

VXD Status : R&D and SW Description

LCWS11/Granada – 28 Septembre 2011

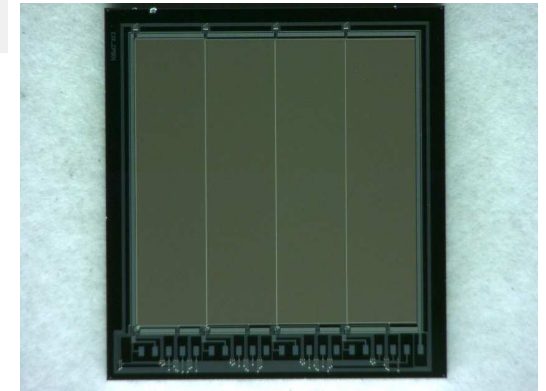
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 - ✧ sensors (DEPFET, FPCCD, CMOS)
 - ✧ integration issues (ladders, global detector)
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 - ✧ services, periphery
- *Summary*

Progress on Sensor R&D

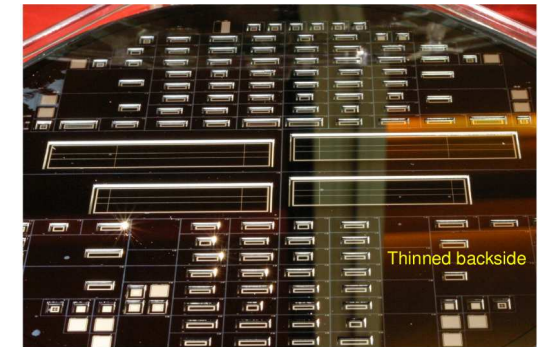
● Delayed read-out : FPCCD

- ✳ Proto.4 fab. in 2010 ($6 \times 6 \text{ mm}^2$) with pixel pitch of 12, 9.6, 8 and $6 \mu\text{m}$
 - ▷ tests under way ▷ $50 \mu\text{m}$ thinning of proto. seems OK
- ✳ Proto.5 expected in FY 2012 : 1st large size chip ($\sim 1 \times 6 \text{ cm}^2$)



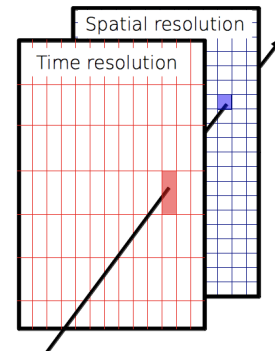
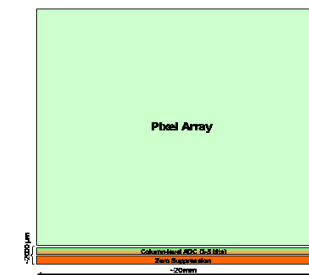
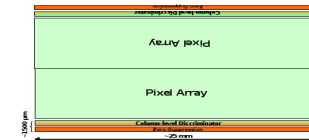
● Continuous read-out : DEPFET

- ✳ Devt mainly driven by BELLE-2 specifications (e.g. $50 \mu\text{m}$ pitch)
 - ↪ sensors oriented towards VXD also part of wafers fabricated
- ✳ $50 \mu\text{m}$ thin sensors fabricated and partly tested (SNR)
 - ↪ complete assessment of prototypes' performances under way



● Continuous read-out : CPS

- ✳ Final archi. prototypes being fab. in $0.35 \mu\text{m}$ techno. :
 - MIMO-30 (in: σ_{sp} & speed) / MIMO-31 (out: power)
 - ⇒ validation of sensors w.r.t. all VXD specs by Summer '12
- ✳ Translation from $0.35 \mu\text{m}$ to $0.18 \mu\text{m}$ techno. under way
 - ↪ validation of sensor's architecture by Fall 2012
- ✳ Devt common to ALICE-ITS/MFT, CBM-MVD and AIDA-BT



Progress on System Integration

● Ladders :

※ 2-sided : PLUME coll. (based on CPS)

- 1st proto. (0.6 % X0) fab. with 2×6 MIMOSA-26 sensors ($12.7 \times 1.1 \text{ cm}^2$)
 - ↳ 8M pixels; $\gtrsim 3 \mu\text{m}$, $100 \mu\text{s}$; 300 kRad; $2 \cdot 10^{12} \text{ n}_{eq}/\text{cm}^2$; air cooled
- sensors work as expected \Rightarrow beam tests in Nov.'11 (SPS)
 - ↳ assess added-value of 2-sided for DBD
- 2nd proto will address mat. budget (0.3 % X0)
 - ↳ fab. & tested by Summer '12

