

# EICSC Work Package Proposal

We are developing two detector concepts:

1. ITS3 like for the vertexing layers.
2. EIC variant for the staves and discs.

We will need to develop the capabilities to bring both detector concepts and the associated infrastructure to completion.

We need a work package structure that covers this full range of tasks.

The goal of the EICSC is to develop a complete silicon tracking system solution for EIC detector collaborations based on the development of a new sensor derived from the CERN ALICE ITS-3 silicon project. The EIC SC welcomes institutions from different emerging collaborations interested in working on the proposed sensor solution for their specific EIC detector implementation.



# Organization of effort for ITS3

## **ITS3-WP1: Physics studies, Simulation and Reconstruction**

- Physics performance studies
- Detector functional requirements
- Detector model and simulation
- Reconstruction

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## **ITS3-WP2: Pixel chip design**

- Test structures and validation of the technology
- Optimization of the pixel layout
- Large area building block prototypes
- Full scale prototypes
- Final chip

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## **ITS3-WP3: Pixel chip characterization**

- Development of hardware and software for the pixel chip characterization
- Laboratory, Beam and Radiation tests
- Pixel chip device simulation

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# Organization of effort for ITS3



## **ITS3-WP4: Pixel sensor thinning, bending and interconnection**

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- Tests with existing material (ALPIDE wafers)
- Tests with 300 mm dummy wafers
- Test with full-scale prototypes
- Mechanical, electrical and functional validation of the procedures

## **ITS3-WP5: Mechanics and cooling**

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- Selection and characterization of carbon materials (structural and thermal properties)
- Development and production of support structures
- Development, production and validation of the Engineering Module based on dummy chips
- Development, production and validation of the Qualification Module based on prototype chips
- Production of the Final Module based on final chips

## **An EIC effort will require additional effort in R&D**

Sensor development for staves and discs

Discs based on ITS3 sensors

Long staves based on ITS3 sensors

Support and cooling for discs and staves

+?

# Proposal of work packages for EICSC

The overall work package structure for the ITS3 is well thought out and can be mostly adapted with a few modifications. Propose that we adopt the ITS3 work package structure but add in the additional tasks that are needed.

**So – EIC WPs contain all of the tasks in the ITS-3 WPs but with the added tasks shown below.**

**This will lead to EIC WPs joining the ITS-3 existing WPs now and moving forward with the EIC specific tasks as the timing becomes relevant.**

## **EICSC-WP2: Sensor design**

- Full participation and engagement with the ITS-3 WP2 for the design of the vertexing layers sensor.
- Adaptation and forward planning for the fork off of the ITS-3 sensor to give a sensor with good yield characteristics that is optimized for use on discs and staves.
- Development of both sensor configuration for EIC use. A stitched sensor design that meets the vertex detector requirements and a smaller stitched design that meets the yield and other requirements for stave and disc use.
- Engineering run designs and submissions.

## **EICSC-WP3: Pixel chip characterization**

- Full participation and engagement with the ITS-3 WP3
- Adaptation and/or development of hardware and software for characterization of vertexing and barrel/disc sensor types.
- Laboratory, Beam and Radiation tests.
- Pixel chip device simulation.



# Organization of effort for ITS3

## **EICSC-WP4: Pixel sensor thinning, bending and interconnection**

- Full participation and engagement with the ITS3 WP4
- Bending/interconnection optimization for EIC vertex radii/dimensions
- Development of infrastructure for bent mid-size EIC prototype functional test
- Development of interconnect for power, signal, control for disc and stave sensor modules.
- Tests with engineering run EIC full scale prototype sensors
- Mechanical, electrical and functional validation of the procedures for vertexing and stave/disc sensors and modules.

## **EIC-WP5: Mechanics and cooling**

- Full participation and engagement with the ITS3 WP5
- Selection and characterization of carbon materials (structural and thermal properties)
- Development and production of support structures
- Development, production and validation of the Engineering Module based on dummy chips (vertexing and stave/disc)
- Development, production and validation of the Qualification Module based on prototype chips (vertexing and stave/disc)
- Production of the Final Module based on final chips (vertexing and stave/disc)
- Development of cooling (air for vertexing layers and water/? for staves/discs)
- Development of services, routing, machine/detector interface.

## Plans – (strongly tied to ITS-3 schedule)

### **2021 –**

- Testing and characterization of MLR1
- Sensor design for MLR2 or ER
- R&D into powering, stave/disc construction, cooling, overall infrastructure
- MLR2 submission
- Thinning, bending and sensor interconnection

### **2022 -**

- Testing and characterization of MLR2
- Sensor design for ER
- R&D + prototyping into powering, stave/disc construction, cooling, overall infrastructure
- ER submission

### **2023 -**

- Testing and characterization of ITS3 ER and assessment of yield
- Assessment and planning for EIC sensor fork of ITS3 design
- Fork off sensor design and work on EIC variant for staves and discs (may move to next year depending on results)
- Detailed prototyping into powering, stave/disc construction, cooling, overall infrastructure
- ER submission for EIC variant sensor for staves and discs (may move to next year depending on results)
- Investigation of adaptation of ITS3 design for use in EIC inner layers (different radii, # layers, services from both ends to meet length requirements, etc.

### **2024 –**

- Testing and characterization of EIC ER and assessment of yield
- Si design for EIC ER2
- Detailed prototyping into powering, stave/disc construction, cooling, overall infrastructure using EIC ER1 prototypes.
- ER2 submission for EIC variant sensor for staves and discs
- adaptation of ITS3 design for use in EIC inner layers and integration of design into ER2 if necessary.

We are developing two detector concepts:

1. ITS3 like for the vertexing layers.
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We will need to develop the capabilities to bring both detector concepts and the associated infrastructure to completion.

## Expanded task list for 2021 (applies to following years as well)

These tasks complement and are in addition to robust participation in the ITS3 work packages to prepare for the EIC vertexing layers design.

### **2021**

#### Testing and characterization of MLR1 – EICSC WP3

- design of testing system that extends into the testing of the next submissions. Beam testing, Latch-up testing, SEU testing, radiation tolerance testing (kRAD, NIEL), firmware, software, mechanical carriers, alignment stations, analysis, etc. This work is starting in ITS3, we can/should join this effort.

#### Sensor design for MLR2 or ER – EICSC WP2

- Inclusion of other silicon design sites into the design process (in progress), Assessment of the testing results and incorporation into the new designs, significant digital design (in pixel logic, readout structures and architecture), design for stitching, significantly more complex structures and pixel layout studies, design for yield, etc.

#### R&D into powering, stave/disc construction, cooling, overall infrastructure – EICSC WP5

- Take up DC-DC converter and serial powering R&D, studies of stave and disc design, cooling studies (air for inner layers, liquid? For outer layers and discs), investigation of on detector data multiplexing and implications for single point failure and redundancy studies, initial studies for carbon fiber designs for overall mechanical support structures, services routing studies, radiation length minimization, etc.

#### MLR2 submission – EICSC WP2

- Detailed silicon design as per sensor design section, layout and DRC, integration into MLR, etc.

#### Thinning Bending and Interconnection – EICSC WP3

- Thinning/bending studies, test beams and assessment, interconnection designs