



ForwArd Search ExperRiment

Supported by:



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Deion Fellers (University of Oregon)

on behalf of the FASER collaboration

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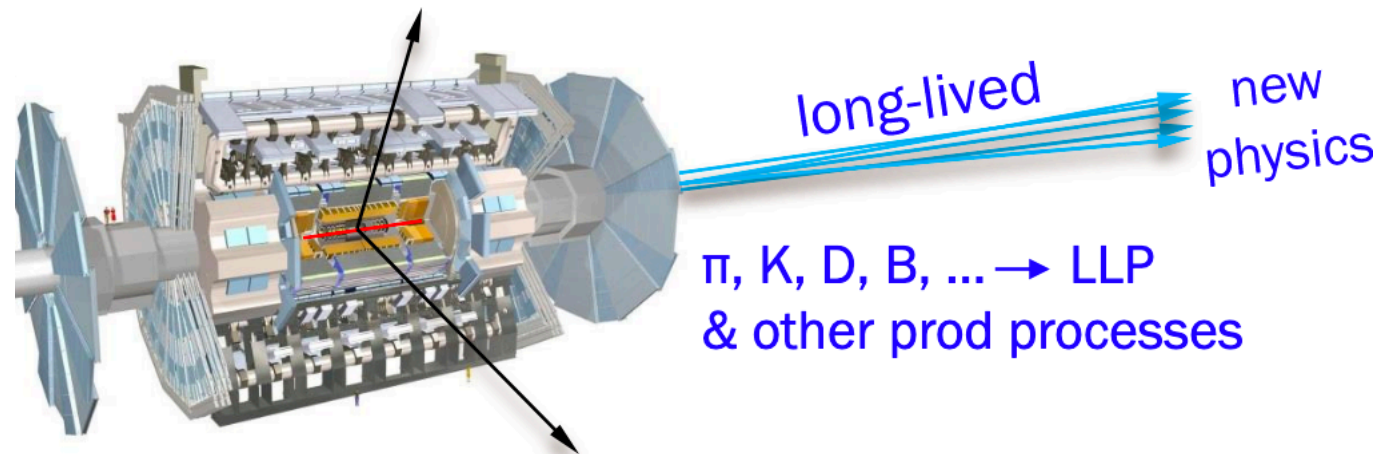
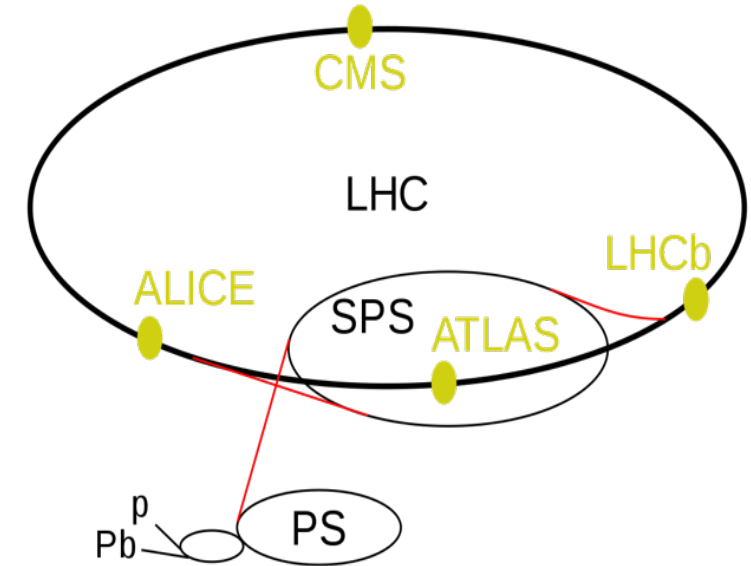
February 25th, 2022

Additional US support from:



