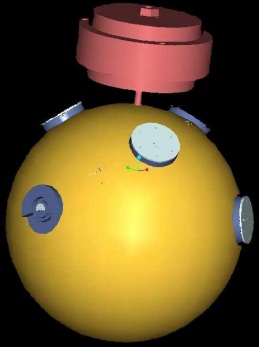




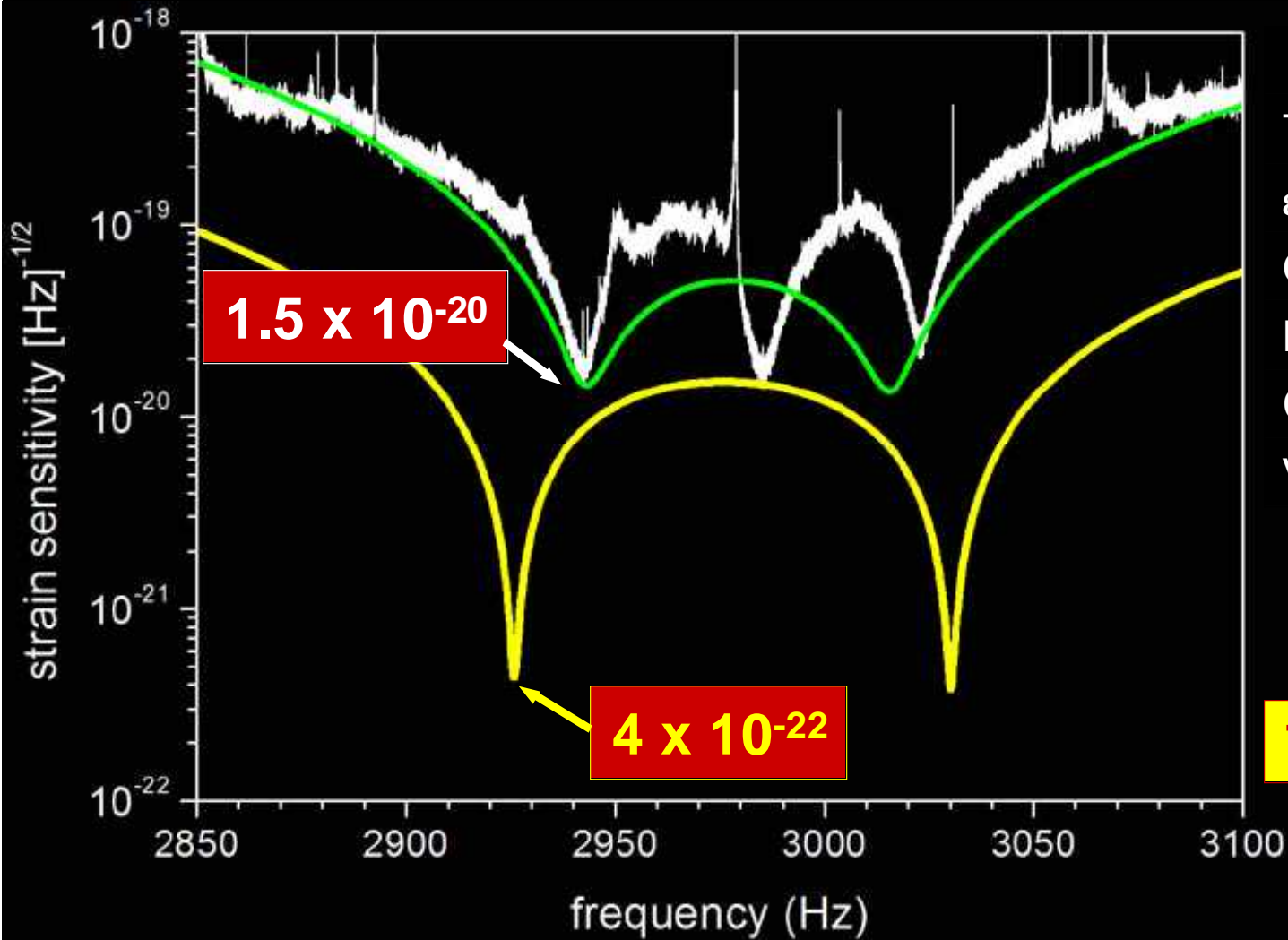


# 3 hour acquisition @ 5K of mode 3 (2943 Hz)



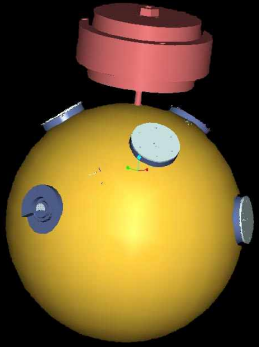


# MiniGRAIL sensitivity

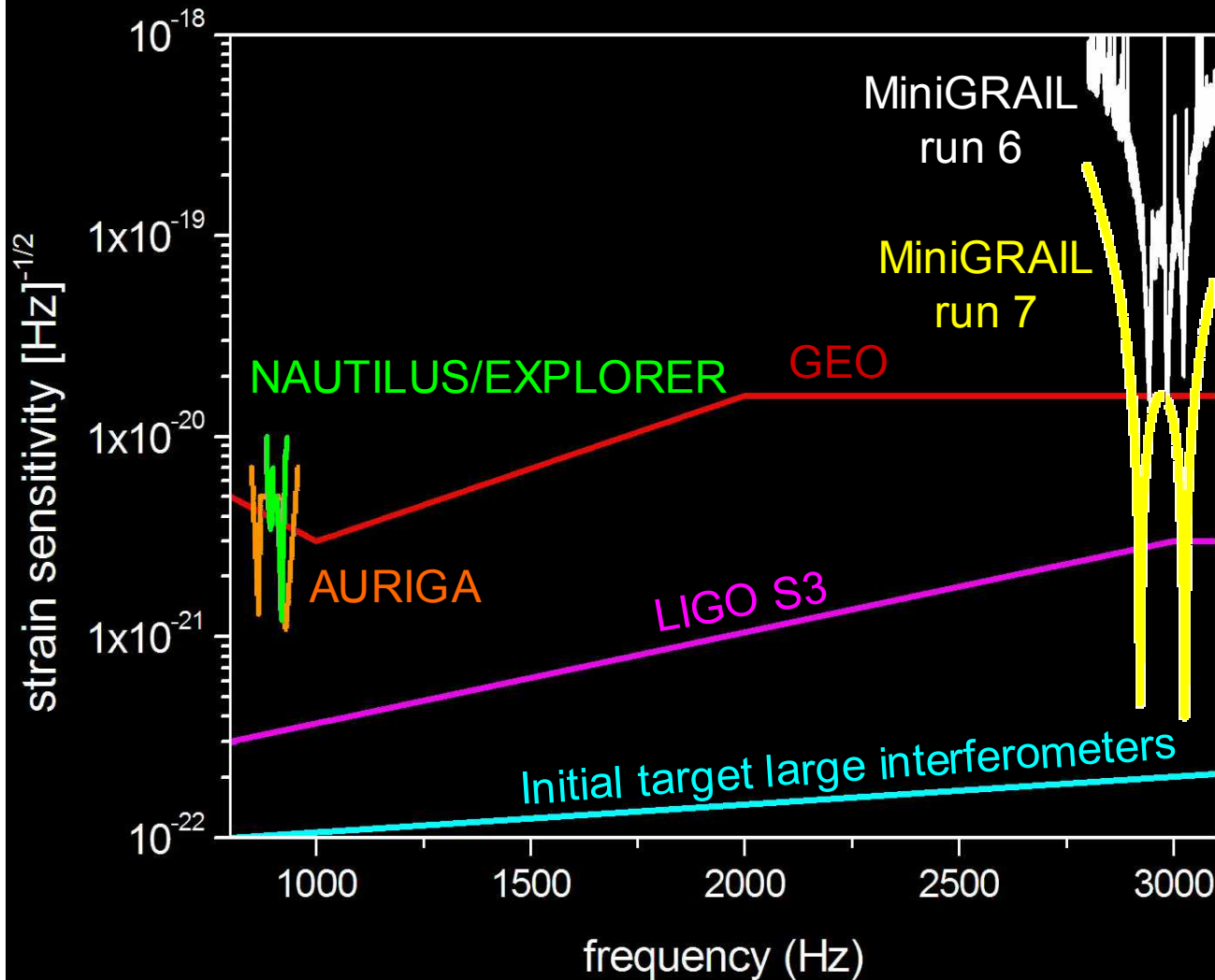


	Run 6	Run 7
T	5 K	80 mK
$\epsilon$	700'	100'
Q	$10^5$	$10^6$
M	200 g	400 g
C	1.1 nF	1.5 nF
$V_{\text{bias}}$	200 V	400 V

$T_{\text{eff}} = 40 \mu\text{K}$



# MiniGRAIL sensitivity - comparison



Planned at the end of 2004