

Mighty-Tracker

U2PG Meeting

30 October 2026

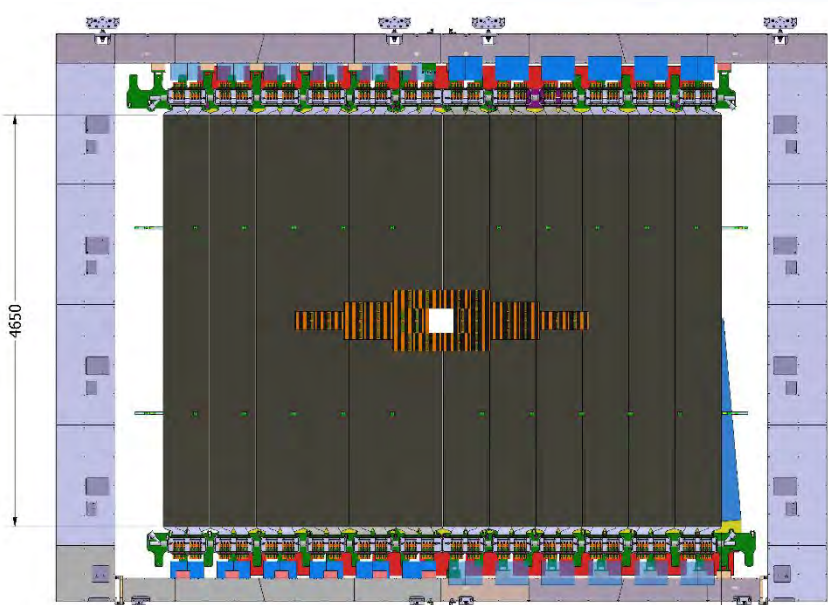
Blake Leverington, Eva Vilella, Pascal Perret

Scoping TDR options

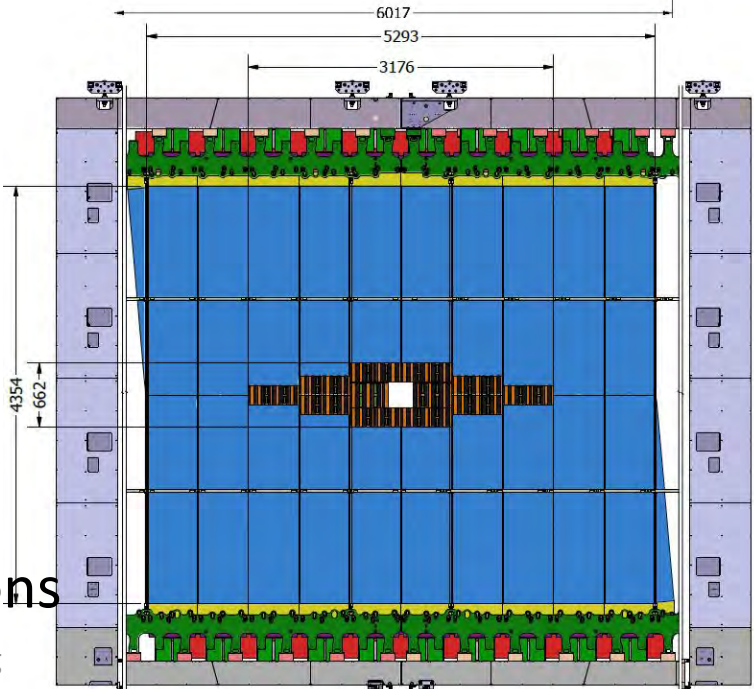
Baseline	Middle	Low
$1.5 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$	$1.0 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$	$1.0 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$
	<u>Mighty-Pixel</u>	
6 planes pixel $\times 2.1 \text{ m}^2$	6 planes pixel $\times 1.3 \text{ m}^2$	6 planes pixel $\times 1.3 \text{ m}^2$
	<u>Mighty-SciFi</u>	
12 planes fibres	12 planes fibres	12 planes fibres
$25.9 \text{ m}^2/\text{plane}$	shorter, $23.7 \text{ m}^2/\text{plane}$	narrower, $18.9 \text{ m}^2/\text{plane}$

	Middle (kCHF)	Low (kCHF)
Mighty-SciFi	21 273	17 388
Mighty-Pixel	11 641	11 061
Mighty-Tracker	32 914	28 449

- No M5 or M4 modules
 - $\eta > 2.0 - 2.1$ (T2), $2.0 - 2.2$ (T3) (x, y) all stations



Middle



Low

Mighty-SciFi: to the low scenario

- No M5 or M4 modules
- Data & control links
 - With **netFELIX** boards: **cheaper** ~12 kCHF (-18%), up to **60 data links/board**
 - Grouping 8 quadrants (1/2 station)
 - Data links: 58 netFELIX + 10% spares
 - ECS links: 20 netFELIX + 10% spares
 - Cost saving: up to ~750 kCHF
 - Good, but not enough ...

