A possible method for adding services load to the EIC simulations

- Services (power, signal, configuration, cooling, etc.) are expected to be a dominant part of the material in the large acceptance of the EIC central detector region.

- Unlike the support pieces, which need to change according to the detector configuration and would be difficult to parametrize, the services load can be scaled with reasonable accuracy to the silicon surface area.

- The parameters of this then method can then be adjusted to different sensor technologies showing performance differences from the services load standpoint.

- The physical volumes required at the end of staves/discs can also be added to the simulation models to allow for more realistic geometries.

Example: Services for existing technology (ALPIDE sensor) in ALICE ITS upgrade services for outer half-barrel layers

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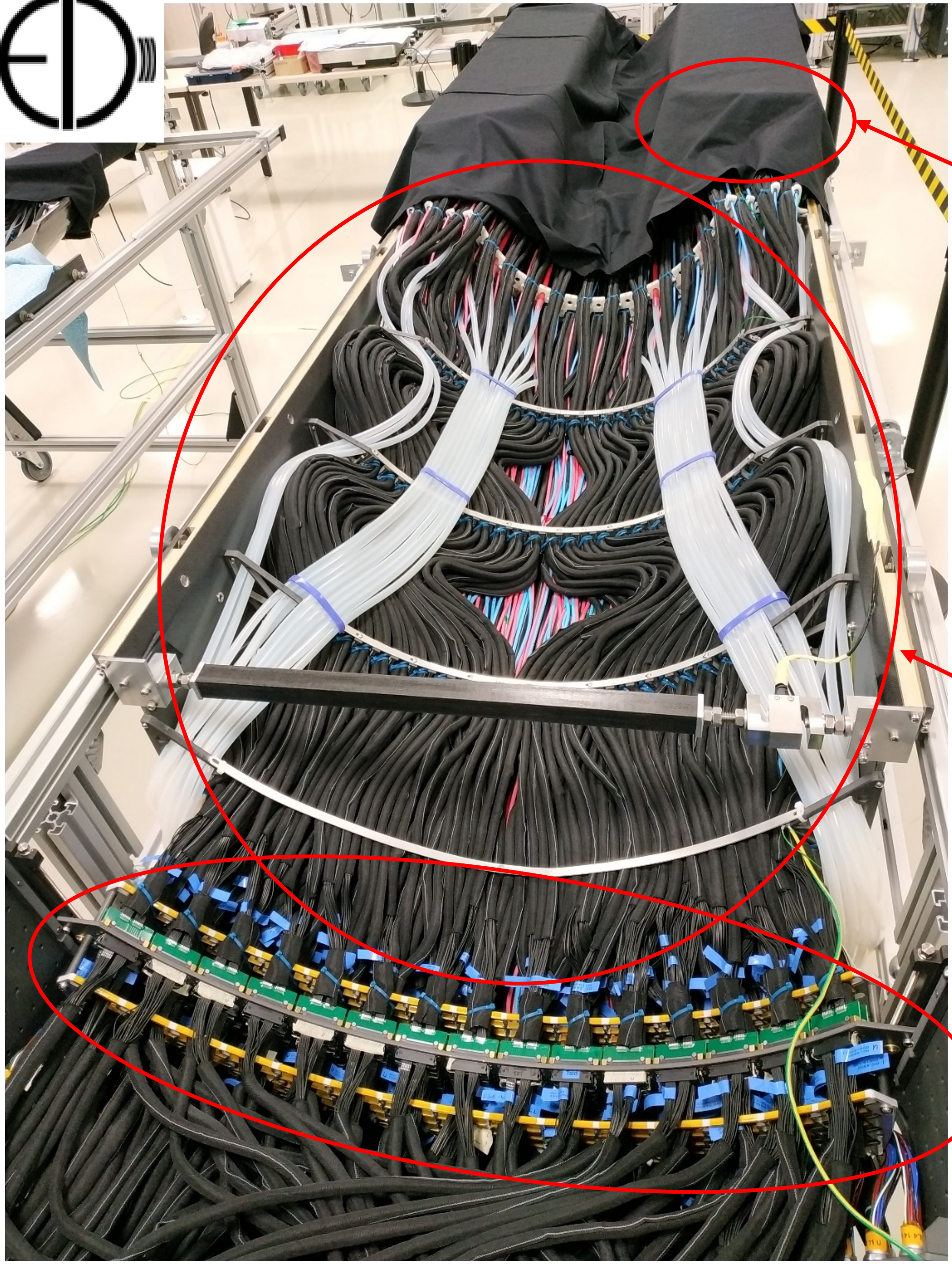
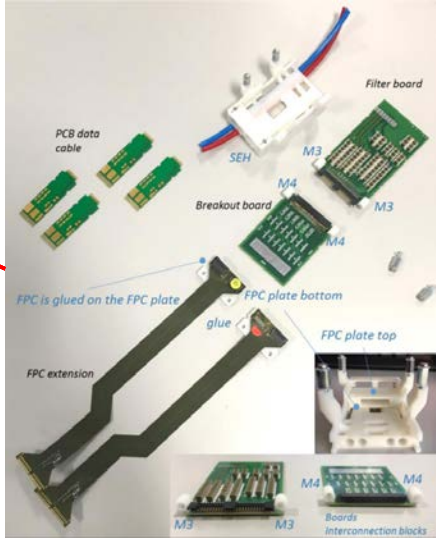


