

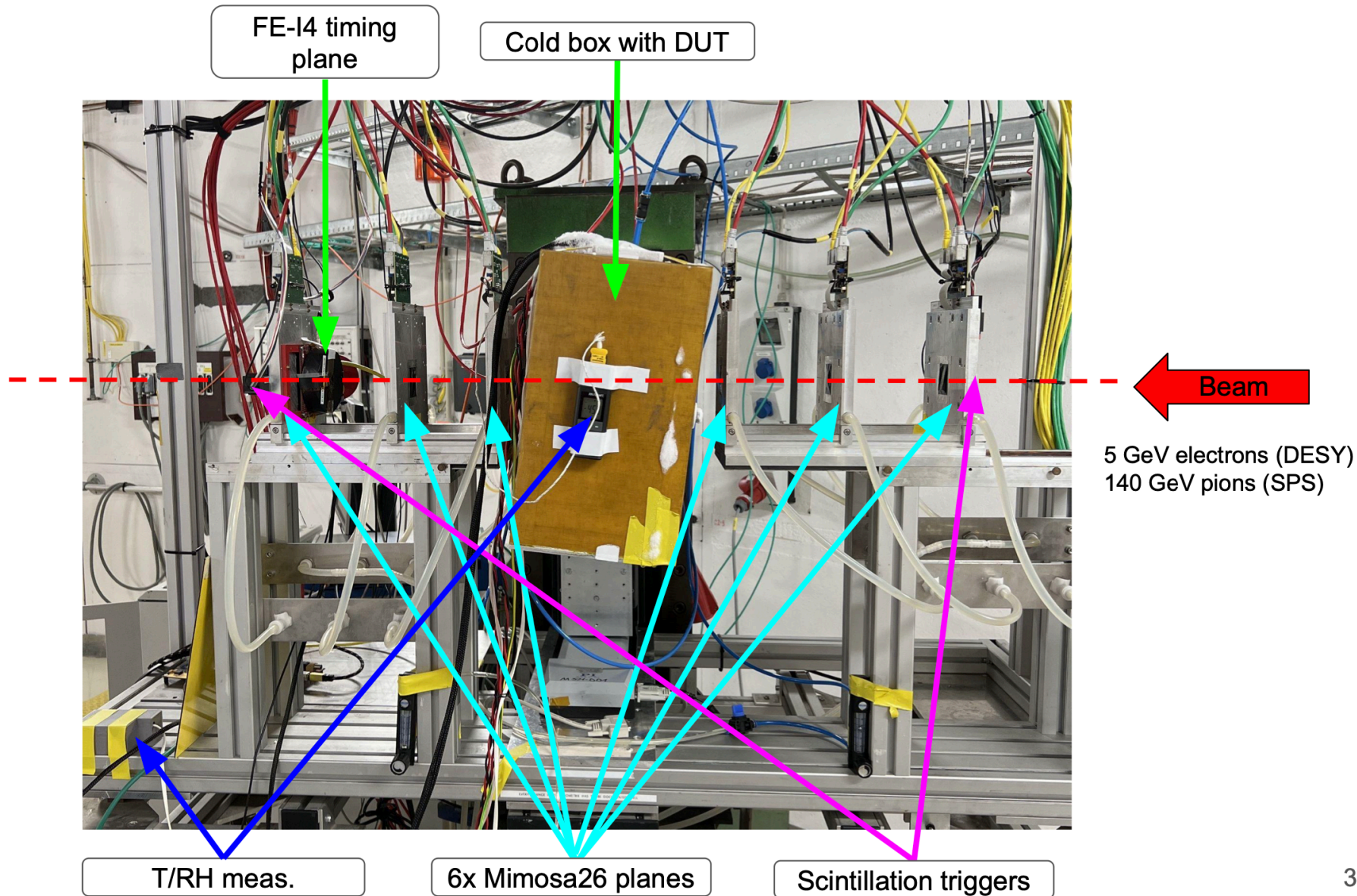
Strips testbeam activities at DESY

21 September 2023

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¹ DESY- Deutsches Elektronen-Synchrotron, GE