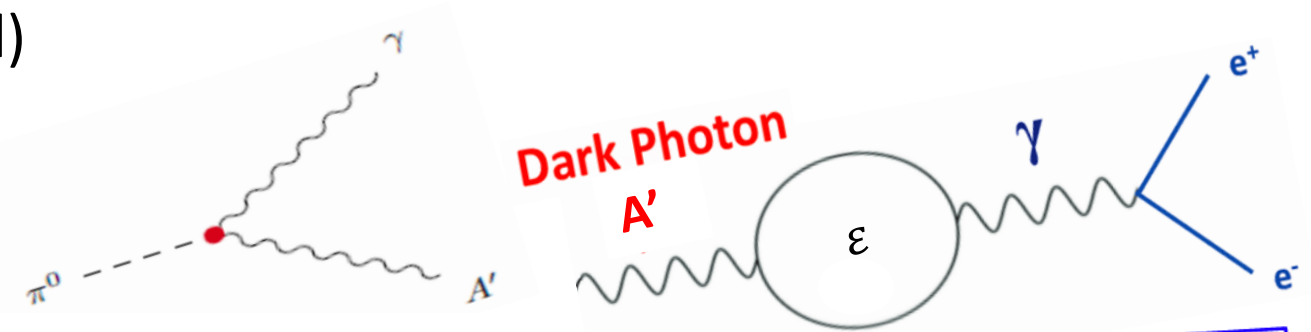
LHC Forward Physics

- Main LHC detectors are sensitive to transverse particles from head-on pp collisions
- Large forward cross section is currently wasted
 - $N_{\pi} \approx 10^{16}$ in far-forward region (300 fb^{-1})
- Forward particles are highly collimated
 - Typical π^0 $p_T \approx \Lambda_{\text{QCD}}$
 - $\theta \approx p_T/E \approx 10^{-4}$ rad (for $E \approx \text{TeV}$)
 - Only ~ 1 cm spread for 100 m longitudinal travel
- A small detector far away will see a large flux of long-lived particles



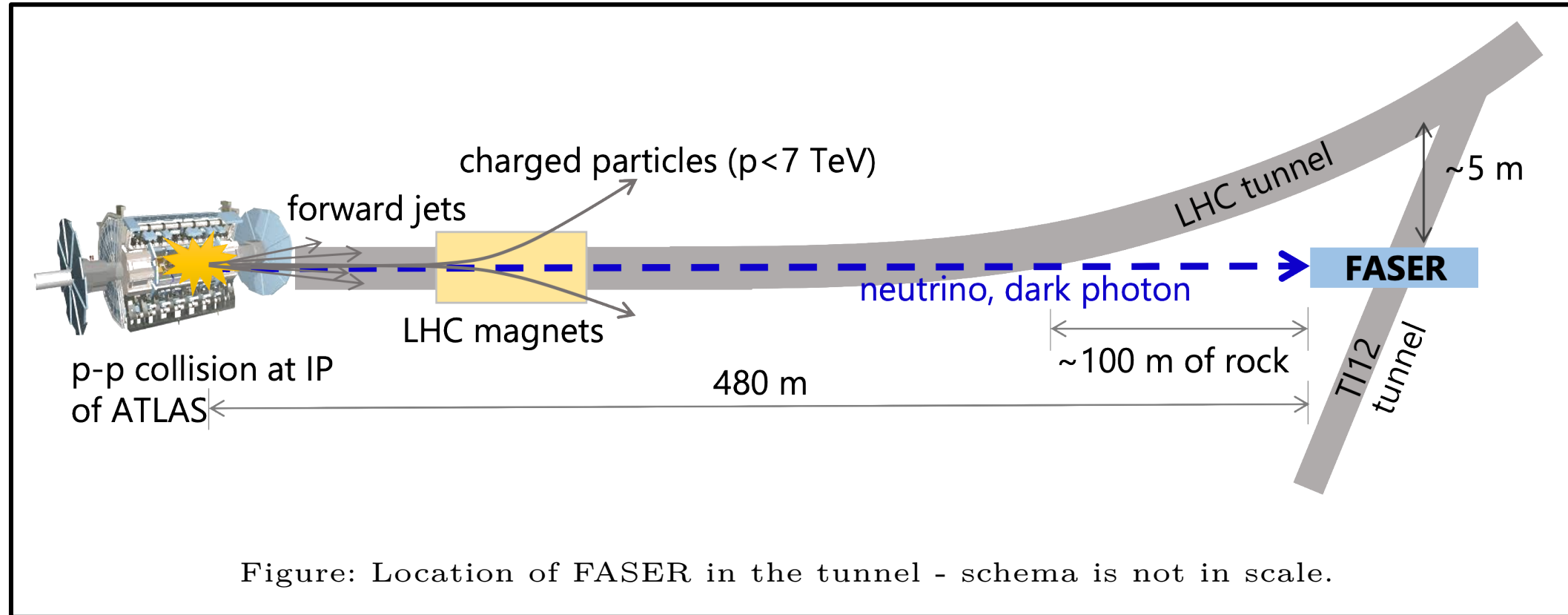
FASER Overview

- New experiment at LHC looking for long-lived particles (Dark Photon) that travel 100's of meters along the longitudinal beam axis and decay into e^+e^-
- Very rare ($\epsilon \approx 10^{-5}$): A' production $\propto \epsilon^2$ and visible decay $\propto \epsilon^2$
- Saved by super high intensity in far forward direction (light meson decays) and very low background (unique signal)



