

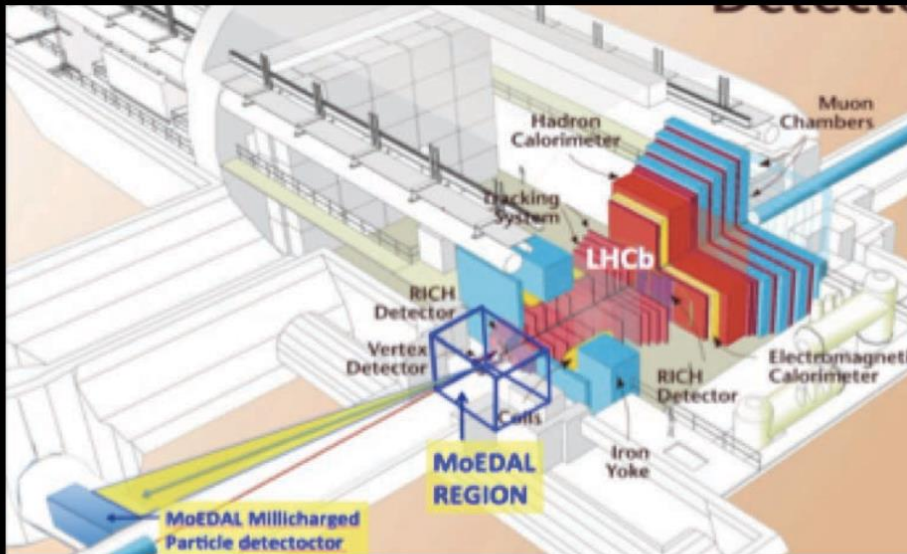
# A Detector for Millicharge Particles for the MoEDAL Upgrade

Albert De Roeck

# MAPP Detector for MoEDAL

- MoEDAL considers a detector for millicharge particle detection.
- proposes a simpler version compared to MilliQan so likely with reduced sensitivity, maybe up to  $\sim 0.01e$ ?
- Most of the material (scintillator, electronics) seems available/recycled. No real details given.
- Discussed at the LHCC closed session, positive reaction.
- No detailed studies started yet on sensitivity, background, trigger details, etc. Cavern option explored
- Manpower to work on it seems limited so far, due to present other priorities in MoEDAL