Strips testbeam: much more than the picture shows



Setting up a testbeam

- Preparation (focusing on testbeam at DESY, > 2 weeks before testbeam)
 - Equipments provided by DESY: PC, DAQ, FEI4 and its readout system.
 - Other essential equipments: Coldbox and position control system from Prague.
 - **Modules:** reception and testing if time allows.
 - Communications among DESY, testbeam conveners and the 3rd institutes for hot modules.
 - **Person power:** 3 or 4 people from Prague + Yajun (before was Jan-Hendrik) + ???
 - Lisa in June. Judith Schlaat this week. Yvonne next week?
 - A newdle link will be advertised before each testbeam (like this time). If you are able to provide one hand, please fill the newdle when you receive the ad. and we will organise the training for you in advance. Even you are not able to do the shifts as filled in the newdle, it is okay. We can rediscuss during the testbeam. The important thing is to keep you in our hands pool.
- Installation: put everything in their positions, cabling, networking, preparing PC ...
- **DUT test: see module performance in next slides.**
- Full DAQ debugging: TLU+Telescope+ FEI4 + DUT
 - Autotrigger: everyone is responding?
 - With beam: beam position? correlation?
- Data-taking: 7/24h, monitor current, temperature, data quality, refill dry ice, position scan ...

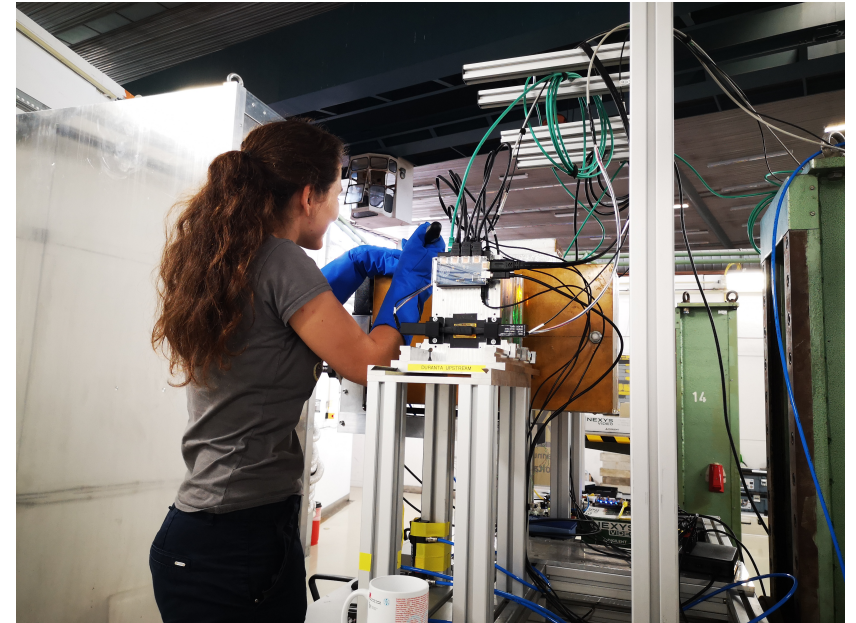
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 - **Modules:** reception and testing if time allows.
 - Communications among DESY, testbeam conveners and the 3rd institutes for hot modules.
 - **Person power:** 3 or 4 people from Prague + Yajun (before was Jan-Hendrik) + ??? (future)
 - One hand from the little G... hand from Y...
 - A ne... provide one hand, please fill the ... you receive the ... and we will organise the training for you in advance.
- Installation: put everything in their positions, cabling, networking, preparing PC ...
- **DUT test: see module performance in next slides.**
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Setting up a testbeam

