ATHENA Proposal Committee: Integration & Global Design Subgroup NEWS

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HOW ARE WE WORKING

REMINDER

Proposal Committee: Integration & Global design

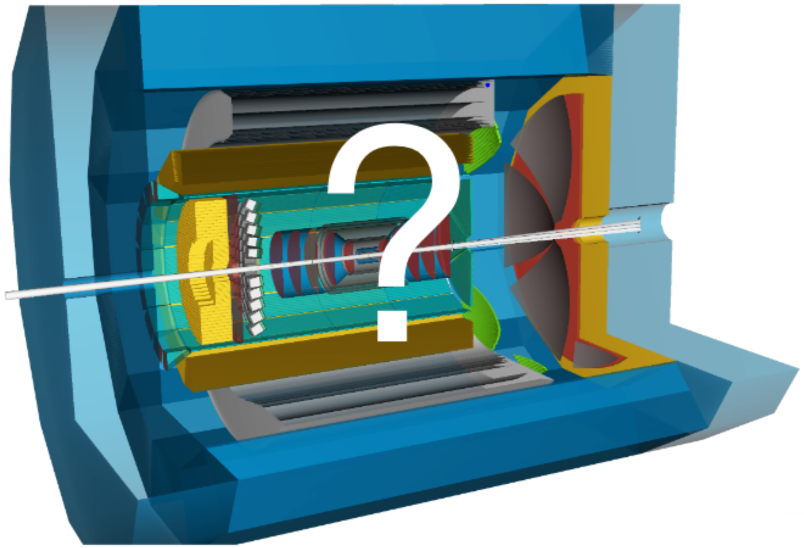
- 14 meetings so far
- each Wednesday, at 11.00 am (EDT)
  - WG conveners invited according to the needs of the agenda of each individual meeting
  - An opportunity to thank all of them for their help and collaborative attitude
  - Material posted in INDICO
- INDICO page: https://indico.bnl.gov/category/378/

Integration & Global Design Subgroup, GOAL

REMINDER

The Goal of the I/GD Subgroup is …

Design this:



and:

- Meet all physics requirements
- Low risk
- Upgradable
- Cost effective
- Superior to other concepts

with:

- Detector Working Groups
- Engineers
- Project
- Software Group
- DD4HEP
- Physics Working Groups
- Patience
- Little Time

In a constructive and friendly way

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slide by Thomas Ullrich, bi-weekly 9/16

WHERE ARE WE vs GOAL

REMINDER

INTRODUCTION - The principle that guides us

- Design a detector where:
  - All the essential subdetectors are present in the baseline configuration and no more than that
  - The configuration is realistic from the engineering point of view:
    - The different subdetectors do not interfere one with another
    - The subdetectors can be mechanically supported
    - The subdetectors can be supplied (power, cooling, data transfer)
    - The detector can be assembled
  - Later, strategic upgrades can be easily accommodated within the baseline configuration

