Comment pouvons nous contribuer dans notre communauté à un ou plusieurs Detector Concepts (via nos MP) ?

Microvertex
Tracking
PID
Calorimétrie

Previous General conclusions (Didier) :

maybe a good time to form dedicated FCC-ee MPs acknowledged by IN2P3 & IRFU

- Common with ILC existing progams where relevant

Current Conceptual Design proposals

Best simulation performance (everywhere?) see Roy's presentation at last meeting

CLD

- B-field ability for 3 – 4 T
- 3D High Gran. PFlow
- Med. track IP & p_T precision
- Med.(-) γ-energy precision
- Low p PID

IDEA

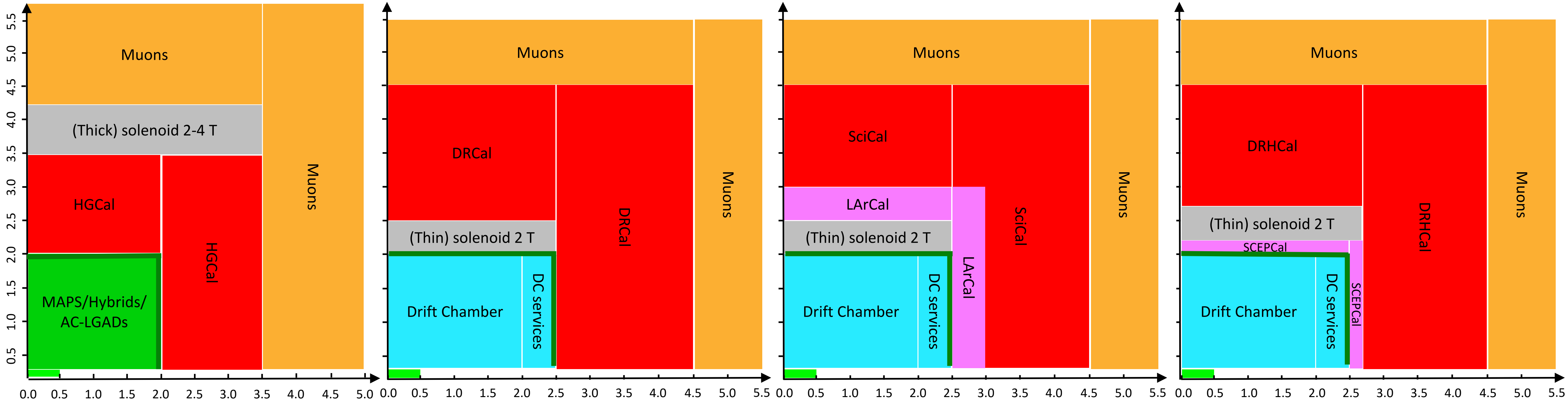
- B-field limited by X/X_0
- 2D Medium Gran. PFlow
- High track IP & p_T precision
- Med.(+) γ-energy precision
- High p PID

LArDet

- B-field limited by X/X_0
- 3D Medium Gran. PFlow
- High track IP & p_T precision
- Med.(+) γ-energyprecision
- High p PID

IDEA+ (SCEPCal)

- B-field ability for > 2T ?
- 2D Medium Gran. PFlow
- High track IP & p_T precision
- High γ-energy precision
- High p PID



CLD variants:
- PID RICH before HGCAL

IDEA variants:
- TPC instead of DT

LArDet variants:
- TPC instead of DT

IDEA+ (SCEPCal) variants:
- TPC instead of DT
- LKr instead of SCEPCal
- SciCAL instead of DRHCAL

Options & Variants

- Tracking systems (w/ - w/o PID) can be exchanged in different conceptual designs

Vertex Detector: MAPS

Wrap-up/Timing: Layer MAPS/Hybrids/AC-LGADs/SPADs/MicroMegas…

R&D topics in French community (Tracking-MAPS)

- MAPS for Vertex Detector - O(12) sensors in 12'' wafers times number of experiments

