Internationalization of Detector R&D

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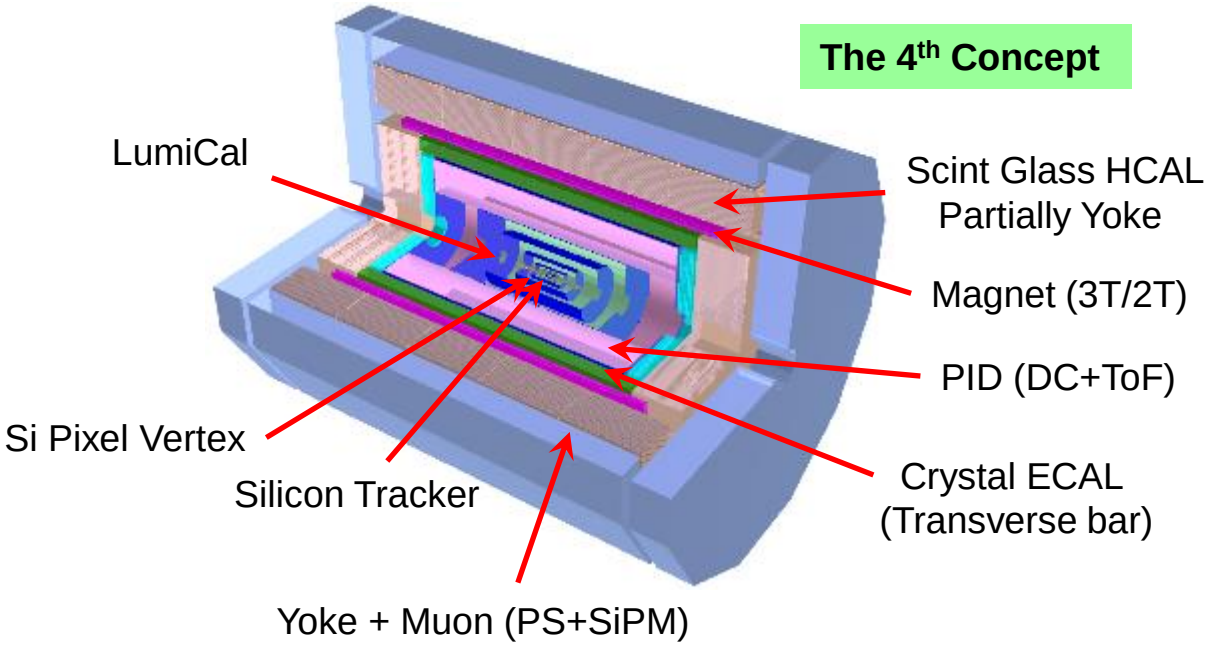
IHEP, CAS

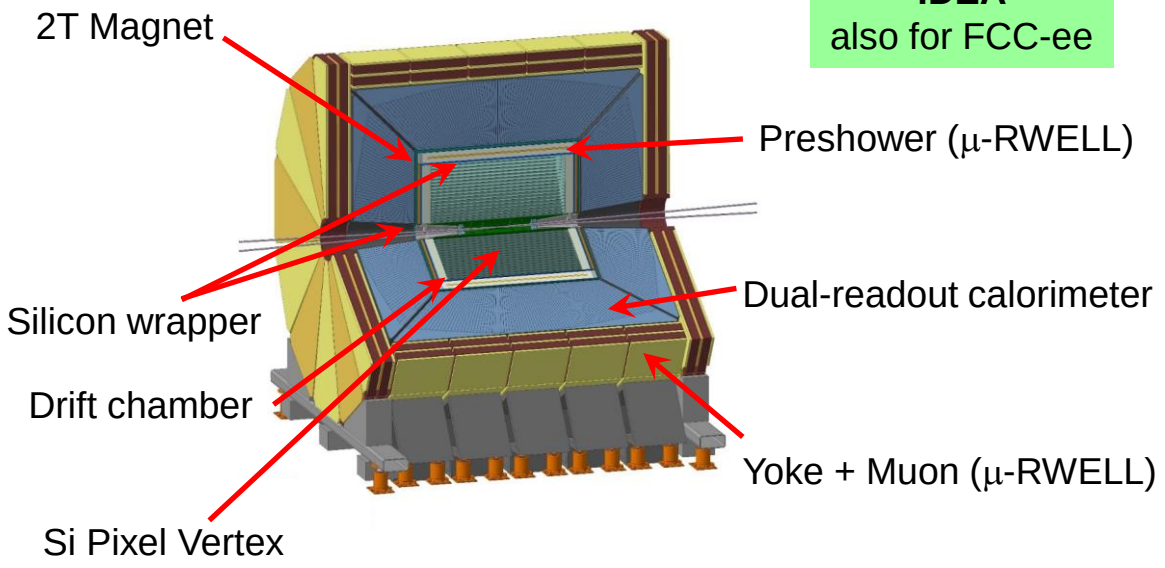
CEPC IAC Review, Oct 30-31, 2023

Towards A Detector TDR

The 4th Concept



IDEA
also for FCC-ee



- The CEPC Accelerator TDR will be released by **Dec 15, 2023.**
- **TDR of a reference detector** is to be prepared, to show the maturity of the detector R&D
  - Start preparation in January of 2024
  - A draft version by December, 2024
  - Official release by June 30, 2025.

R&D Efforts

Det	Technology
Pixel Vertex	JadePix
	TaichuPix
	CPV(SOI)
	Stitching
	Arcadia
Tracker & PID	CEPCPix
	Silicon Strip
	TPC
	Drift chamber
	PID DC
	AC-LGAD ToF
Lumi	SiTrk+Crystal ECAL
	SiTrk+SiW ECAL
	Fast LumMoni
Muon	Scintillation Bar
	RPC
	μ-Rwell

Det	Technology
Calorimeter	HG Crystal ECAL
	Stereo Crystal ECAL
	Scint+W ECAL
	Si+W ECAL
	Scint+Fe AHCAL
	ScintGlass AHCAL
	RPC SDHCAL
	MPGD SDHCAL
	DR Calorimeter
Miscellaneous	HTS / LTS Magnet
	MDI & Integration
	Trigger scheme
	Global electronics
	Wireless readout
	SiPM
	FPMT

- Need to converge soon for the TDR of a reference detector.
- International collaborative efforts:
  - DRD collaborations (CALICE, LCTPC, & RD* will phase out)
  - HL-LHC detector R&D's, help preparing teams for the CEPC detectors.

