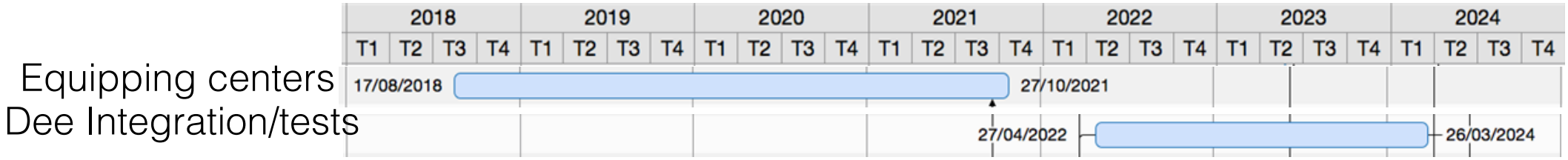
Dee integration

CMS Tracker Upgrade France, 05/12/2018

Colin Bernet, Gaëlle Boudoul, Nicolas Chanon, Pierre Dené, Thierry Dupasquier, Nick Lumb, Muriel Vander Donckt, Sébastien Viret

Dees integration: plans



Dee Integration steps

- **Module reception** from Quality control centers
- Module **tests at reception**
- **Assembly line** for PS and 2S module mounting on Dees
  - System **test during assembly**
- **Cold tests after mounting**
- **Shipment** of the Dees to TEDD assembly centers

Clean room at IPNL

Clean room for Dee construction and integration, Building Van De Graaf

- Work basically done, a few remaining items
- Clean room to be equipped very soon:
  - **New fridge** able to contain 1 full-size Dee (ordered),
  - **Dry air supply** (2019),
  - Preliminary version of **system tests…**

New clean room with labex LIO funding

Receiving and storing modules

Dee Integration steps

- **Module reception** from Quality control centers
- Module **tests at reception**
- **Assembly line** for PS and 2S module mounting on Dees
- **Cold tests after mounting**
- **Shipment** of the Dees to TEDD assembly centers

Receive modules shipped from Quality Control centers (Germany)

- Project of a **shipment box** is not started in CMS
  - The same box will be used to move/store modules inside the clean room.
- Scanning system to **identify components** (not yet existing) and connect to **database** (in construction)
- Visual inspection with a binocular
- Plan to store the modules a few days in a closed storage cabinet, under **dry air**: will decrease **humidity** if any
- Modules ready to be tested

System tests at reception

Dee Integration steps

- **Module reception** from Quality control centers
- Module **tests at reception**
- **Assembly line** for PS and 2S module mounting on Dees
- **Cold tests after mounting**
- **Shipment** of the Dees to TEDD assembly centers

Testing modules at reception

At **room temperature** (assume burn-in was done at QC centers)

1) Need **automated tests** to measure sensor **I-V curves**

- Use a system to test several modules at once, similar to burn-in, but at room temperature: **from KIT ?**

2) Measuring **basic module properties** (module connectivity, test slow control, test reading data, channels alive)

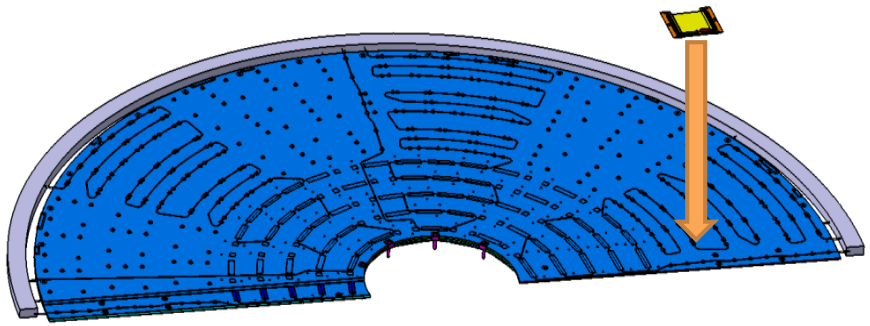
3) *Calibration and* ***noise measurement*** *should take ~few minutes (efficiency vs threshold, voltage). Still in discussion (is it needed ?).*