FASER Location

- 480m along the longitudinal line-of-sight of the ATLAS interaction point



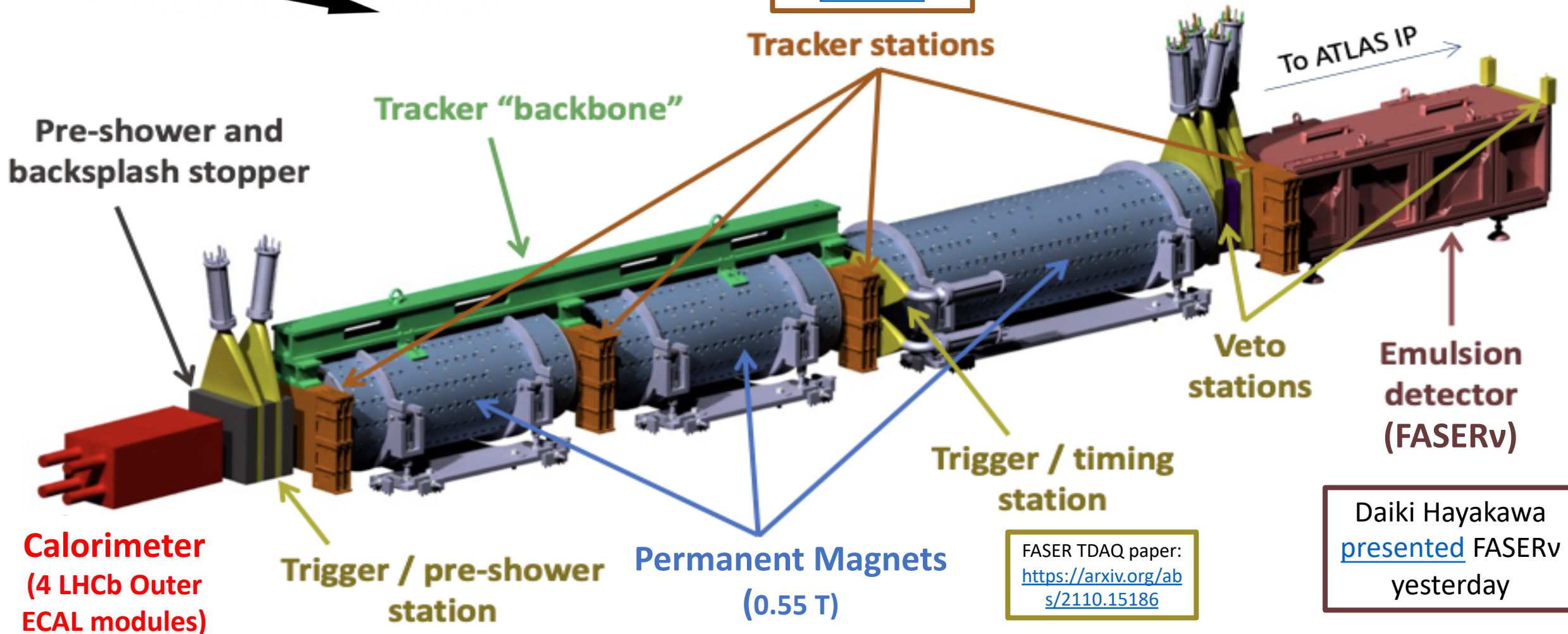
- Strong magnets and shielding ensure only weakly interacting particles reach FASER