The ECFA DRD Collaborations

- Philip Allport delivered a nice review at the CEPC 2023 workshop on "Implementation of the ECFA Detector R&D Roadmap and Progress on Detector R&D (DRD) Collaborations"
- Couple of useful information:
  - The DRD proposal submission by end of July, 2023.
  - The DRDC is working with the DRD task forces on the proposals and recommendations.
  - The MoUs with funding agencies (or institutes) are expected to be signed in 2024. CERN is preparing the template.
- About 30 proposals from Chinese institutes were submitted or accepted.
- At the "2023 ECFA Workshop on Higgs/EW/Top factories in Paestum", Karl Jakobs told Xinchou that the Chinese contribution was significant and useful, and advised us to prepare for the MOUs.

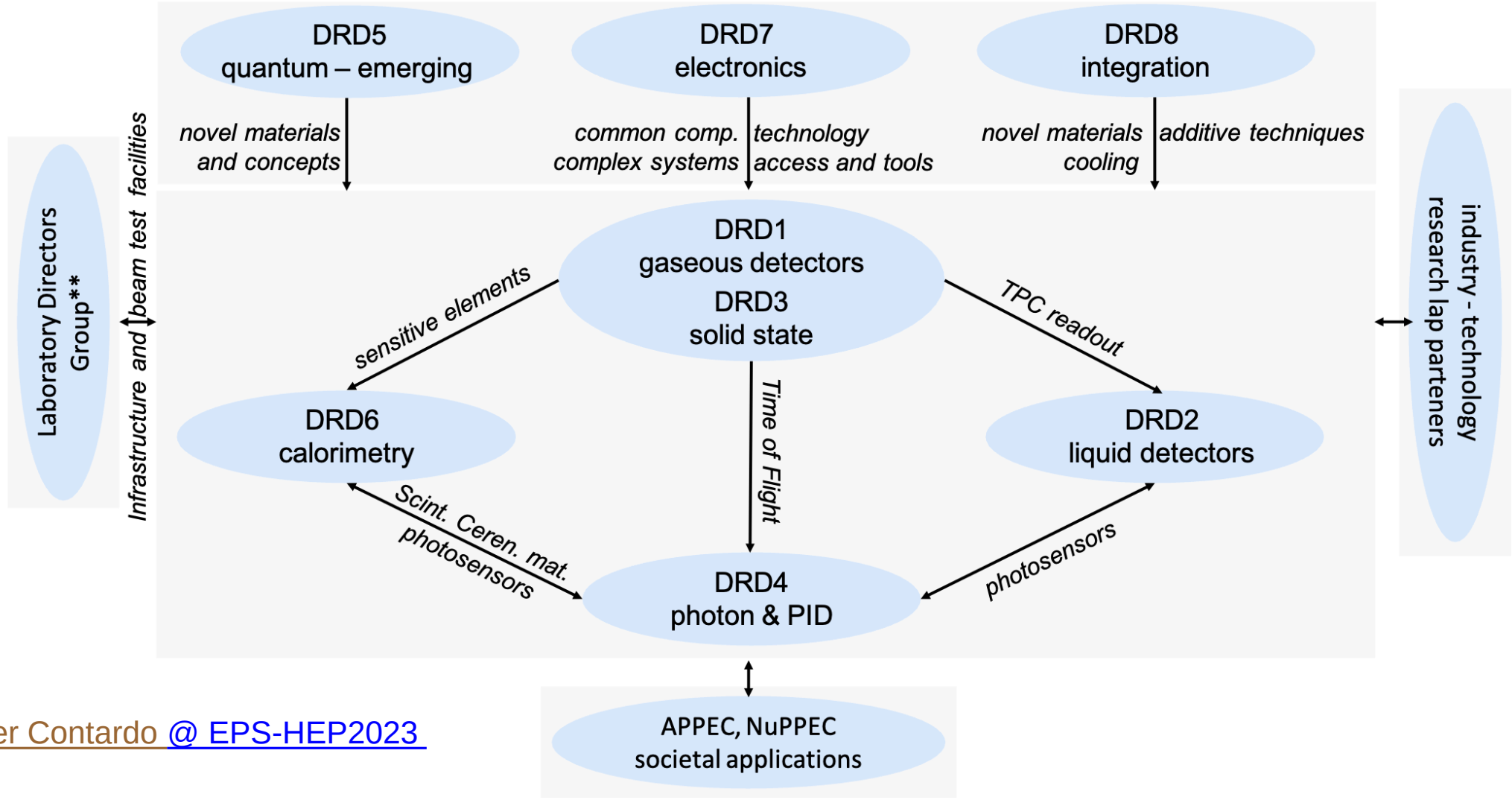
DRD Proposals From Chinese Institutes

- Information are extracted from a local survey (HJ), the DRD drafts (DD), and/or Phil's talk (PA).
- Not all information are available. There could be small errors in the table.

DRD Themes	Proposals	Institutes	People
1 Gaseous detectors	7 (DD)	IHEP, USTC, SJTU, JLU, SIAT, THU, WHU	46
2 Liquid detectors	2 (PA)	IHEP	7
3 Solid state detectors	4 (HJ)	SCNU, SDU, SJTU, THU	10
4 PID and photo detectors	3 (HJ)	IHEP, Henan NU, SDU	11
5 Quantum & emerging tech	2 (HJ)	SDU, THU	7
6 Calorimetry	6 (PA)	IHEP, SDU, SCNU, PKU	37
7 Electronics	3 (HJ)	IHEP, SDU, SJTU	5
8 Integration	3 (HJ)	IHEP	8
Total	**30**	**11 institutes**	**131**

- The total funding, already allocated or wished for, is ~50 MCNY
- Many of the CEPC ongoing R&Ds are in this list. Some may be missing. We will go through all directly related projects and make sure that all necessary ones have proper collaboration.