=> Needs **FC7 with µTCA crate**, with µDTC firmware to test PS and 2S modules: need automated tools, with a GUI and connection to database to upload results

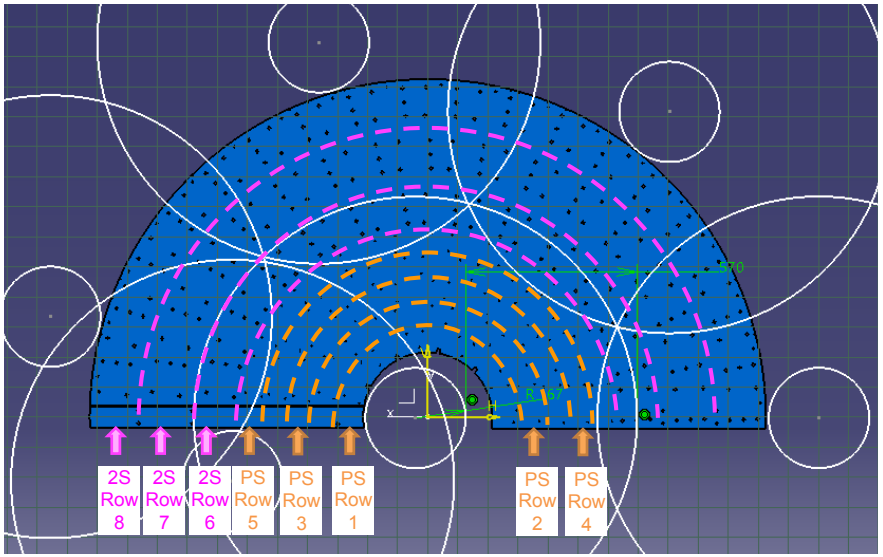
Assembly line (1/2)

Dee Integration steps

- **Module reception** from Quality control centers
- Module **tests at reception**
- **Assembly line** for PS and 2S module mounting on Dees
- **Cold tests after mounting**
- **Shipment** of the Dees to TEDD assembly centers

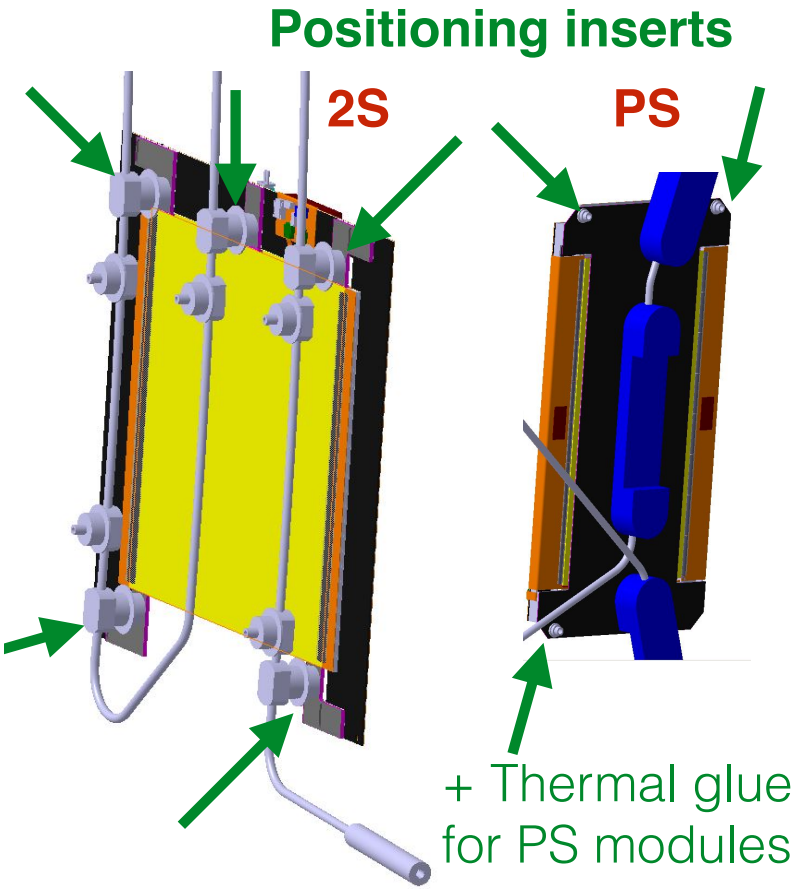


- Installing the modules in **horizontal** position on a workbench
- Protect mounted modules with plexiglass (“assembly box” to be designed)
- The arch makes it easy to rotate the Dee and mount the other face