※ Single-sided: DEPFET and CPS

- CPS sensor based ladders (0.37 %X0) in production for STAR-PXL
- DEPFET based ladders being developed for BELLE-2
- R&D on unsupported ladders ($< 0.15\% \text{ X0}$) \triangleright SERNWIETE

● Overall VXD integration :

- ※ DEPFETs preparing for BELLE-2 (installation by mid-2015)
- ※ CPS final prod. for STAR-PXL engineering proto. launched
 - ↳ data taking at RHIC in FY2012
- ※ 2-phase CO_2 cooling under study for FPCCD (-40°C , 100 W)
 - ↳ several generic aspects



VXD Description in Simulation (1/2)

- "Hybrid" VXD description :

- ✧ Ladders : inspired by PLUME and CMOS sensor design

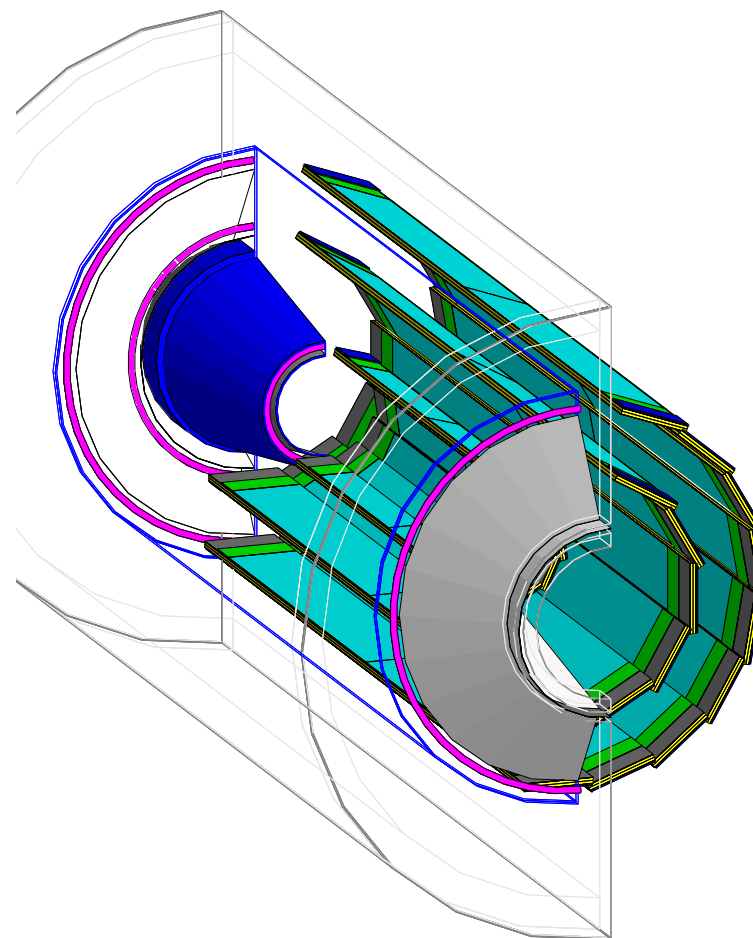
- continuous (\equiv fast) read-out with integrated data sparsification operated at room T
- end of ladder material \equiv FPCCD
- cooling assumed by air flow
- Faraday cage (Al foil)

- ✧ Global mechanics & Services \cong FPCCD design

- gasket is closed \rightarrow operation at low T
- cooling services as for FPCCD
- cabling as for FPCCD

- Design definitely more realistic than for Lol

\Rightarrow more material ...



VXD Description in Simulation (2/2)