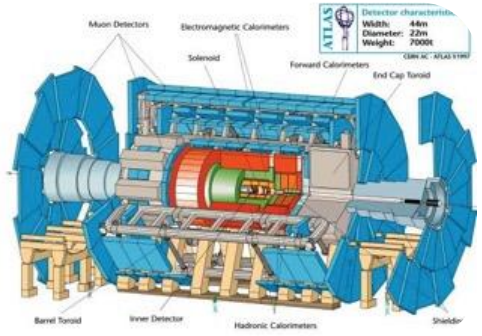
Interconnection Between The DRD Themes



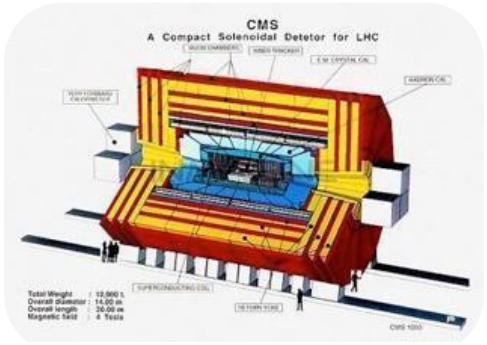
Didier Contardo @ EPS-HEP2023

Participating The LHC Upgrades

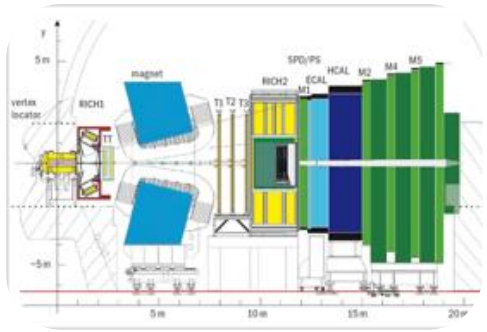
ATLAS



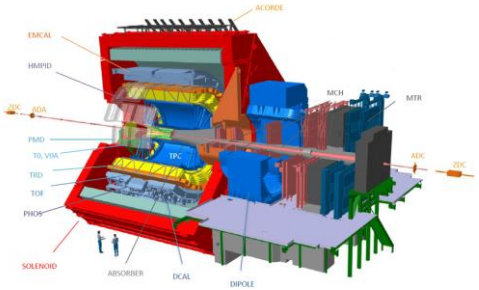
CMS

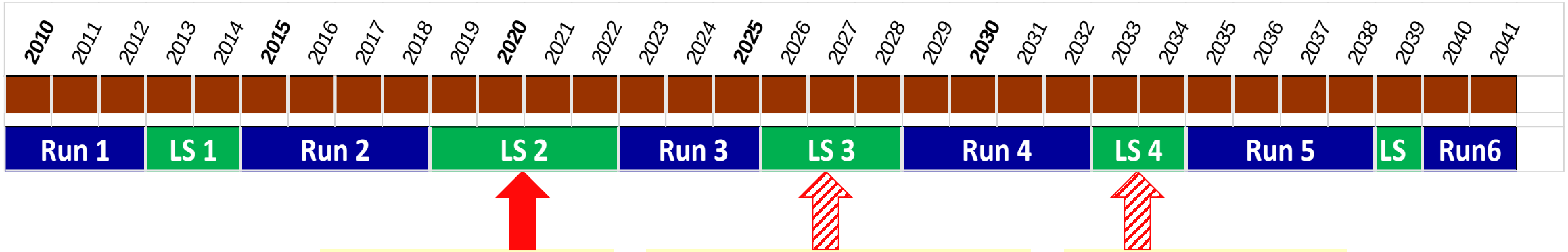


LHCb



ALICE





Participated by the Chinese group

ATLAS	NSW
CMS	CPPF, CSC
LHCb	UT, SciFi
ALICE	ITS2, MFT

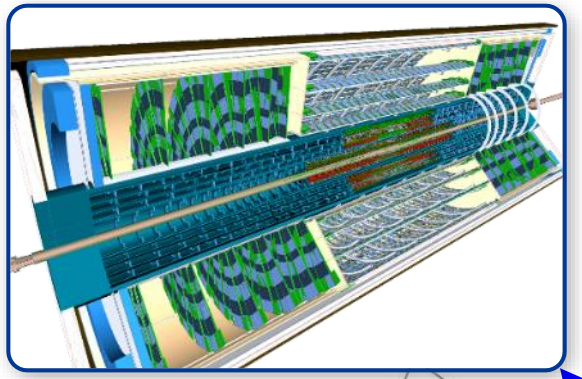
ATLAS	ITK, HGTD, Muon
CMS	HGCAL, MIP-TD
	Muon, Muon trigger
ALICE	ITS3, FoCal

LHCb	UT, ECAL
ALICE	ITS4?,TOF
ATLAS/CMS ??	