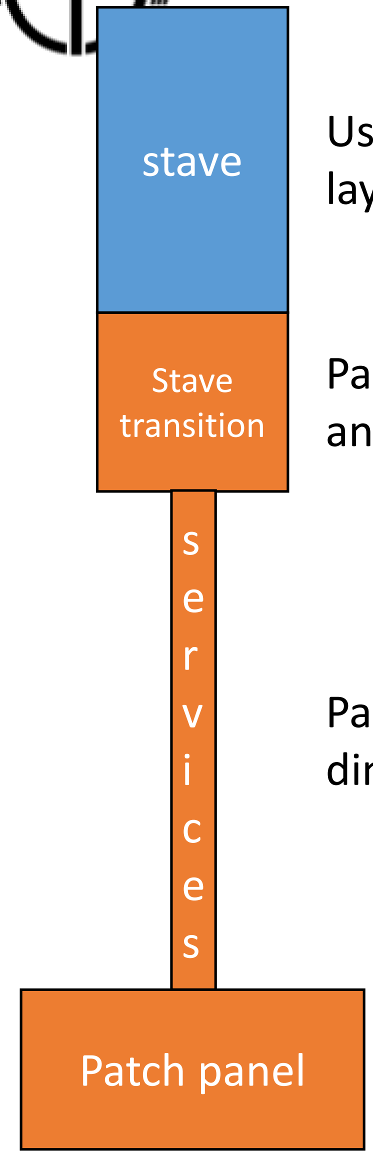


Material at end of each stave

Power, signal, cooling

Patch panel
(usually required for all detectors)

Approach to separate pieces of parameterized services



stave: Usually with the average radiation length of the layer implemented in the stave model

→ Easiest attribute to work with is surface area

Stave transition: Parametrized as a block of particular dimensions and averaged X/X0

services: Parametrized as a square tube with particular dimensions and averaged X/X0

Patch panel: Parametrized as a block of particular dimensions and averaged X/X0 (usually arranged to be out of the acceptance)

→ These blocks should be represented as a function of silicon surface area in stave with different values based on technology/configuration

Approach to separate pieces of parameterized services

Method –

- Sum the material composition and homogenize to average X/X0 for given mechanical cross section.
- Check that the specified sizes make mechanical sense and scale appropriately. This allows for reasonable mechanical integration in simulation.