March 2021



FASER Tracker paper:
<https://arxiv.org/abs/2112.01116>

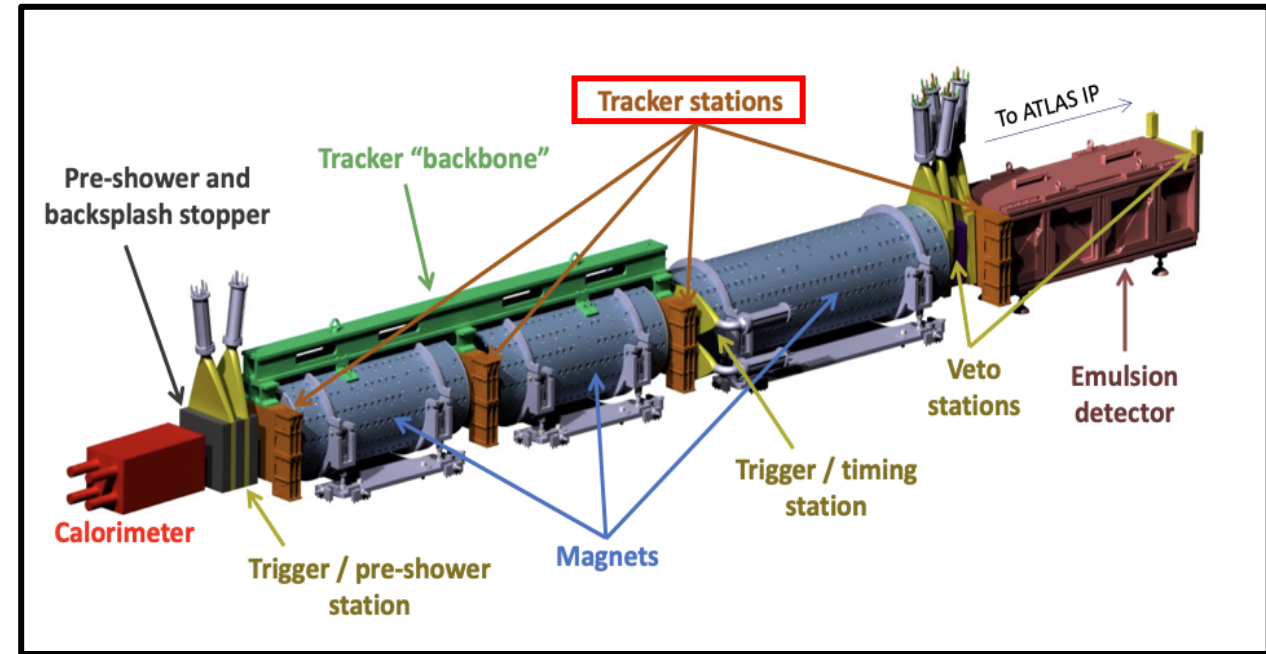


FASER TDAQ paper:
<https://arxiv.org/abs/2110.15186>

Daiki Hayakawa
[presented](#) FASERV
yesterday

Tracking Stations

- Silicon strip tracking (SCT) modules borrowed from ATLAS
- $\sim 20 \mu\text{m}$ position resolution in charged particle bending direction
 - $\sim 550 \mu\text{m}$ resolution in non-bending direction due to 20 mrad stereo angle



