


IJCLab group

E.K.

*Visit of QMUL
15 December 2023*

Members

Physics:

 *Permanent: Ph. Bambade, A. Martens, E. Kou, F. Le Diberder, R. Mizuk, Z. Zhang*

 *PhD: F. Callet, M. Li, F. Mawas,*

Mechanics (VXD upgrade, IR beampipe upgrade)

 *J. Bonis (IR), D. Auguste (AI), Y. Peinaud (AI), M. Winter (Emeritus)*

DAQ upgrade

 *P. Robbe (LHCb), D. Charlet (IR), E. Plage (AI)*

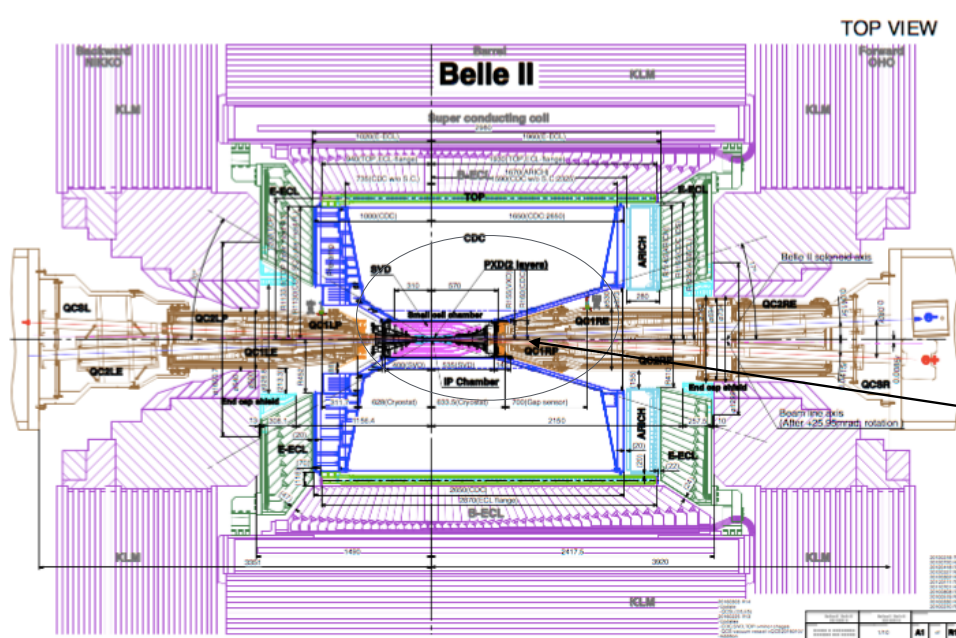
Past members:

PhD: B. Knish (2021), M. Liu (china, 2024), G. De Marino (2022), P. Oskin (2023), V. Vobbilisetti (2023), Y. Zhang (china, 2023)

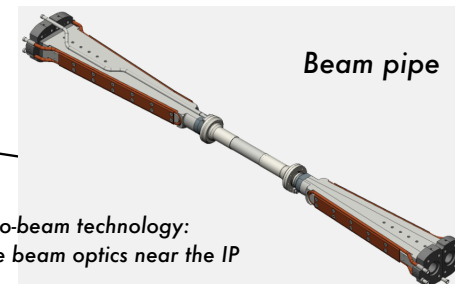
Postdoc: S. Watanuki (2019-2021), T.S. Lau (2021-2023)

Permanent: K. Trabelsi (2018-2023)

IJCLab in the Belle II VXD team



Belle II VXD mechanics team:
 IJCLab group belongs to the VXD (PXD, SVD, beam pipe) mechanics team
 [KEK, DESY, IJCLab, Pisa, HEPHY, MPP...]