Essential contribution of the project thanks to our project contact person

→ Minimize the number of detectors

→ With the help and support of the WG conveners, operate choices

→ Define the R&D's of interest for the base-line and the possible upgrades

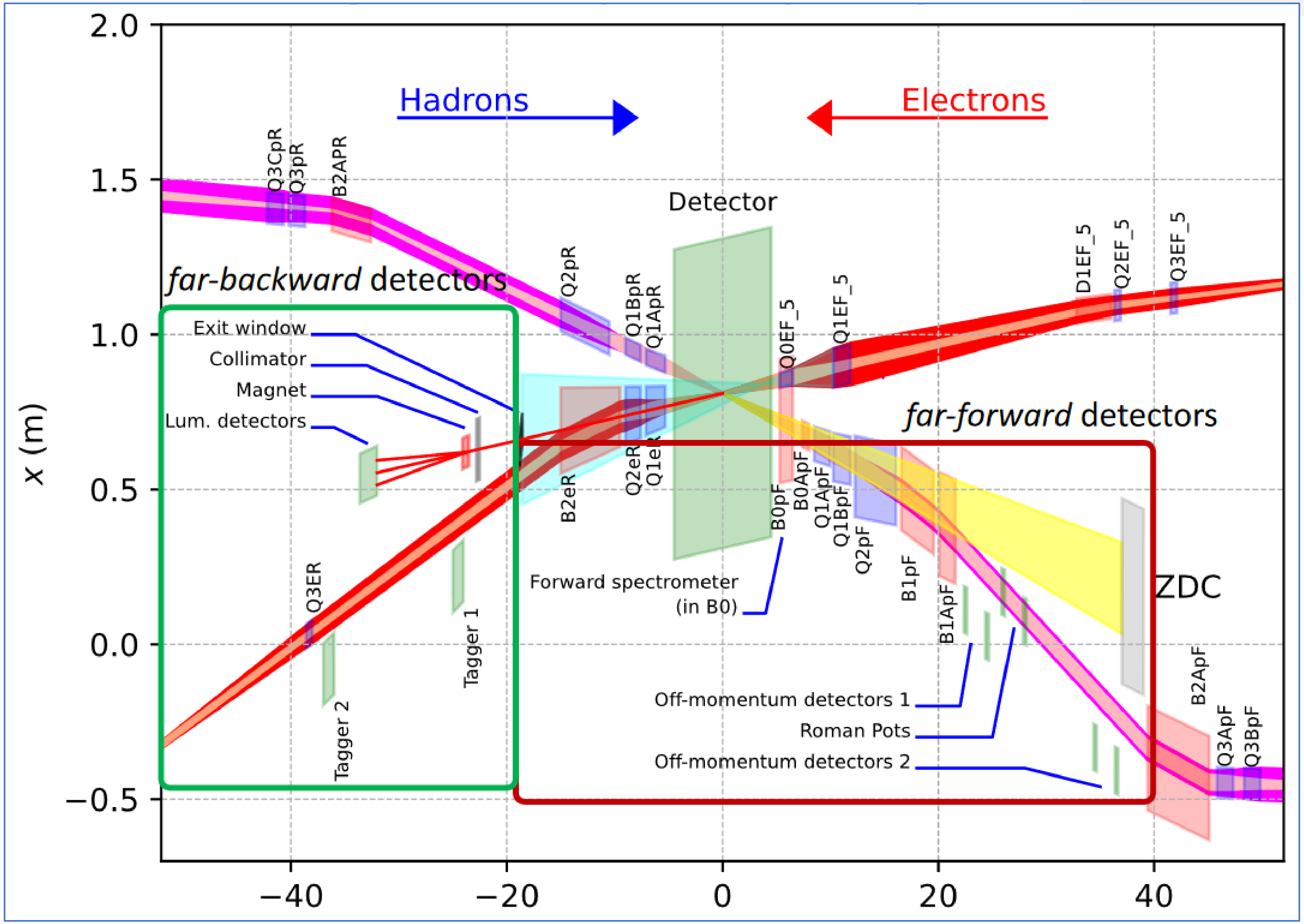
WHERE ARE WE vs GOAL

- At the previous meeting focus was mainly on CD
- New: Calorimeter configuration for the Proposal defined
  - Reported in the dedicated talk

TODAY we report about FF and FB DETECTORS

- FF, based on
  - the 10/4 report by WG conveners (Alexander Jentsch, John Arrington)
  - Further contributions about ZDC layout (Elke Aschenauer, Alexander Kiselev, Thomas Ullrich)
- FB, based on
  - the 10/4 report by WG conveners (Krzyzstof Piotrzkowski, Jaroslaw Adam)