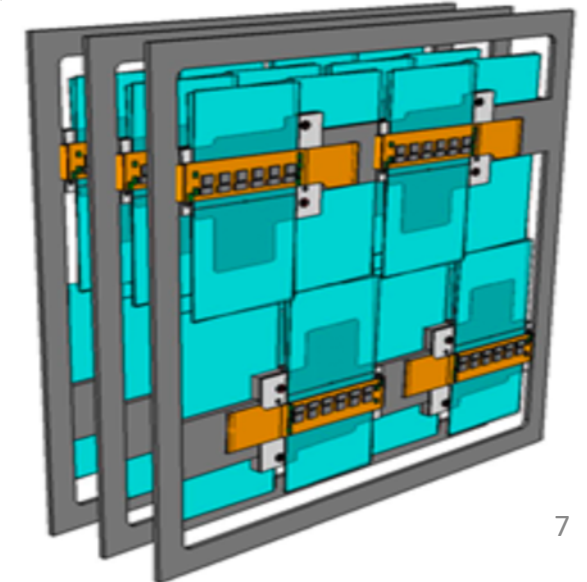
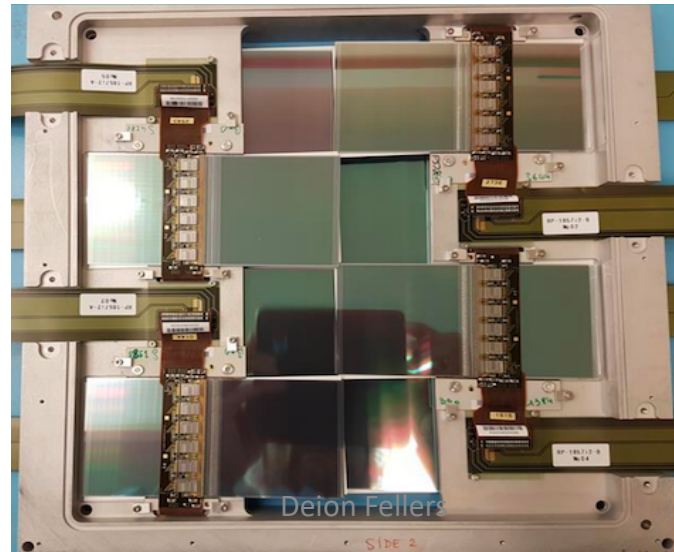
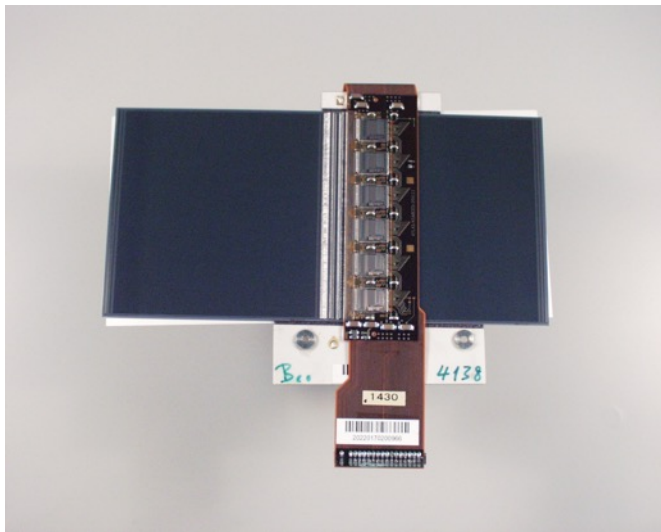
1 SCT Module

$\times 8$

1 Tracking Plane

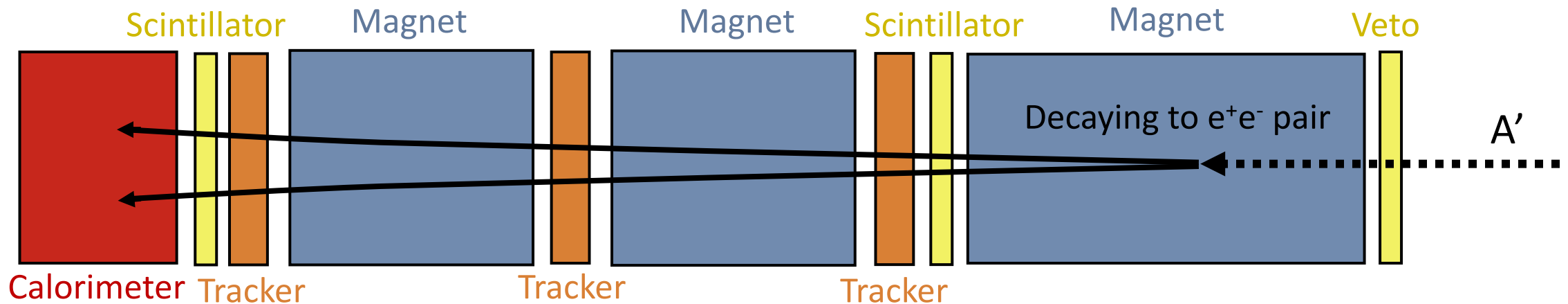
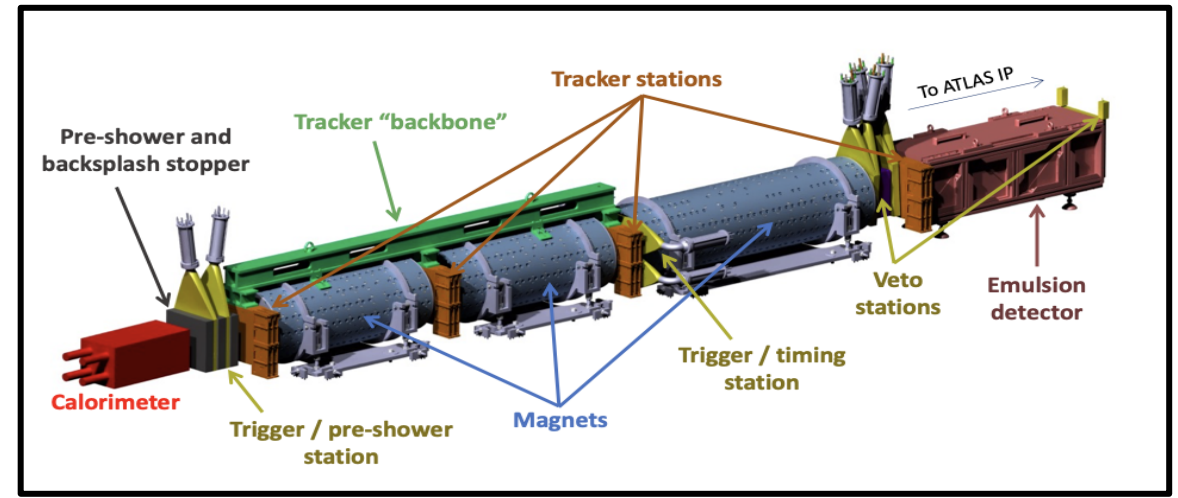
$\times 3$