All numbers are preliminary, being discussed internally

Mighty-SciFi: towards a lower cost ... and performances...

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- Operating at 0.8 does not allow for cost savings for SciFi by itself.
- Scenario A
- **Do not use LN2:** SiPM cooling set point at higher temperature $\Rightarrow$ **higher noise**
 - On going studies by EN-CV to use for SciFi air chillers MIRAI X Cryo with water cool condenser (MIRAI Intex, czech republic) @ -60/-70°C.
 - We need a lower temperature, but according to the specs -100/-110°C (~-140°C ?) should be reachable.
 - To be validated
 - Air chillers MIRAI X Cryo: can run efficiently at very low temperature.
 - NOVEC 7100: can operate at these low temperatures & its use is permitted (PFAS ban in EU).
 - Cost saving: ~2.5 MCHF $\Rightarrow$ **~14 MCHF**
 - *To be validated: enough light to keep 4 fibre layers per mat*
 - **This option could be reversed** if we receive additional funding or CERN could pay for it to improve our environmental impact.

Mighty-SciFi: towards a lower cost ... and performances...

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- To save more:
- **Scenarios Bx (in addition to A)**
 - Consider new tooling costs as part of lab equipment or R&D cost, when possible
 - E.g. fibre winding machines, cryo lab plants, leak testers, tooling for modules, etc:
 - Reuse part of current SciFi
 - Infrastructure: cable chains, FE LV PS, water cooling, cables and pipes, large fraction of the CPS system.
 - Do not replace the bridge; only modify to reduce sagging, prevent buckling: **Access?**
 - **Reuse C-Frames**
 - Some modifications/ adjustments will be necessary.
 - An extra year could be needed, before LS4, to do the full assembly.
 - The C-Frames on side C must be removed last and are the first to be put back in place.
 - **Additional work/persons required during LS4.**
 - Access limited/difficult in the cavern (C-side).
 - **Commissioning period reduced: final pre-commissioning will only begin after LS4.**
 - **Reuse outer modules (not discussed here): No compatible with a 2-year LS4 alone.**

Mighty-SciFi: towards a lower cost ... and performances...

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- To save more:

- **Scenarios Bx (in addition to A)**

- Consider new tooling costs a part of the project
 - E.g. fibre winding machine to produce cables
- Reuse part of current SciFi
 - Infrastructure: cable chain, LV P, and pipework
- Do not replace the bridge; only the bridge deck

- **Reuse C-Frames**

- Some modifications/ adjustments to the structure
 - An extra year could be needed before the first assembly
 - The C-Frames on side of the structure must be replaced
 - **Additional work/persons needed**
 - Access limited/difficult in some areas
 - **Commissioning period reduced: final pre-commissioning will only be done after the first assembly**
- **Reuse outer modules (not discussed here): No compatible with a 2-year LS4 alone.**

Cost saving:

~1.6 MCHF

~3 MCHF

Risks:

- Parts damaged or not reusable
- Additional person power needed
- Reduced commissioning period
- Access limited
- Extra time needed

Mighty-Pixel: towards a lower cost

... and performances...

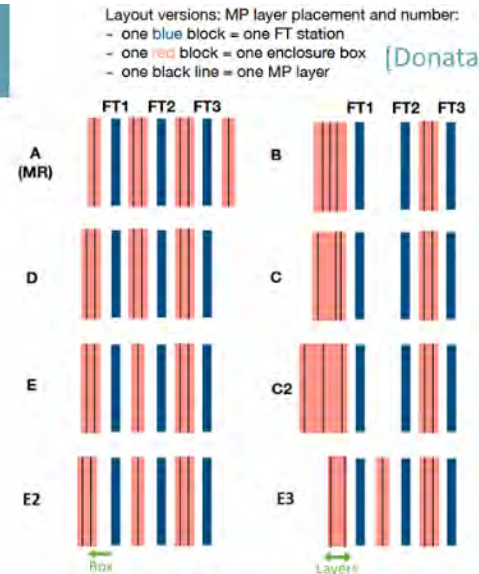
- A lot of work has been done during the summer by [Christoph](#), [Claudia](#), Donata et al. during the summer (in conjunction with the U2 Re-optimization task force) to study alternative geometries (Thank you!)