Global layout

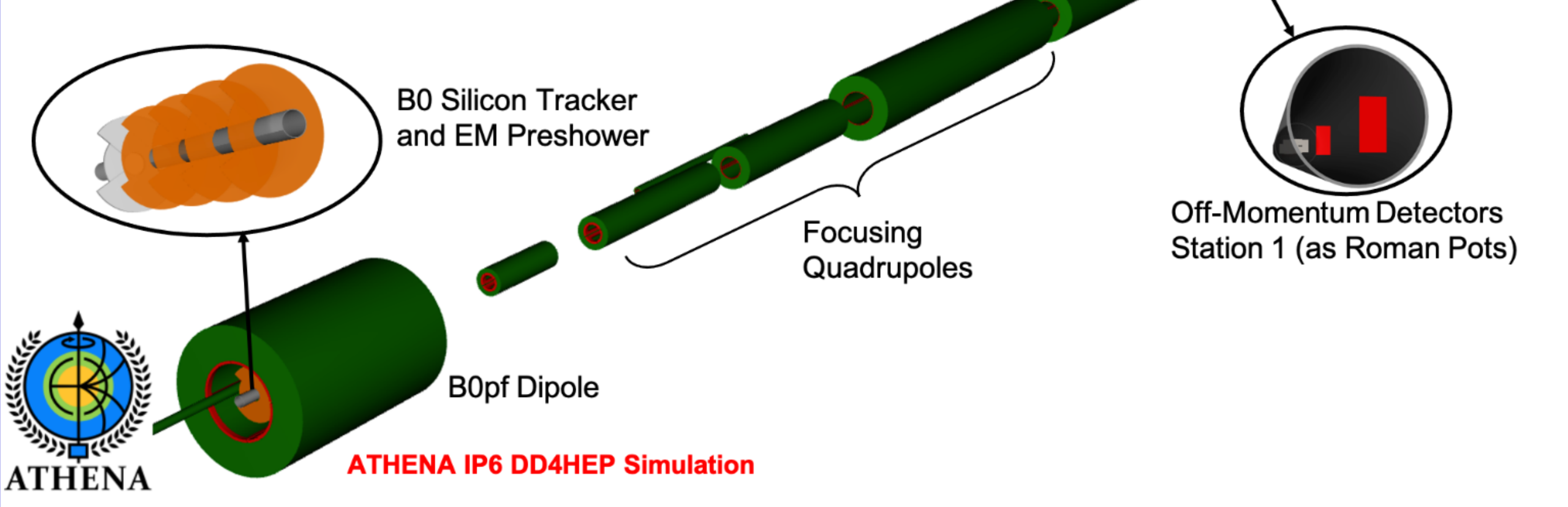


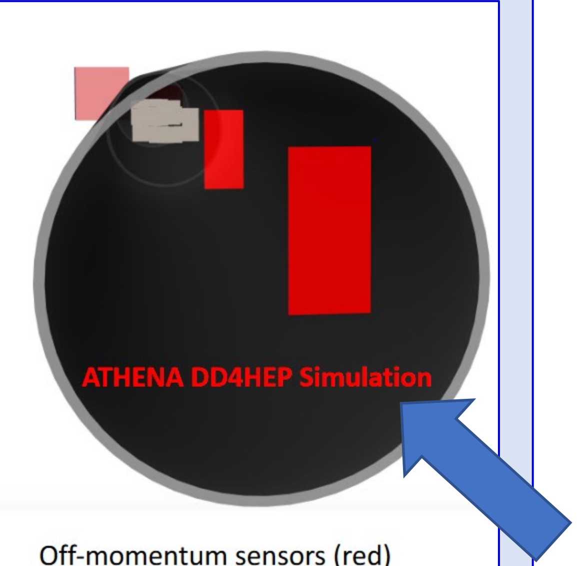
Far Forward

About Off-Momentum Detectors

- **1 single station covering the requested phase-space**
- **same technology as for Roman pots**

Detector	Acceptance
Zero-Degree Calorimeter (ZDC)	$\theta < 5.5$ mrad ($\eta > 6$)
Roman Pots (2 stations)	0.0* < $\theta < 5.0$ mrad ($\eta > 6$)
Off-Momentum Detectors (2 stations)	$0.0 < \theta < 5.0$ mrad ($\eta > 6$)
B0 Detector	$5.5 < \theta < 20.0$ mrad ($4.6 < \eta < 5.9$)