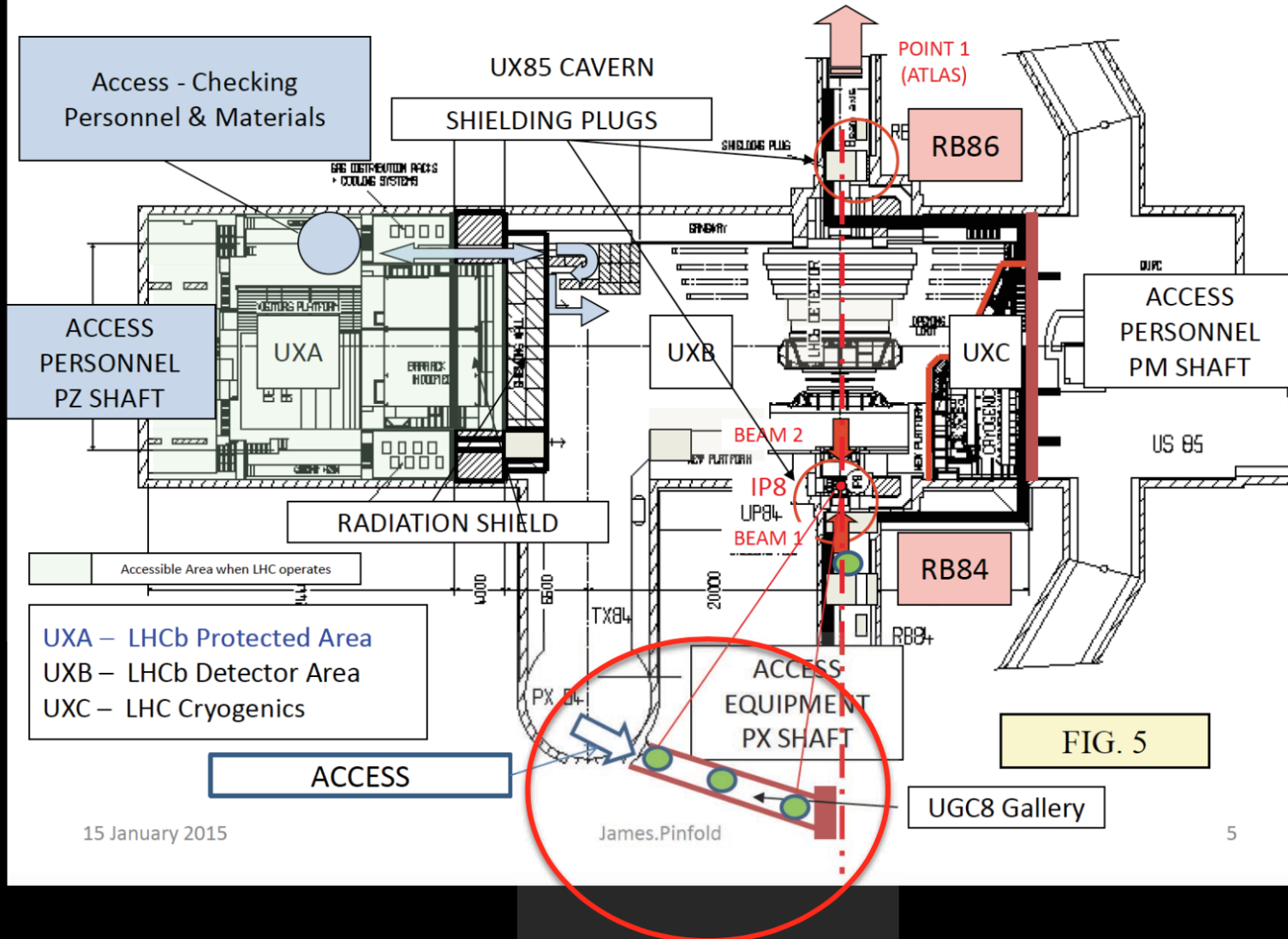
# 1) MoEDAL Apparatus for Penetrating Particles (MAPP)



