

Multi-PMT DOM for Next-Generation IceCube

ERLANGEN CENTRE
FOR ASTROPARTICLE
PHYSICS

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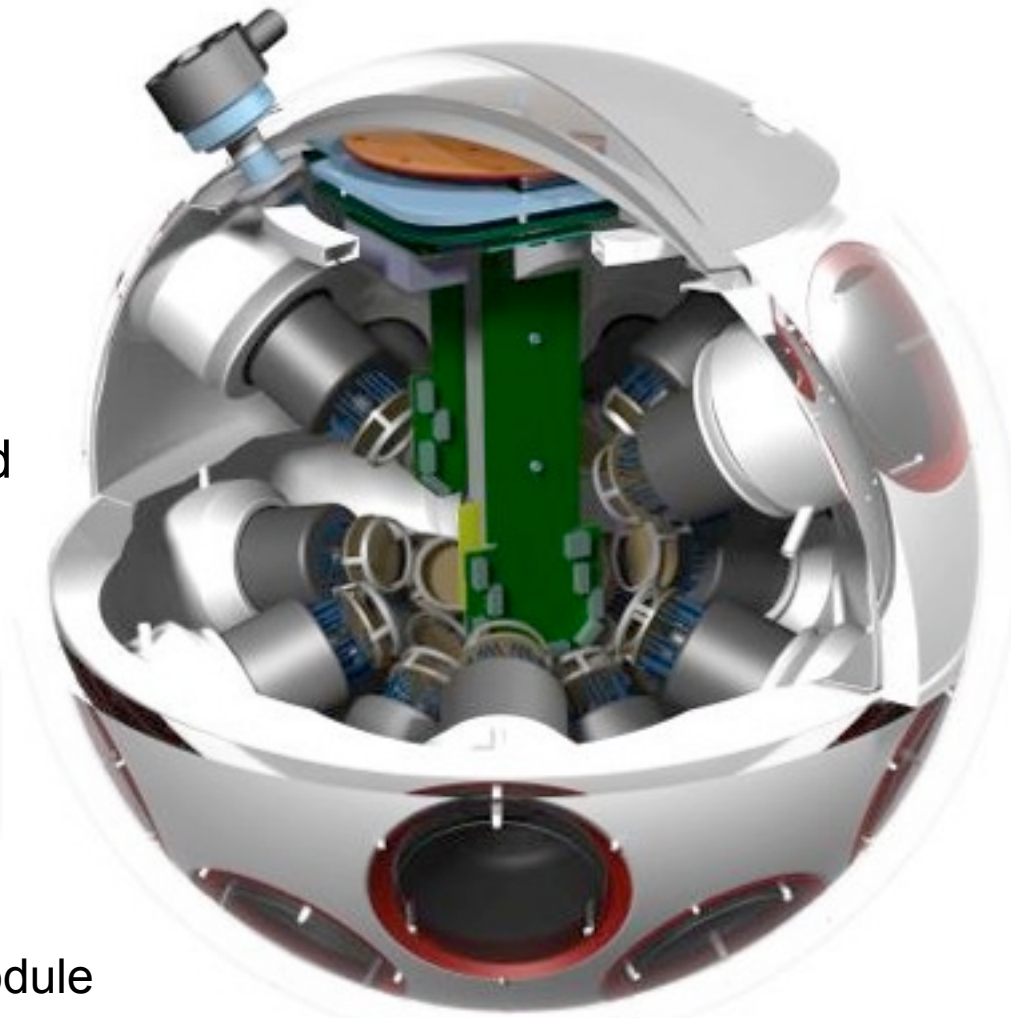


Concept advantages

- tripled photocathode area*
- local coincidences
- angular acceptance 4π
- directional sensitivity
- no magnetic shielding needed