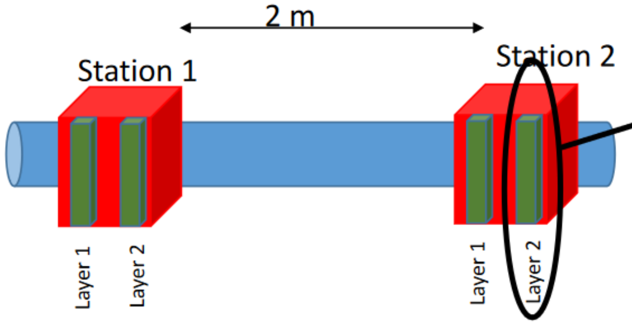


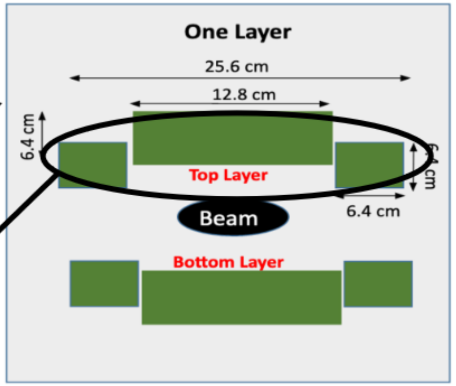
Off-momentum sensors (red) inside beam pipe vacuum.

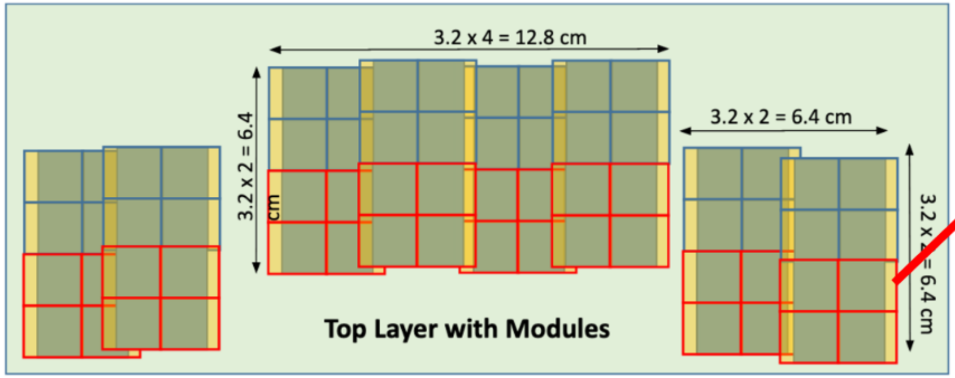
About Roman Pots

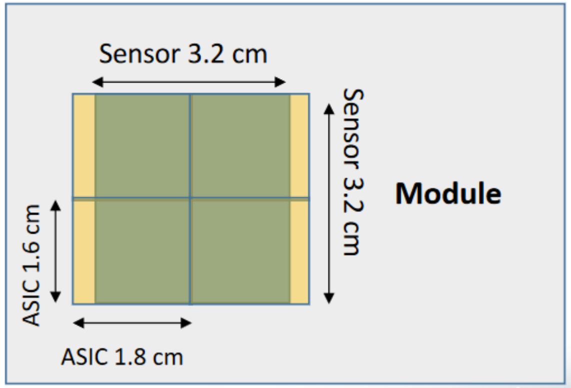
Roman Pots

- Updated layout with current design for AC-LGAD sensor + ASIC.









- Current R&D aimed at customizing ASIC readout chip (ALTIROC) for use with AC-LGADs.

Based on eRD24 R&D work.