Nano-beam technology:
 innovative beam optics near the IP

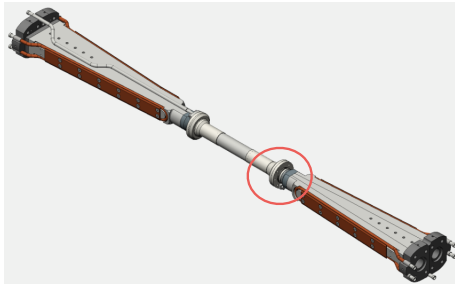
Upgrade (LS1) 2022-23
 IJCLab group is contributing to
 Improvement of the beam pipe cooling.
 [KEK, IJCLab]
 VXD installation
 [KEK, DESY, MPP, IJCLab...]

Upgrade (LS2) 2027 or later
 IJCLab group plans to contribute to
 VXD upgrade
 [IPHC, CPPM, IJCLab, Bonn, Valencia...]
 Beam pipe upgrade
 [KEK, IJCLab]

LS1

(Long Shutdown 2022-2023)

The beam pipe hot spot issue



Hot spot Issue:

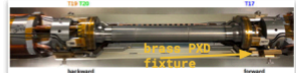
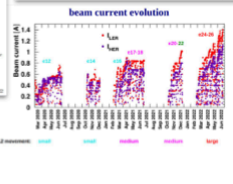
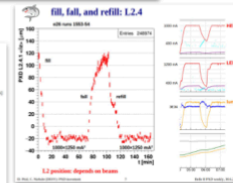
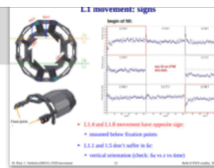
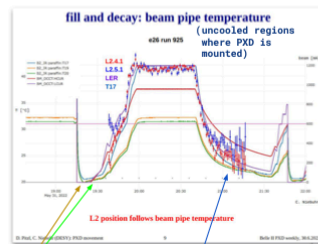
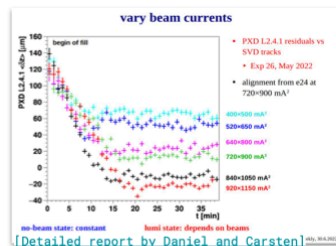
Unexpected temperature rise observed at a single spot

Challenge:

1. Temperature was measured only at **two points** during the run
2. It increases **linearly with the beam current increase**
3. **Little place** to add a new cooling system

PXD1 Ladder Movement at KEK

- PXD ladders move with beam pipe temperature (in uncooled region)
 - discovered only at end of 2022 b run period
- temperature driven by beam currents
 - ie. getting worse with time
- alignment cannot correct for movements
 - happen on too short timescales
- problem different/worse for PXD2
 - complete half-shells, expect higher currents
 - even more worrying in face of broken ladder
 - NB: PXD1 alignment suggests PXD1 ladders are all still in-tact

