eRD111 Task:
Forming modules from stitched sensors

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Forming modules from stitched sensors

The process of taking sensor reticles (even stitched sensor reticles) and integrating them into building block units that are compatible with detector size requirements, electrically and mechanically integrated units, and can be joined together to propagate power and signal lines is a significant effort. In general, a module will consist of a set of sensors mechanically and electrically joined on a flexible PCB with careful silicon positioning and reference markers for further assembly and survey. For large area applications, this work needs to be automated such that the level of personnel effort can be managed. In ALICE ITS-2 upgrade this was accomplished with custom high precision pick-and-place machinery and extensive supply chain management system. The sizes and compositions of the module type(s) together with the reticle size (and number stitched together) dictate a set of possible configurations that need to be evaluated with respect to suitability for forming staves and discs out of these module type(s).

Adapt ITS3 to EIC Vertex – Scale sensor to module

Milestones:

- Adapt ITS3 to EIC radii and optimize bending and interconnections
- Study how to configure sensors into staves and discs based on reticle sizes on a 12” wafer.

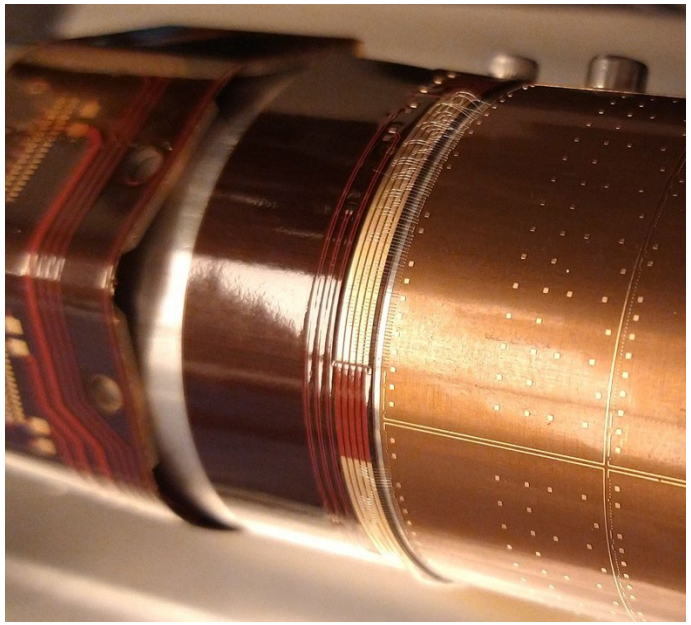
Ongoing activities:

- Size options for ITS3 and EIC-specific sensors studied by Peter in: https://indico.bnl.gov/event/15486/contributions/62590/attachments/40656/67919/EIC-Sensors-Jones.pdf
- Tiling options for disks studied by Ernst in: https://indico.bnl.gov/event/15486/contributions/62591/attachments/40661/67928/20220425%20-%20EIC%20Silicon%20Consortium%20mtg.pdf
- Bending and Wire-bonding on curved silicon being studied within ITS3 on lower and more challenging radii.
  - Large-area sensors bending being mastered at INFN Bari
  - Wire-bonding on curved silicon already well exercised at INFN Bari and Trieste

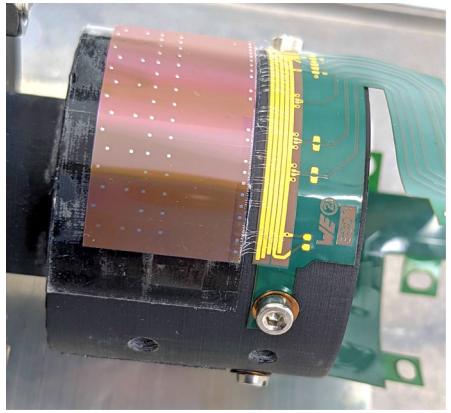
Adapt ITS3 to EIC Vertex – Scale sensor to module/2

- Current developments within ITS3

https://indico.cern.ch/event/797047/contributions/4455208/attachments/2308662/3928179/PSD12_Colella_ITS3.pdf