1 Tracking Station



FASER Signal

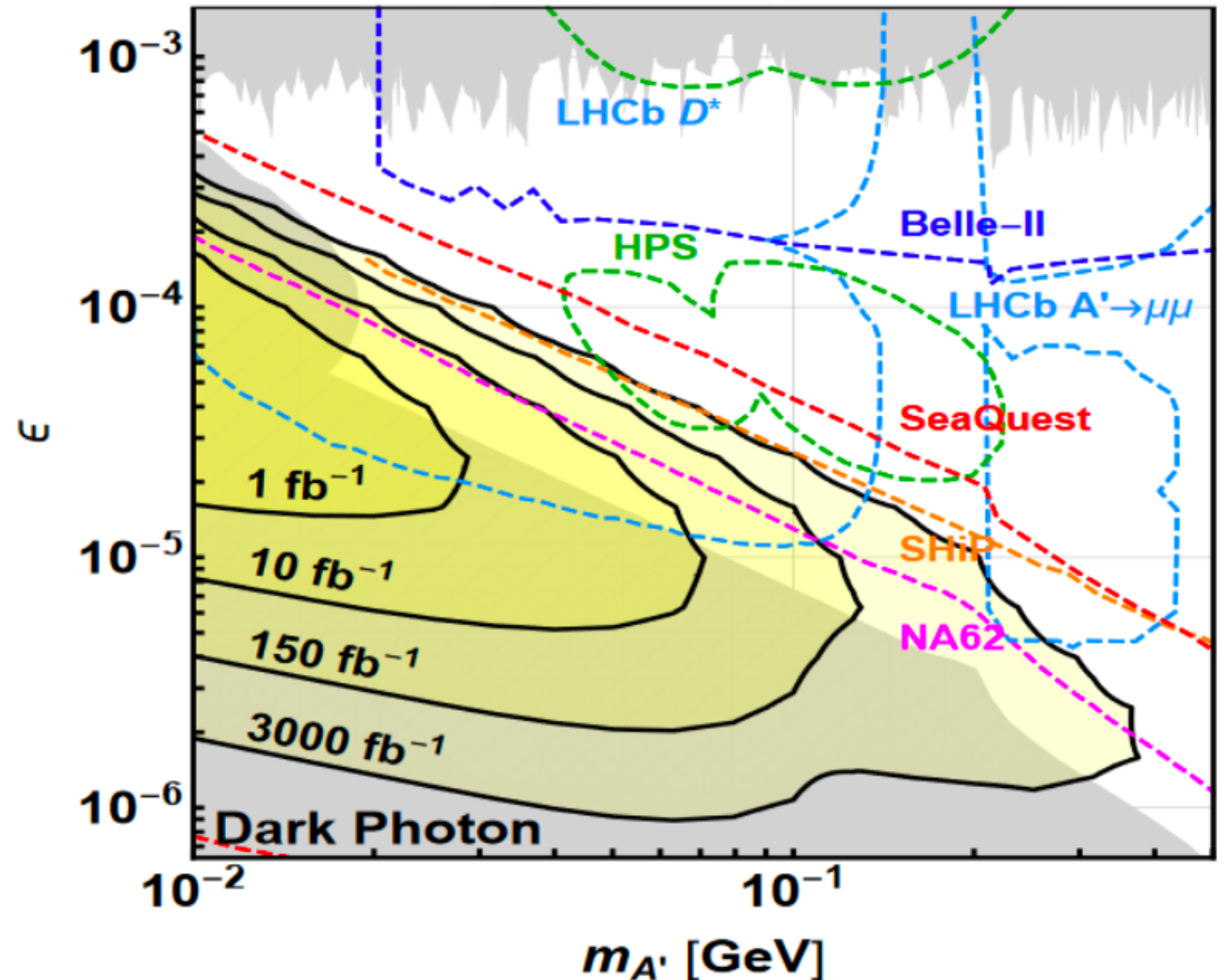
- Two extremely energetic ($\sim \text{TeV}$) oppositely charged tracks that have a common vertex inside the FASER decay volume and point back to the ATLAS IP