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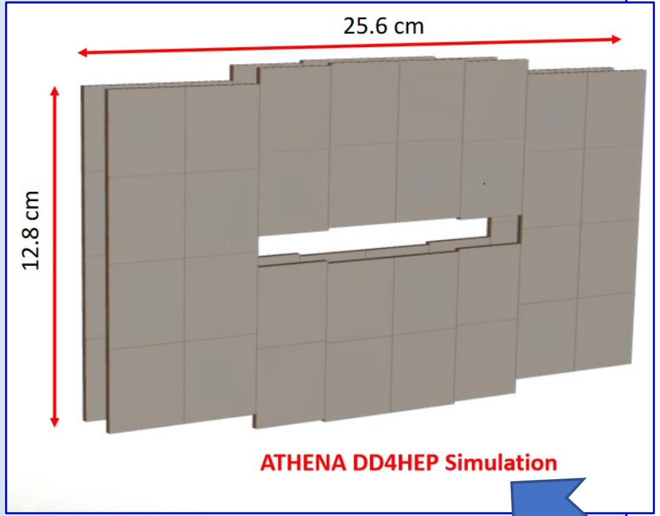
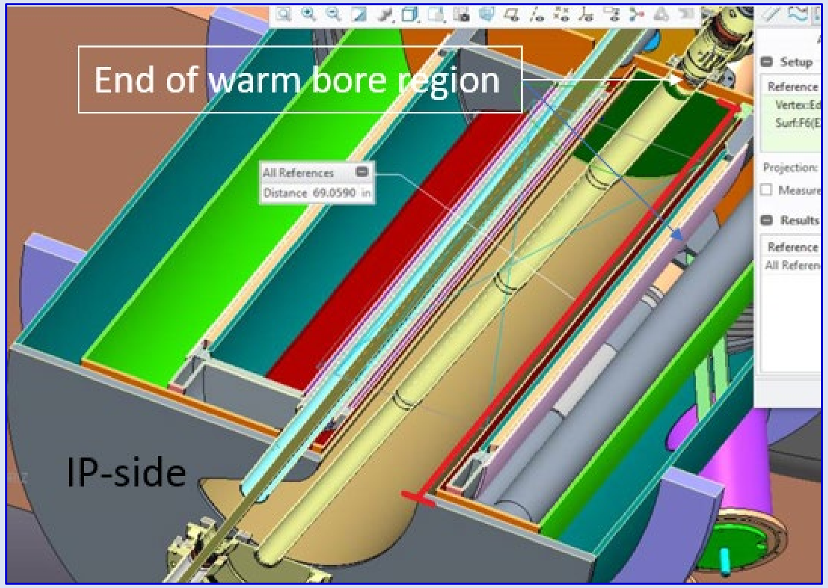
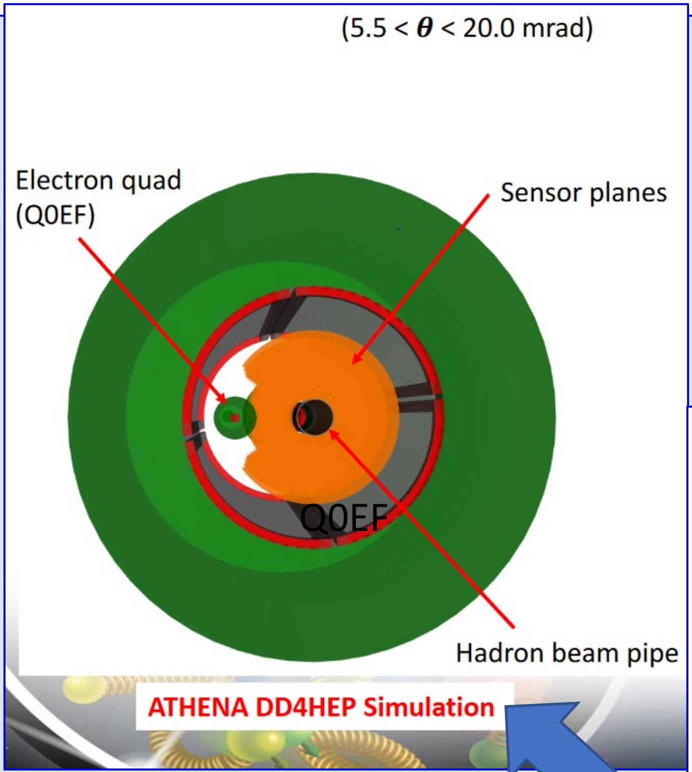


- AC-LGAD sensor provides both fine pixilation (500um square pixels), and fast timing (~30ps).
- “Potless” design concept with thin RF foils surrounding detector components.

BO Detectors

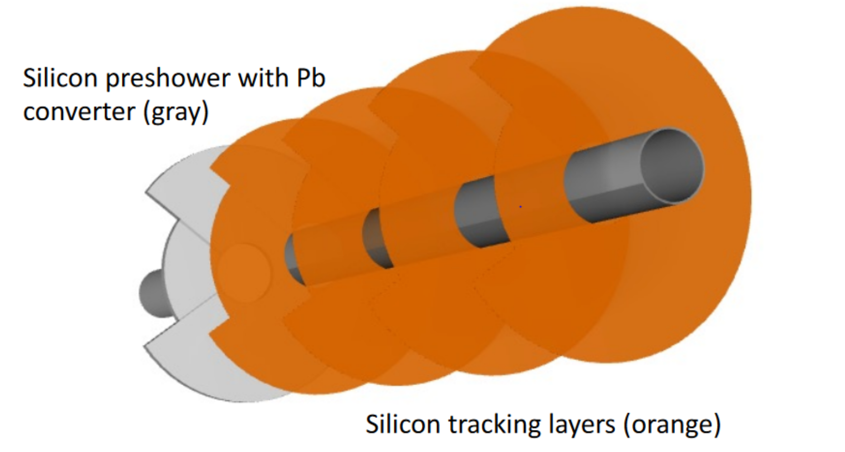
Difficulties and constrains for detectors in B0PF in evidence in a message from the project management