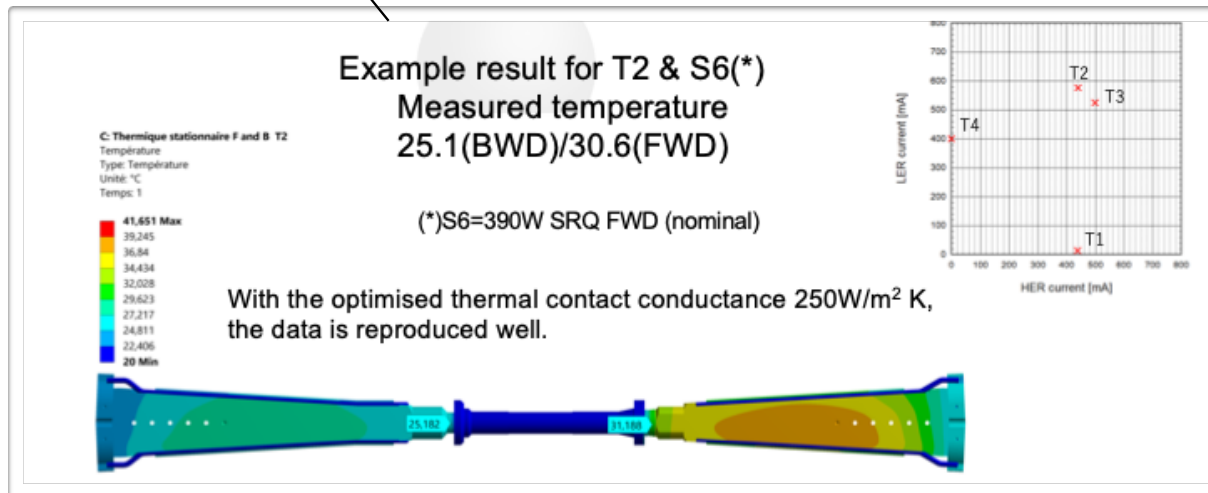
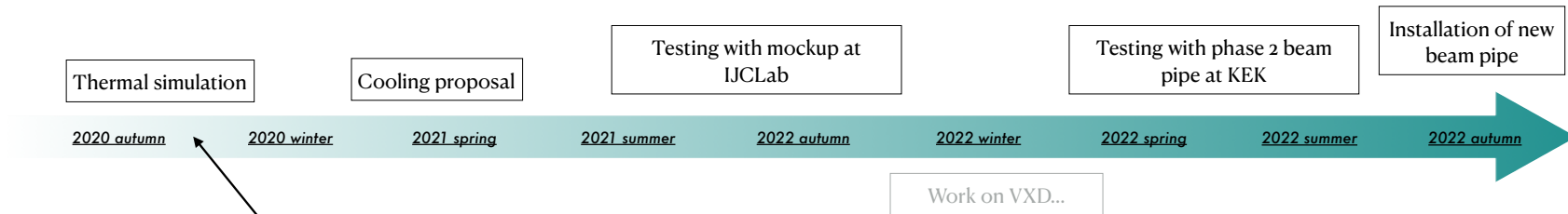


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Damages for the PXD operation...