**same price
per photocathode area***

*compared to standard IceCube module



Adaptation for the use in deep ice



reuse
PMTs
bases
connectors

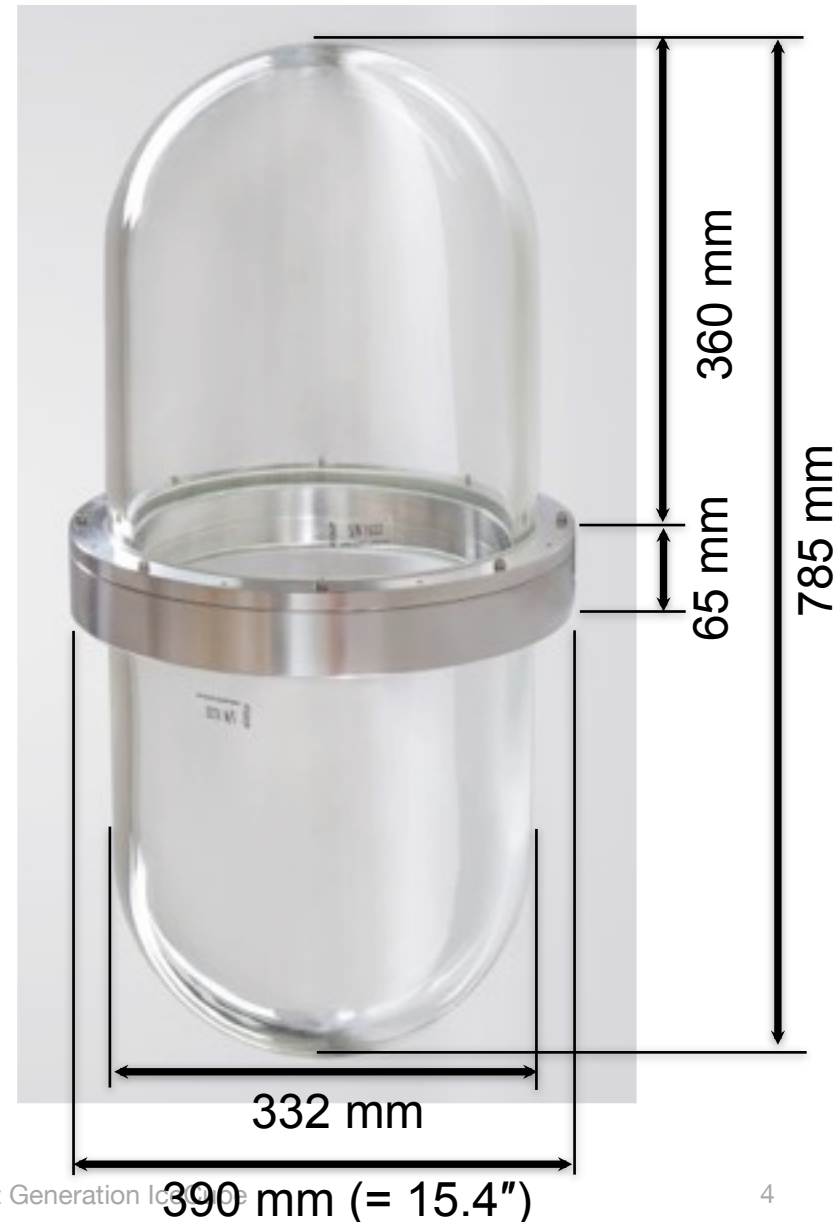
adaptation/ new development
pressure vessel
PMT holder
reflectors
electronics



Cylindrical pressure vessel

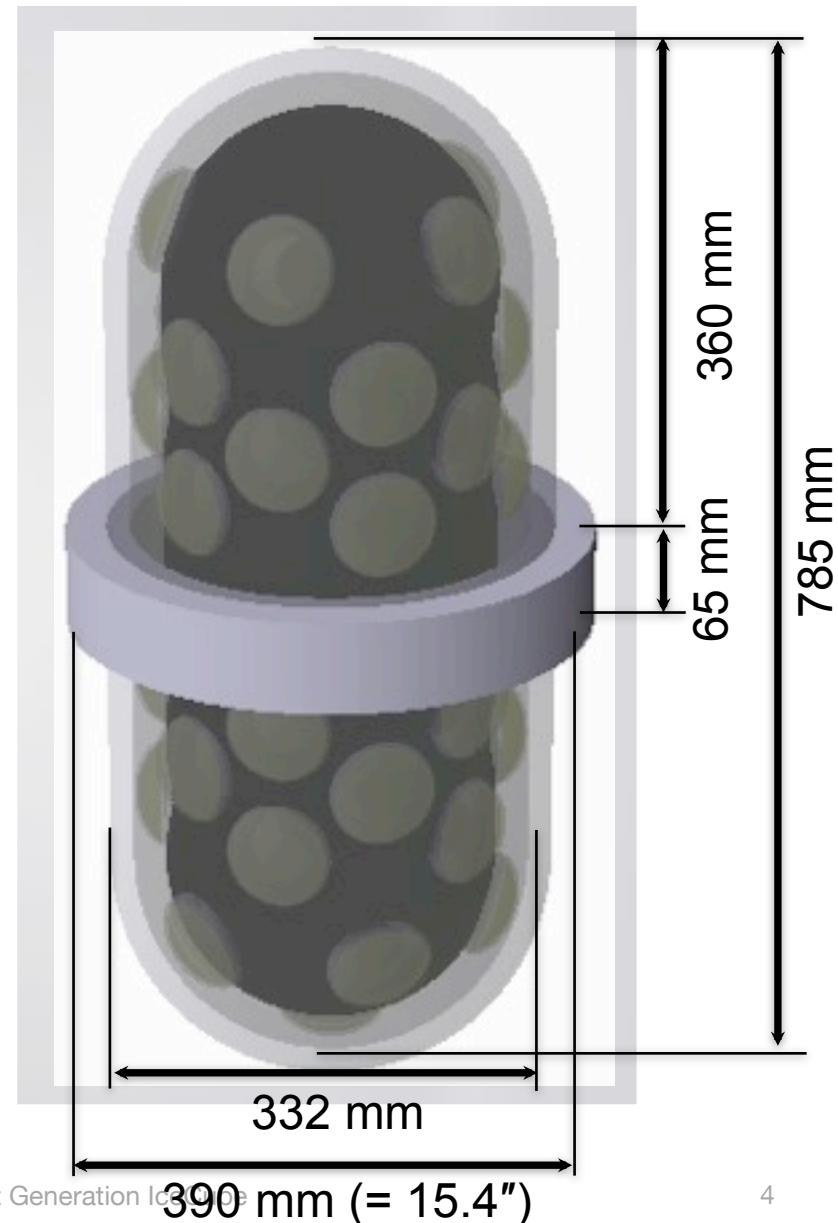


- wall thickness up to 18 mm
- rated for 700 bar
- steel connectors
- mass (f/m): 28,2 kg/22,5 kg