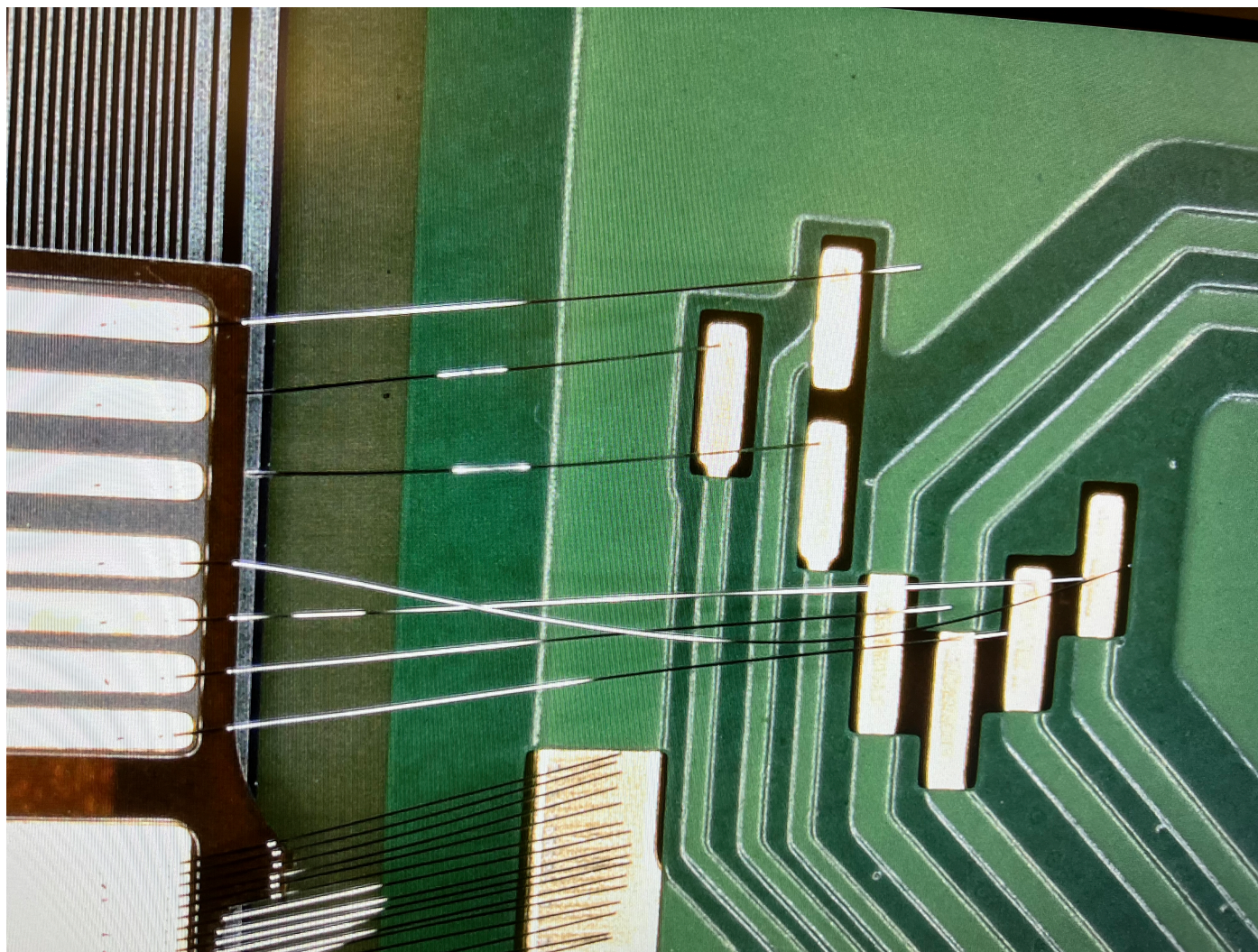


Testbeam area with everything in place.