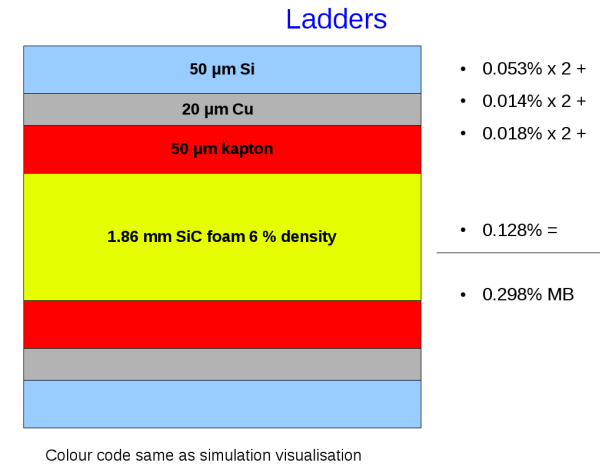
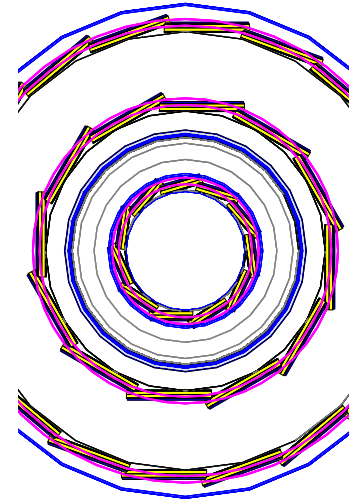
● 2-sided ladders and their supports :

- ✳ 2 mm spacing (SiC foam) between both sensor layers
 - ⇒ nb of ladders per layer adjusted
- ✳ material budget is $\sim 0.3\%$ X0 (Lol: 0.16% X0)
- ✳ modified ladder fixings w.r.t. Lol
- ✳ modified Be support :
 - end plates' thickness ($0.5 \rightarrow 2$ mm) , holes
 - clearance for pipes
 - closed enclosure
 - modified supports w.r.t. beam pipe

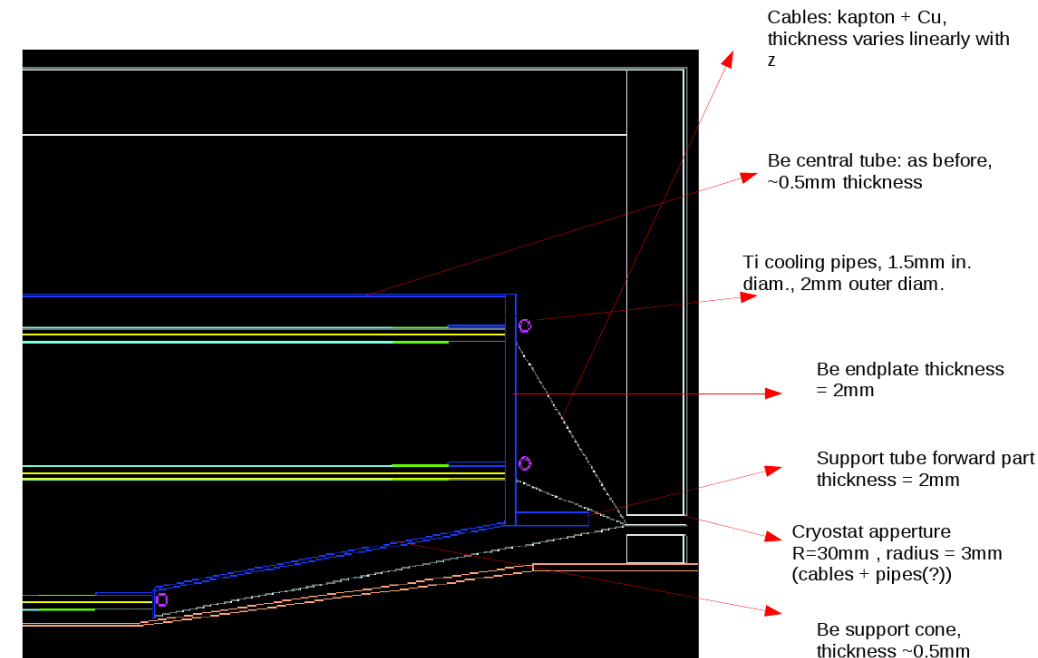
● Services introduced according to FPCCD needs:

- ✳ cooling pipes & coolant distribution spiral at ladder ends
- ✳ cables from both sides (continuous cones) & connections

● Work still on-going (G. Voutsinas)



Cryostat: styropor at 90mm, aluminium at 100mm (0.5mm thickness), as before



SUMMARY

- **Validation of VXD concept :**

- ✧ Sensors : requirements in speed, resolution, thickness, power, rad. tolerance likely to be met for DBD
(continuous read-out approach)
- ✧ Ladders : 2-sided approach validation & added-value assessment progressing well
↳ though unlikely to go < 0.3 %X0 for DBD
- ✧ Services and global aspects : several issues being addressed
↳ stand-alone studies or construction of sub-systems composing upcoming experiments
- ⇒ Concept significantly more trustable in DBD than in Lol (though not yet very well proven)