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PMT characteristics



Hamamatsu
R12199
Ø = 80 mm




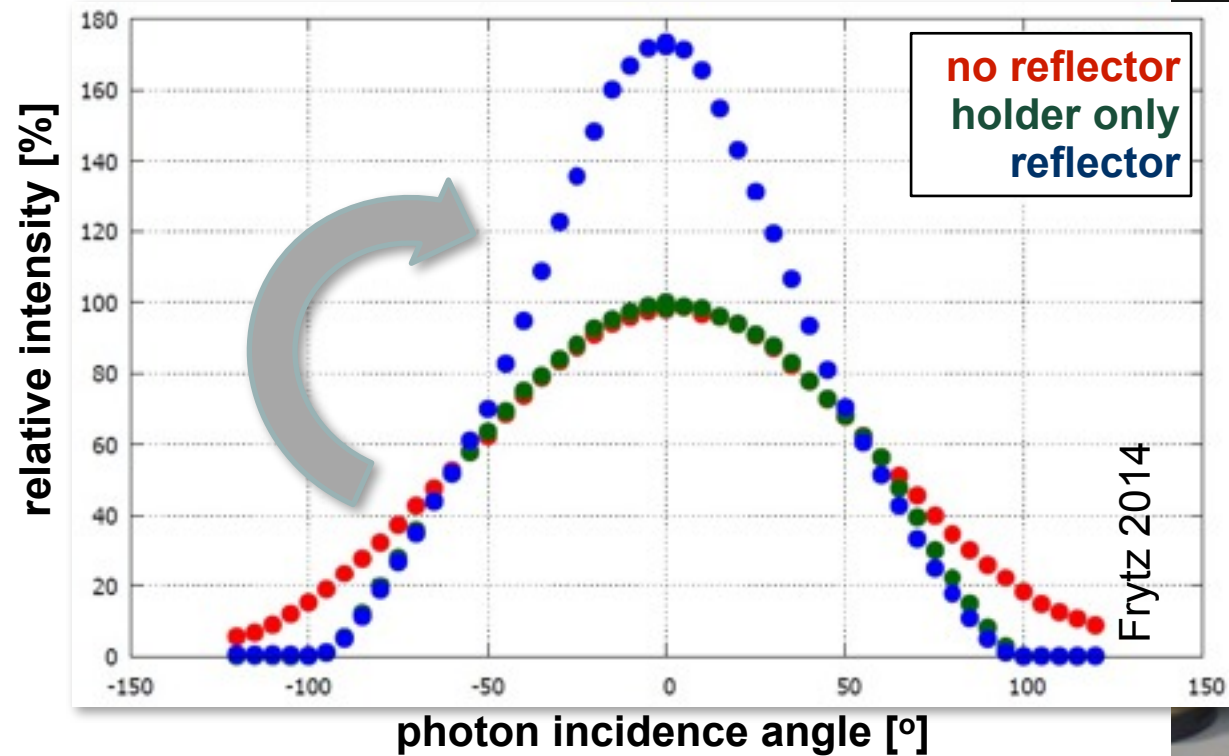
ETEL
D792KFL
Ø = 86 mm



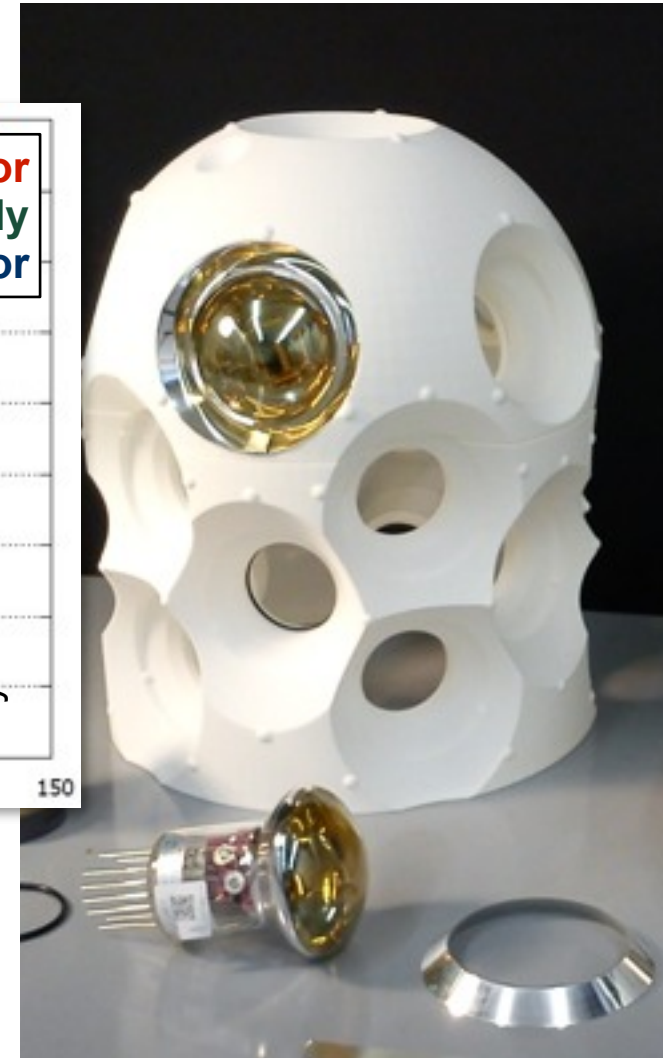
HZC
XP53B20
Ø = 76 mm

KM ₃ NeT requirements	
quantum efficiency @ 470 nm	> 20%
transit time spread (σ , FWHM)	< 2 ns, < 4.6 ns
gain	> $2 \cdot 10^6$
supply voltage	< 1400 V
dark count rate @ 15°C	< 1.5 kHz
peak to valley ratio	> 3
length	< 120 mm
power consumption incl. base	< 4 mW

