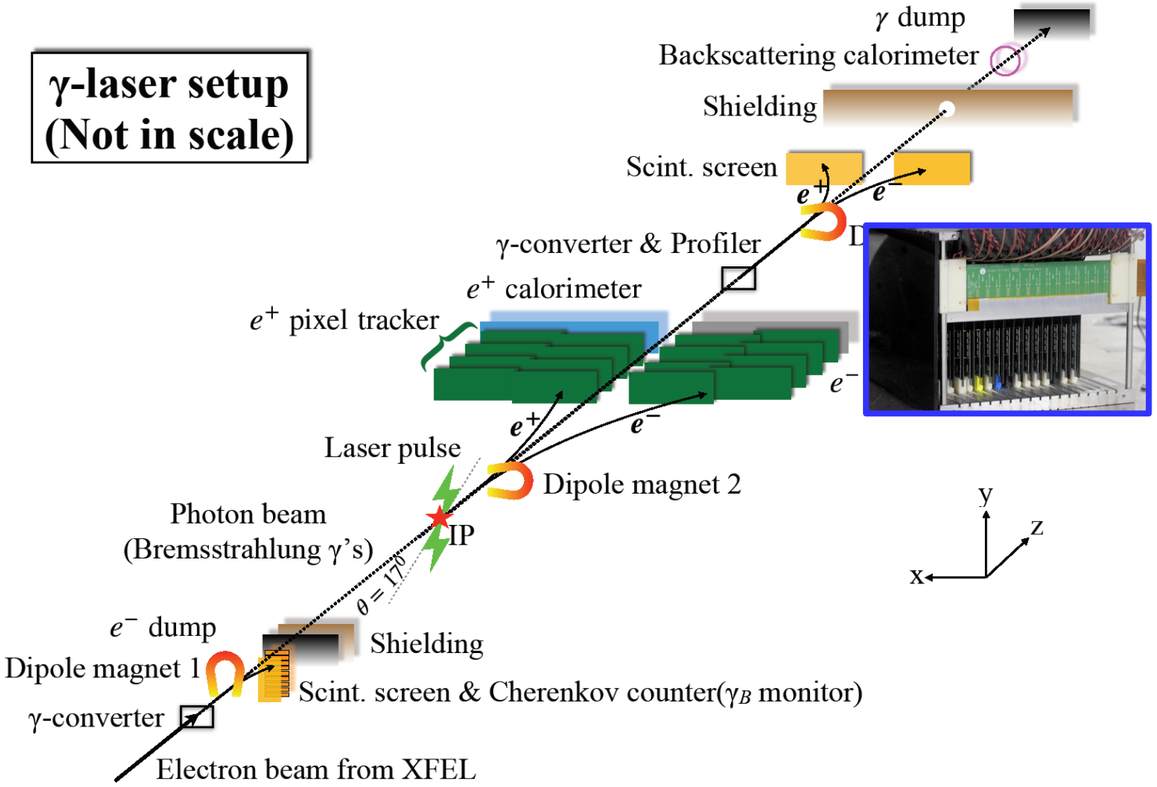
LUXE

Roman Pöschl

Rough planning of ECAL-E

LUXE ECAL Meeting – 28/07/2022

ECAL-E



Calorimeter setup is complemented by granular SiW tungsten calorimeter in the electron arm of the spectrometer

- Main application electron measurement of Breit-Wheeler process in γ-laser setup
- Can also be used in early LUXE phase in case of delays of dedicated ECAL-P
- Ideal application of CALICE SiW Ecal technological prototype

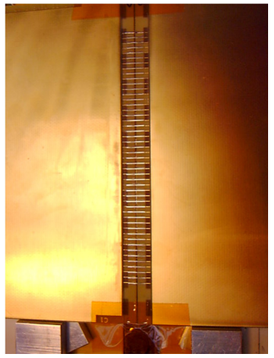
CALICE SiW ECAL

A layer is composed of several short ASUs:

