DarkLight@ARIEL

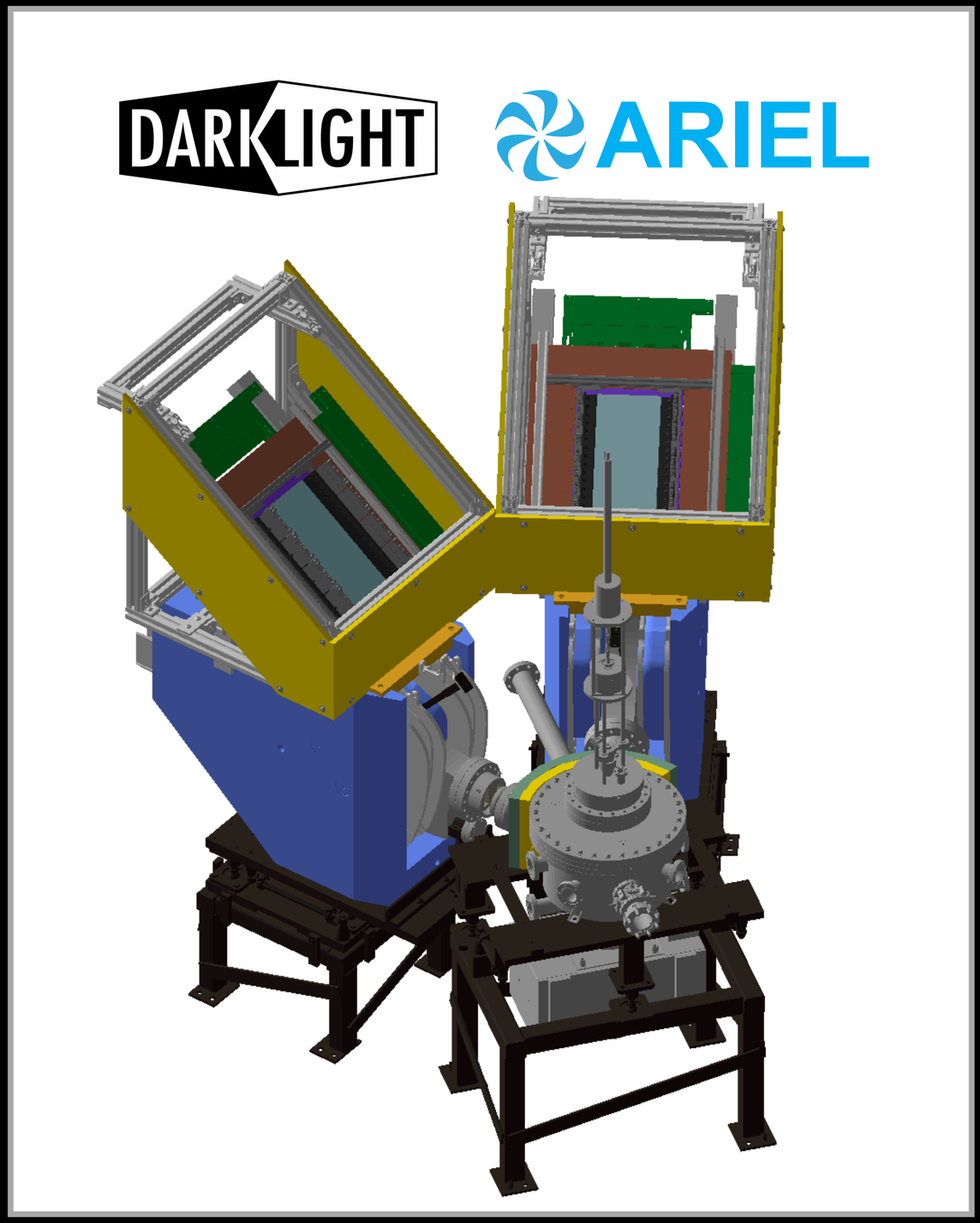
Win Lin • Stony Brook University

CFNS Postdoc Meeting • 04/02/2026

Center for Frontiers in Nuclear Science

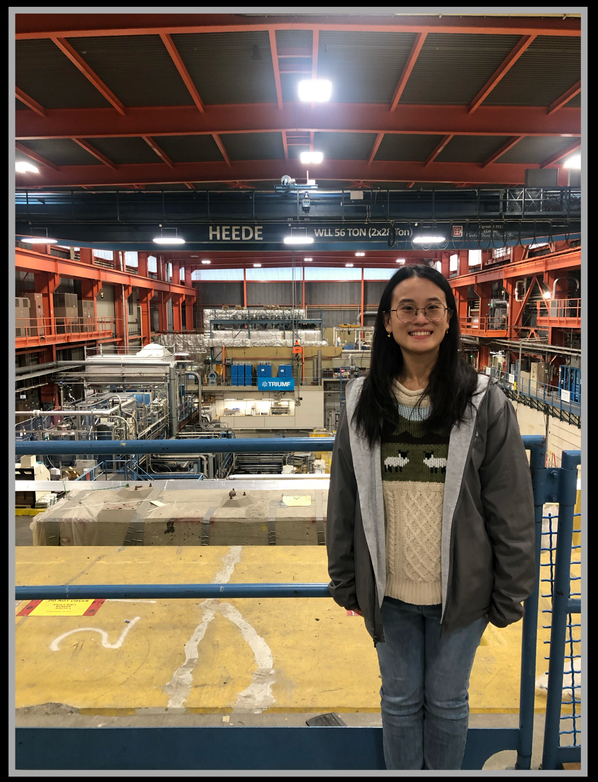
Stony Brook University

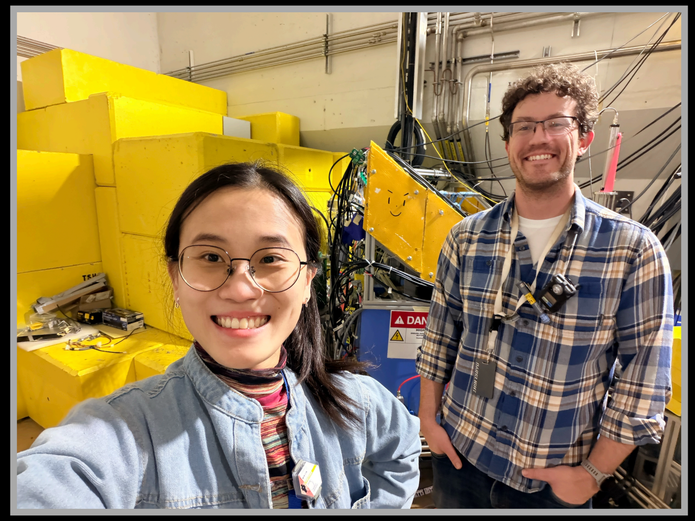
This work is supported by DOE grant DE-SC0024464. DarkLight has been supported by DOE, NSF, NSERC and the Moore Foundation



Content of this talk:







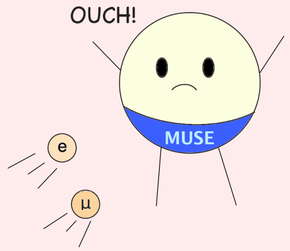
ME :)

TRIUMF

DarkLight


Wan
Lin
Physics and Astronomy
Adviser: Ronald Gilman
POA
PRINCETON ORTHOPAEDIC ASSOCIATES