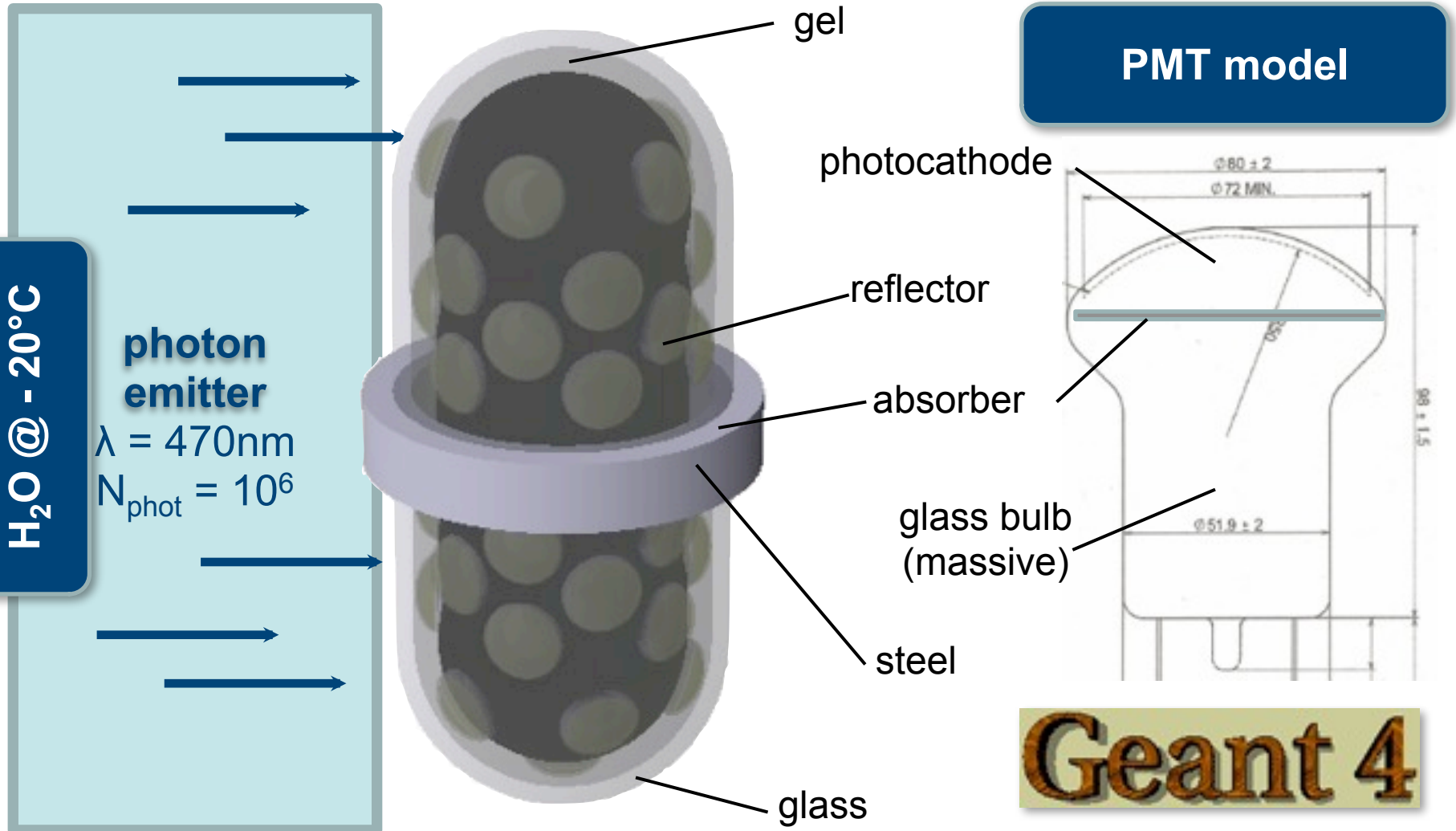
Effect of reflectors



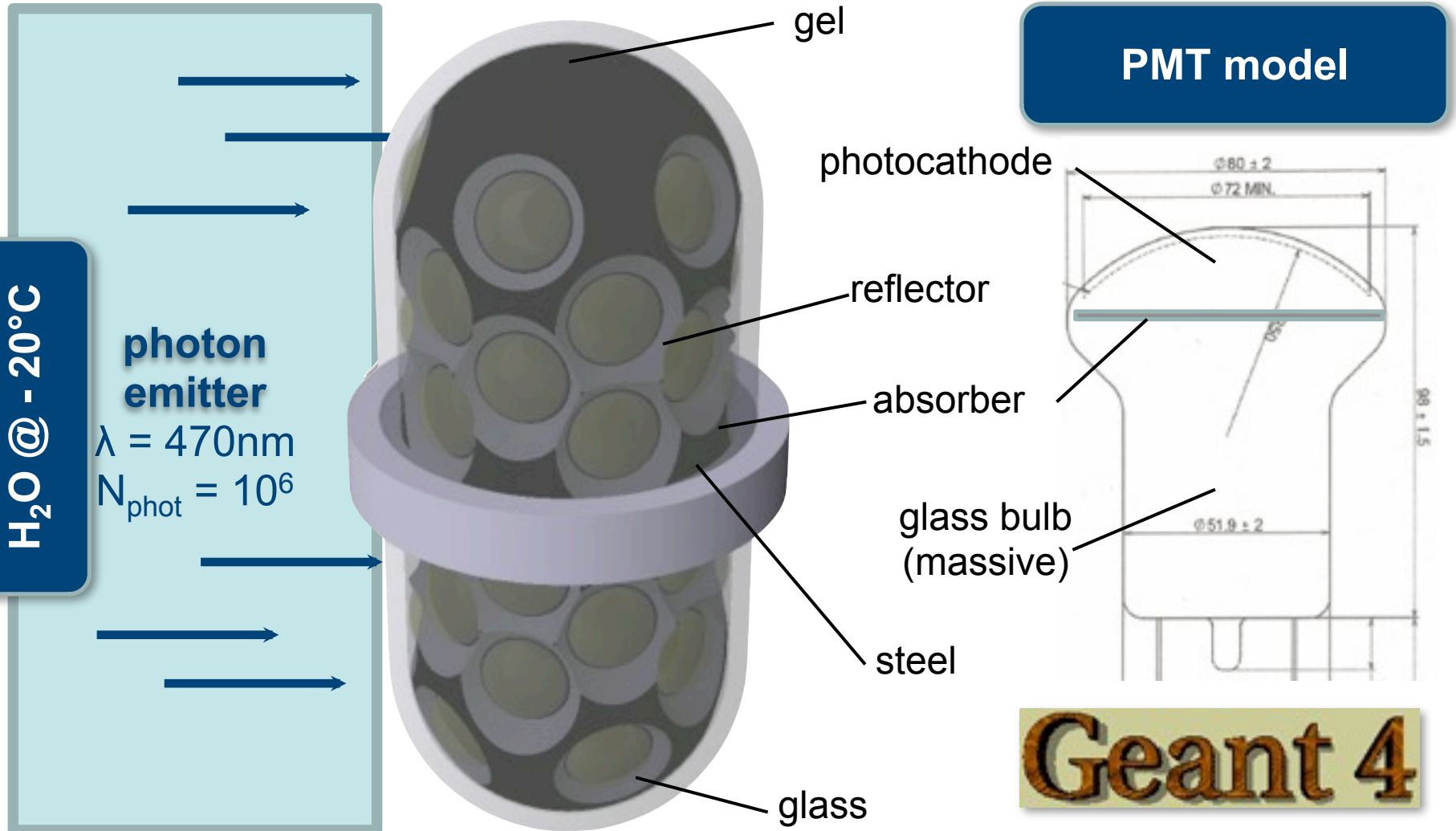
beamed acceptance



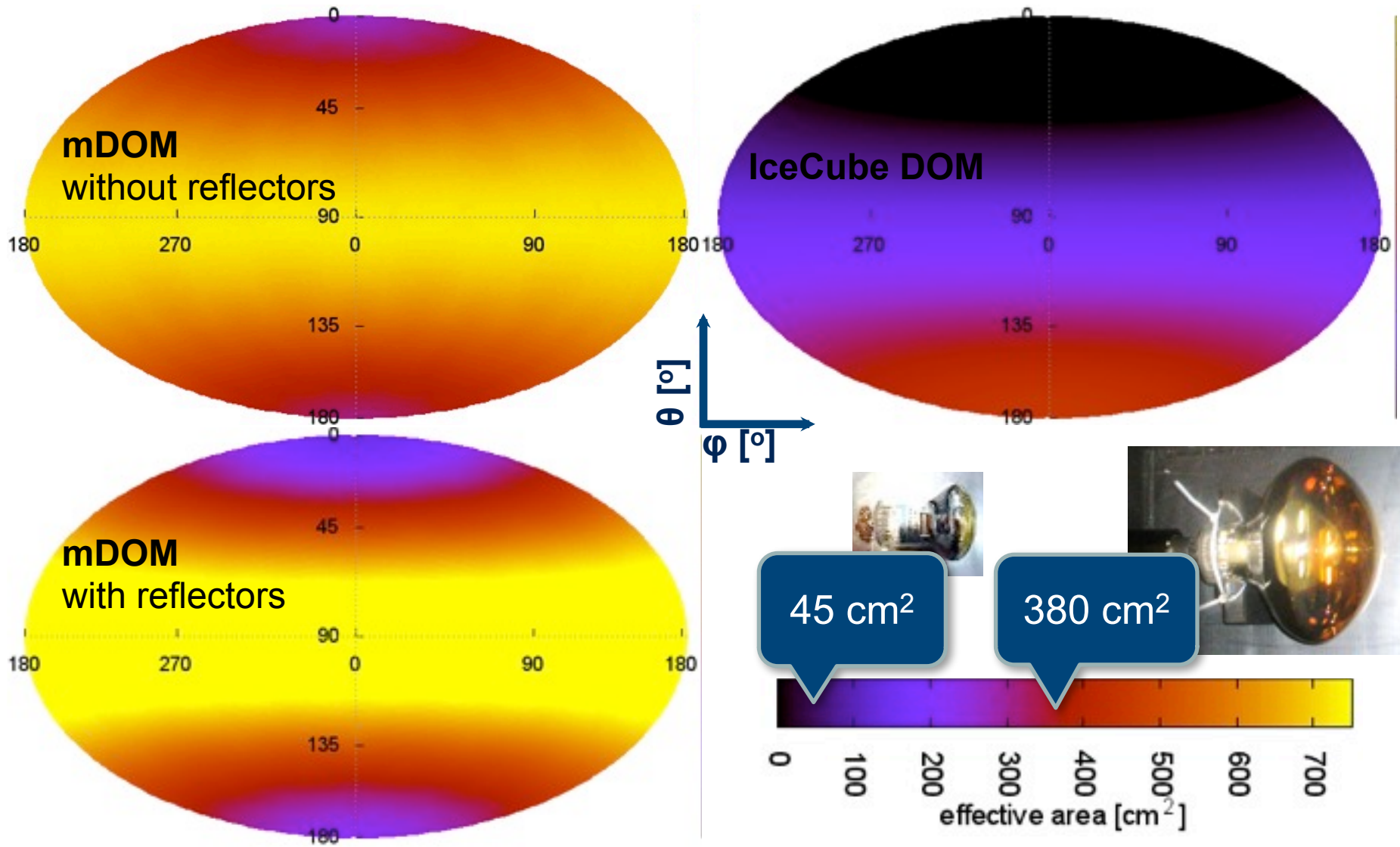
Angular acceptance simulation