All numbers are preliminary, being discussed internally

Efficiencies with alternative geometries

- Alternative geometries for the MP:
 - Reduced MP area to 1.3 m², stave geometry
 - 6 layers: Layout A, D
 - 5 layers: Layout B, C, E, E2, E3
 - Layout C2 not studied
- Results for 100 events $\hat{=}$ $\mathcal{O}(10^4)$ tracks
- 3 hit χ^2 fit
- Efficiencies of Long tracks being reconstructed as T-tracks
 $\Rightarrow$ similar for layout E variants

Claudia



- Evaluation of alternative geometries (A–E).
 - From 6 layers $\rightarrow$ 5 layers
- Impact on tracking efficiency, ghost rate, and momentum resolution.
- Preparation for future central productions and geometry updates.
- Geometries with 5 layers (B, C, E) perform similarly to the nominal layout.
- Layout E stands out as the most promising option.

5-layer MP tracking is viable, with only a modest efficiency loss compared to 6 layers.

- Less/loss of redundancy in case of module failure. Cost saving: ~ 1.8 MCHF $\Rightarrow \sim 9$ MCHF

Cf Christoph

Mighty-Pixel: towards a lower cost

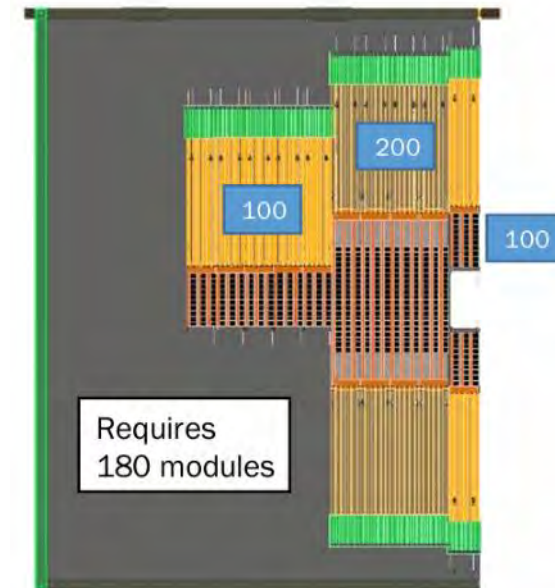
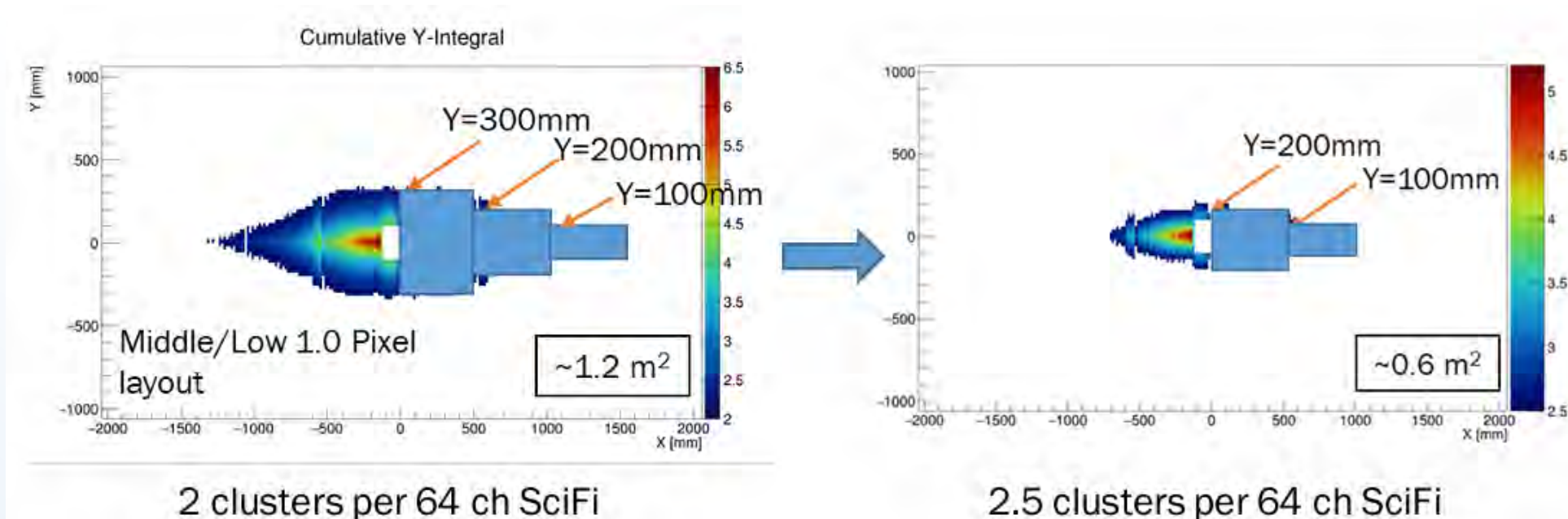
- **0.8 ($\times 10^{34} \text{cm}^{-2}\text{s}^{-1}$) at point 8**

