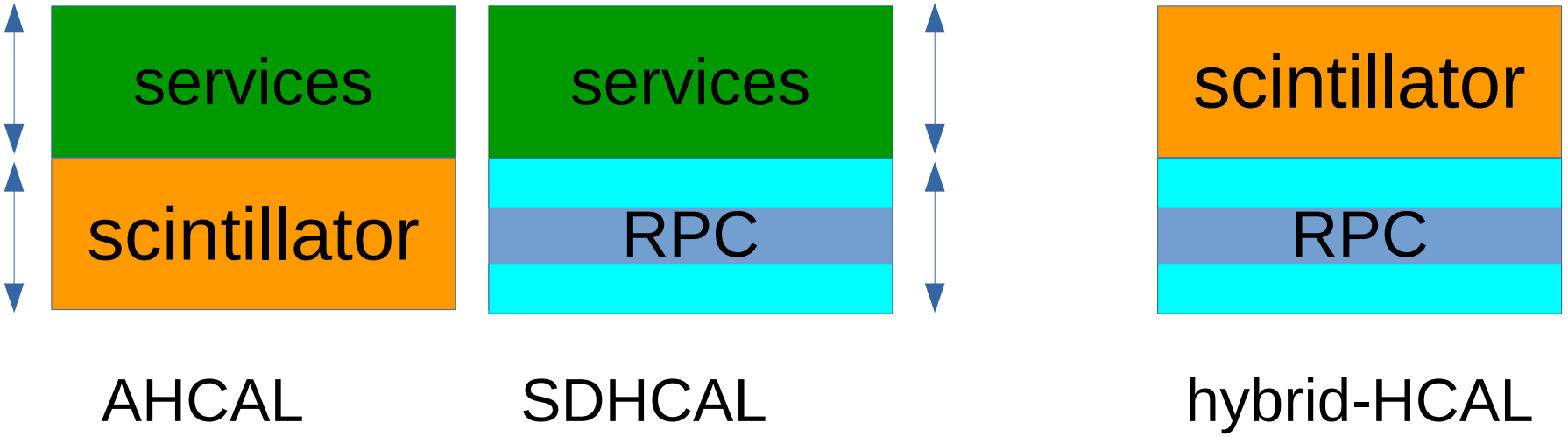
status of hybrid ECAL simulation model in ILD

Daniel Jeans, KEK
ILD meeting, 5 September 2017

for next large-scale ILD simulation, plan to use hybrid HCAL simulation,
in which we can simultaneously simulate
scintillator and RPC technologies

this is quite straight forward, since the
thickness of the services ≈ thickness of the detector (scint. or RPC)



at the AWLC/SLAC meeting, the Sc-ECAL group (Tohru Takeshita)
asked me to implement a similar hybrid ECAL simulation

Si-ECAL group have recently done a lot of work to implement
a less aggressive and more realistic design in the simulation:
the famous growth of ECAL thickness by ~3.5 cm

For a hybrid simulation, I propose:

→ keep the same overall dimensions as the SiECAL

→ keep the same number, thickness, position of absorber plates

→ keep the silicon thickness the same

then, the SiECAL performance should be unchanged at 1st order

from ScECAL point of view, try to have 2mm of scintillator

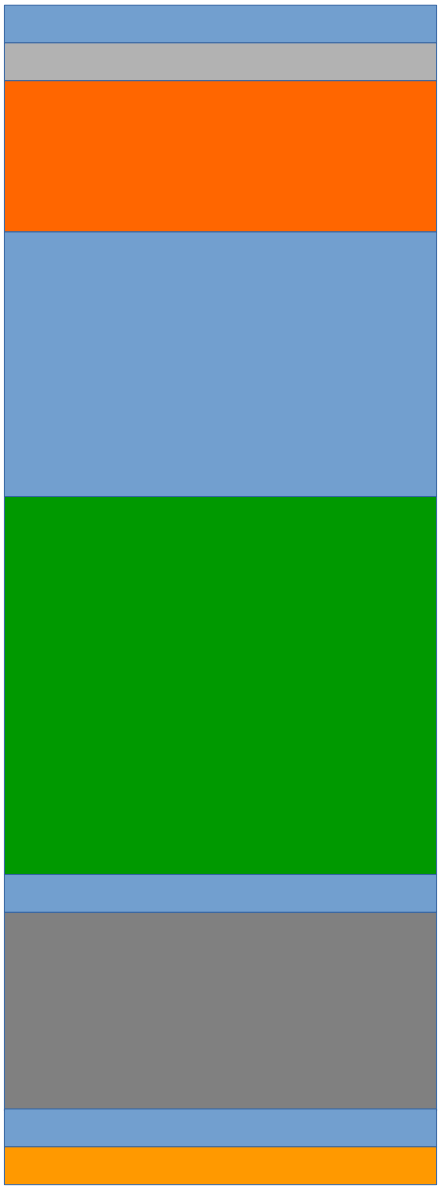
To first order,
and if absorber thicknesses are fixed