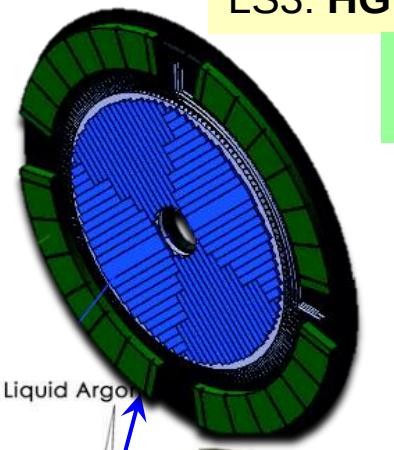
The ATLAS Upgrades

IHEP-THU-NJU-SYSU
SSD module production

LS3: **ITk**



LS3: **HGTD**

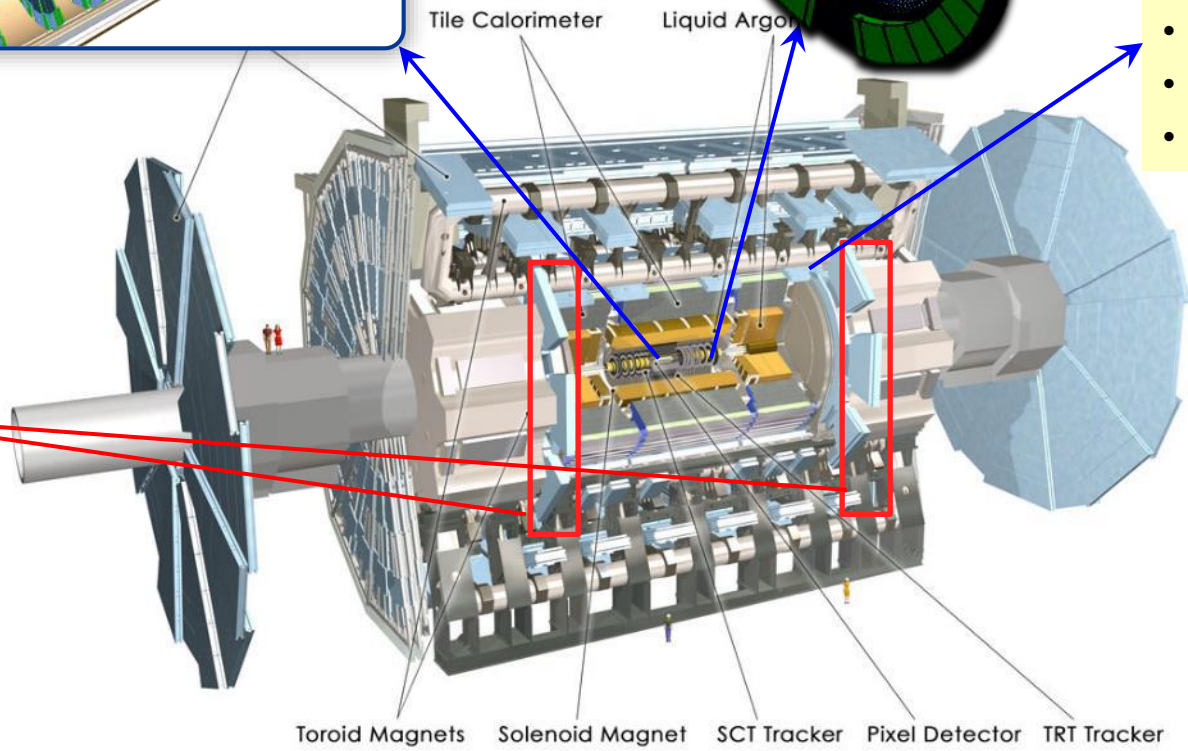


IHEP-THU-NJU-SYSU
Use LGAD, leading project

LS3: **Muon**

- BI RPC trigger detector
- MDT TDC ASIC
- High-eta tagger

USTC-SDU-SJTU-TDLI



LS2: **NSW**

Small strip Thin Gap Chamber

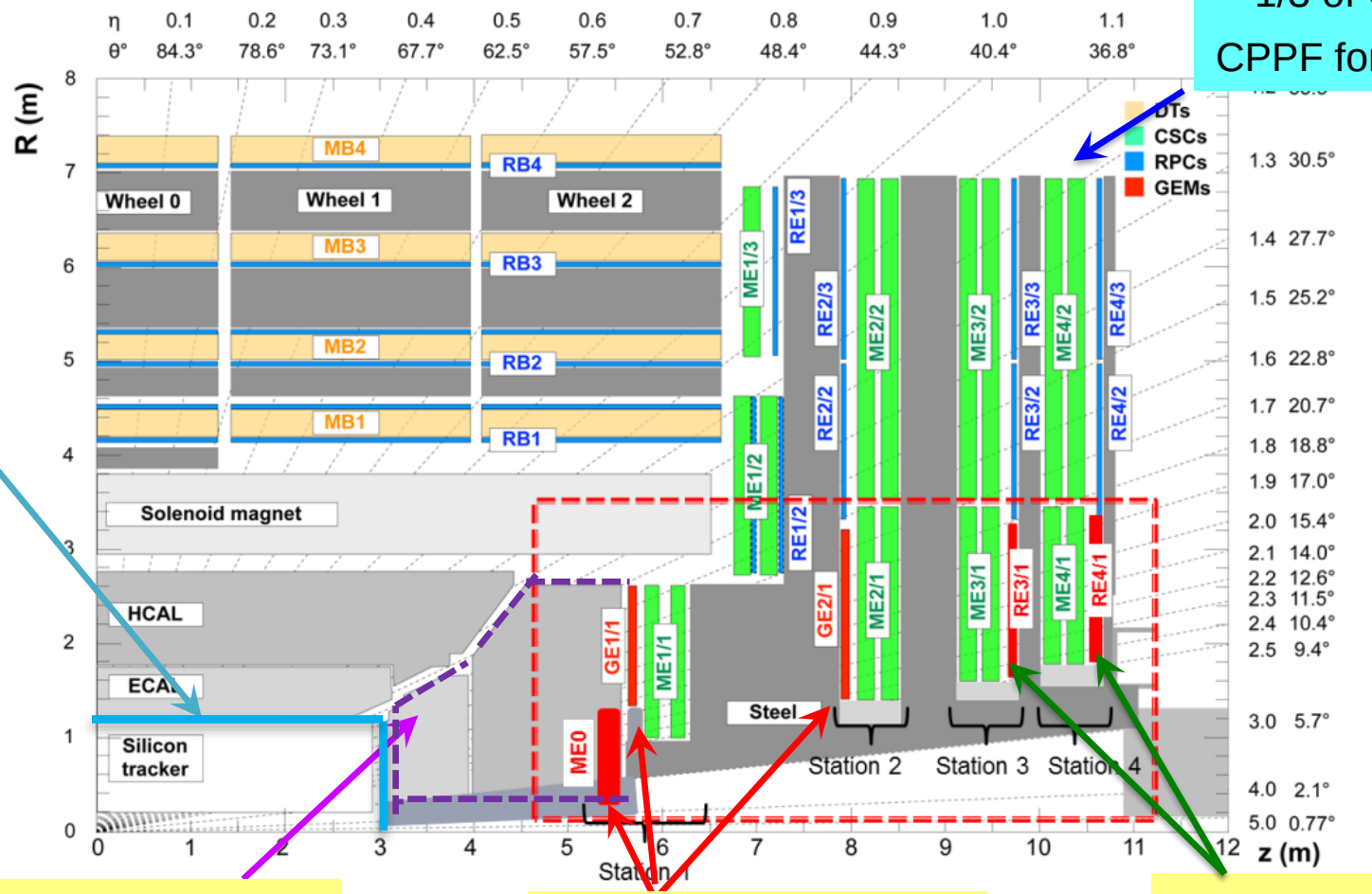
SDU+USTC
Produce: sTGC & FEBs

The CMS Upgrades

LS2

1/3 of CSC for ME4/2

CPPF for Muon L1-trigger



LS3

MIP-TD

PKU/THU/BUAA

USTC/SDU/SCNU

LS3

HGCAL

IHEP/THU/ZJU/FDU

LS3

GE1/1, GE2/1+ME0

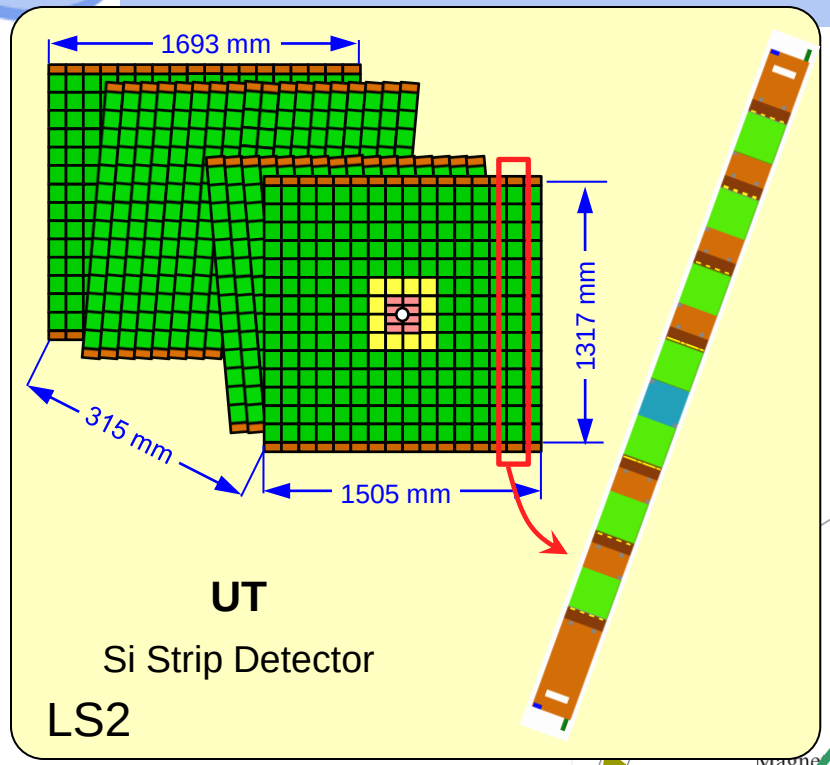
PKU/THU/SYSU/BUAA

LS3

Muon trigger backend

IHEP

The LHCb Upgrades



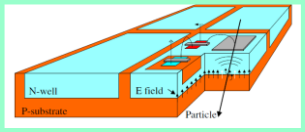