ATHENA B0 (5.5 < θ < 20.0 mrad)

- Charged particle reconstruction and photon tagging.
  - Four tracking layers
  - silicon preshower detector for photon tagging.
    - 2 radiation of lengths of Pb followed by silicon plane.



- Two possible configurations.
  - 2 layers of MAPS + 2 layers of AC-LGADs
  - 4 layers of AC-LGADs
- The latter option is ideal if the spatial resolution demonstrated at the test beam (5-10um) is the true performance.

YR studies pointed to the need for accurate t measurement in the B0, with 4 Silicon planes separated by 30 cm each, indented by 10 cm from the surface of the B0
→ this would occupy 1 m of the 120 cm.
→ a passive absorber as pre-shower allows identification of γ's

ZDCalorimeter

ZDC: the only element of the FF still requiring refinement

- **Goals:**
  - photon (from nuclear breakup) tagging
  - π^0 reconstruction
  - hadron (n) identification and measurements
- **Intrinsic limitations**
  - huge low energy photon background
  - n-momentum with Fermi motion effect
- **In this context, eRD27 approach (400 pieces of (3 x 3 x 5) cm^3 PbWO4 crystals) appears overdoing (and expensive)**
- **Presently considered design:**
  - ECAL part: tungsten powder SciFi calorimeter
  - HCAL part PbSc with imaging either by PbSi or PbSCiFi
    - 1000 (1 cm x 10 cm x10 cm) Pb plates re-used
- ZDC, the only FF detector still requiring work for its full implementation in DD4HEP