thickness of active material → energy resolution

size of gaps → lateral size of showers
thinner gaps = smaller showers
= larger shower separation
= better PFA (in principle)

a realistic simulation model should have
accurate descriptions of both aspects

current ILD SiW ECAL model

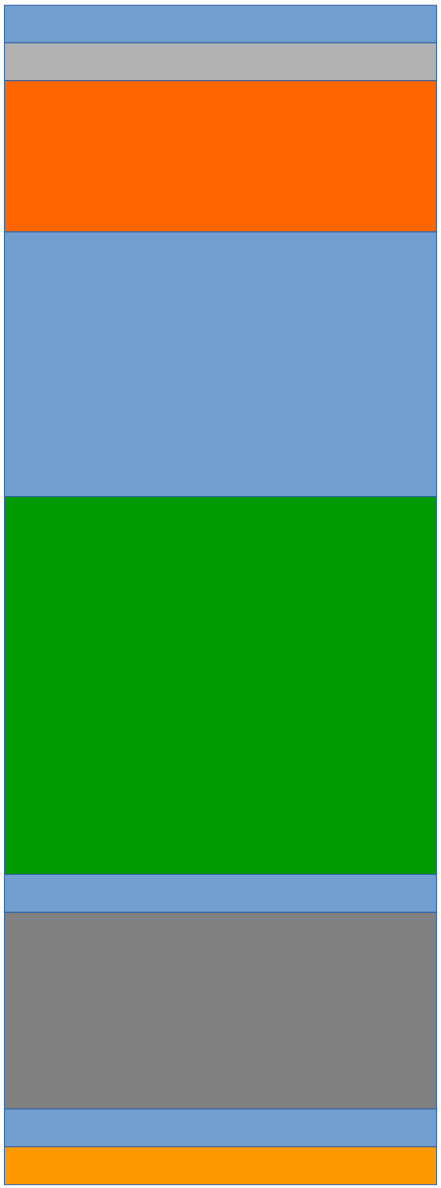


air (toler.)	0.1
Al	0.1
Cu	0.4
air (ASIC)	0.7
PCB	1.0
air (glue)	0.1
Si	0.525
air (glue)	0.1
kapton	0.1

~4.4 % of X_0 in 3.125 mm

total thickness of Si-ECAL detector layer = 3.125 mm

current ILD SiW ECAL model



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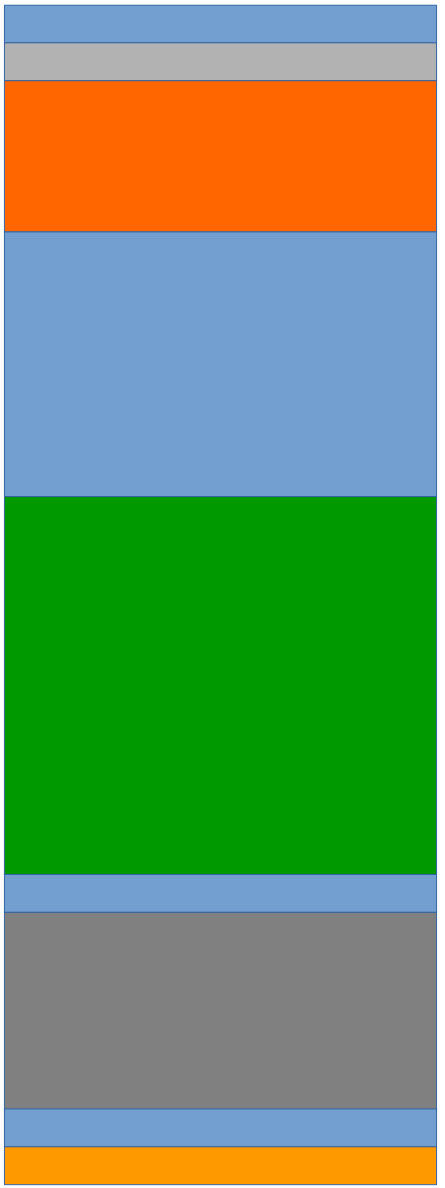
~4.4 % of X_0 in 3.125 mm