- **VXD description in simulation:**

- ✧ Active area: more detailed description than for Lol
- ✧ Inactive areas of detector : clear progress in realism
- ✧ Services outside detector : striking progress
- ⇒ Significantly more realistic description in DBD than in Lol (though incomplete)

- **Developments expected to evolve fast in the coming 10-15 months**

- ⇒ **try incorporating maximum of their outcome in the DBD**

VXD Services : Junction Box

- Junction box
 - Flexible printed circuit (FPC) cables from the ladders are connected to the junction box using micro connectors
 - The junction box (PCBs) are placed surrounding beam pipe
 - Electronics parts on the PCB are represented by uniform 0.2mm-thick Si
 - Power cables to the junction box have cross section of 30mm² in total

Junction box; z=230~368 mm

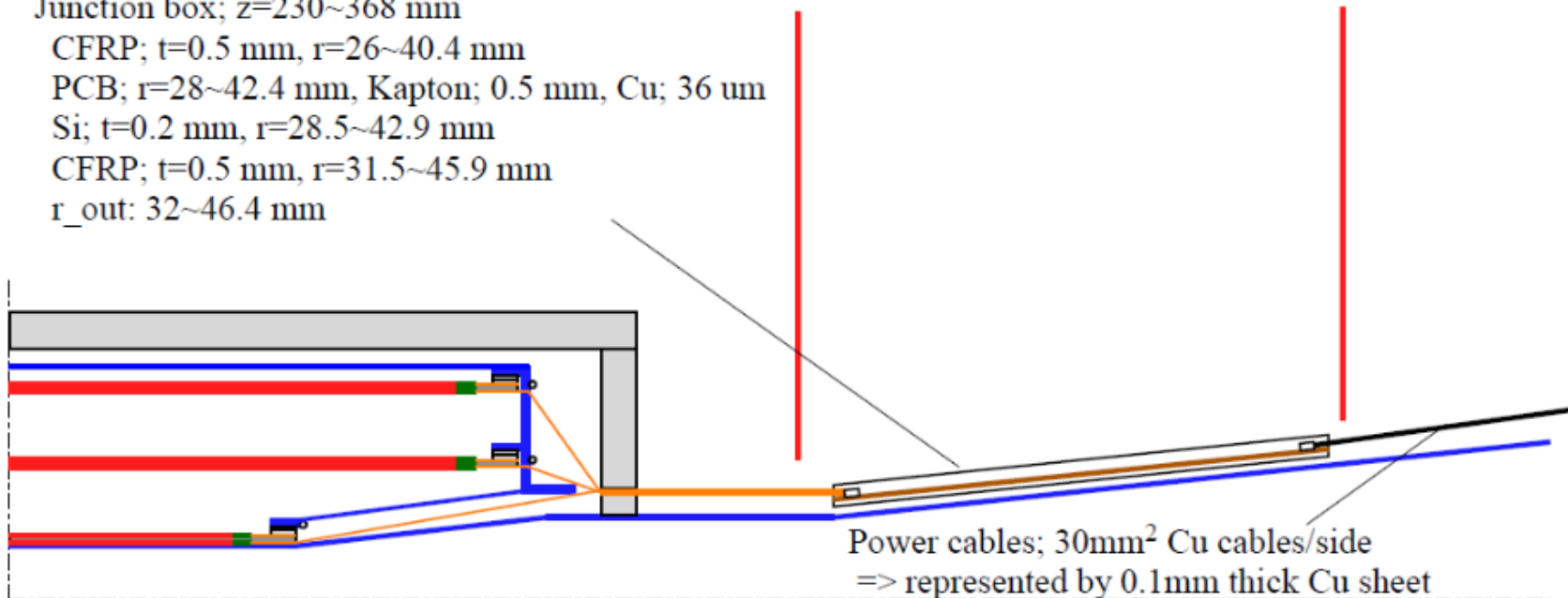
CFRP; t=0.5 mm, r=26~40.4 mm

PCB; r=28~42.4 mm, Kapton; 0.5 mm, Cu; 36 μ m

Si; t=0.2 mm, r=28.5~42.9 mm

CFRP; t=0.5 mm, r=31.5~45.9 mm

r_{out}: 32~46.4 mm



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