UT

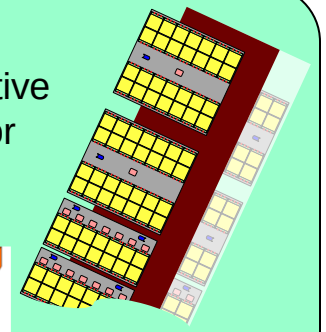
Si Strip Detector

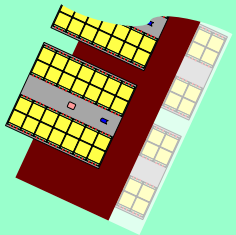
LS2

UT2

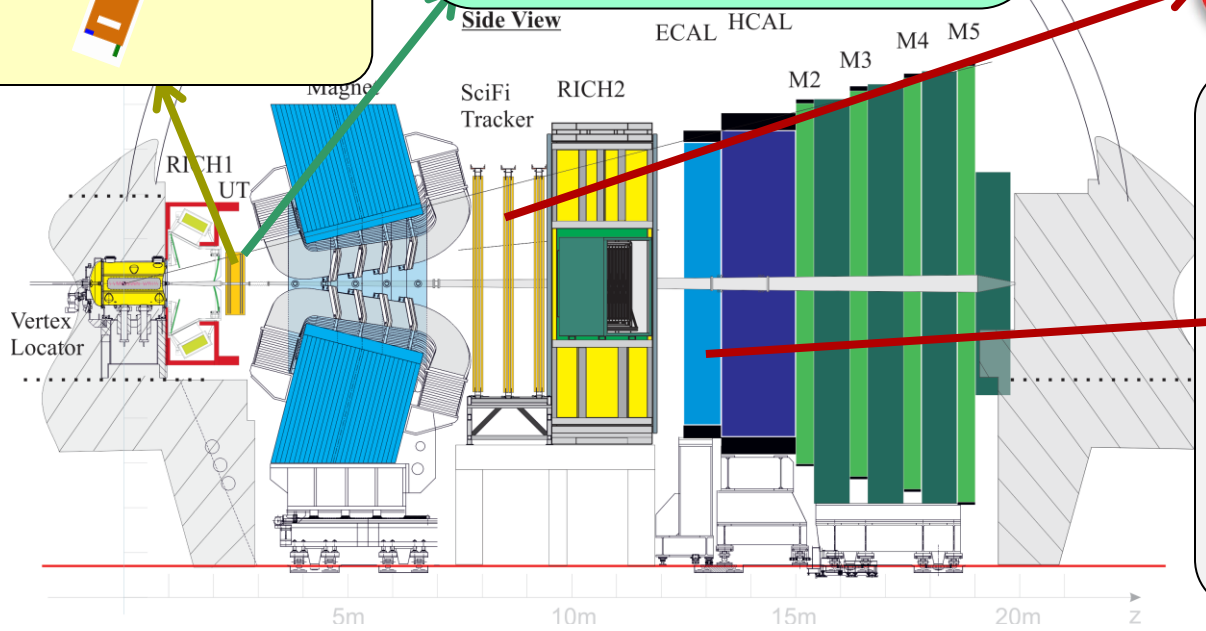
Monolithic Active Pixel Sensor

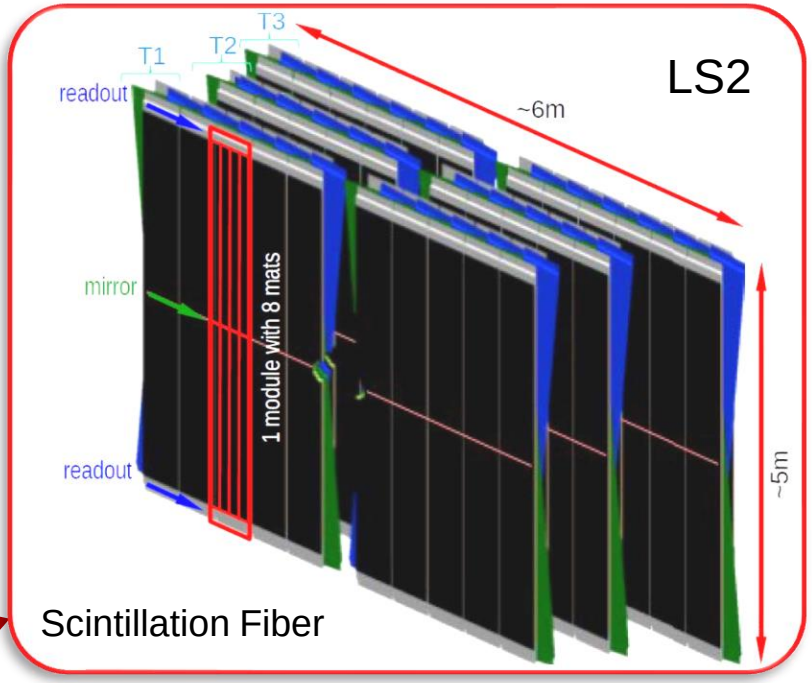






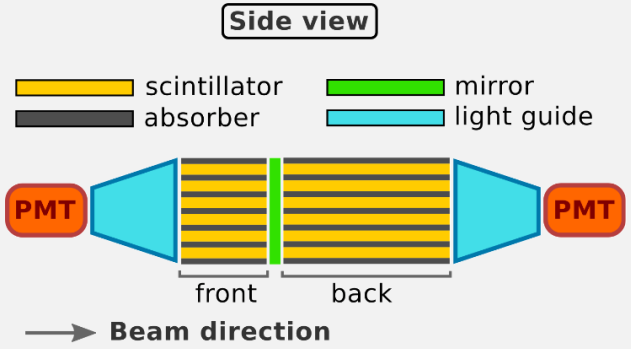
LS4





LS2

Scintillation Fiber



LS4 / 3

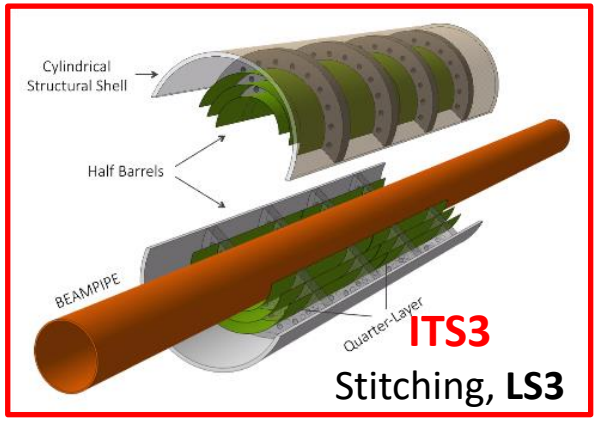
SPACAL

Spaghetti Cal

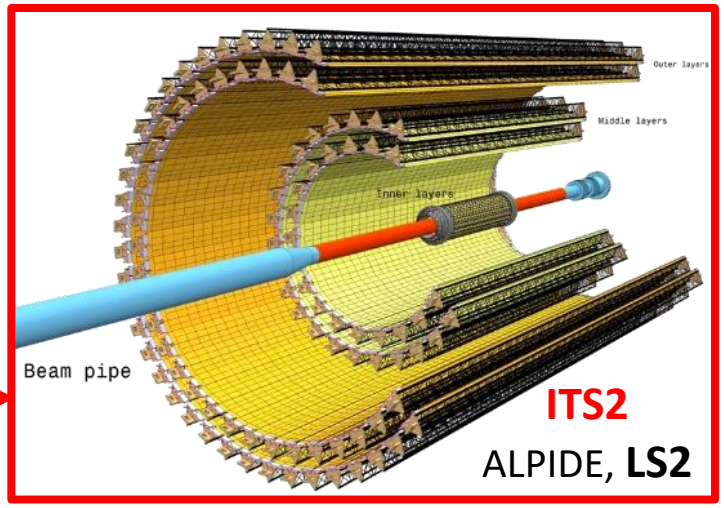
The ALICE Upgrades

ToF
LS4, LGAD,
or LGAD with MAPS

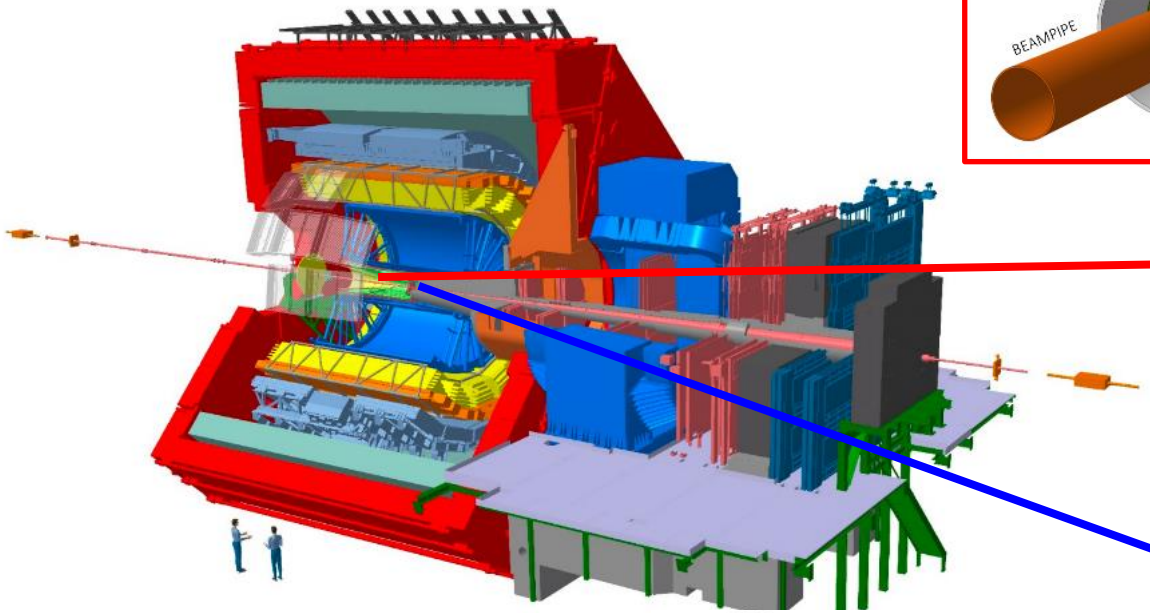
ITS4
LS4, bigger area ALPIDE



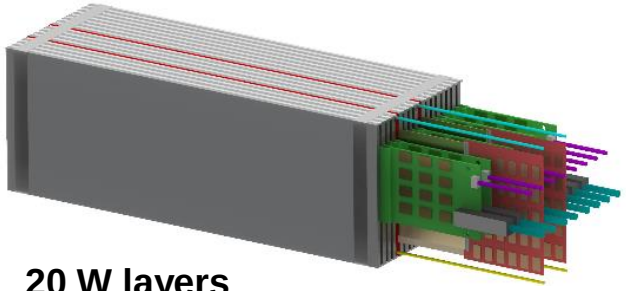
ITS3
Stitching, **LS3**



ITS2
ALPIDE, **LS2**

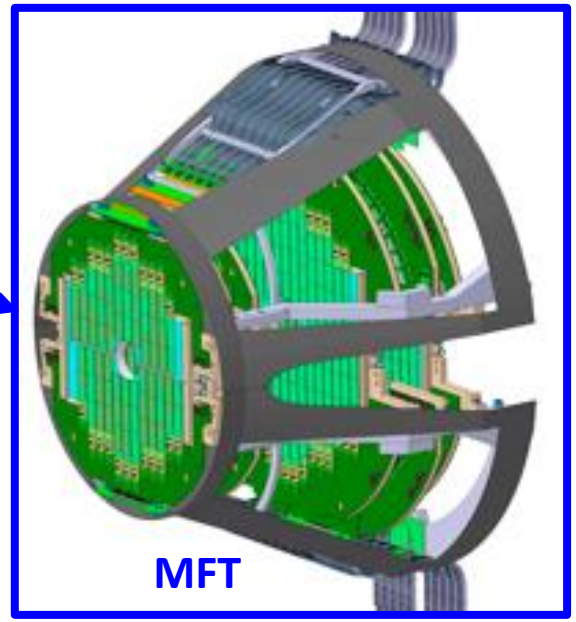


A full pixel layer with 3x15 ALPIDE chips



20 W layers