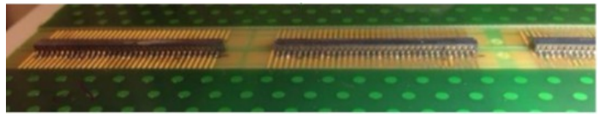
- A.S.U. : Active Sensors Units

ASIC+PCB+SiWafer =ASU

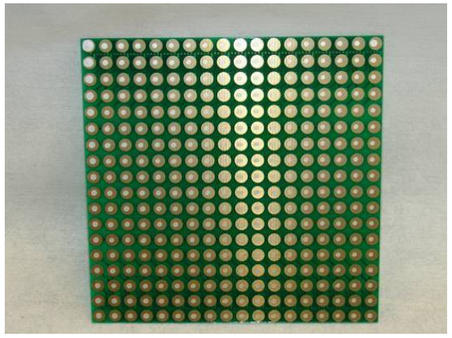
Wire Bonding or BGA

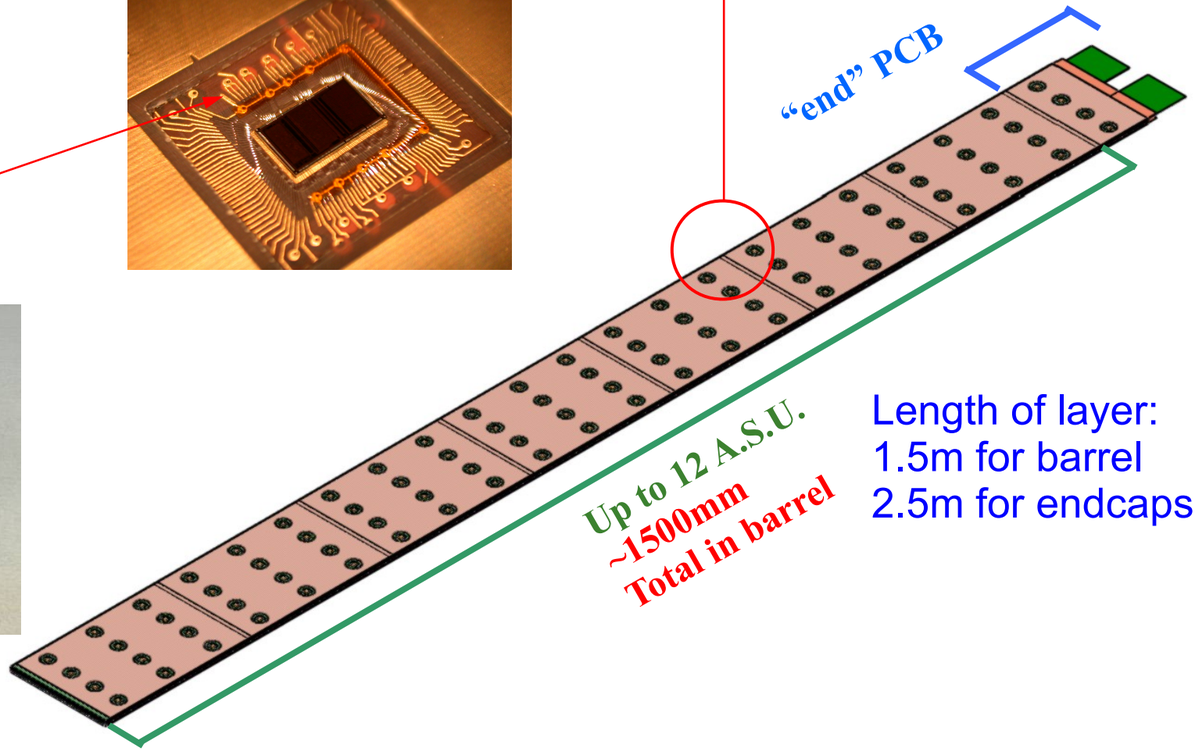


Interconnection
Important for signal integrity



PCB is glued onto SiWafers using gluing robots

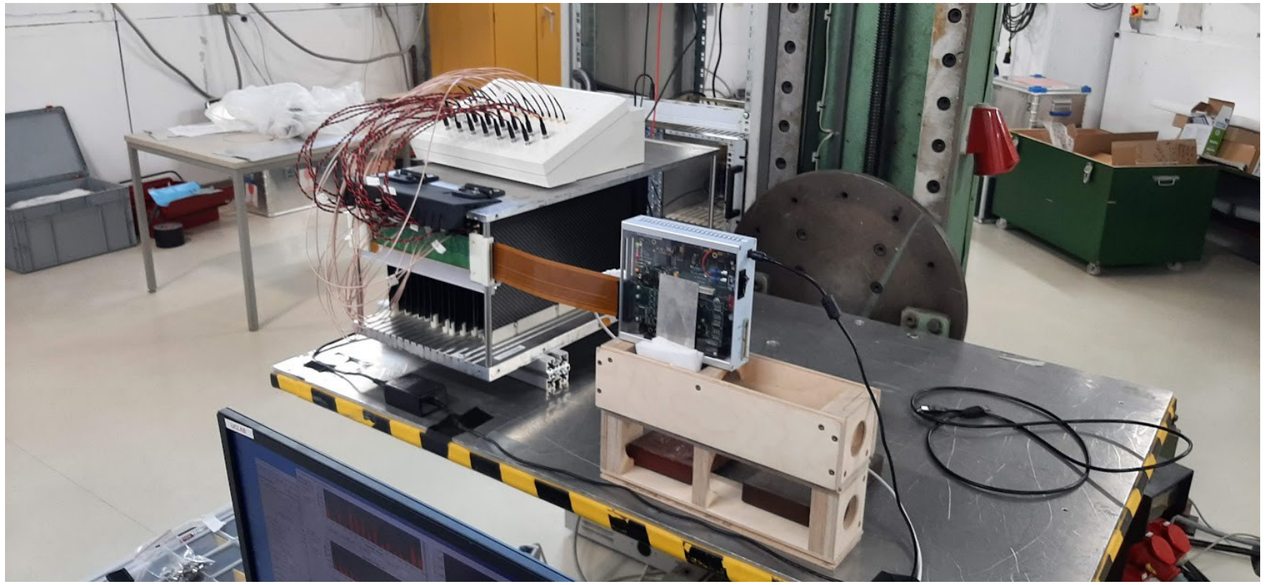


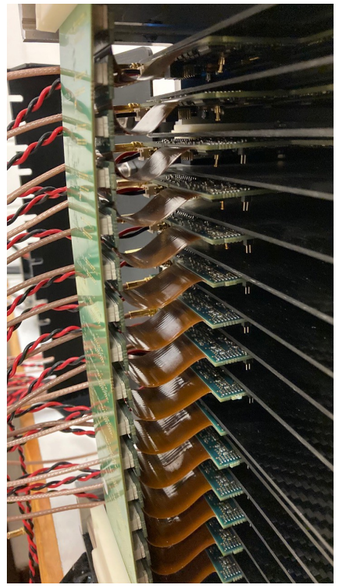


Length of layer:
1.5m for barrel
2.5m for endcaps

Recent achievements

Digital readout, mechanics and commissioning of current CALICE SiW ECAL stack

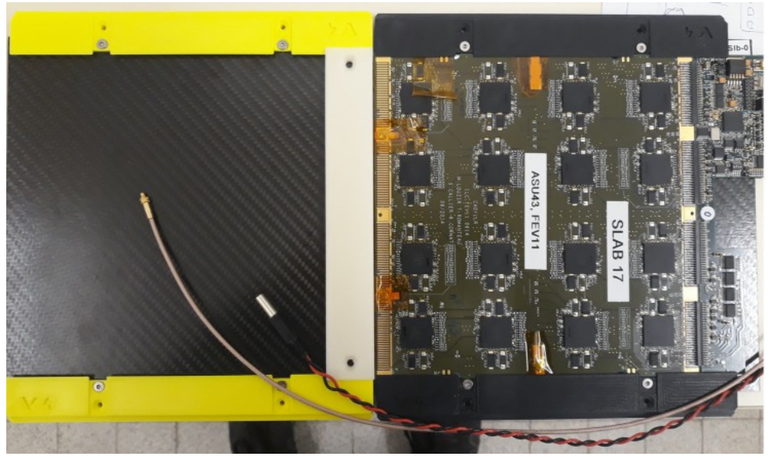