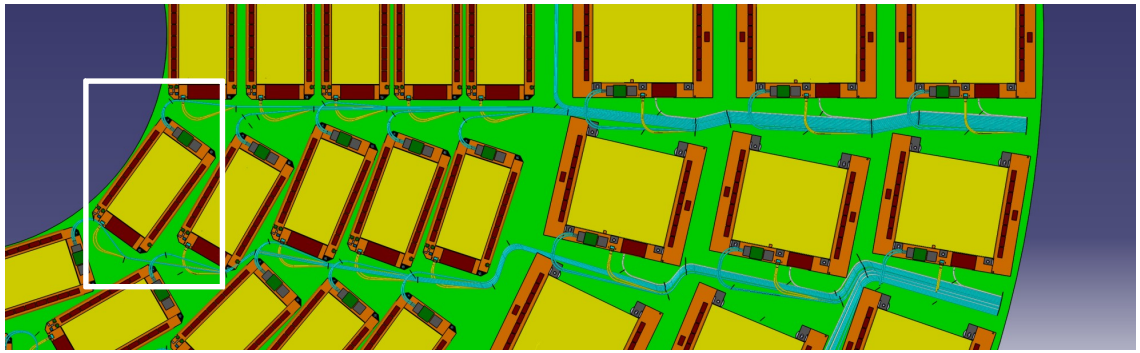


2 technicians can mount modules on one Dee at the same time (one for 2S, the other for PS modules)

Assembly line (2/2)



- Appropriate screw torque needed to conduct heat properly
- Thermal glue foreseen for PS modules has a phase-change. We are evaluating using graphite foil instead



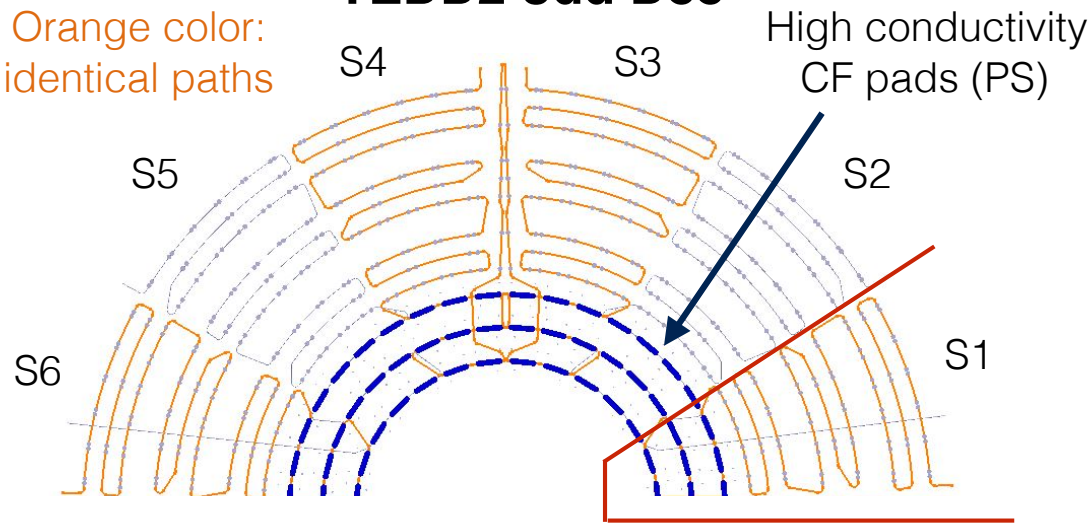
- **Final cabling** of modules on Dees: HV, LV. Opto-link will be connected to the **octopus** (at the edge of Dees)
- Each time **8(?) modules are mounted, test them** with 1 FC7 at room temperature (assumes that the cabling operation is performed each time a module is mounted on the Dee and not once the Dee is fully mounted)