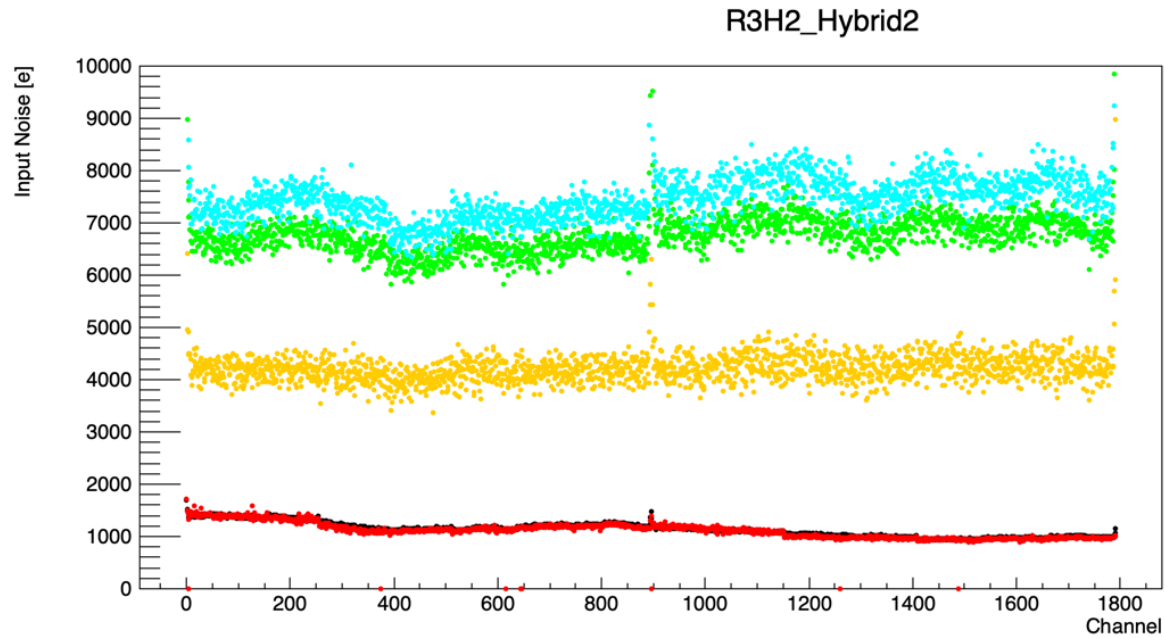
With Judith this morning.

Module performance

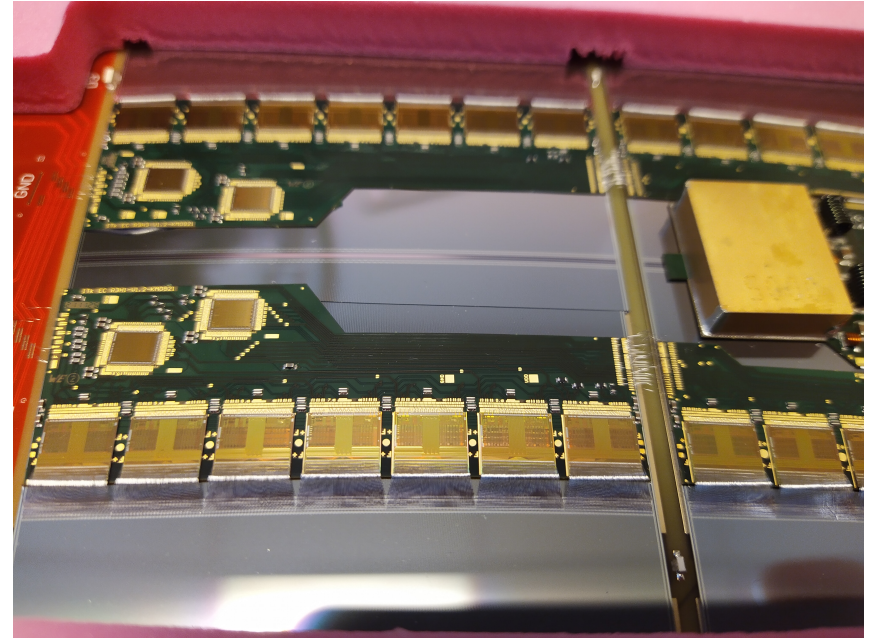


Celine repaired it!

Module performance



- Warm 0V
- Cold 0V
- Cold O(5)V
- Cold O(50)V
- Cold O(100)V



The R3 is broken at CERN and shipped back to Zeuthen for further steps (maybe repair).

Module performance - noise behaviour

- LS True Blue: It was tested twice in testbeam coldbox. In the first time, there was no increase of noise with HV. In the second time, there was increase of noise, but the behaviour is not reproducible in Prague thermal cycling box after the second test. The module was able to do testbeam data-taking.
- LS SE4445: It was observed to have the increase of noise with HV, but still in an acceptable region from 800 to 1600e for HV from 0V to -500V (around 100e more per 100V). The behaviour was confirmed in Prague thermal cycling box. We got a proton-irradiated LS SE module during this testbeam, There is no increase of the noise level with HV observed!
- R3: We were struggling to communicate with this module from the beginning. Only part of the module was reachable. And the noise level for H2 jumps from 1000e to 4000e when the HV is from 0V to -5V. We were NOT able to do testbeam data-taking with it at all. We can not conclude until another irradiated R3 behaviour is confirmed.
- R4: It was observed in March for the first time. However, no test has been done for this module since March. It didn't affect the testbeam data-taking.
 - The module is now at DESY.