- 15 layers equivalent to 15360 readout cells
  - Currently one layer corresponds to a surface of 18x18cm^2
- Overall size 640x304x246mm^3
  - Commissioned in 2020 and 2021
  - Testbeams (finally) in November 2021, March 2022 and June 2022
  - 1.5 years in waiting loop due to pandemic

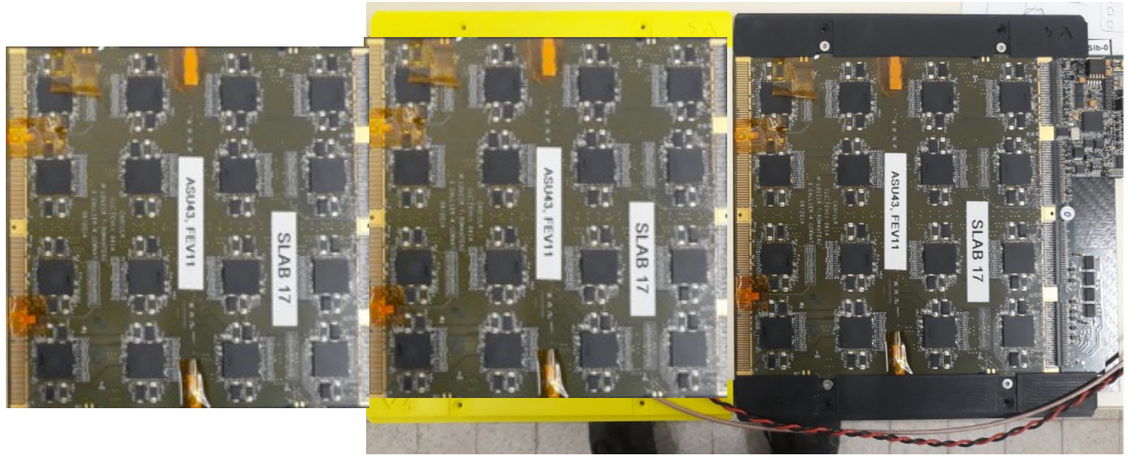
Plans (not only) for LUXE

Current: Tower of 15 18x18cm^2 layers



- The current stack is in principle operational but several layers need revision
- Revision possible with small amount of funding
  => Revised stack should/could be available during 2023