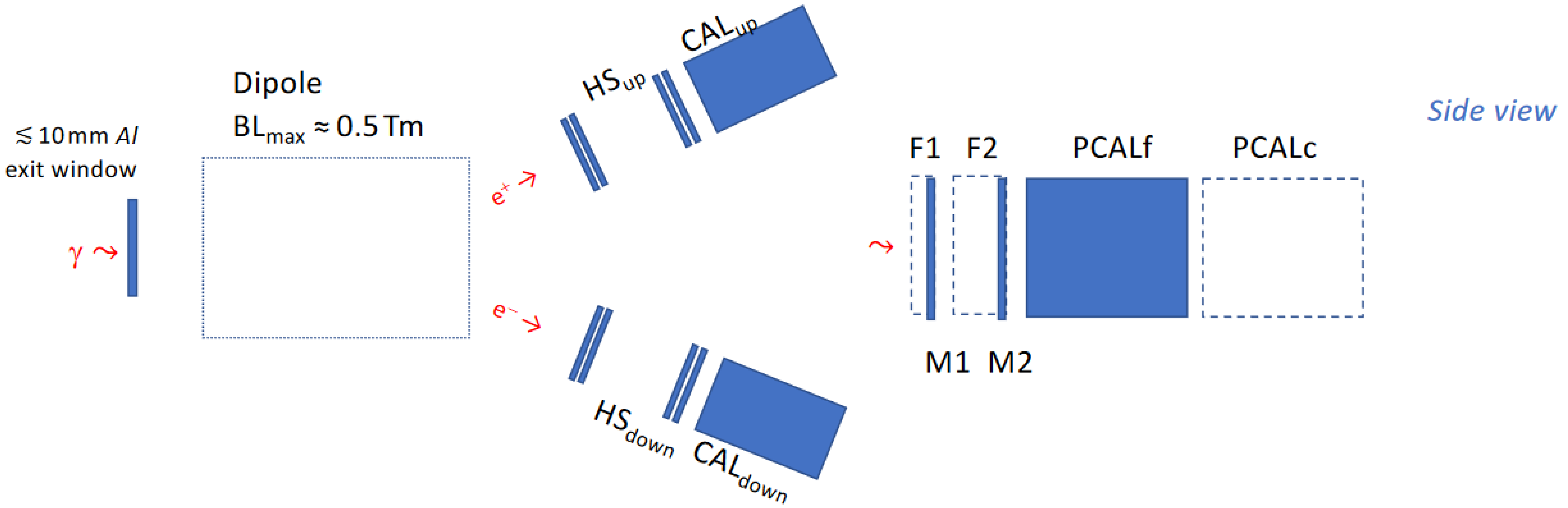
Far Backward

LUMINOSITY MEASUREMENTS : the approach

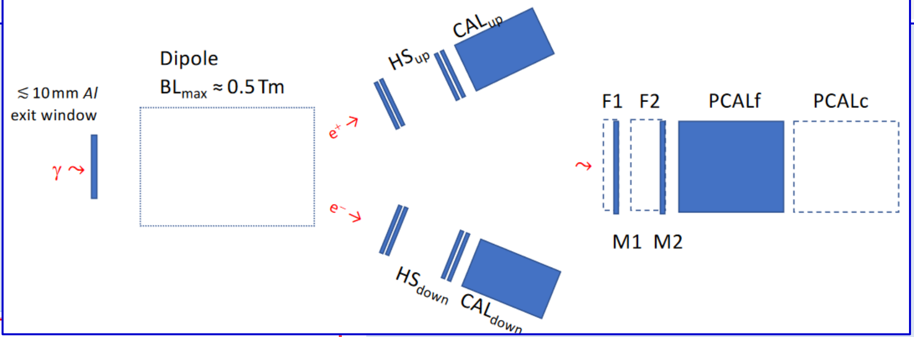
FarBackward WG: need for three luminosity methods

Luminosity measurements at the EIC are very challenging: huge event rates + wide electron beam energy range (5… 10… 18 GeV) + large spectrum of nuclei species (from *p* to *Au*) ⇒ there is no unique best solution – one needs to use 3 largely complementary bremsstrahlung measurements**:

1. *Reference* measurement – photon **counting** with a (movable) calorimeter PCALc, only at *low L*
2. Photon conversion **counting** using $CAL_{up/down}$ + $HS_{up/down}$ (outside SR fan)
3. Photon **energy flow**, or $\langle E_{PCALf} \rangle$, using a movable calorimeter PCALf, with SR filters/monitors in front



LUMINOSITY MEASUREMENTS : the technologies



PCALf – **Luminosity (online) Monitor**: for 10 × 275 GeV *ep* ⟨E_{PCALf}⟩ ≈ **40 GeV** at the nominal *L* ⇒ huge detector irradiation ≈ 100 Mrad per 100 fb^{-1} for *ep* ⇒ proposed solution – movable tungsten (or lead) spaghetti calorimeter with fused quartz (silica) fibers readout by SiPMs (or fast PMTs)

F1/2 + M1/2: at 18 GeV SR is hard and needs strong filtering/suppression ⇒ proposed solution – two movable tungsten /graphite filters 0.5 X_0 and 1 X_0 thick, equipped with fused silica fibers + SiPMs as SR monitors

A similar energy resolution of about 10%/√E should be required for the three calorimeters **PCALc + $CAL_{up/down}$** + a very good linearity well below 0.1 GeV for PCALc and higher segmentation for $CAL_{up/down}$

Event rates for $CAL_{up/down}$ are around 100 MHz, and the expected maximal irradiation is less than 1 Mrad per 100 fb^{-1} for *ep* collisions – proposed solution: tungsten (lead) *spaghetti calorimeter* with radhard scintillator fibers + PMTs

HS_{up} + HS_{down}: "spectrometer" method has to deal, at the nominal *L*, with a significant *event pileup* ≈ 0.1 for *ep* and about 2 for *eAu; hodoscopes* are also essential for calibrations/systematics ⇒ proposed solution – 2 × two parts: with 4 front planes of 1 mm square, straight scintillating fibers + 4 back planes of 2 mm fibers, all read out by SiPMs – **about 800 channels** in total.