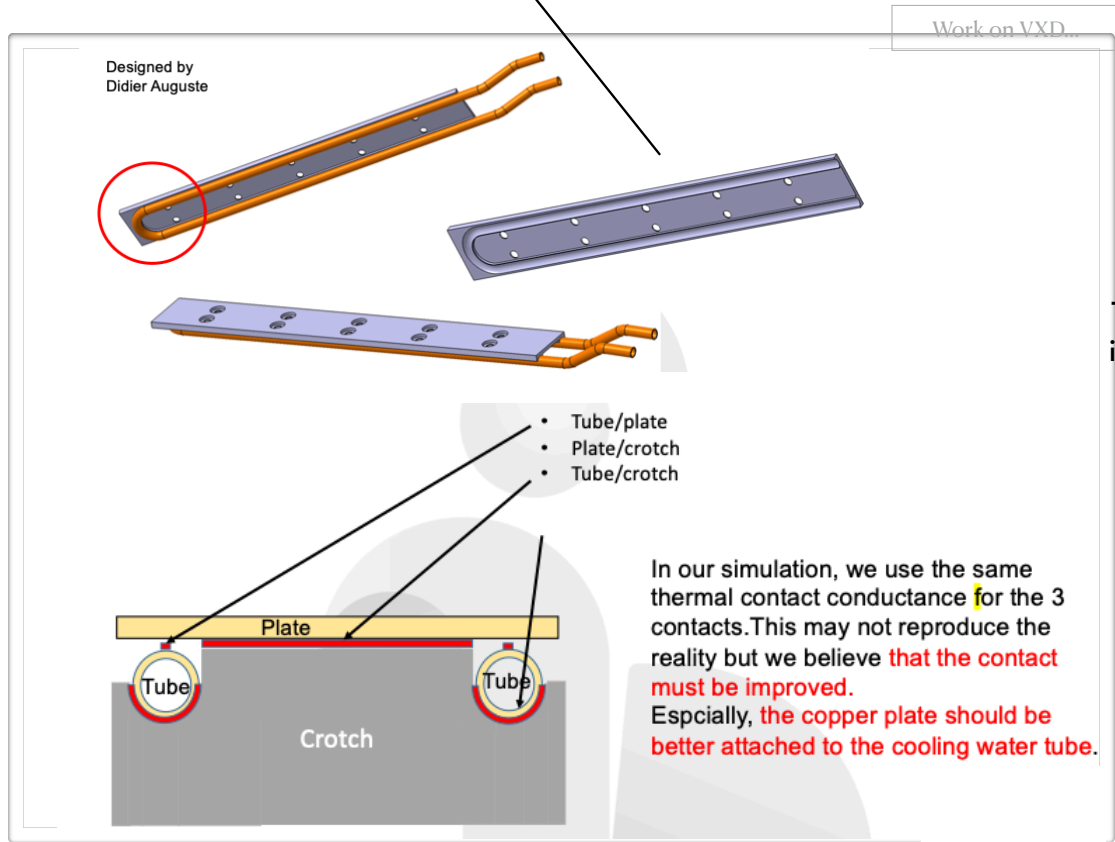
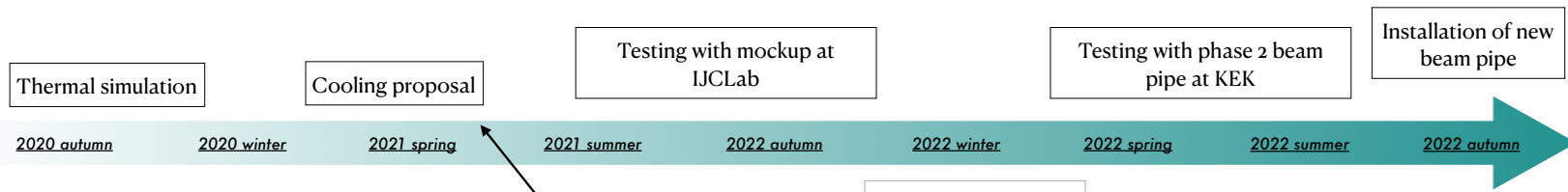
At the end of run 2b, the temperature rise reached to about 40 degree. Then, the PXD started moving...

Beampipe cooling work by IJCLab team



We computed the “expected” source of heat and make a full simulation of the beam pipe by the finite element method.