+ 18 pad sensors
+ 2 pixel layers

FoCal
LS3



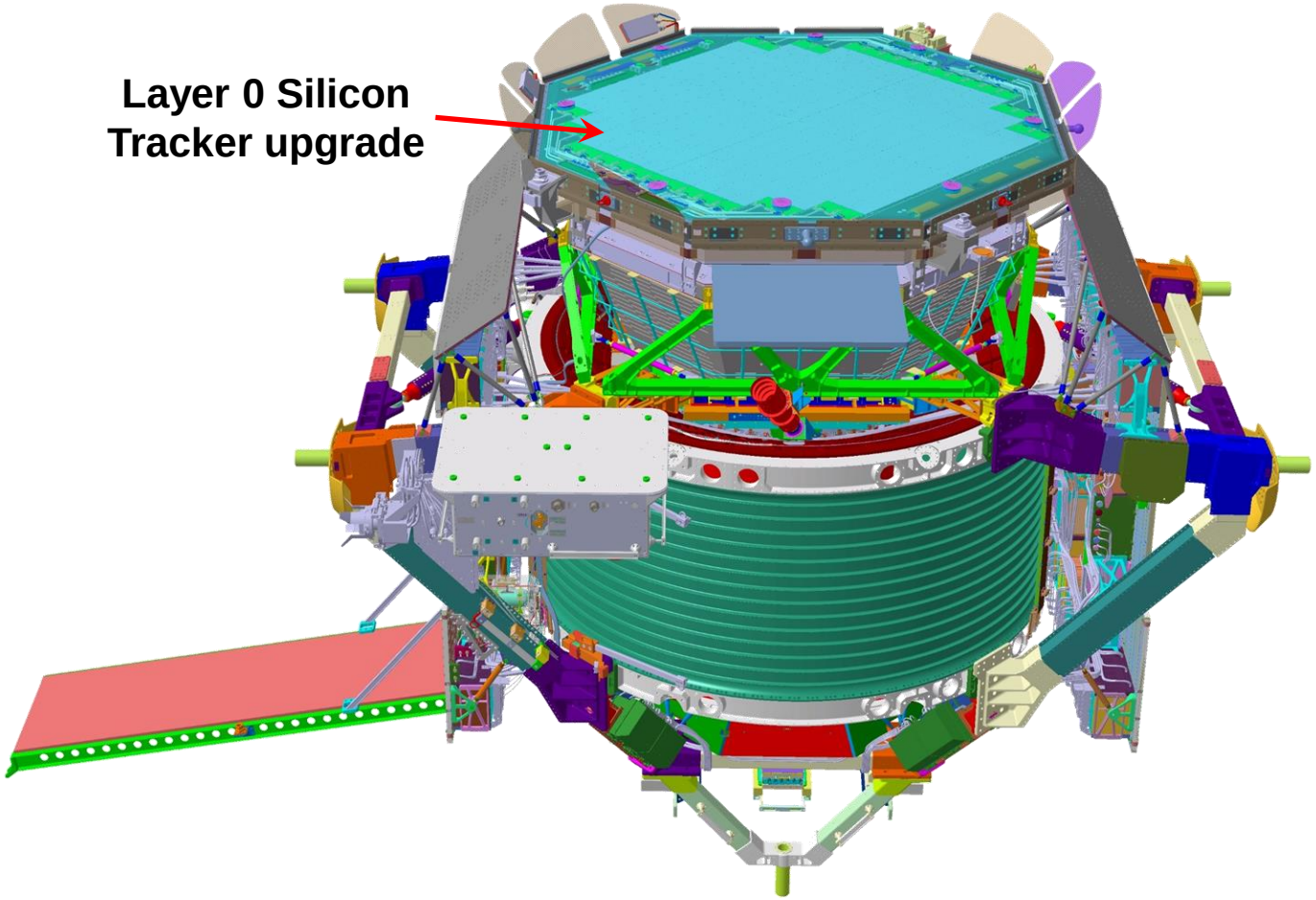
MFT

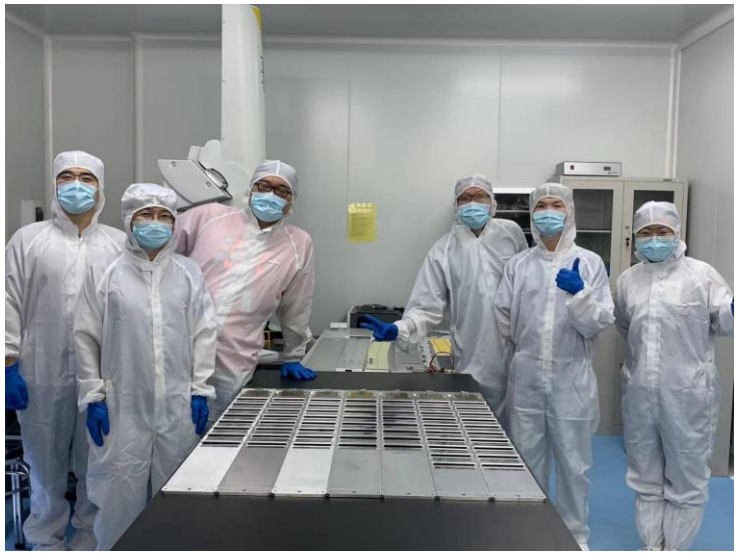
LS2
MFT discs

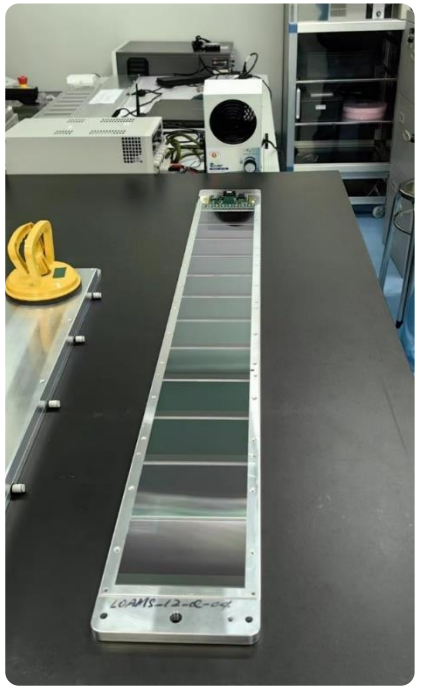
LHC Upgrades

	Detector	Basic technology	Major Contributions
ATLAS	NSW / LS2	Small strip thin gap chamber	sTGC panel, FEBs
	ITk / LS3	Silicon strip detector	Module production
	HGTD / LS3	LGAD	Whole process, project management
	Muon / LS3	RPC, sMDT, TGC	RPC trigger detector, MDT TDC ASIC, high-eta tagger
CMS	CPPF / LS2	Electronics for muon trigger	Concentrator, preprocessor and fan-out for Muon L1 trigger
	CSC / LS2	Cathode Strip Chambers	Module production
	HGCAL / LS3	Endcap calorimeter, sampling	Module construction
	MIP-TD / LS3	Mip timing detector, LYSO+SiPM	Electronics board, module test, …
