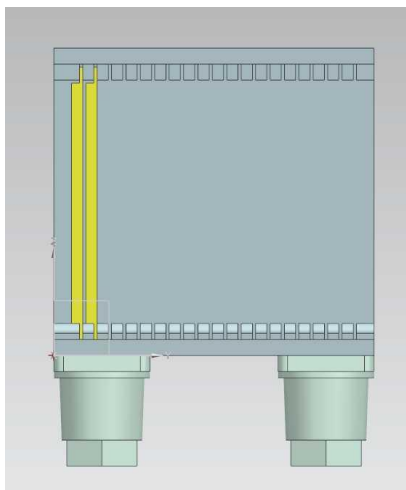
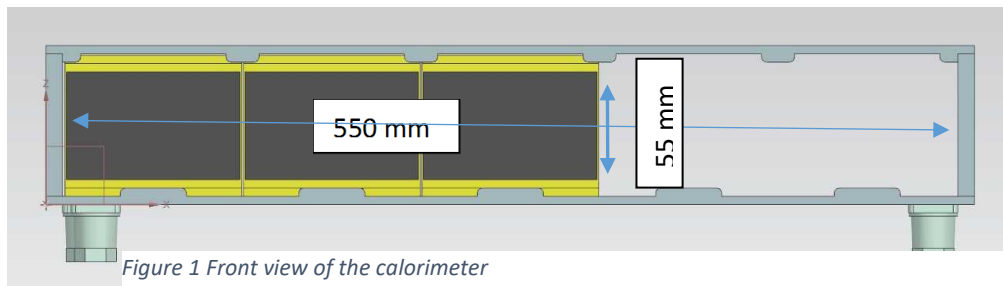


Cost estimate for the LUXE phase 1 electromagnetic calorimeter

August 8, 2020

One rectangular Si-W sandwich calorimeter of area $550 \times 55 \text{ mm}^2$, and a depth of $20 X_0$ is assumed.



20 W absorber plates of 3.5 mm thickness, interspersed with silicon sensors encapsulated in C-fiber structures and Kapton flexible PCB for signal transport and HV supply

The calorimeter is subdivided in 5 modules, each $10.5 \times 5.5 \text{ cm}^2$ in area.

Each sensor has a size of $5.5 \times 10.5 \text{ cm}^2$. Tungsten plates are made of the full length of the calorimeter .

The volume of one tungsten plate is $550 \times 55 \times 3.5 \text{ mm}^3 = 105,88 \text{ cm}^3$. With the tungsten mass density $\rho = 19.3 \text{ gcm}^{-3}$ the mass per plate amounts to 2,04 kg. For 20 plates this is 41 kg.

Assuming a price of 400 \$ per plate, the total price amounts to about 8000 \$, or 6720 Euro.

The cost for the production of the mechanical frame is estimated from the DESY engineers to be about 1000 Euro.

The sensor area amounts to $10.5 \times 5.5 \text{ cm}^2 = 58 \text{ cm}^2$. For one module this results to 1160 cm^2 and for the whole calorimeter to 5800 cm^2 . Assuming a price about 8 Euro cm^{-2} , the price for one piece is 464 Euro, for one module is 9280 Euro, and for the calorimeter about 46400 Euro.

Each sensor needs two Kapton PCBs for signal transmission and HV supply. Assuming 60 Euro per piece, for one module 2400 Euro are needed, and for the calorimeter 12000 Euro.

In addition carbon fibre supports are needed. For these supports a price of 300 Euro per piece is assumed.

The number of readout channels depends on the pad-size. Assuming 5 x 5 mm² pads, the number of channels per sensor is 231, per module 4620, and for the calorimeter 23100. Assuming for ASIC production a price of 1.5 \$ per channel, the cost for ASICs is about 36000 Euro.

In addition, expenditures for ASIC prototyping, probe-cards, PCBs for FE electronics, LV and HV supplies, Crates, receiver cards and tooling are foreseen. A summary is given in the following table.

LUXE calorimeter

Mechanics			
	number	price	total
tungsten plates	25	400	10000
support frame	1	1000	1000
sensor support structures (carbon etc)	100	300	30000

Connectivity

fan out Kapton HV	100	60	6000
fan out Kapton, signal	100	60	6000

Silicon sensors	100	470	47000
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Front-end ASICs

prototyping, ASICs	50	1000	50000
channels	24000	1,5	36000
probecard for tests	1	20000	20000

front-end electronics

PCB and assembly	100	100	10000
auxiliary components			15000

Power supplies

HV			10000
LV			10000
cables and connectors, patch panels			15000

Data acquisition

Receiver cards (FPGA based)	100	500	50000
crates	5	1000	5000
crate computer	5	1000	5000
racks	1	2000	2000

Tooling			30000
sum			358000

Engineering Personpower, 2 FTE years			160000
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total			518000
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The costs of the components for one Luxe ECAL amount to 358 k Euro. The engineering person power is estimated to be 2 FTE years, corresponding to 160 k Euro. The total budget then amounts to 518 k Euro.