total thickness of Si-ECAL detector layer = 3.125 mm

total "air" thickness = 1mm
(glue gaps + ASIC + tolerance)
PCB thickness = 1mm

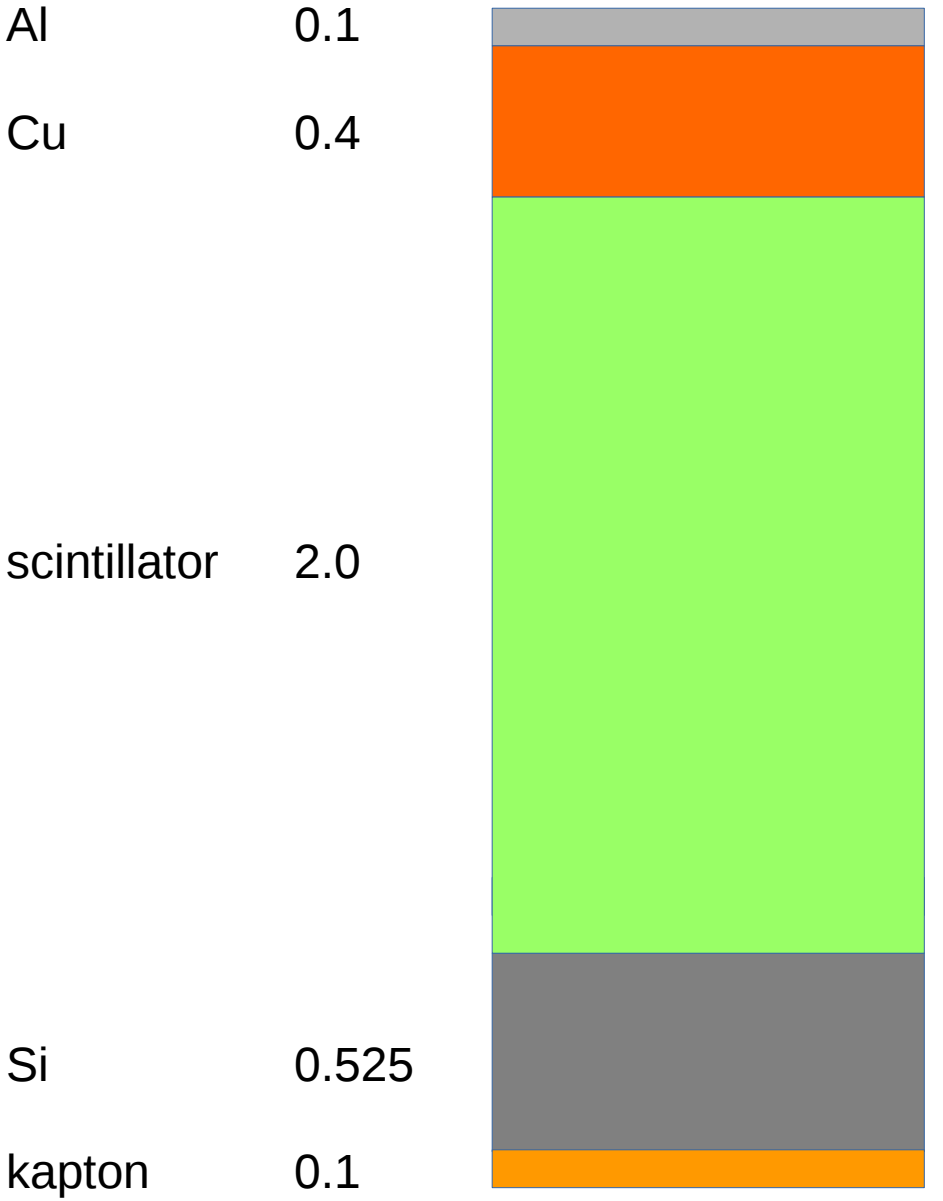
→ replace these by 2mm scintillator

current ILD SiW ECAL model



~4.4 % of X_0 in 3.125 mm

proposed hybrid ECAL model

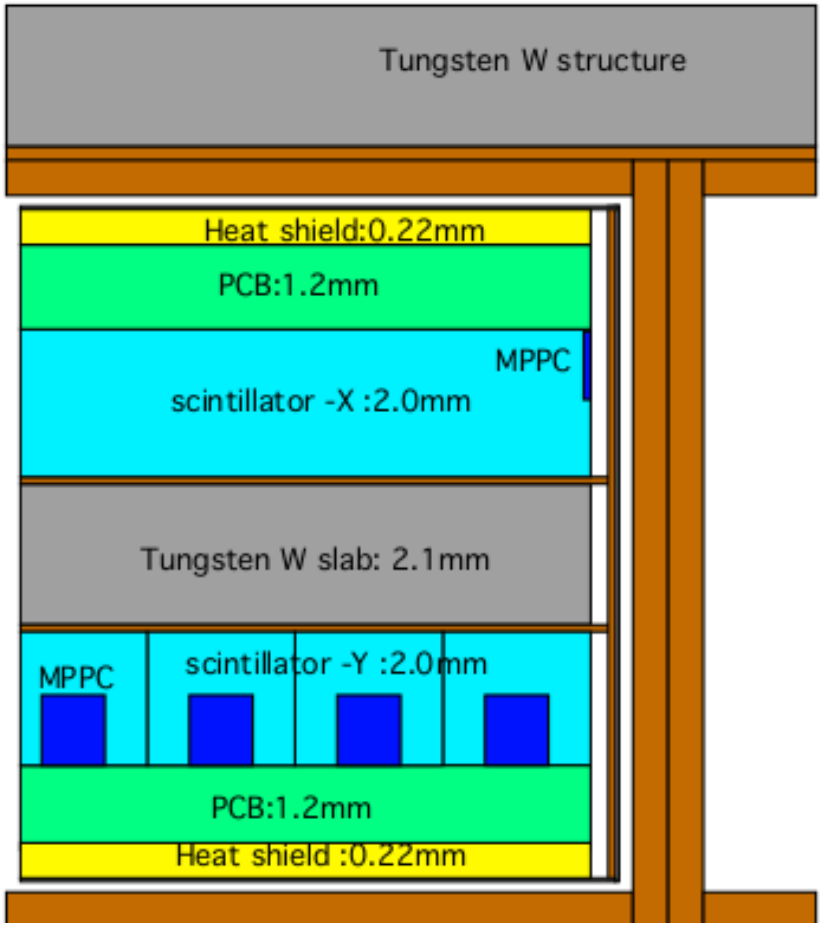


~4.3 % of X_0 in 3.125 mm