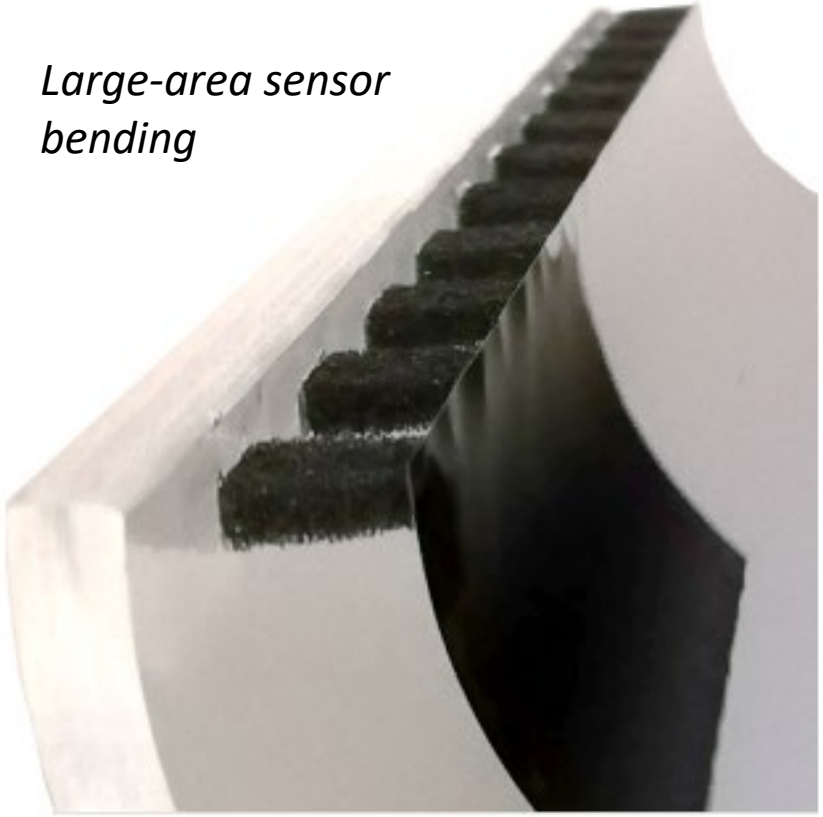
Dummy large-area sensor wire-bonding



Bent 50-µm ALPIDE wire-bonding

https://indico.cern.ch/event/1044975/contributions/4663684/attachments/2395104/4095066/20220222ITS3_vci.pdf

Large-area sensor bending



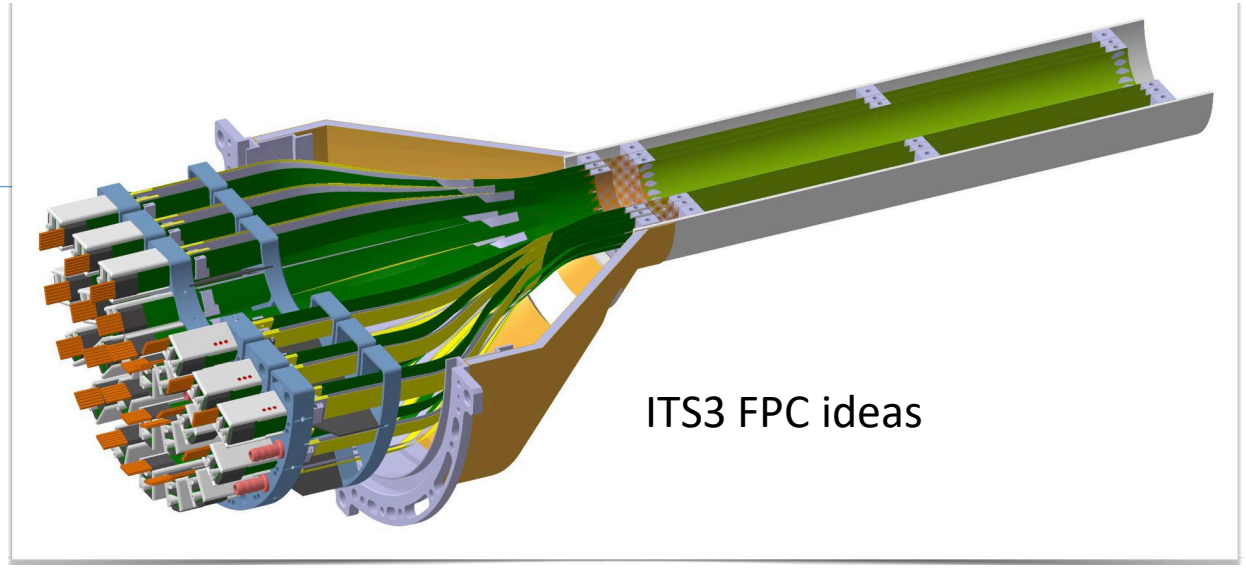
- Next step: try on EIC Vertex radii and sizes once they are defined