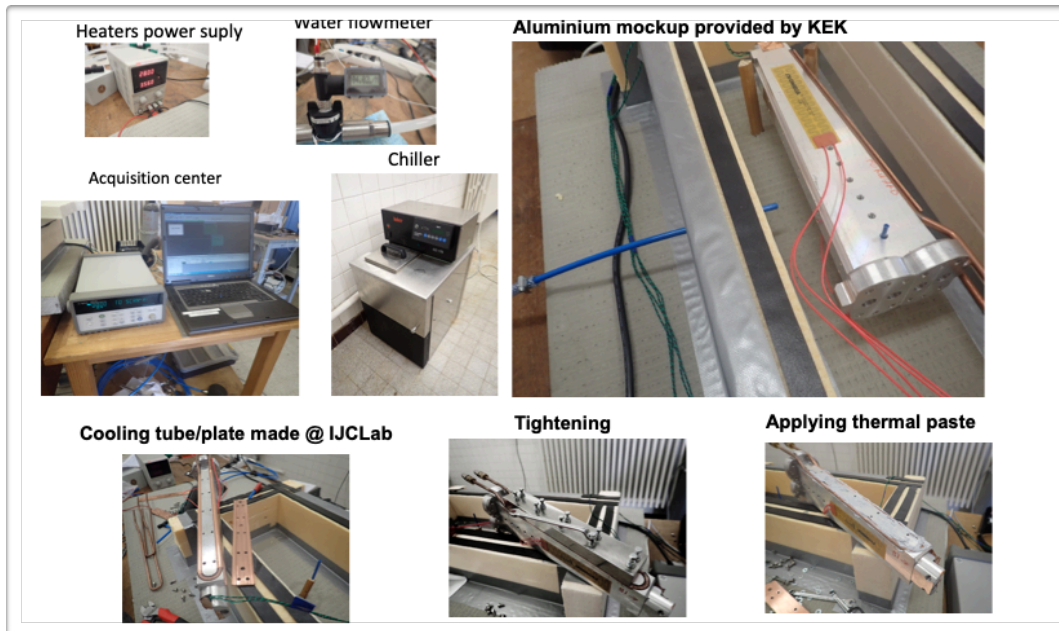
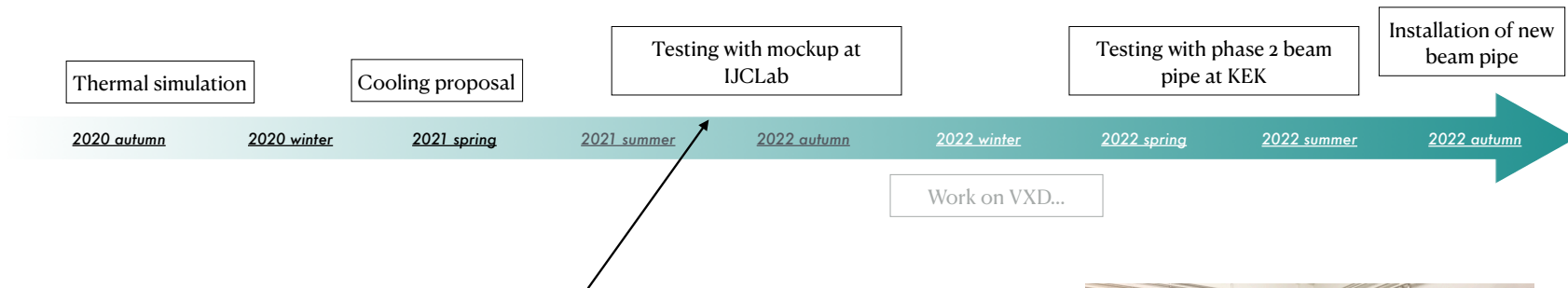
Beampipe cooling work by IJCLab team



Thermal conduct conductance must be increased. Thermal paste must applied generously...



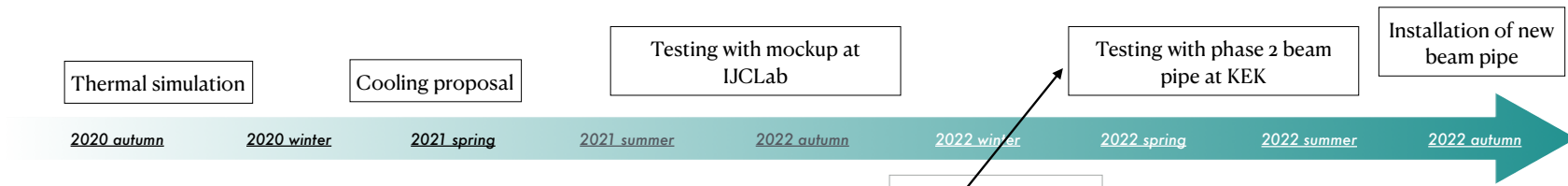
Beampipe cooling work by IJCLab team



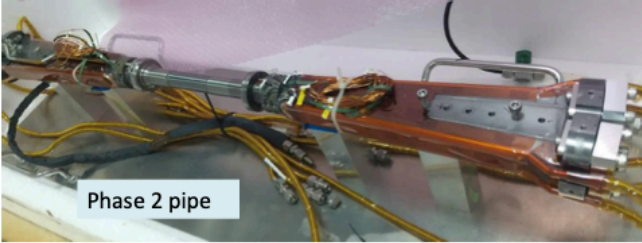
Test bench @ILC workshop

Aluminium mock up was provided to test at IJCLab. At this point, the thermal paste seemed to be the good solution...