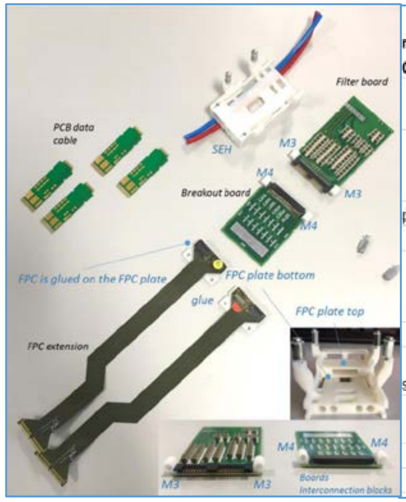
Example:

ITS ALPIDE staves (layers 3-6)

Stave transition

Parametrized as a block of particular dimensions and averaged X/X0

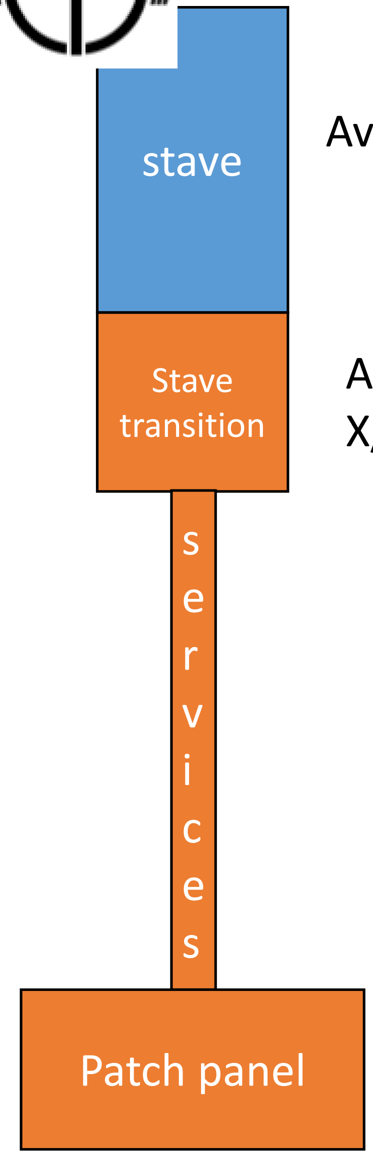
Excel Spreadsheet



material associated with each module for ML, OL											services/module material total (cm^3)
	cross section (cm^2)	material	length (cm)	material radiation length (g*cm^-2)	density (g/cm^3)	comment		total material (cm^3)			
power filter board PCB	0.42	FR4	10	30.17	1.8			4.2		FR4	4.2
copper	0.12	Cu	10					0.12		Cu	0.42
capacitors	0.08	chip ceramic caps	15.75	11.16	6.02	2.5 x 2.5 x 3.2 mm each x 63 capacitors		1.26		Chip ceramic caps	1.26
										kapton	3
stave extenstion pieces						kapton + Cu + connector				PEEK	10
kapton	0.1	kapton	30	40.58	1.42			3		polyethylene	44
Cu	0.01	Cu	30	12.86	8.96			0.3		water	56
Stave Extenstion Holders	1	PEEK	10	39.6	1.32	PEEK		10			

- Combine to get averaged radiation length
- Combine with known physical size and scale radiation length to new volume

Approach to separate pieces of parameterized services



<u>If we use ALPIDE (existing technology) we can estimate services as below</u>

Average of 0.7-0.8 % X/X0 in simulation

Area of (63 cm^2) of sensor requires 3 cm^3 material with an X/X0 of 0.0383 per traversed cm.

This should also work for discs

Area of (63 cm^2) of sensor requires a cross section of 1 cm^2 with a X/X0 of 0.007861 per traversed cm of length.

Area of (63 cm^2) of sensor requires a block of 2cm x 1 cm x 1 cm with 0.03423 X/X0 per traversed cm.

Some Comments

- The starting point of this exercise is an ALPIDE like sensor as this is what is often used in the simulations.
- This approach allows us to integrate the radiation length and the services volume and to add then to the simulation.
- In the ITS upgrade, we did not make heroic measures to minimize the services mass as it was mostly out of the tracking acceptance. This will be less true for the EIC.
- This method may be used as a starting point to assess the effect on the physics of using an ALICE ITS services load.
- If this is found to unacceptably affect the physics (I suspect it will) we can then attempt to ameliorate this by:
  - moving to an ITS3 type sensor that has inherently lower service requirements
  - targeted R&D to minimize services
  - ideally we do both.
- This estimate is also valid for discs. I will work on parameterizations for the inner vertex layers and an estimate for what can be expected for an ITS3 type sensor.