everything else identical (absorber, CF structure, total thickness...)

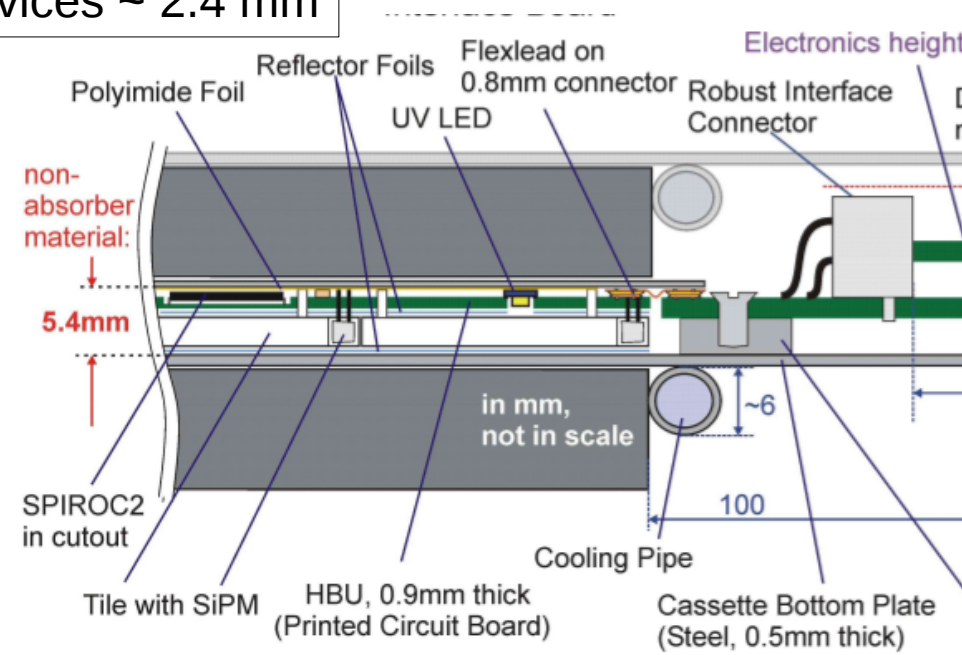
So it is possible to fit a scintillator layer into a hybrid ECAL, without significantly changing the properties of the realistic Si-ECAL model

ScECAL: services within the layer
PCB hosting frontend ASICS,
SiPMs, LEDs, passive cooling, etc.