Track IP precision ALICE ITS3 in LS3 fulfil current FCC-ee requirements

- MP CMOS: IPHC , CBM, ILC TJ 180 nm, ILC TJ 65nm
- MP DICE: CPPM, IPHC, IP2I proposal for approval to join

TJ 65 nm in framework of WP1.2 CERN

Timing O(100) ps expected with current devices, compatibility with IP precision & benefit undefined yet

- MP Quartet: IPHC TJ 180 nm (targeting ns, now closed)
- IRFU Lfoundry: 150 nm
- May need further technology node step, possibly 3D integration, for real estate at small pitch

- MAPS for Central Tracking – Medium production O(100) m^2

Improve X/X_0 for p_T precision
ALICE-3, LHCb UT & MT in LS4

- No dedicated R&D: grouped pixels in strips slightly released ⊥ pitch

Timing implementation may not affect significanly X/X_0, benefit undefined yet

- R&D similar as for pixels
- Alternative technologies: CMOS, 3D, LGAD hybrid designs*

- MAPS for Wrap-up/Timing Layer:

Wrap-up - p_T precision w/ DC/TPC

- Same as MAPS layer in a Central Tracker

Timing Layer to provide low p PID** can be integrated in a Si-CT

- Need specific R&D, possibly new node and 3D integration, to reach $\lesssim$ 30 ps requirements
- IRFU: Micromegas + cerenkov radiator + photocathod
- Other alternative technologies 3D, LGAD, SPADs

** Today: CMOS hybrid same order of precision as MAPS, 3D and LGADS O(30) ps*

R&D topics in French community (Tracking-MAPS)

- **Summary MAPS (more possibilities in CLD-like full Si tracker design, depending on technology choice for Wrap-up/PID layers in a gaseous detector design)**
  - Current effort addressing mostly impact precision and low X/X_0
  - First attempts at exploiting timing properties with current technologies O(100) ps
  - Strong justification to develop designs that could provide $\lesssim$ 30 ps
  - System aspects (mechanics, cooling…) important for X/X_0
  - ➢ Large community with an IN2P3 platform C4PI at IPHC
    - Intermediate project interests ex. ALICE ITS3, BELLE 2, ALICE 3, LHCB 2
  - ➢ Right time to define common orientations beyond current R&D activities
    - Should consider technology aspects but also detector target, Vertex/Central Tracking, HGCalorimetry
  - ➢ Goal is to widen the R&D collaboration and to structure the common effort
    - Large consortium: CPPM, IJCLab, IPHC, IP2I, IRFU, LLR, LP2I, LPNHE, LPSC, Subatech
  - ➢ Opportunity for synergies with electronics R&D MP, ex. for timing implementation (including 3D integration)
    - MP Fastime ASIC < 10 ps precision, MP Lojic130 clock precision (IP2I + …) in 130 nm TSMC
  - ➢ Requires substancial resources both funding and RH; competitive international environment
    - Technology access complex for sensors (so far driven by CERN) no identified path towrd 3D integration

R&D topics in French community (Other Tracking , PID)

- Drift Chamber

Light wires Assembly techniques

➢ R&D MP Change at IJCLab - not in FCC-ee IDEA framework

- TPC

Ability to operate at Z-peak luminosity (ion-feedback) Ability for dN/dx

➢ R&D TPC at IRFU for ILC
➢ R&D MicroMegas at IRFU, option for TPC readout

- PID

Timing Layer

➢ R&D at IRFU Micromegas with Cerenkov radiator and photocathode
➢ R&D at IJCLab AC-LGAD

RICH

➢ R&D MP Cerenkov Lab (DIRC with ToF design) at IJCLab - not in FCC-ee framework

- **Interest to follow-up these developments and connect them to FCC-ee**
  - ➢ Resource needs relatively limited at this stages

R&D topics in French community (Calorimetry)

- Noble Liquid Calorimeter

Improve granularity for PFlow ability High density feedthrough Low noise electronics in cold Improve EM-energy resolution w/ LKr