Cold tests after mounting (1/2)

Dee Integration steps

- **Module reception** from Quality control centers
- Module **tests at reception**
- **Assembly line** for PS and 2S module mounting on Dees
- **Cold tests after mounting**
- **Shipment** of the Dees to TEDD assembly centers

TEDD2 odd Dee



Module/Dee	PS	2S
TEDD1 odd	76	96
TEDD1 even	84	66
TEDD2 odd	52	96
TEDD2 even	70	64

- **Max 25 module / sector** in TEDD2
- Final CMS DTC / ATCA crate may not be ready on time
- It was suggested that **1 FC7** will be able to **connect to 8 modules** (if read out is done alternatively between modules…) : to be verified (hw, sw and fw do not exist yet)

=> 4 FC7 boards are needed to test modules in 1 TEDD cooling sector

Cold tests after mounting (2/2)

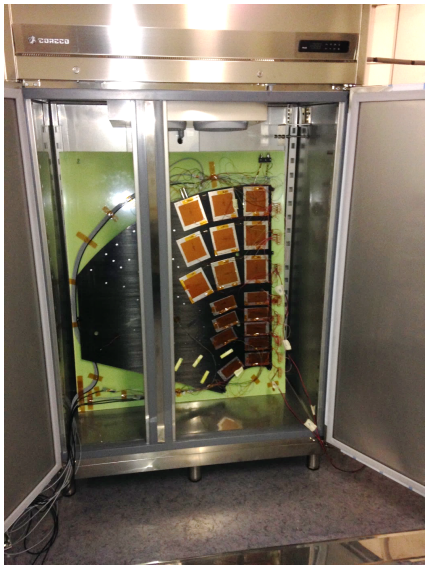
Procedure for sector cold tests:

- Full Dee put in the **fridge** (fully mounted would be better)
- Will test modules **1 cooling sector by 1 cooling sector**

- Use **dry air** for the cold tests, and **monitor humidity and temperature**
- **Cool down 2 sectors at -35°C** (with just 1, modules at the sector border would not be cold enough) while actively cooling the fridge at -25°C
- Operate **several cycles** between **-35°C and room temperature**

- **Verify that connections are OK**
- Measurements:
  - **ΔT measurement:** Goal ΔT < 10°C between CO_2 and modules
  - **Calibration curves at -35°C**

Custom cooling system at IPNL, can cool 2 sectors at -35



Temperature tests of a 40% Dee prototype in Lyon

Shipment to TEDD assembly centers

Dee Integration steps

- **Module reception** from Quality control centers
- Module **tests at reception**
- **Assembly line** for PS and 2S module mounting on Dees
- **Cold tests after mounting**
- **Shipment** of the Dees to TEDD assembly centers

- Dee-boxes with accelerometers
- CNRS logistics (Ulisse) or private transporter ?
- Insurance ? The cost of a mounted Dee is about 600 k€ !

IPNL

- Construction and qualification of 24 TEDD2 Dees
- Integration of 12 TEDD2 Dees

Shipment of 12 TEDD2 Dees (non-equipped)

DESY

- Construction of TEDD1 Dees
- Integration of Dees
- Integration of 1 TEDD

Shipment of 12 TEDD2 Dees (equipped)