Future: Lateral extension to up to 18x54cm^2 layer, up to 15 layers of this type



- Straightforward continuation of work
  - Collaboration of CALICE SiW Groups
- Requires dedicated funding

CALICE SiW Ecal -> LUXE-E – Partners and Funding Needs

	Pure CALICE		LUXE-min		LUXE-max	
Cost item	Cost/kEUR	Partners	Cost/kEUR	Partners	Cost/kEUR	Partners
Si sensors	available		60	LLR, IJCLab, IFIC, Kyushu, TAU	120	LLR, IJCLab, IFIC, Kyushu, TAU
PCBs	10	LLR, IJCLab	20	LLR, IJCLab	30	LLR, IJCLab
Digital readout	10	IJCLab	10	IJCLab	10	IJCLab
ASICs	available		???	OMEGA	???	OMEGA
Sensor HV	5	IJCLab	10	IJCLab	20	IJCLab
Mechanical structure	available		10	IJCLab	10	IJCLab
Absorber Tungsten	available		15	LLR	30	LLR
Assembly and tools	10	IJCLab, LLR	10	IJCLab, LLR	10	IJCLab, LLR
Sensor gluing	5	IFIC, LPNHE	10	IFIC, LPNHE	15	IFIC, LPNHE
Miscellaneous	10		10		10	
Total	50		155		255	

“Tower” of 15 18x18cm^2 ASUs

+ 2nd “Tower” of 15 18x18cm2 ASUs

+ 3rd “Tower” of 15 18x18cm2 ASUs

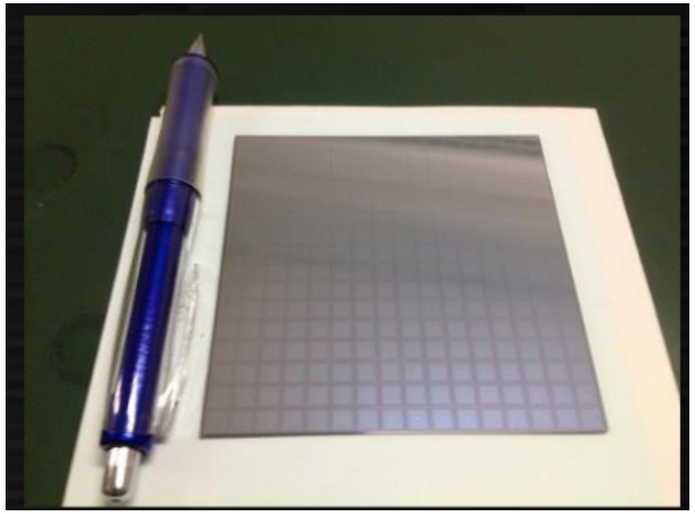
CALICE SiW Ecal -> LUXE-E – Rough Planning

- Revision of current stack until Summer 2023
  - Understanding and solving gluing issues until Xmas 2022
- Extension to LUXE needs starting in Autumn 2023
  - Notably design and construction of definitive mechnanical structure
  - How much extension depends on funding but mech. Structure should be prepared for maximum scenario
- Construction and tests during 2024
  - Data taking in LUXE starting in 2nd half of 2025
- Questions:
  - Common purchase of sensors this autumn (the more we order in one go the cheaper it gets) ?
  - Common purchase of W plates?
  - 3x15 ASUs is maximum scenario, may be possible to live with less (3x12, 3x10?)
  - CALICE SiW ECAL is sufficiently modular
  - Requires dedicated studye

Backup

CALICE – SiW Wafers

Si Wafer



Tab 1 : Summary of the substrate characteristics			
	Min.	Typ.	Max.
N type silicon	-	-	-
Resistivity (kOhms.cm)	4	5	-
Thickness (µm), option T1	310	320	**330**
Thickness (µm), option T2	490	500	**510**
Width (mm), option S1	89.7	89.8	89.9
Width (mm), option S2	44.7	44.8	44.9

Definition of specifications for different wafer types:
Resisitvity: > 5 kΩxcm
Price: Typically 1000-1500 EUR/wafer (when ordering small quantities)

N-type silicon
Crystal Orientation: <100> or <111>

- In addition we require small leakage current:s under full depletion a few nA/pixel
  but for cost reasons we tolerate a certain fraction of pixels with higher leakage currents

- Vendors: OnSemi (CZ) and Russian company for physics prototype (~2003)
  Hamamatsu for technological prototype (since ~2010)
  Contacts with other vendors (e.g. LFoundry) hibernating mainly for funding reasons
  The drop-out of Infineon for the CMS HGCAL was/is bad news