Beampipe cooling work by IJCLab team



For the consistency check with FEM analysis
(Parts preparation is ongoing)



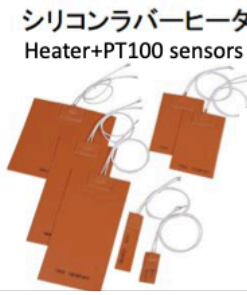

Phase 2 pipe



Chiller

シリコンラバーヒーター (SRタイプ)
Heater+PT100 sensors

★★★★☆☆ 平均

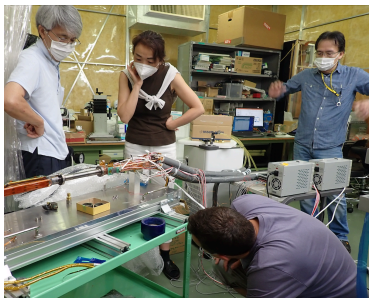
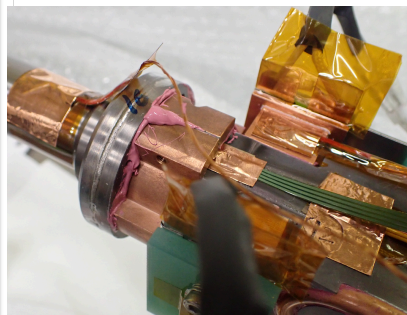
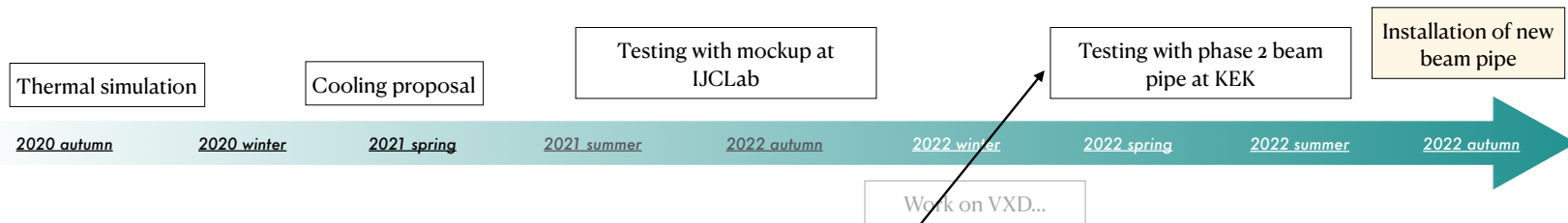
Flow meter

異機配管

The same test set up was prepared at KEK to repeat the test with the Phase2 beam pipe (tantalum). But... it turned out there was some kind of glue applied, which plays a role of the thermal paste...

The problem might not be the cooling, but possibly, a huge synchrotron radiation hitting the hot spot area...

Beampipe cooling work by IJCLab team



New strategy:

- i) The new geometry to avoid the SR hit would relax the problem.
- ii) Cooling block at the hot spot (Original design done by IJCLab, modified by KEK).
- iii) Copper sputtering at the internal area of the hot spot.
- iv) Generous thermal paste and the screw tightening.
- v) Careful observation of the phase 3 beam pipe!

LS2

(Long Shutdown ~2027 or later)

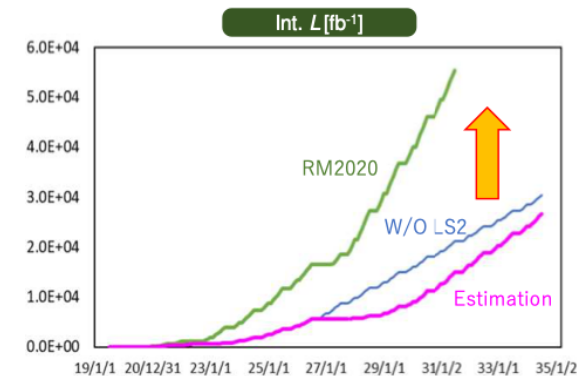


Longer-term upgrade R&D



There will be another long shutdown (LS2, 2026 or later) for machine upgrade.
We are preparing for possible detector upgrade taking this opportunity.