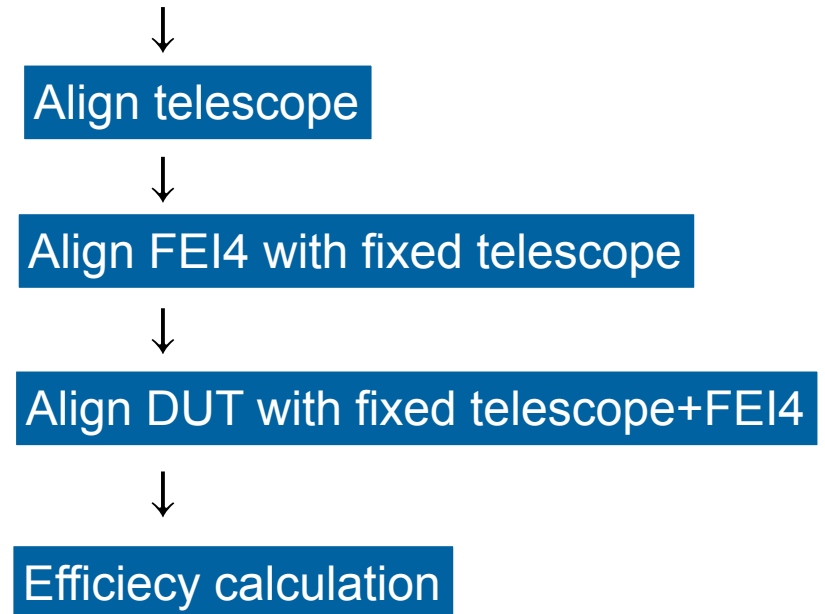
Data reconstruction



Corryvreckan



- DESY had break of contribution here before I joined.
- The official git repo for ITk strips data reconstruction is out-of-date. Each contributor has their own project ...
- The data reconstruction gets delayed.
- We want to have a maintainable workspace for reco.
 - Support from corry experts at DESY: Simon, Lennart ...
 - MR is being discussed for the EC modules (Max is one of the major contributors from the petal side.)
 - Step-by-step studies and A-B-C documentation.
 - Alignment: the procedure is optimised (details to be checked).
 - Efficiency (including edge area, in strip area).
 - Yvonne is joining me.

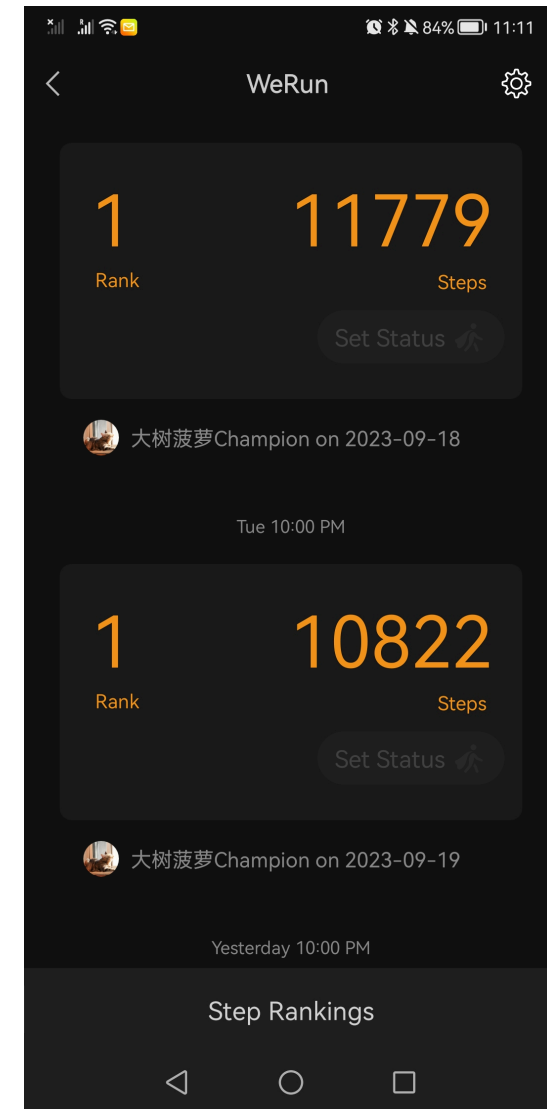


$$\epsilon = \frac{N_{\text{track}}^{\text{FEI4+DUT}}}{N_{\text{track}}^{\text{FEI4}}}$$