... and performances...

- Mighty-Pixel: Pixel area can be reduced
 - Evaluation of SciFi occupancy under different lighting scenarios and determination of the pixel area required for U2, without causing saturation and while maintaining the tracking performance achieved by [Blake](#)
 - Minimal configuration: $\sim 0.7 \text{ m}^2$ at 0.8×10^{34} pushes SciFi to its limits;
 - **usable only if tracking performance stays robust (tbc).**
- Mighty-SciFi: pushed to its limits; no cost saving

All numbers are preliminary; being discussed internally

Cf [Blake](#)



Mighty-Pixel: towards a lower cost

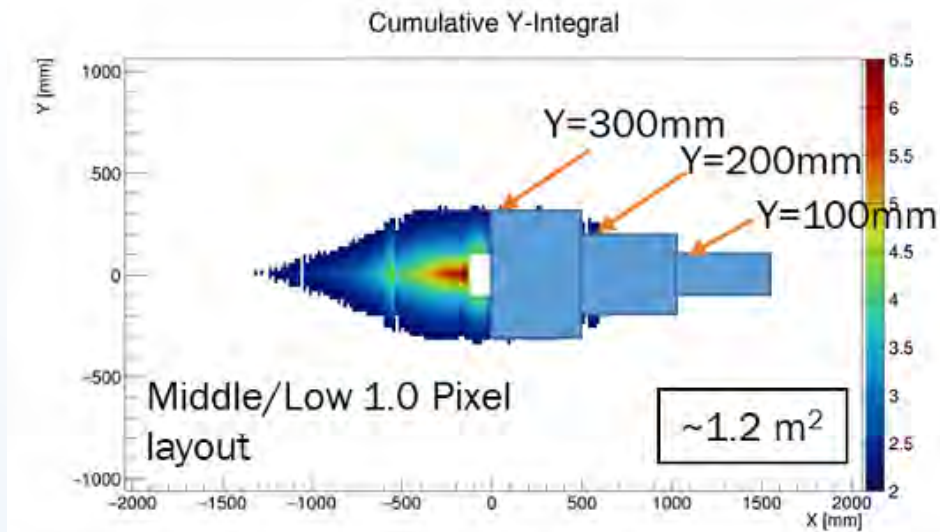
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... and performances...

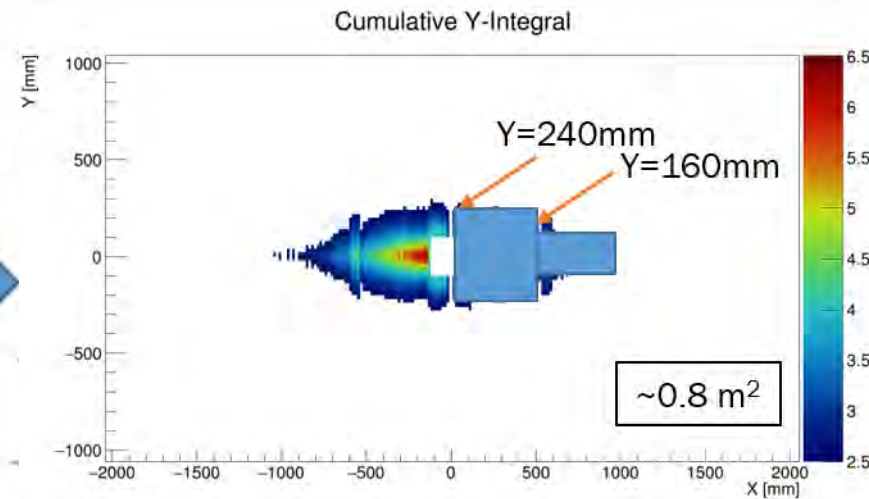
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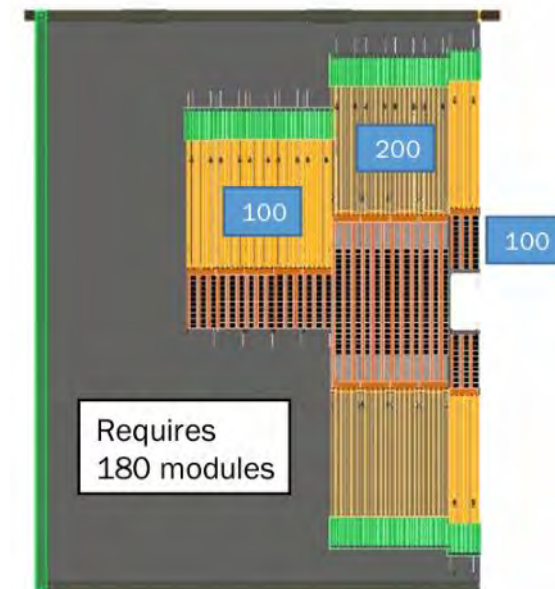
Cf [Blake](#)