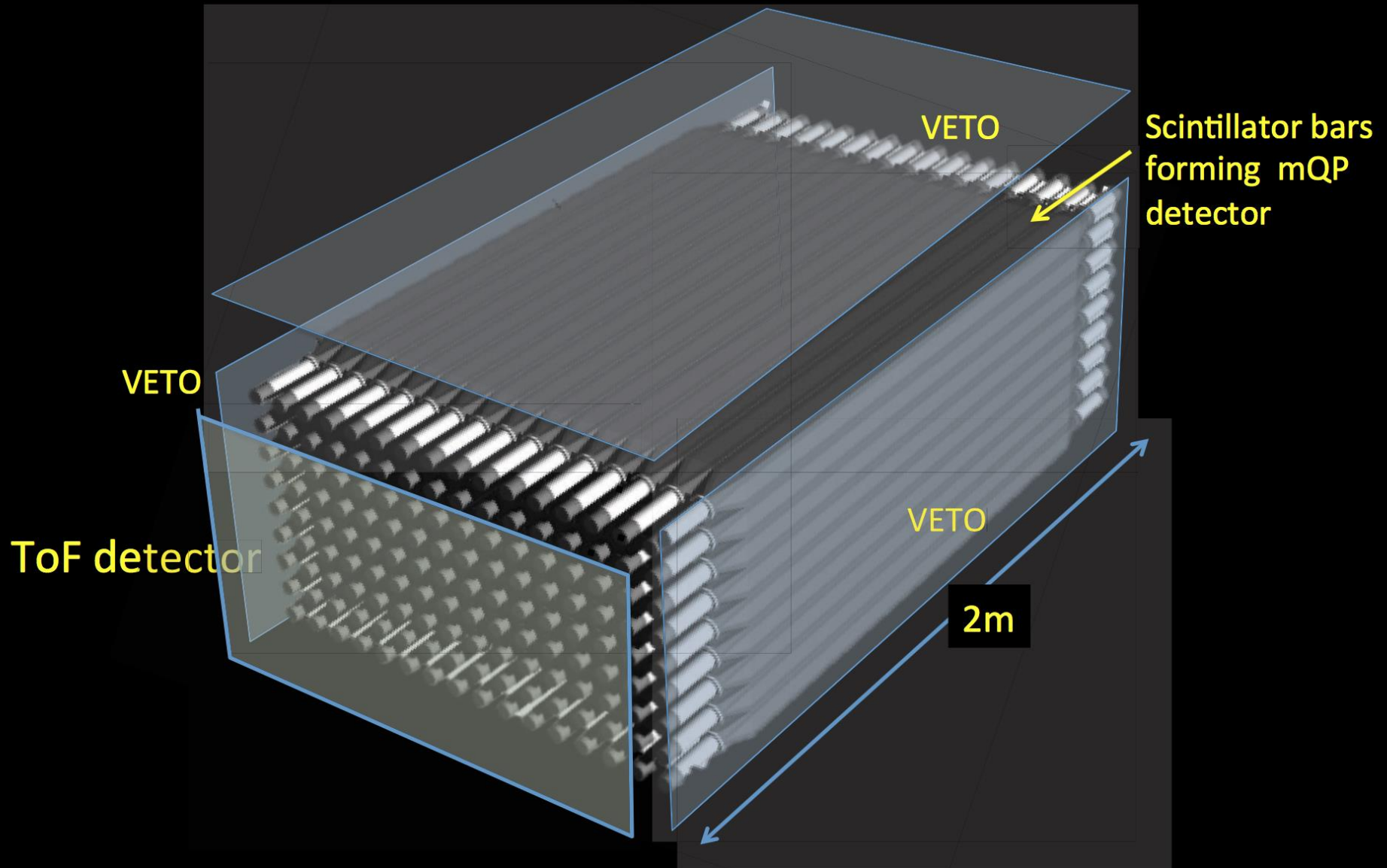
- *MAPP will be able to take data in  $p$ - $p$ ,  $p$ - $A$ ,  $A$ - $A$  and also fixed target interactions using SMOG (an internal gas target in LHCb)*
- *MAPP has three motivations*
  - *To search for particles with charge  $\leq 0.1$  (beyond the reach of the other LHC detectors)*