Modules for staves and disks

- **Milestone**: Integrate sensors with FPC into a module
- **Ongoing activities:**
  - Preliminary considerations presented by Leo in: https://indico.bnl.gov/event/13870/contributions/57478/attachments/38502/63492/2021_11_17_pathway_its3_to_large_area_discussion.pptx
  - Collecting the requirements on the Flex PCB to integrate with sensors:
    - Conductor: aluminum; copper to be evaluated for material budget and if multi-layer FPC is needed
    - Max bandwidth on ITS3 sensor: 40 Gb/s over 8 x 5 Gb/s transmitters per 18mm-wide unit
    - Power domains: Analog, Digital, High-speed data
    - Power density: 20-40mW/cm2 on matrix
  - Considering alternative ways to embed the chips in modular structure

Integration sensor/FPC

- Vertexing layers leveraging ITS2/ITS3 ideas



ITS3 FPC ideas

https://indico.cern.ch/event/276611/contributions/622863/attachments/502969/694527/dulinski_FEE-2014.pdf

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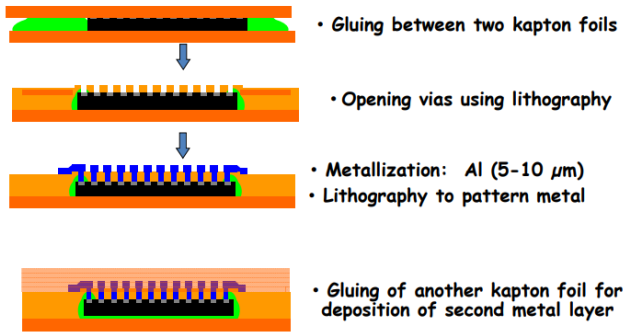
Novel approach for ultra thin sensor packaging:

use of a "standard" flex PCB process for chip embedding in plastic foils

The goal: < 0.1 % of X_0 per sensor layer (large area ladder, all included)

Embedding principle



No wire bonding, excellent mechanical chip protection

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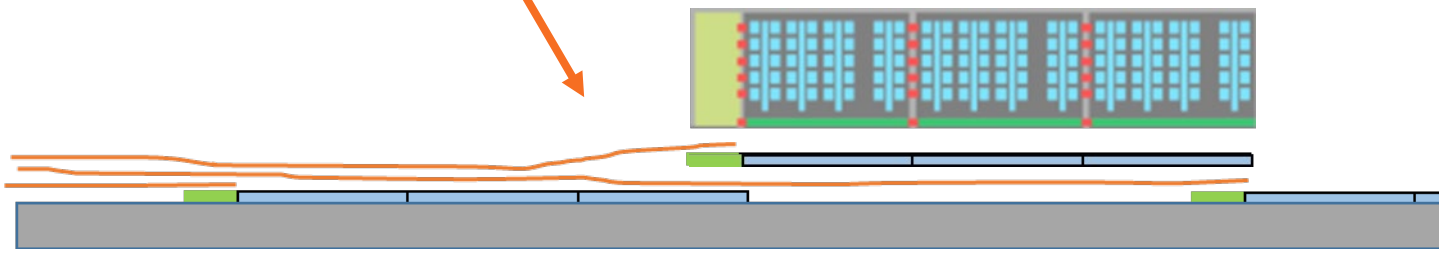
Sensor embedding in kapton foil

- Staves/disks



Traditional module structure: support+FPC+sensor

Other milestones

- The need for **tooling to assemble and test sensors** in module form will be investigated (this was a very significant part of the ALICE development for ITS2).
- This will inevitably be a survey effort and will need to be further optimized once yield figures are known. Nevertheless this work is needed to form requirements for the large-area sensor design in a multiple sensor => **single readout chaining**. This will inform the functionality needed to be built into the forked sensor design.
- A **written report** covering this will be delivered.