Sc-ECAL in DBD
services ~ 1.42 mm

A-HCAL in DBD
services ~ 2.4 mm



rather similar systems,
ScECAL has 4x higher channel density

are these estimates of similar realism?

in hybrid model,
in addition to scintillator,
there is available space of
1.125 mm

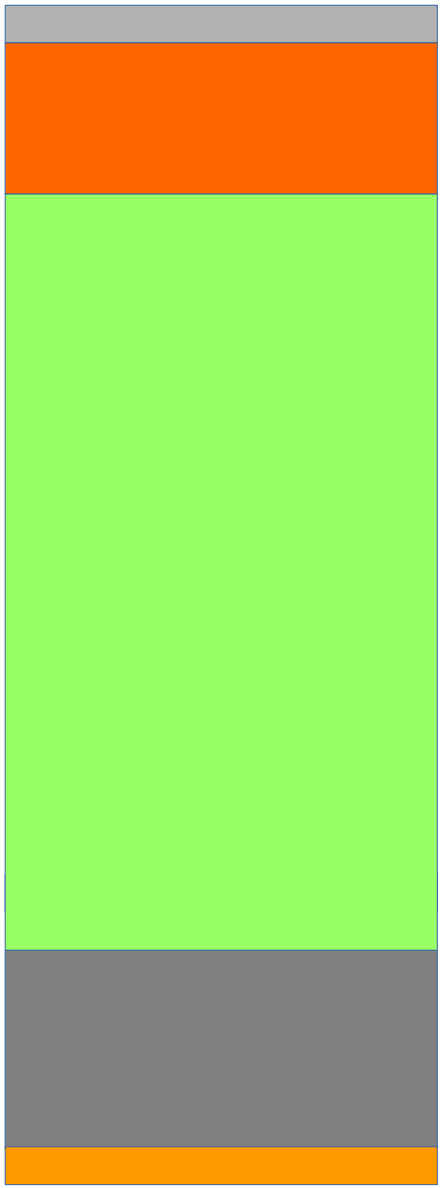
ScECAL [DBD] requires ~1.4 mm
AHCAL [DBD] requires ~2.4 mm

ScECAL
[reasonable extrapolation of
today's prototypes] require ???

This hybrid model is almost
certainly more compact than a
realistic ScECAL, and would
underestimate the width of
showers in a Sc-ECAL

proposed hybrid ECAL model

Al	0.1
Cu	0.4
scintillator	2.0
Si	0.525
kapton	0.1



Despite these imperfections,
this hybrid ECAL model has been implemented
as an option for ILD: ILD_(l/s)5_v02 models
thanks to F. Gaede and S. Lu for their help

silicon and scintillator technologies are
simultaneously simulated

hits in the silicon and scintillator detectors are
placed into separate collections

at reconstruction time,
choose to use one or the other technology when running
e.g. PandoraPFA clustering

There are plans to validate it in the ScECAL group
no results are yet available,
but I have been promised some soon by the Shinshu group