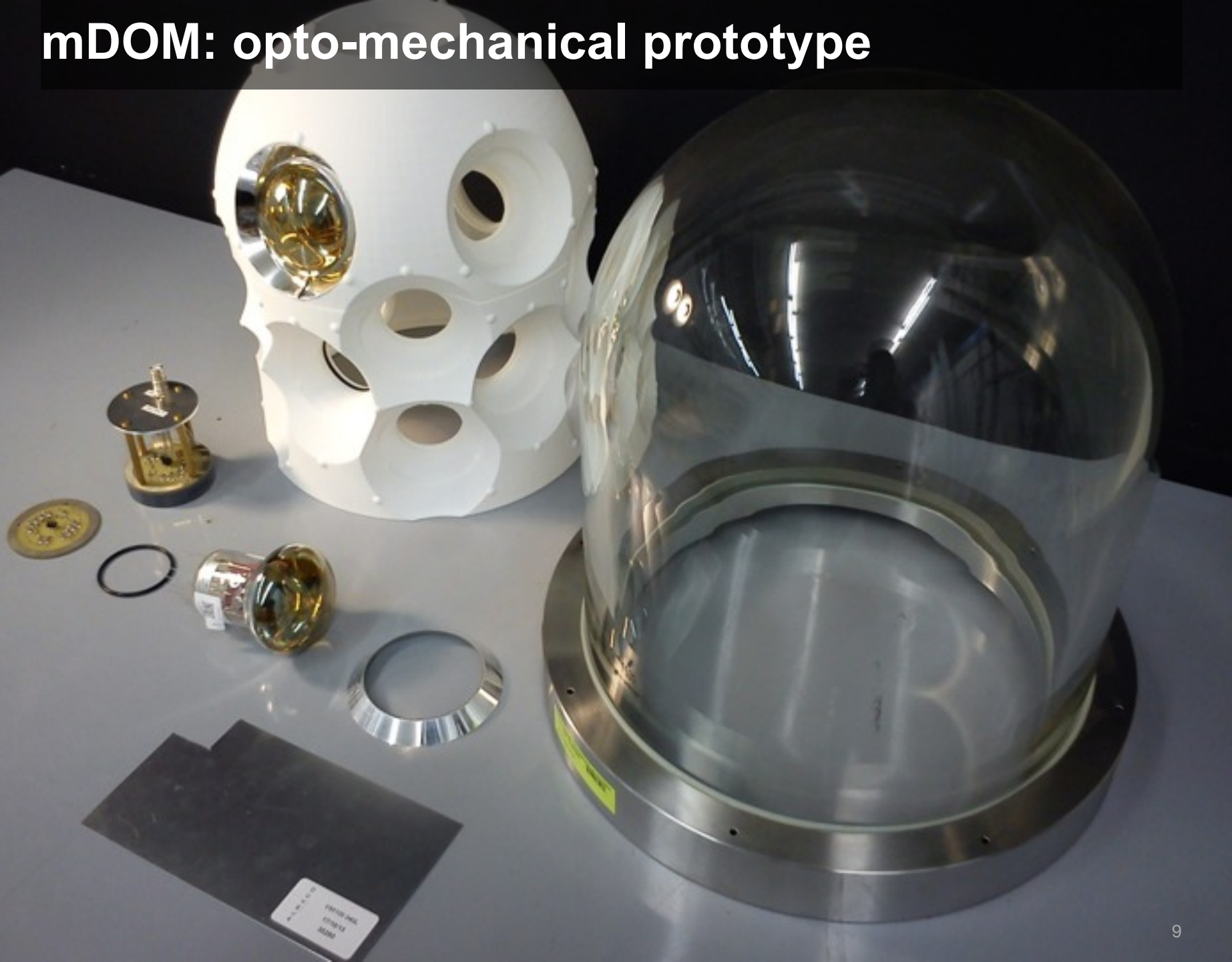
Angular acceptance simulation



Simulation results



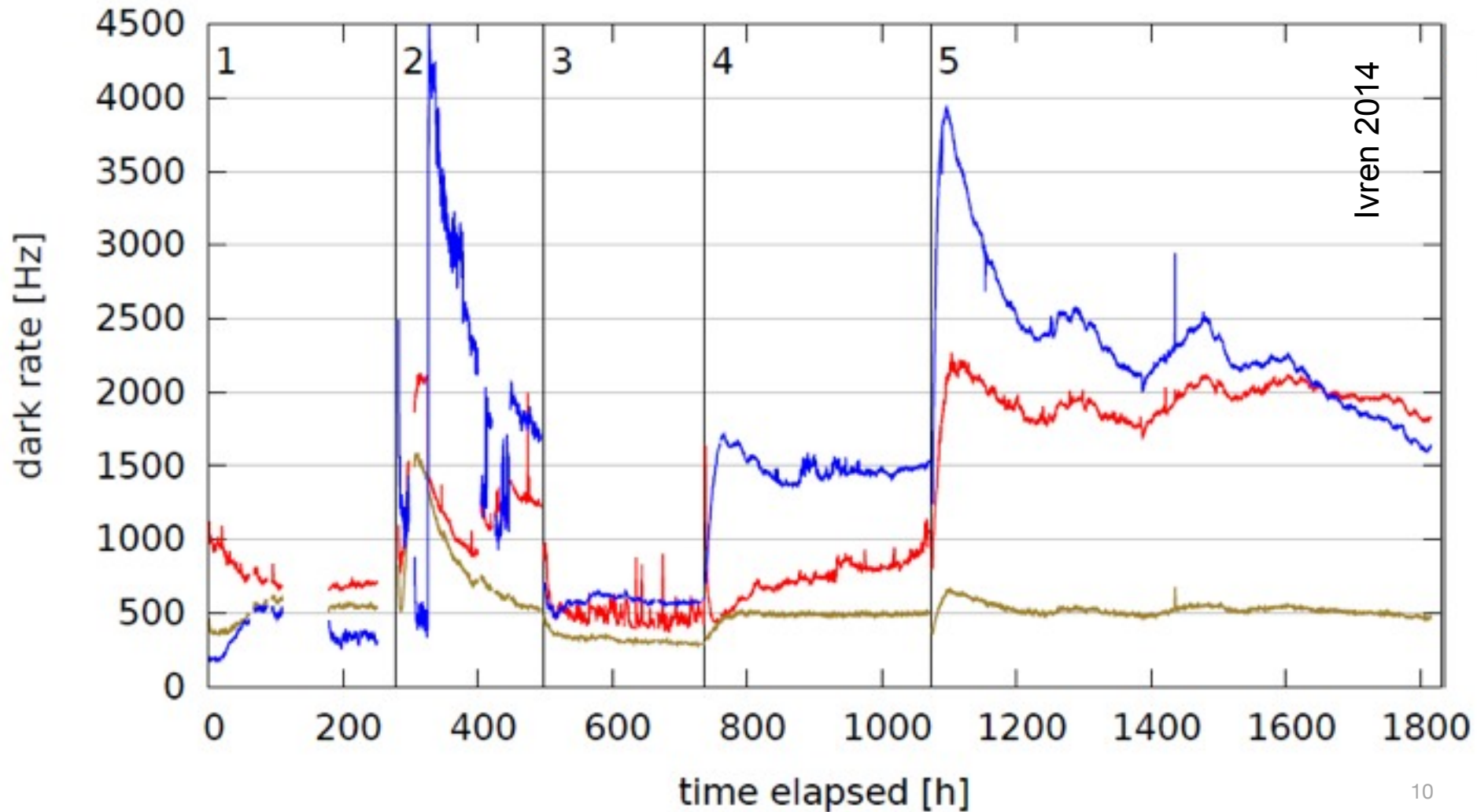
mDOM: opto-mechanical prototype