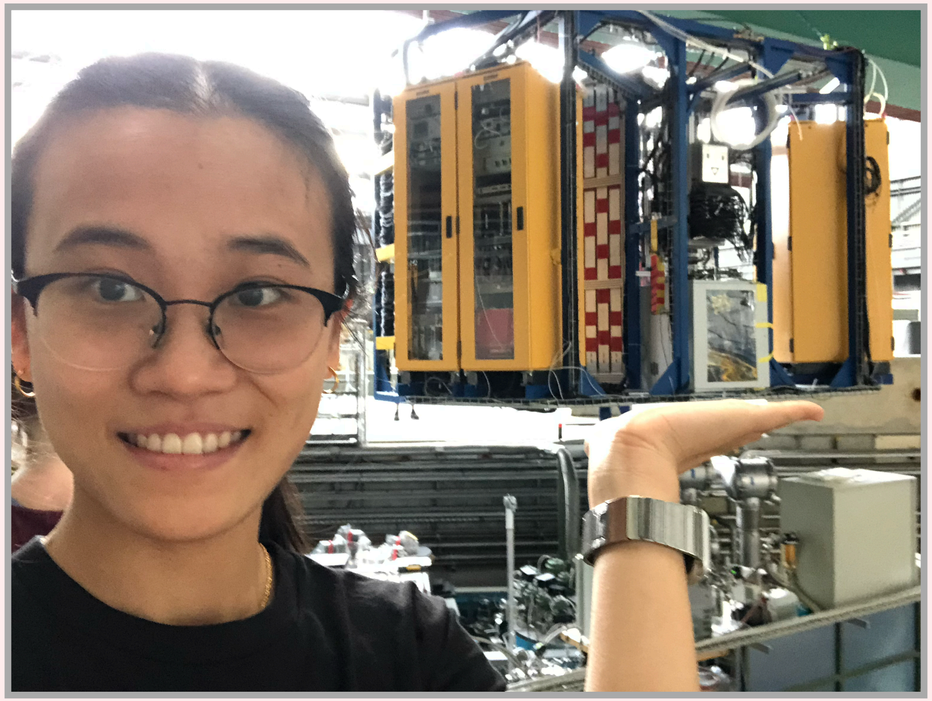


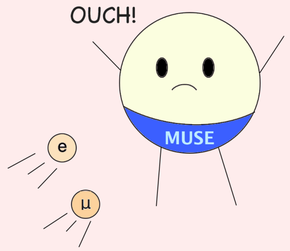

OUCH!
MUSE
e
μ


Wan
Lin
Physics and Astronomy
Adviser: Ronald Gilman
POA

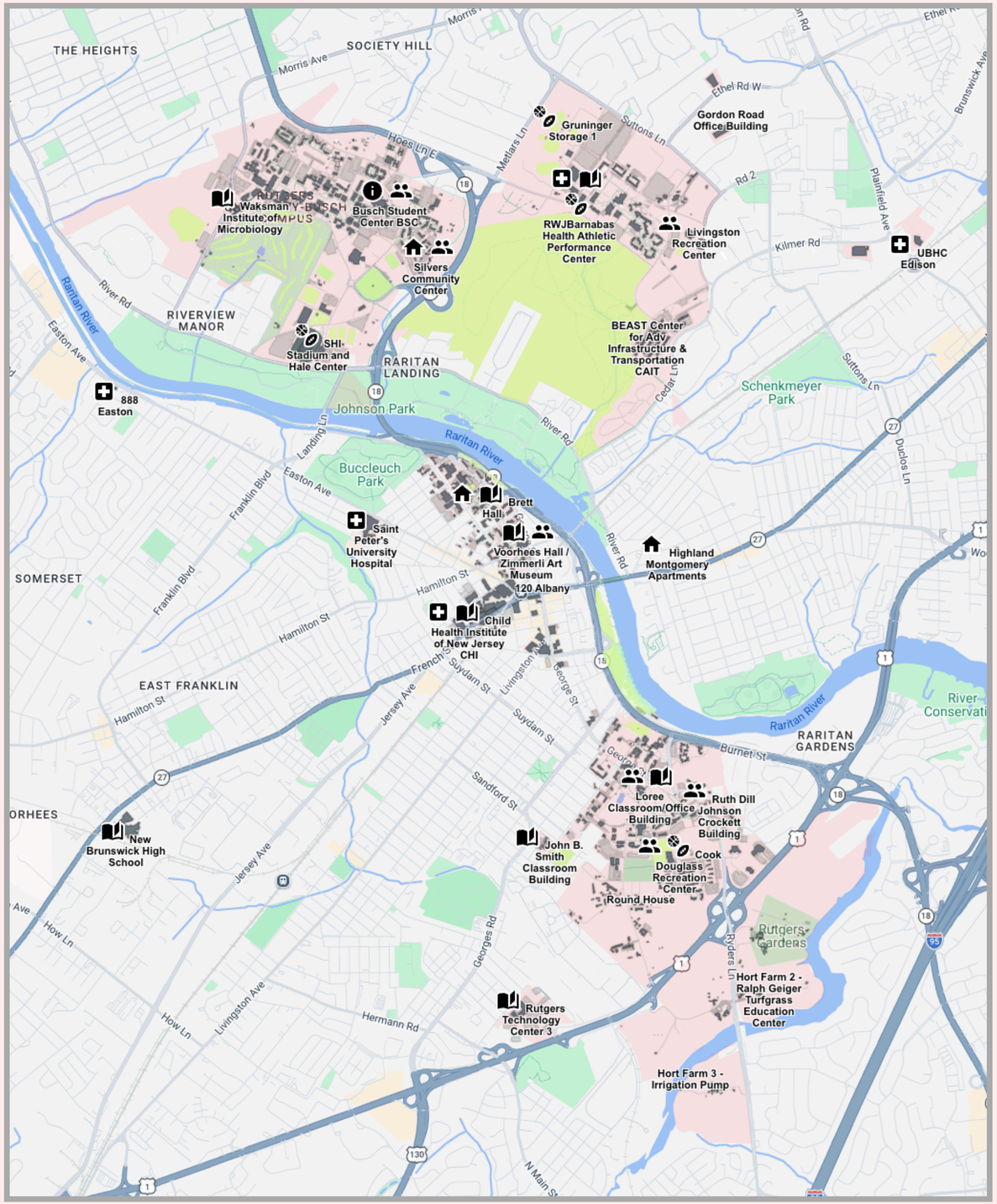




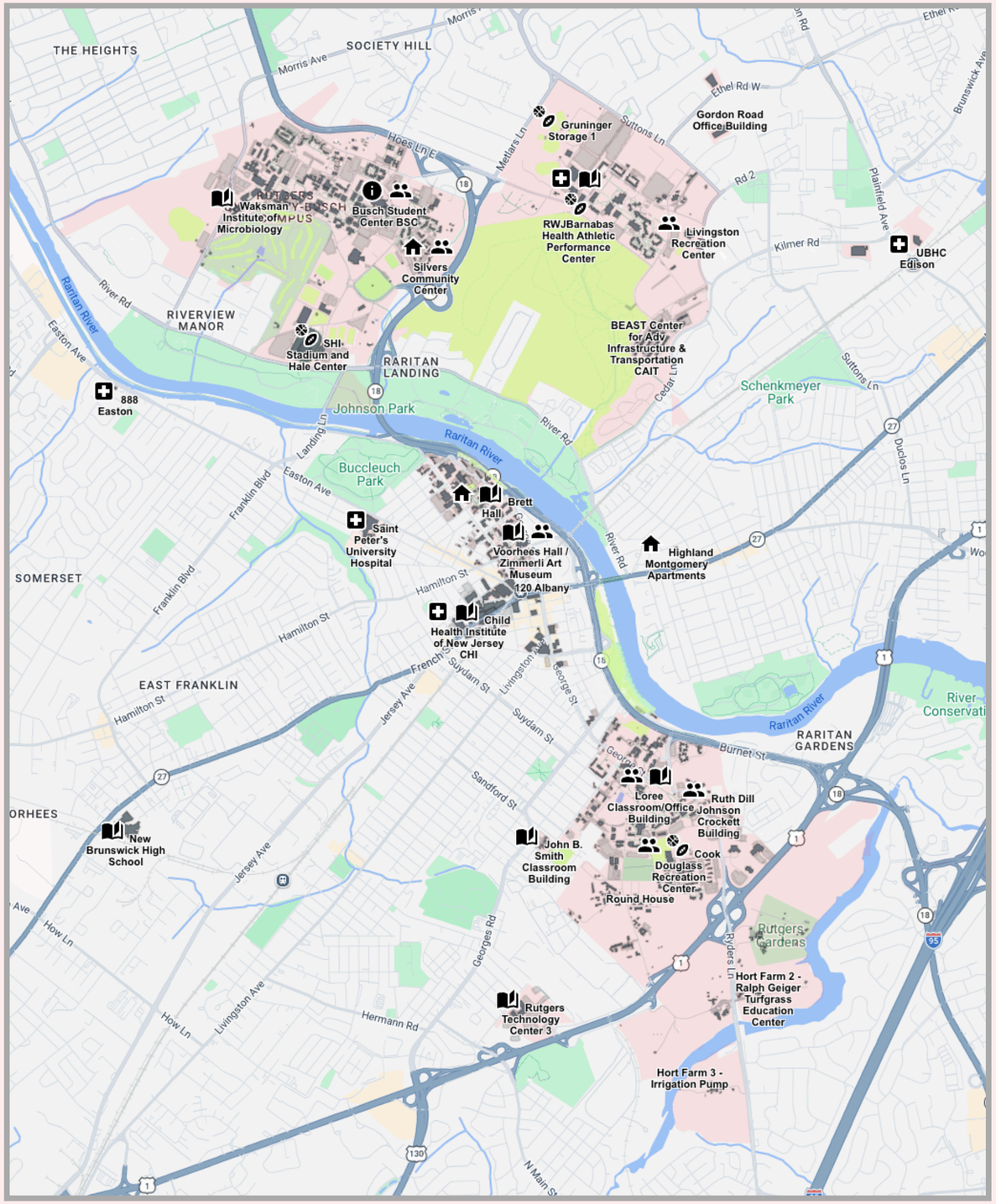



OUCH!
MUSE
e
μ


Stony Brook University
RUTGERS
UNIVERSITY | NEW BRUNSWICK
CONNECTICUT
Newport
New Haven
New York
Philadelphia
Wilmington
Allentown
Baltimore
Annapolis
DELAWARE
Hershey
Harriman State Park
Delaware Water Gap National Recreation...
Gateway National Recreation Area
Six Flags Great Adventure
Wharton State Forest
Edwin B. Forsythe National Wildlife
Diggerland USA
NORTHLANDZ Train Museum &...
iPlay America
State Game Lands Number 13
Long Island Sound
Great South Bay
Block Island Sound
Delaware Bay
Kent Island