# A More Detailed Geography

## IP8 /UX85 - MoEDAL Millicharged Part. Det.



# Sketch of a MAPP Particle Detector Module



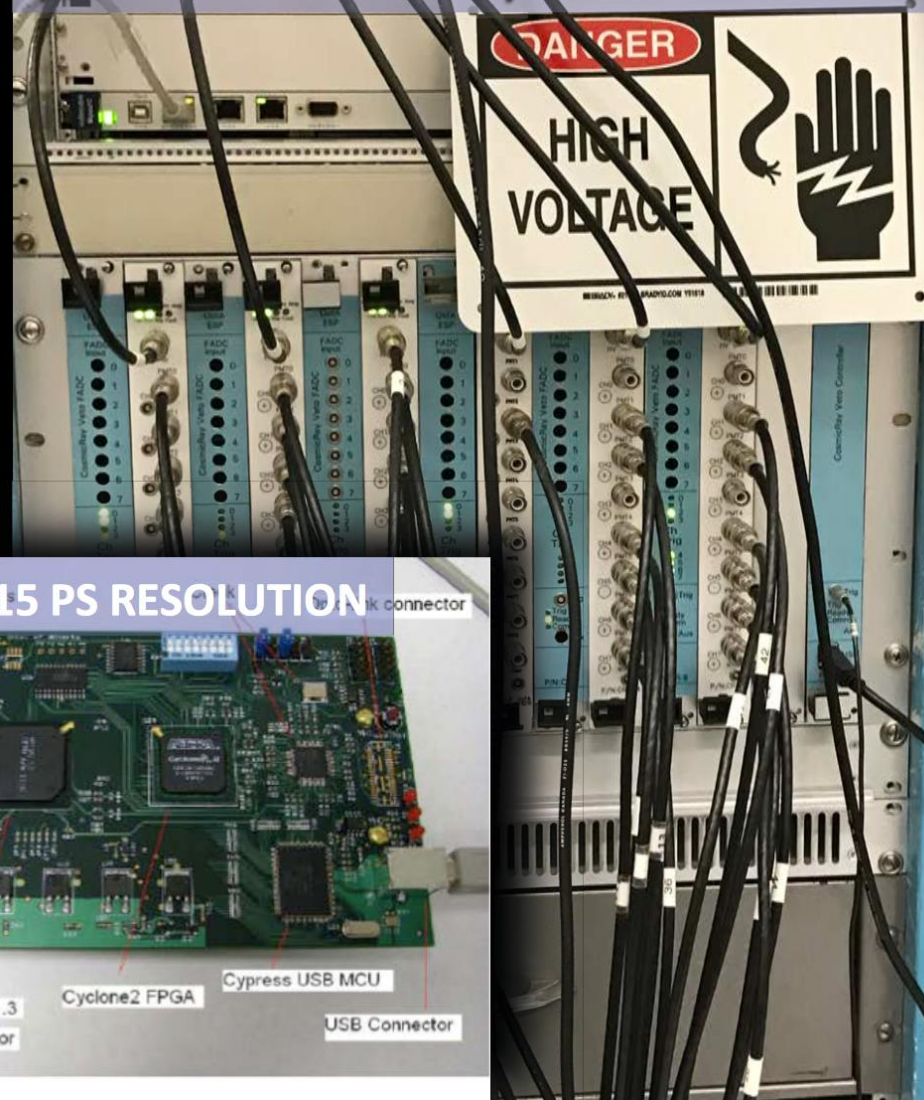


# MAPP Detector Electronics

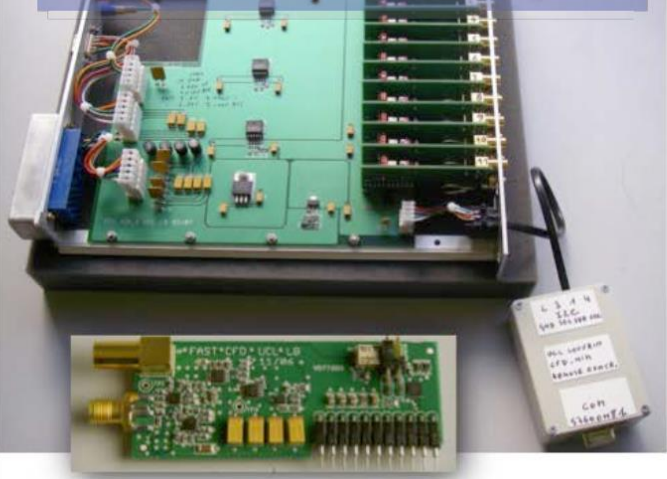
RCE (RECONFIGURABLE CLUSTER ELEMENT)



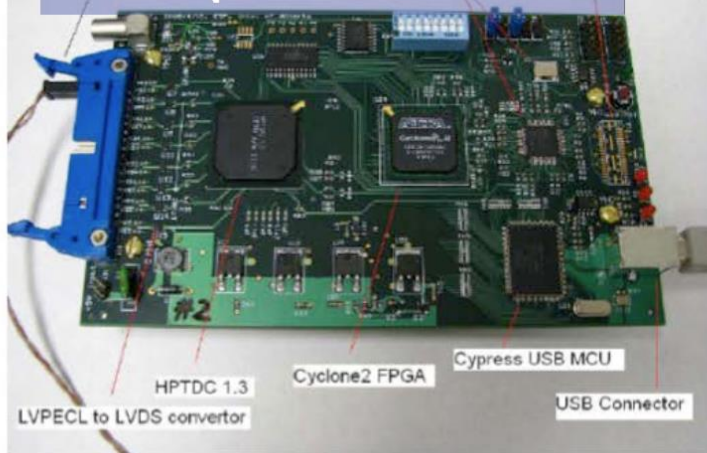
PROGRAMMABLE COINCIDENCE UNITS (WITH PULSE READOUT)