2 clusters per 64 ch SciFi

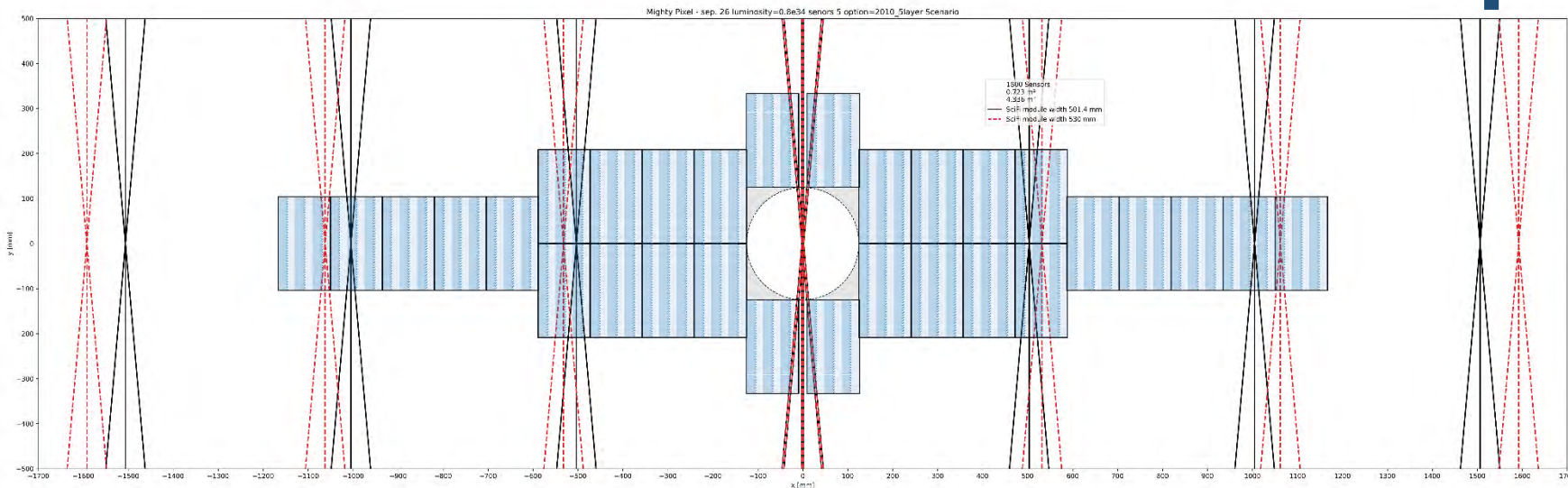


2 clusters per 64ch could be safer



Mighty-Pixel: towards a lower cost ... and performances...