Person power

- Yajun (50%, preparation, module testing, DAQ, shifts, reco)
- Yvonne (new, FTE?, focus more on reco and shifts?)
- Jan-Hendrik (super busy)
- Hands are super welcomed for testbeam shifts

Workout with TB



Ready for production ?

- Testbeam is different from other topics, because we can not say: DESY testbeam is ready for production or not. It is more about ITK strips testbeam.
- R3 and another R0 are needed. Sensors are being irradiated. (It mainly depends on what/when we will get from the ITk strip collaboration.)
- More data need to be analysed.

Module	Where	Operating Window	Win. Width	Comments
PPA R0	H1	0.32 - 0.33 fC	0.01 fC	Comparing efficiency from H1 to noise from H0
PPB R1	S30	0.35 - 0.47 fC	0.12 fC	
	S31	0.30 - 0.57 fC	0.27 fC	20deg along the Y-axis
PPB R2	S33	0.37 - 0.57 fC	0.20 fC	
PPB R4	S22	0.40 - 0.56 fC	0.16 fC	Missing 3 streams
PPA R5	S32	0.48 - 0.58 fC	0.10 fC	
	S33	0.36 - 0.58 fC	0.22 fC	
	S33	0.36 - 0.61 fC	0.25 fC	15deg along the X-axis