- R&D at IJCLab dedicated to FCC-ee
- Large community in ATLAS

- High Granularity Calorimeter

ECAL section electronics and system integration	MP CALICE/ILC, IJClab, LLR, LPNHE, LPSC, and CMS at LLR, OMEGA for electronics
ECAL section Si-sensors	Possible synergy with MAPS developments
HCAL section	MP CALICE, SemiDigital HCal with RPCs IP2I or with MicroMegas IRFU

- Scintillating – Cerenkov in DRCal and SCEPCal

Material	R&D at ILM (UCBL1), CPPM in CERN Crystal Clear (LHCb 2 - LS4), interest at IP2I and LPCC New powder-O concept R&D at IJCLab
Electronics	R&D at LPCC: 65 nm electronics for LHCb 2 LS4

Scintillator- Cerenkov “Chronography” (C. Morel) timing oriented (including medical application) – CPPM, ILM, IJClab, IP2I, IRFU, LPCC, LPSC, Omega

Calorimetry

- Several technologies being considered

Technology	ECAL	HCAL
CLD / CALICE-like	W/Si W/scint + SiPM	Steel/scint + SiPM Steel/glass RPC
IDEA / Dual Readout	Brass (lead, iron) / parallel scint + PMMA (Č) fibres, SiPM	
Noble Liquid	Fine grained LAr (LKr) / Pb (W)	CALICE-like ?
Crystals	Finely segmented crystals (possibly DR)	Dual Readout fiber

- **Summary Calorimeters (fully Conceptual Design correlated)**
  - Large community for HGC and Noble Liquid
    - HGC R&D oriented towards ILC up to now, possible synergy with MAPS R&D;
    - Noble liquid fully dedicated to FCC
  - Interest to follow-up other options for contribution in a high E-γ resolution and/or DRCAL Conceptual Design
  - Requires substancial resources both funding and RH, when reaching system design level

Discussion on selected topics

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- Possible synergy with MAPS developments

HCAL section

- MP CALICE, SemiDigital HCal with RPCs IP2I or with MicroMegas IRFU

- Scintillating – Cerenkov in DRCal and SCEPCal

R&D at ILM (UCBL1), CPPM in CERN Crystal Clear (LHCb 2 - LS4), interest at IP2I and LPCC
New powder-O concept R&D at IJCLab

Detector Concept Working Group Goals & Plans

Overall goals:

- Demonstrate that detectors can be built to fully exploit the FCC physics opportunities
  - Optimize the compatibility of the detector concepts with operation at the FCC-ee, with the Machine-Detector Interface layout (MDI), and with the timing and background conditions
  - Show that performance requirements can be met with existing or emerging technologies and realistic integration concepts
- Provide guidance for coherent detector R&D efforts to address FCC detector requirements
  - And to support their funding requests

A Detector Concept eventually includes:

- Assembly of sub-detectors including magnet system
- Systems for data acquisition, processing, powering and cooling based on estimate of data rates and size
- Software implementation of detector allowing performance evaluation
- Overview of services, consumables, power consumption, and ecological impact;
- Evaluation of construction and operating costs.

Programme PostDoc IN2P3 Calorimétrie

Optimisation d'un calorimètre pour FCC-ee

1st objectif: calorimètre ultra-granulaire

a. Formation (outils ILD/FCC)
   Profiter de un ILD-thesard deja a LLR

b. Mise en place d'un outils générique de l'estimation du flux de donnée (→ puissance consommée) à partir des simulation existantes

c. Optimisation des paramètres granularité 4D / puissance
   Estimation/Comparaison pour des canaux simples ZH ($Z \to ee$, jj), séparation $\pi 0/\gamma$, [tau physics]

2nd objectif : calorimètre lAr

En // de b. et c.
Pas mal d'outils existent déjà, collaboration avec NM

Lancer la “call” d'ici une semaine su le site du CNRS