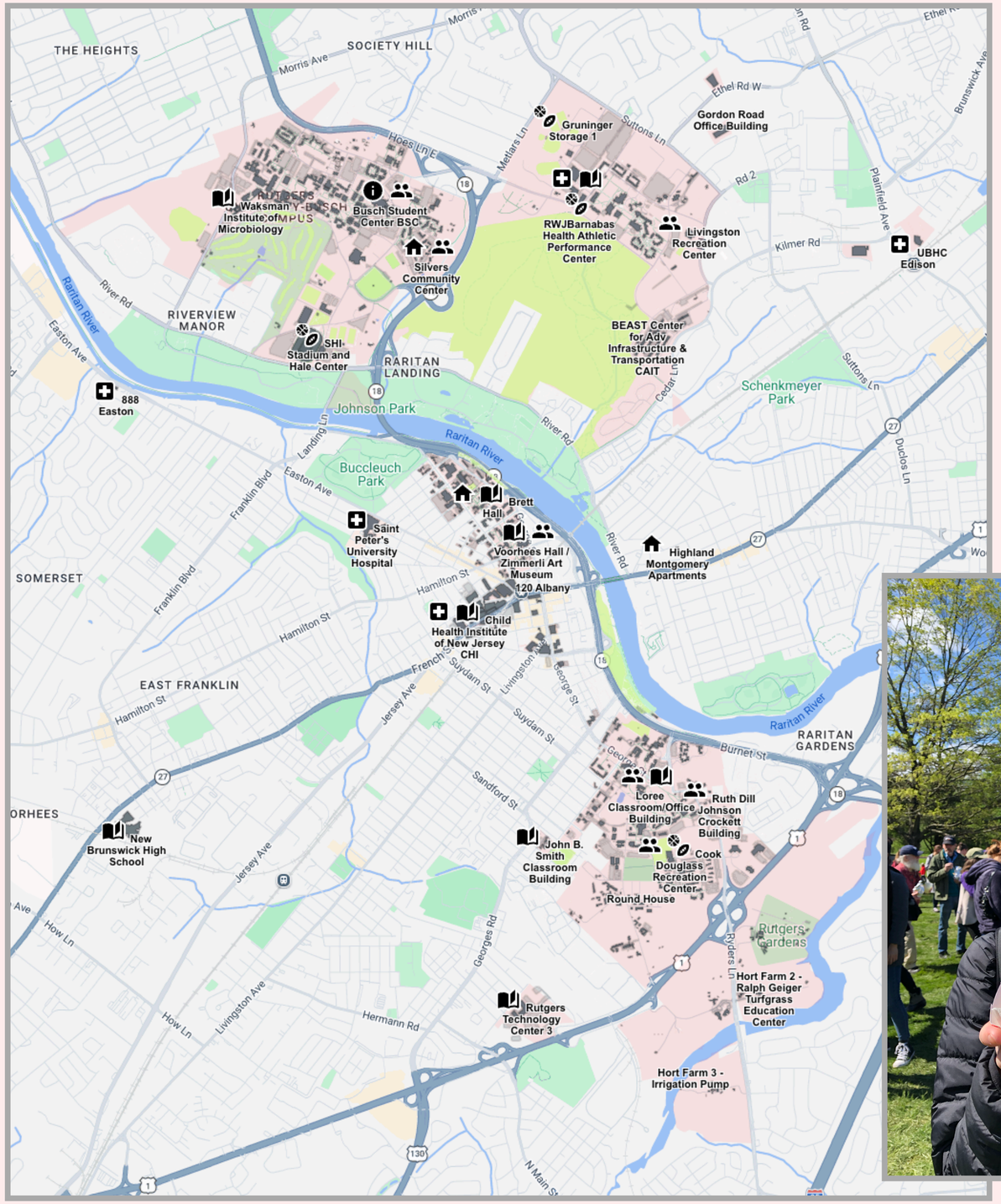

THE HEIGHTS
SOCIETY HILL
Morris Ave
Hoes Ln E
Ethel Rd W
Gordon Road Office Building
Gruninger Storage 1
Suttons Ln
Mettlers Ln
Rd 2
Plainfield Ave
Kilmer Rd
UBHC Edison
RUTGERS BUSCH CAMPUS
Waksman Institute of Microbiology
Busch Student Center BSC
Silvers Community Center
RWJBarnabas Health Athletic Performance Center
Livingston Recreation Center
Raritan River
River Rd
RIVERVIEW MANOR
SHI Stadium and Hale Center
BEAST Center for Adv Infrastructure & Transportation CAIT
Easton Ave
RARITAN LANDING
888 Easton
Johnson Park
Schenkmeyer Park
Cedar Ln
Landing Ln
Buccleuch Park
Brett Hall
Saint Peter's University Hospital
Voorhees Hall / Zimmerli Art Museum
120 Albany
Highland Montgomery Apartments
Franklin Blvd
Hamilton St
SOMERSET
Child Health Institute of New Jersey CHI
EAST FRANKLIN
French St
Suydam St
Livingston Ave
George St
Jersey Ave
Burnet St
RARITAN GARDENS
Loree Classroom/Office Building
Ruth Dill Johnson Crockett Building
John B. Smith Classroom Building
Cook Douglass Recreation Center
Round House
New Brunswick High School
Sandford St
Georges Rd
Rutgers Gardens
Riders Ln
Hort Farm 2 - Ralph Geiger Turfgrass Education Center
How Ln
Livingston Ave
Hermann Rd
Rutgers Technology Center 3
Hort Farm 3 - Irrigation Pump
N Main St
Duclos Ln