summary

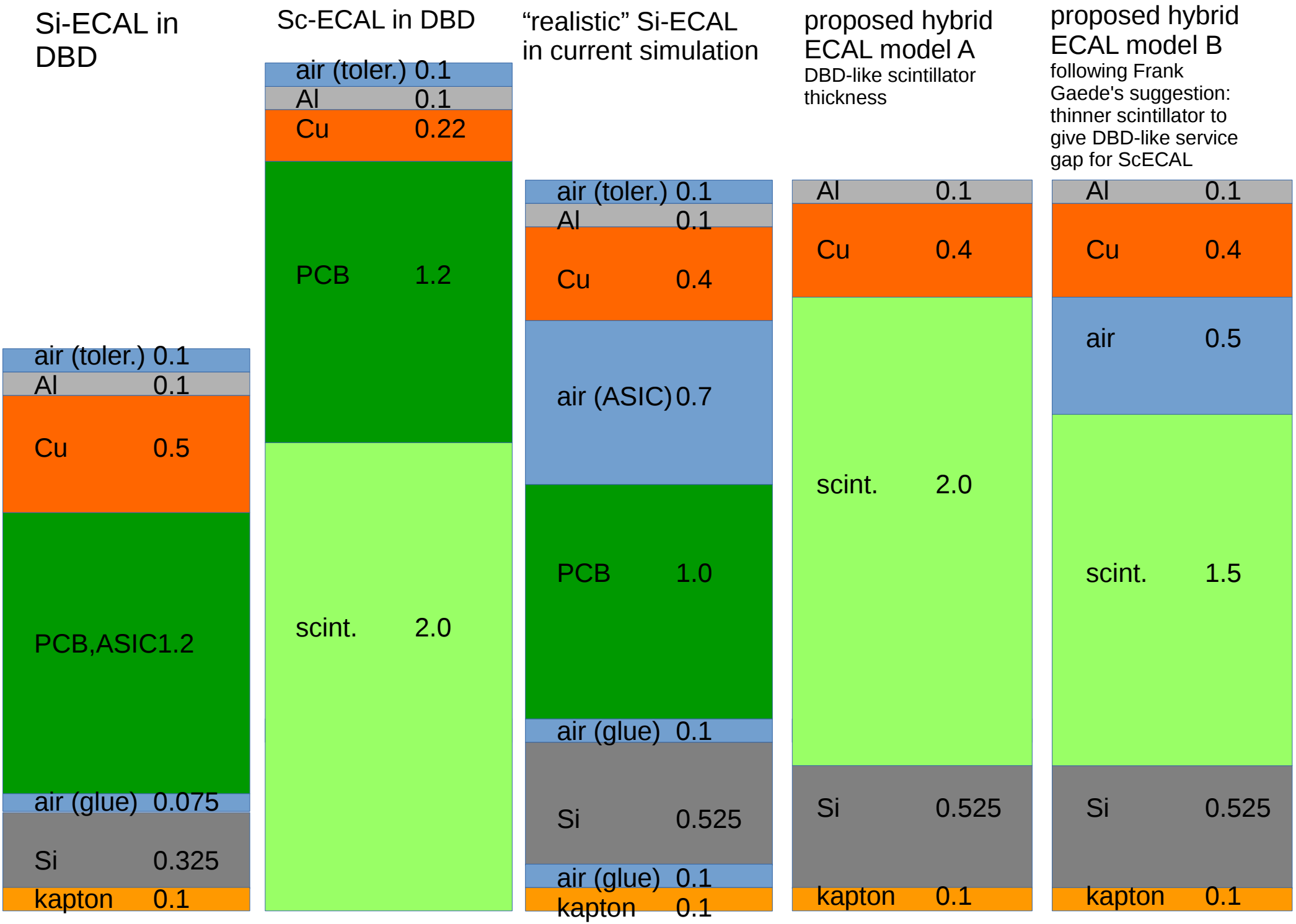
a hybrid ECAL simulation mode has been developed
- maintain realistic SiECAL performance
- probably results in over-optimistic ScECAL

model is available, and is being validated
(results not yet available, rather limited person-power)

alternative approach would be to devise a model
which is a
somewhat optimistic for ScECAL
somewhat pessimistic for SiECAL
but I'm not sure that is the way to go…

other proposals or suggestions?

backup slide added after the meeting


Si-ECAL in DBD
air (toler.) 0.1
Al 0.1
Cu 0.5
PCB,ASIC1.2
air (glue) 0.075
Si 0.325
kapton 0.1
Sc-ECAL in DBD
air (toler.) 0.1
Al 0.1
Cu 0.22
PCB 1.2
scint. 2.0
"realistic" Si-ECAL in current simulation
air (toler.) 0.1
Al 0.1
Cu 0.4
air (ASIC) 0.7
PCB 1.0
air (glue) 0.1
Si 0.525
air (glue) 0.1
kapton 0.1
proposed hybrid ECAL model A
DBD-like scintillator thickness
Al 0.1
Cu 0.4
scint. 2.0
Si 0.525
kapton 0.1
proposed hybrid ECAL model B
following Frank Gaede's suggestion: thinner scintillator to give DBD-like service gap for ScECAL
Al 0.1
Cu 0.4
air 0.5
scint. 1.5
Si 0.525
kapton 0.1