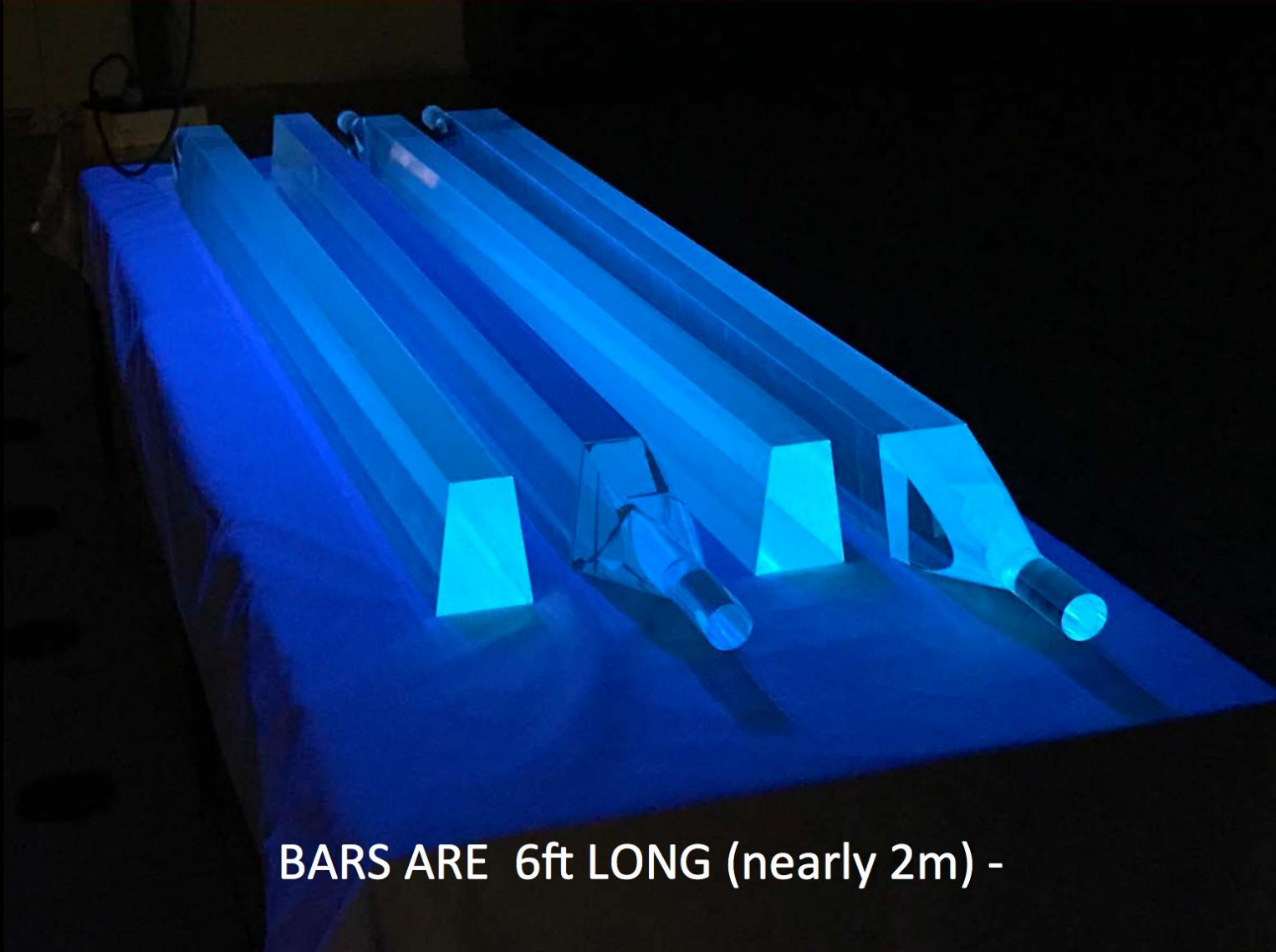
CFD (WITH 3ps RESOLUTION)