Brunswick Ave


Sojourner Truth Apartments


THE HEIGHTS
SOCIETY HILL
Morris Ave
Hoes Ln E
Ethel Rd W
Gordon Road Office Building
Gruninger Storage 1
Suttons Ln
Mettlers Ln
Rd 2
Plainfield Ave
Brunswick Ave
RUTGERS Waksman Institute of Microbiology
Busch Student Center BSC
Silvers Community Center
RWJBarnabas Health Athletic Performance Center
Livingston Recreation Center
Kilmer Rd
UBHC Edison
Raritan River
River Rd
RIVERVIEW MANOR
SHI Stadium and Hale Center
BEAST Center for Adv Infrastructure & Transportation CAIT
Cedar Ln
Schenkmeyer Park
Easton Ave
RARITAN LANDING
888 Easton
Johnson Park
Landing Ln
Buccleuch Park
Franklin Blvd
Brett Hall
Saint Peter's University Hospital
Voorhees Hall / Zimmerli Art Museum
120 Albany
Highland Montgomery Apartments
Duclos Ln
SOMERSET
Hamilton St
Child Health Institute of New Jersey CHI
EAST FRANKLIN
French St
Suydam St
Livingston Ave
George St
Jersey Ave
RARITAN GARDENS
Burnet St
Sandford St
Loree Classroom/Office Building
Ruth Dill Johnson Crockett Building
John B. Smith Classroom Building
Cook Douglass Recreation Center
Round House
New Brunswick High School
How Ln
Georges Rd
Rutgers Gardens
Riders Ln
Hort Farm 2 - Ralph Geiger Turfgrass Education Center
Rutgers Technology Center 3
Hermann Rd
Livingston Ave
Hort Farm 3 - Irrigation Pump
N Main St