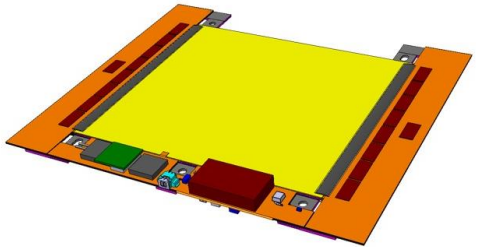
Louvain

- Integration of 1 TEDD

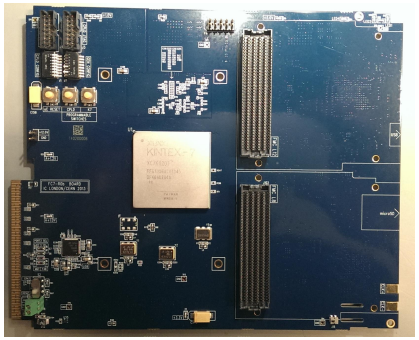
Preparations: Test bench at IPNL

Setting up a test bench at IPNL, preparing for integration

- 1 microTCA crate with MCH, 5 FC7 and 1 DAQ PC (received DAQ PC,1 FC7, MCH)
- LV, HV power supplies (LV received)
- Might get a 2CBC3 hybrid + 1 sensor beginning of 2019 from KIT
- Full-size 2S module to be received by mid-2019
  - New service hybrid (SEH v3.1) should be available by then: need to make sure of which components are needed to build the prototype



2S module



FC7 back-end boards
(+ Mezzanines)

MicroTCA crate with
CMS-style backplane

Conclusions

Preparation of Dee Integration started at IPNL

- Profit from past experience of phase-0 tracker
- Preliminary stages of reflection (presented to System test meeting and got first feedbacks in June)
- Plans of CMS system test group are evolving and not yet fully defined
- Started to equip VdG clean room
- We are setting up a bench test at IPNL, to be ready in 2019. Will be updated when latest components are available