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2010_180

9000 sensors

180 modules/ ½ layer

0.72 m² per layer

5 layers

3.6 m² in total

~7 MCHF

2416

10560 sensors

264 modules / ½ layer

0.85 m² per layer

5 layers

4.2 m² in total

~8MCHF

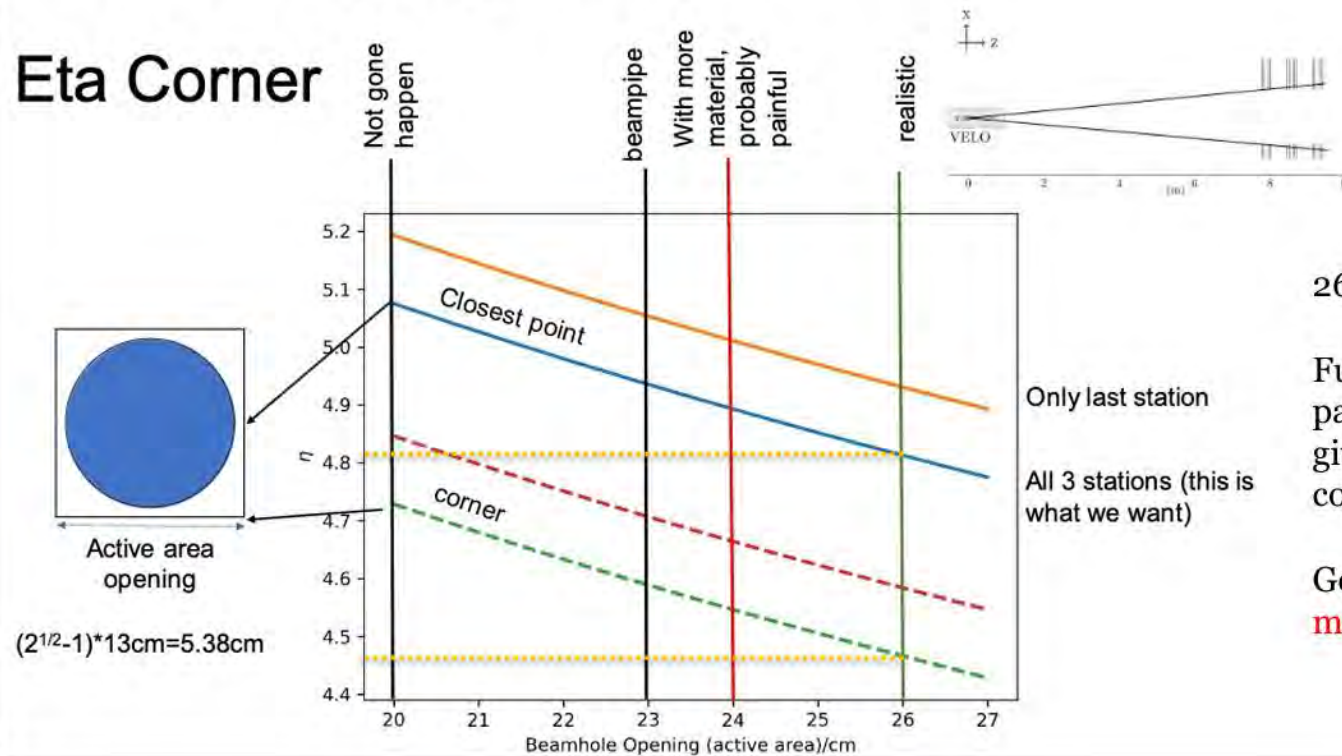
If additional funding comes: possibility to enlarge the pixel area: + 140 modules (~1.2 m² per layer)

Mighty-Pixel: η acceptance

Klaas Padeken, Pascal Perret

The Mighty Tracker

Eta Corner



Cf [Mary](#)

26cm scenario most likely

Full coverage up to **4.4** with partial coverage up to **4.8** given from mechanical constraints

Going up to 4.9 would be **mechanically challenging**

Mary Richardson-Slipper

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Mighty-Tracker: towards a lower cost

- Scenario cost saving (summary)

... and performance

All numbers are preliminary, being discussed internally

Mighty-Pixel	Estimated Cost (MCHF)	Saving (%)	
Scoping Document Low 1.0	10.8	2%	netFELIX boards
Low 1.0 / 5-layers / 302010	~9	19%	Less/loss of redundancy
Lower 0.8 / 5-layer / 2416	~8	28%	
Lower 0.8 / 5-layer / 2010-180	~7	37%	Tracking performances to be validated
Mighty-SciFi	Estimated Cost (MCHF)	Saving (%)	
Scoping Document Low 1.0	16.6	5%	netFELIX boards
Scenario A: no LN2 cooling	~14	19%	Higher noise
Scenario Bx: A+ reuse parts of SciFi	~12.5 – 11	28-37%	Commissioning period reduced, extra FT

- You get what you pay for.**
- The fall in the number of human resources needs to be addressed.**

Backup