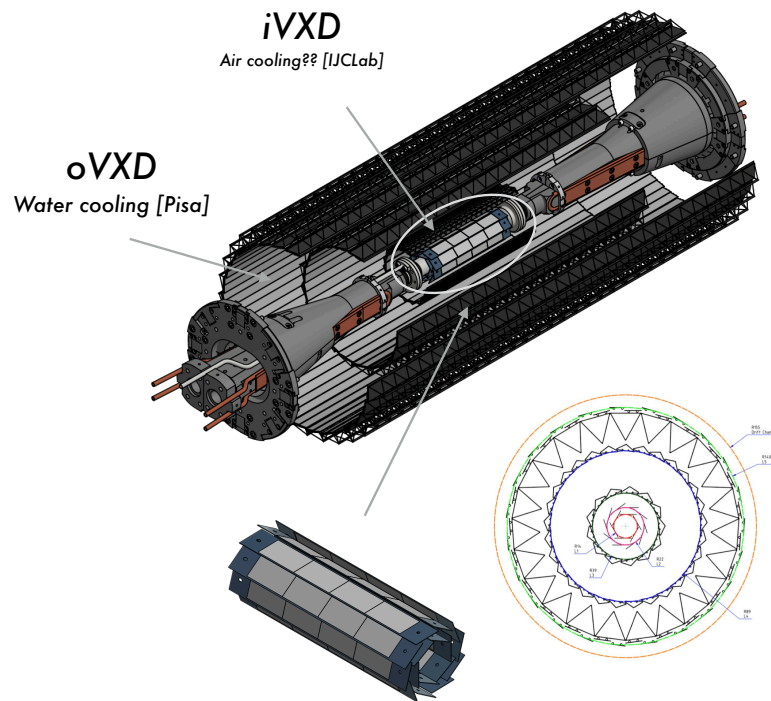
EOI	Upgrade ideas scope and technology	Time scale
RMBA	Improved diamond readout electronics. Integration with SKB abort system	< 2026
DEPFETs	Adiabatically improved replacement of existing system	2026
DMAPS	Fully pixelated Depleted CMOS tracker, replacing the current VXD. Evolution from ALICE ITS developed for ATLAS ITK.	2026
SOI-DUTIP	Fully pixelated system replacing the current VXD based on Dual Timer Pixel concept on SOI	2026
Thin Strips	Thin and fine-pitch double-sided silicon strip detector system replacing the current SVD and potentially the inner part of the CDC	2026
CDC	Replacement of the readout electronics (ASIC, FPGA) to improve radiation tolerance and x-talk	< 2026
TOP	Replace readout electronics to reduce size and power, replacement of MCP-PMT with extended lifetime ALD PMT, study of SiPM photosensor option	2026 and later
ECL	Crystal replacement with pure CsI and APD; pre-shower; rep photosensors.	
KLM	Replacement of barrel RPC with scintillators, upgrade of readout electronics for use as TOF	
STOPGAP	Study of fast CMOS to close the TOP gaps and/or provide timing	