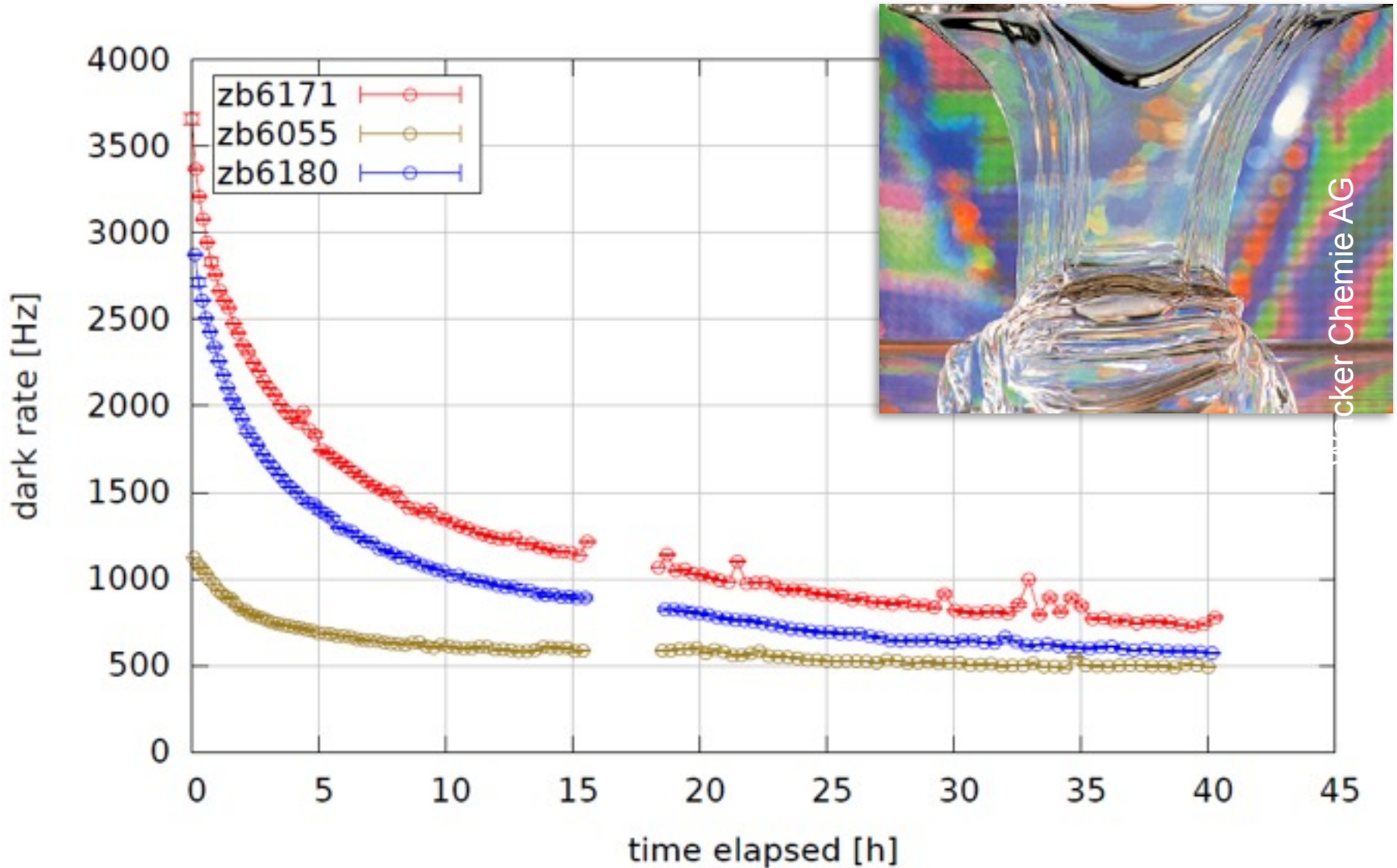
Dark rate development



ZB 6171 — ZB 6055 — ZB 6180 —



PMTs inside silicone oil



Opto-mechanical prototype

- revisit form factor
- module acceptance measurement
- background simulation & measurement

Electronics development

- started cooperation with Erlangen engineering department

Simulation

- implementation of mDOMs in IceTray/clsim
- simulation of mDOM detector



PMT characteristics



PMT #	gain	#PHE @ - 30mV
6171	$4.46 \cdot 10^6$	0.51
6055	$6.44 \cdot 10^6$	0.35
6180	$5.65 \cdot 10^6$	0.40