Back-up slides

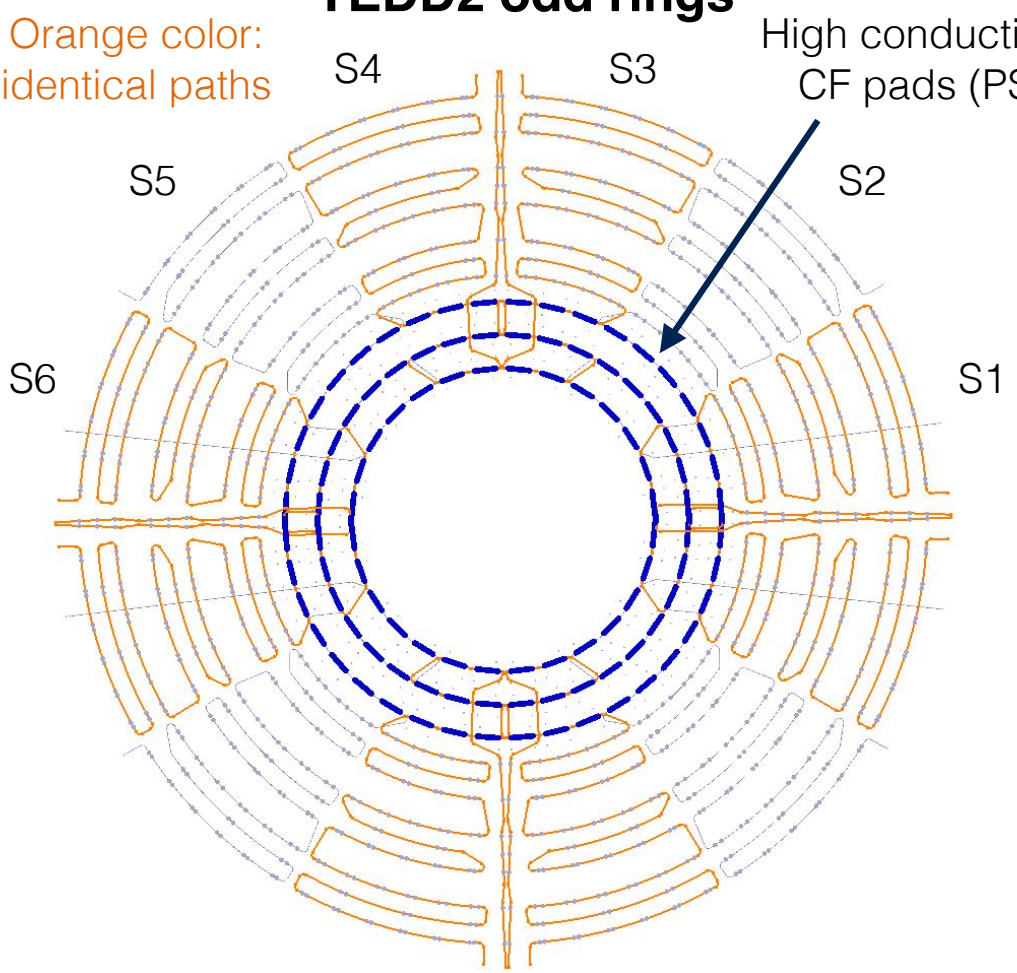
Cooling pipes

Embedded cooling circuits for all Dee types have been designed

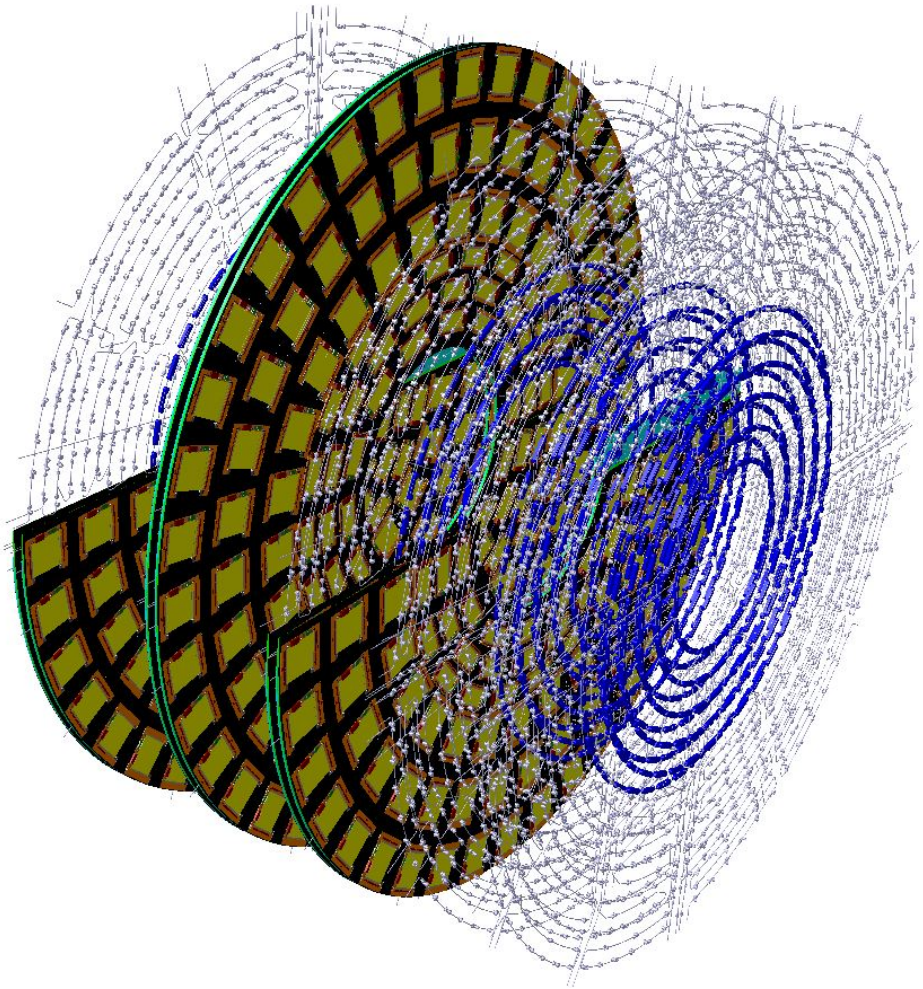
- 6 cooling sectors / Dee, highly symmetric
- 2 cooling loops per sector and per disk (odd/even rings)
- Pipe size 2.2mm inner diameter, optimised for $\Delta T < 10^{o}C$ between CO_2 and modules

TEDD2 odd rings

Orange color: identical paths



Full model



Dees prototypes: thermal measurements

Ongoing work to measure ΔT between CO_2 and modules

- Goal ΔT < 10°C between CO_2 and modules
- "Dummy modules" made of radiator with similar thermal properties as real modules