	Muon & Trigger / LS3	Large area GEM, and electronics	GEM electronics board, GEM modules,
LHCb	UT / LS2	Silicon strip detector	Radiation hardness, installation & commissioning
	SciFi / LS2	Scintillation fibers + SiPM	Front end electronics
	UT / LS4	Monolithic silicon pixel detector	Sensor design, module/stave construction, project management
	SPACAL / LS4,3	Spaghetti calorimeter	GAGG crystal sensor, 3D printing W absorber
ALICE	ITS2 / LS2	ALPIDE pixel detector	Module production
	MFT / LS2	ALPIDE	Disc boards
	ITS3 / LS3	Monolithic stitched sensor MOSS	Sensor design
	FoCal / LS3	ALPIDE + absorber	R&D on pixel layer for 2 gamma separation, …
	ITS4 / LS4	Large size ALPIDE chip	Planning
	ToF / LS4	LGAD, or LGAD with MAPS	Planning

AMS L0 Upgrade







Endorsed in March 2022
Ready to produce real detector and finish by end of 2024

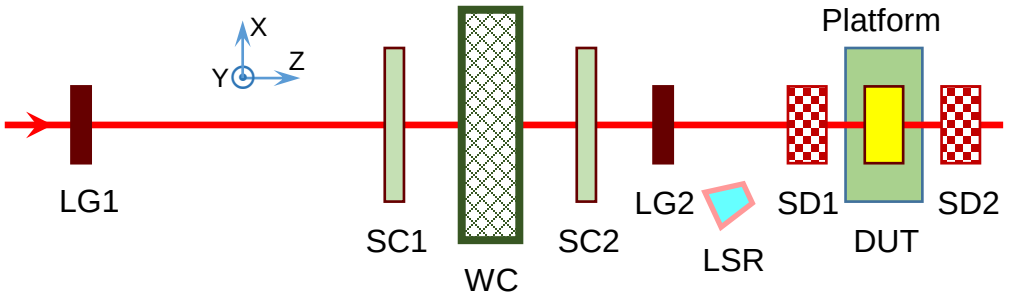
We have a strong team with potential

International Collaboration

- The TDR of a reference detector, aiming to release in June 2025, will aid the CEPC bid in the 15th 5-year plan.
- International collaborations in 2026 & TDR in 2028 are still consistent with the plan.

- Need advices and guidance on forming international collaborations & international collaborative efforts in detector R&D.

Proton Testbeam Facility



Proton Energy	**0.8-1.6 GeV**
Energy resolution	**<1%@1.6 GeV**
Tracking support	**<10 μm**
Beam size	**20×20mm², ≤Ø100 mm**
Weak beam	**<10 kHz**
Particle flux	**≥2×10⁶ p/s**