Backup

Testbeam data overview

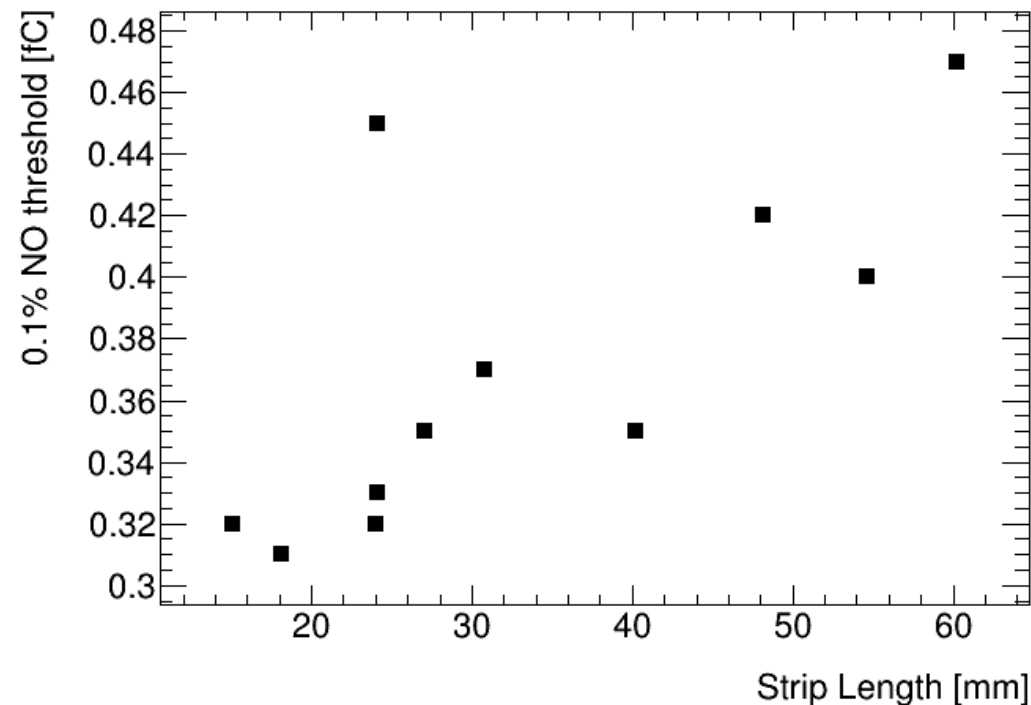
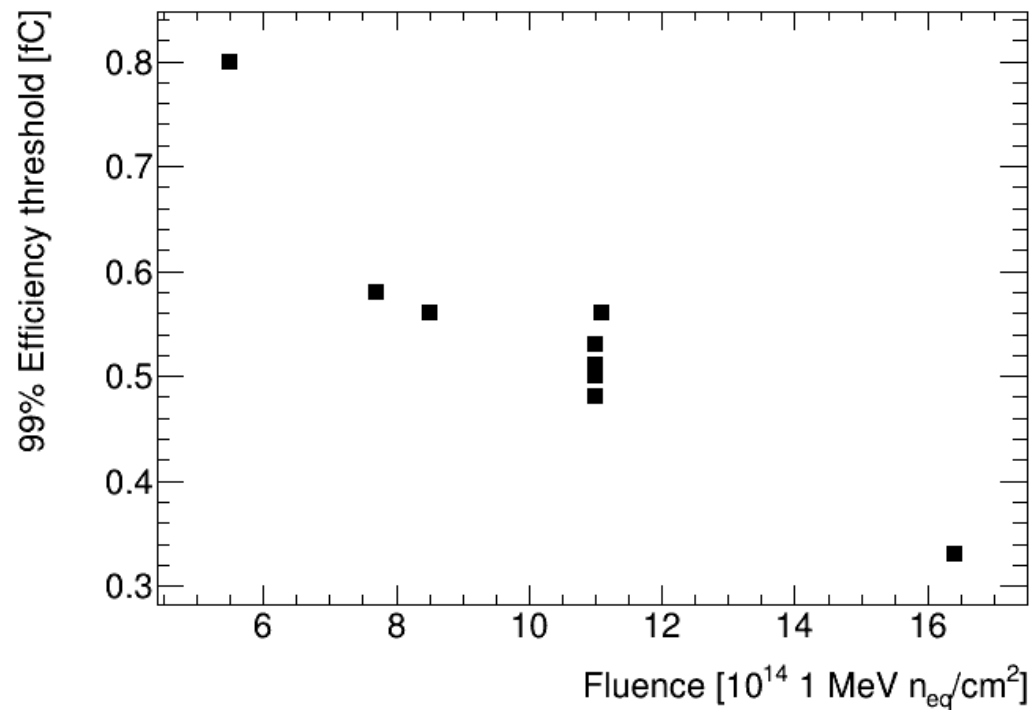
- Testbeam results for ITk strip barrel module PRR: J. Kroll and J. Keller
- PPA EC modules:
 - ✓ R0 (DESY 2021) - sensor ($n, 1.6 \times 10^{15} n_{eq}/cm^2$) + electronics (X-ray, 88 Mrad, Polaris)- narrow operating window when combining efficiency of R0H1 and NO of R0H0
 - ✓ R5 (DESY 2021+2022) - sensor ($n, 7.7 \times 10^{14} n_{eq}/cm^2$, Polaris)
- PPB EC modules:
 - ✓ R1 (DESY + SPS 2022) - sensor ($n, 1.1 \times 10^{15} n_{eq}/cm^2$, Polaris, True Blue) + ASICs (gamma, 8 Mrad)
 - ✓ R2 (DESY 2022) - sensor ($n, 1.1 \times 10^{15} n_{eq}/cm^2$ + gamma, 66 Mrad, Polaris)
 - ⊙ R4 (DESY 2023) - sensor ($n, 8.5 \times 10^{14} n_{eq}/cm^2$ + gamma, 66 Mrad, Polaris)
 - ⊙ R1 (CERN 2023) - module ($p, 1.7 \times 10^{15} n_{eq}/cm^2$, True Blue)
 - R3 (DESY 2023) - sensor ($n, 1.0 \times 10^{15} n_{eq}/cm^2$ + gamma, 66 Mrad, True Blue)
- To be tested:
 - SS, LS, split EC module fully irradiated by protons at FNAL

Analysing data

Preparing new modules

Testbeam reconstruction

Some results



- Analysis ongoing especially for 2023 data.