- No obvious significant backgrounds
 - Expect muon rate of 500 - 1000 Hz, but these will not mimic signal
- Very rare: $N_{signal} \propto \varepsilon^2 \times (\text{probability of decaying in small volume far away})$
 - Decay volume is a cylinder with $r = 10 \text{ cm}$ and a length of 1.5 m

FASER Physics Reach

- Probes new dark photon phase space even after first fb^{-1}
 - $\sim 300 \text{ fb}^{-1}$ expected in Run 3
- Sensitive to other BSM long-lived particles (ALP's)
- FASERv is an emulsion detector at the front of FASER that will measure neutrino scattering cross sections
 - Daiki Hayakawa [presented](#) FASERv yesterday

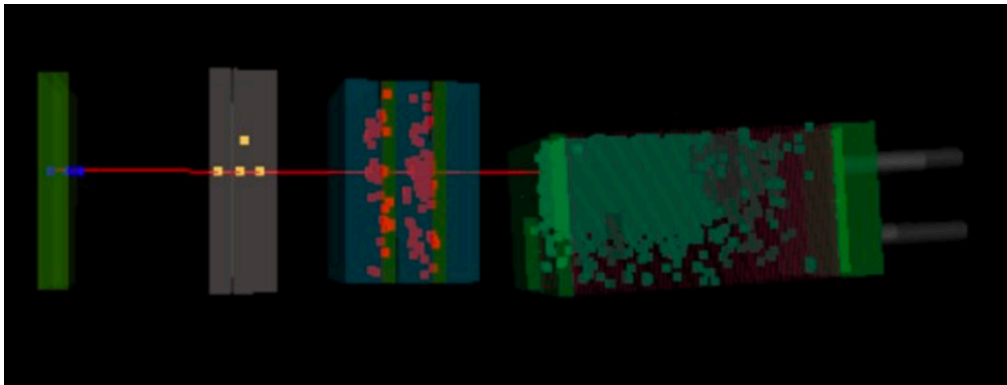


Photos

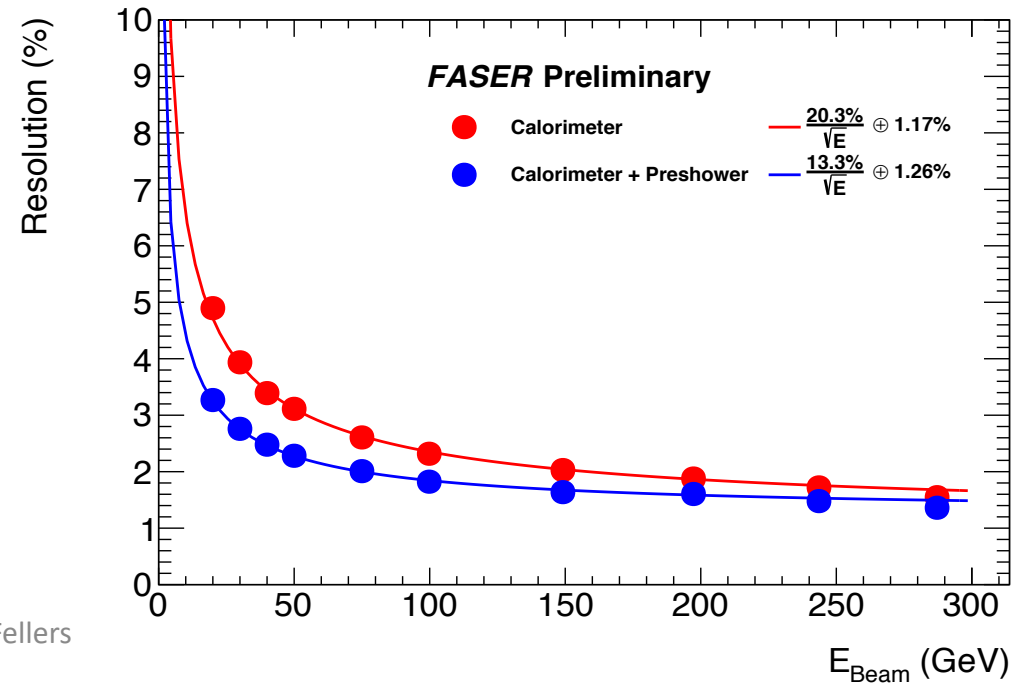
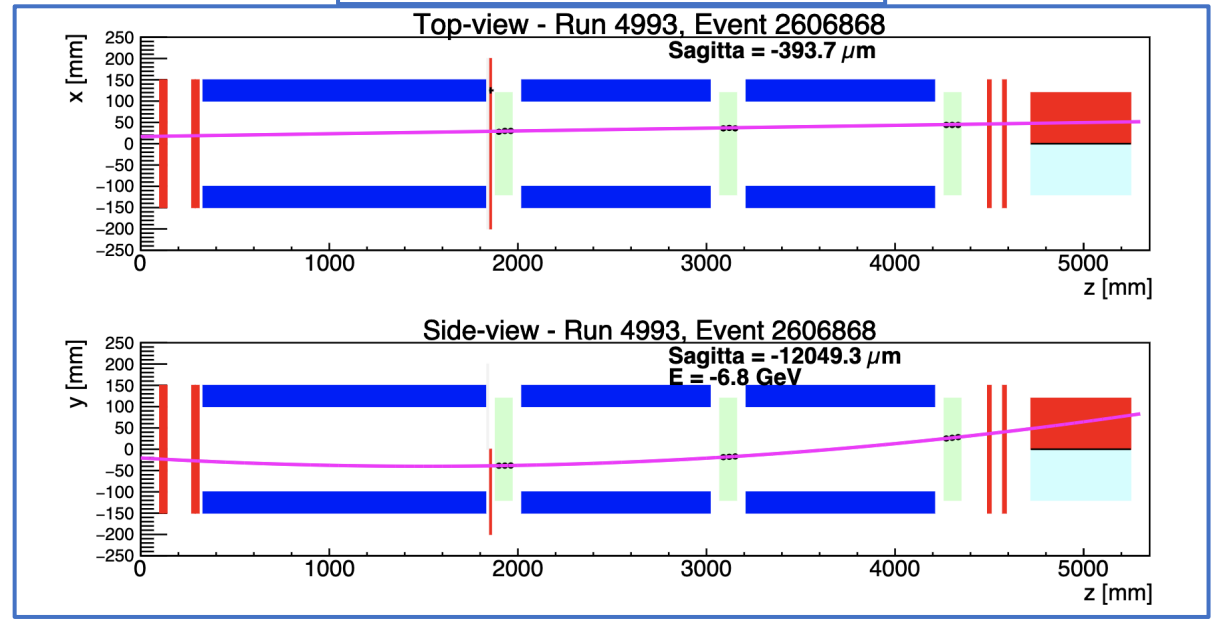


Current Status

- FASER's construction is complete
- Have collected data from LHC pilot beam, test beam, and cosmics
 - Test beam gave us over 150 million events of e , μ , and π particles in subset of detector
 - Data is being analyzed for characterization and commissioning of the detector
- Ongoing simulation and data reconstruction work
 - Both are already well developed



LHC Pilot Beam Event Display



Summary

- FASER is a new experiment at the LHC looking for light long-lived BSM particles in the very far-forward region of ATLAS
 - e.g. Dark Photons ($m_{A'} \approx 100 \text{ MeV}$, $\varepsilon \approx 10^{-5}$)
- We have successfully installed FASER in time for LHC Run 3 (June 2022)
- Currently characterizing and commissioning the detector

FASER links:

- Public homepage: <https://faser.web.cern.ch/>
- Theory paper: <https://arxiv.org/abs/1811.12522>
- Detector design: <https://arxiv.org/abs/1812.09139>