HPTDC (15 PS RESOLUTION)



# *Inspecting the Scintillator*

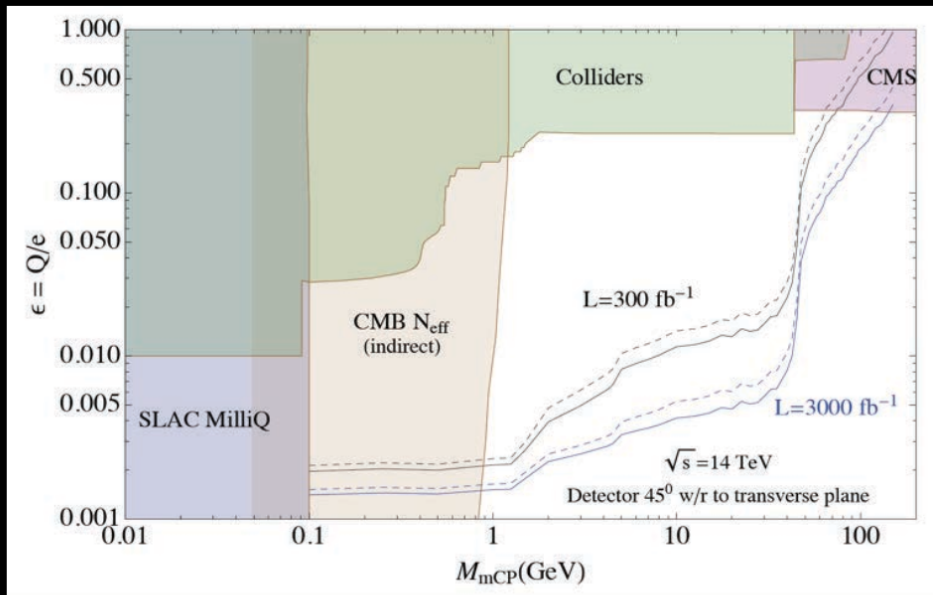


**BARS ARE 6ft LONG (nearly 2m) -**

**BARS + LIGHTGUIDES ARE 8ft LONG**



# Example Physics Rationale for MAPP



**FIGURE TAKEN FROM:** “Looking for milli-charged particles with a new experiment at the LHC Andrew Haas, Christopher S. Hill, Eder Izaguirre, Itay Yavin, . Oct 24, 2014. 4 pp. *Phys.Lett. B*746 (2015) 117-120 – Experiment is planning to run at the CMS IP.

- **Search for milli-charged particles – a dark matter candidate – to which the standard LHC detectors are not sensitive**
- **New dark sectors can have new particles which appear with small fractional charge wrt the Standard Model sector**
- **Charges typically in the range  $10^{-1}$  to  $10^{-3} e$**
- **No direct constraints above 100 MeV and  $Q/e < 0.01$**
- **A MoEDAL millicharged detector could probe up to 100 GeV**



# Observations

- Let's not lose momentum on the planning together with CMS/LHCC for MilliQan!!
- Options for other physics processes to look into, eg long lived neutrals with decays way out of the central detector (a la MATHUSLA)
- Funding: Two EC proposals under discussion in Europe for MilliQan/submission in spring 2017 if followed up

# MilliQan

- Question: do we want a full scale wooden mock-up? Study service routing, cavern constraints, the support structure...
- Could be organized by the CERN group (M. Gastal) with collaborating groups (U. Lebanon) on technical matters
- Time frame:
  - start (design) ~ February
  - Completed: end of summer
- Makes only sense if the project is relatively stable and well defined in some detail