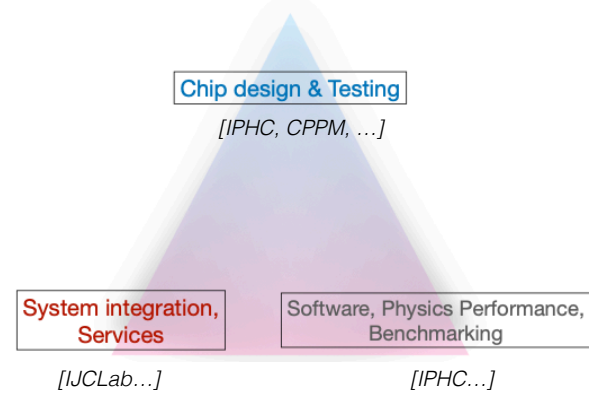
Cooling iVXD & IP beam pipe

Cooling of the iVXD and beam pipe is closely related:

- ✓ IJCLab is given the task of the iVXD cooling !
- ✓ IJCLab is participating the discussion on the new IP beam pipe design !



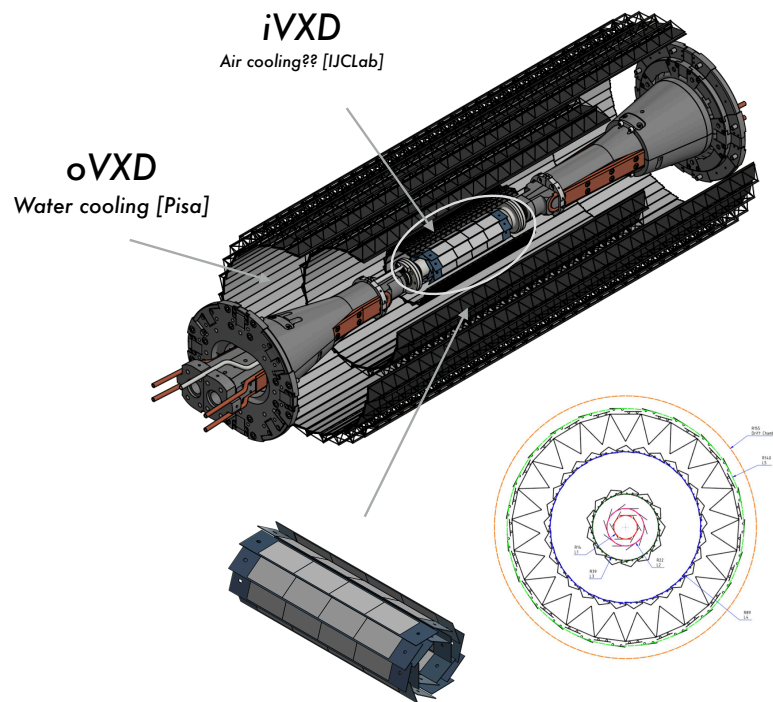
The success of VXD upgrade can not occur without strong implications to the 3 axes of researches.



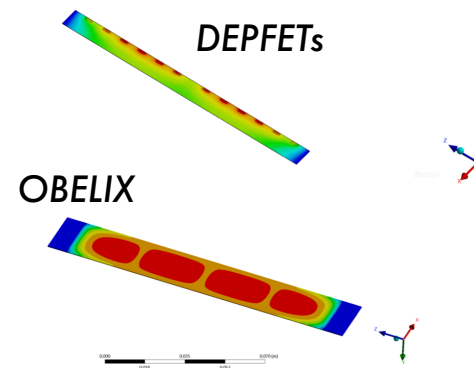
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First result of iVXD cooling by IJCLab



OBELIX chips are located only on the side but the cooling block would not work as it is too thin. Nevertheless, our first result shows that air cooling would be efficient enough.

IJCLab contribution to Forum on Tracking Detector Mechanics in Frascati (June 2022)

Backup

The 2022 LS1: installation + CO2 lines

LS1 PXD installation

We will participate to the installation of PXD together with DESY. We will also produce the prototype of the CO2 cooling pipe (warm-dry lines) which may require a repair in case of damage. We develop the so-called mini-connector for this CO2 lines as well. This installation work will provide us a valuable information of IP region, which is also useful for maintaining the current PXD as well as LS2 the VXD upgrade.