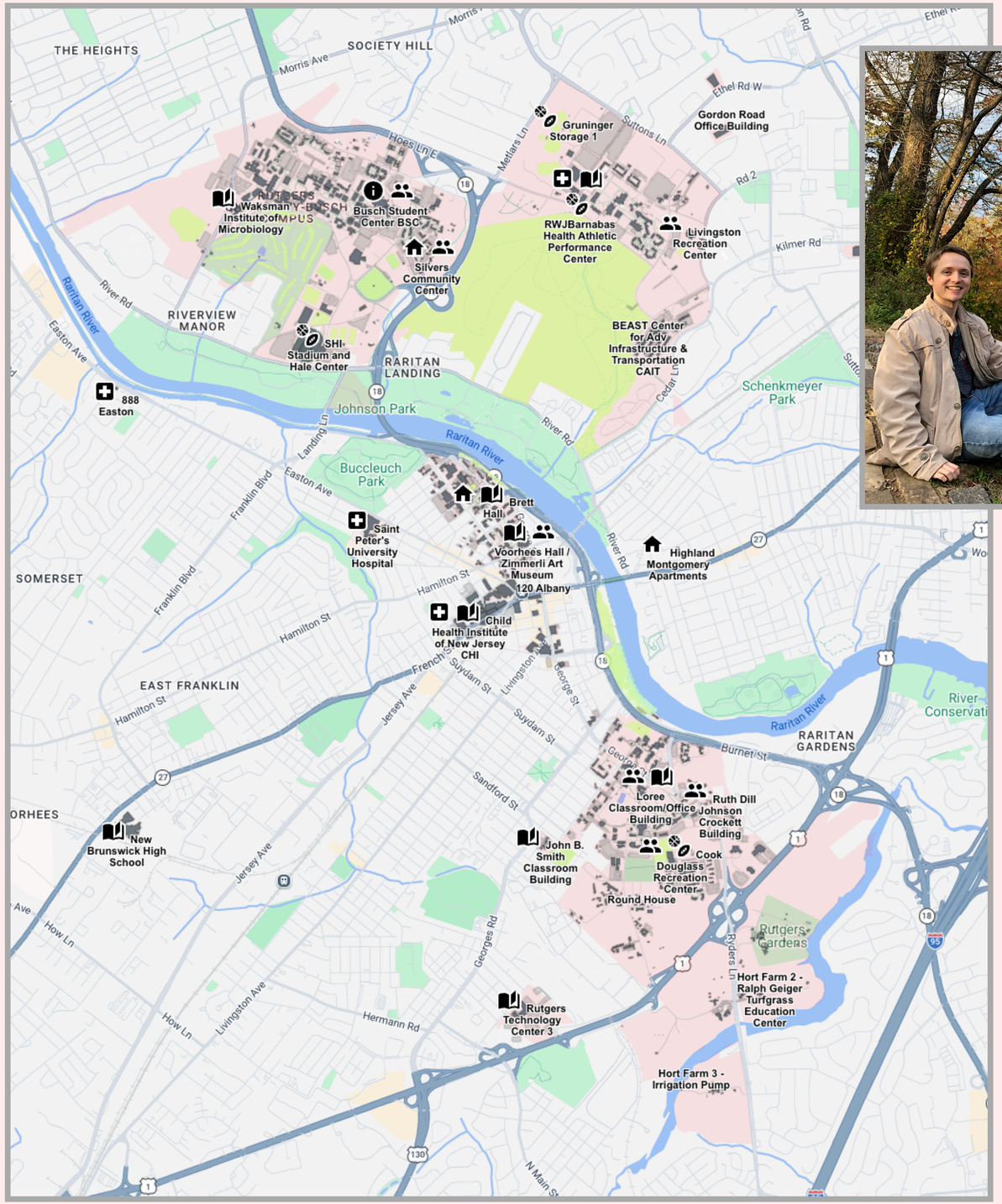





THE HEIGHTS
SOCIETY HILL
Morris Ave
Hoes Ln E
Gruninger Storage 1
Gordon Road Office Building
Ethel Rd W
Suttons Ln
Rd 2
Plainfield Ave
Kilmer Rd
Busch Student Center BSC
Waksman Institute of Microbiology
RWJBarnabas Health Athletic Performance Center
Livingston Recreation Center
UBHC Edison
Silvers Community Center
RIVERVIEW MANOR
River Rd
Raritan River
Easton Ave
SHI Stadium and Hale Center
BEAST Center for Adv Infrastructure & Transportation CAIT
RARITAN LANDING
888 Easton
Johnson Park
Schenkmeyer Park
Landing Ln
Buccleuch Park
Brett Hall
Saint Peter's University Hospital
Voorhees Hall / Zimmerli Art Museum
120 Albany
Highland Montgomery Apartments
Franklin Blvd
SOMERSET
Hamilton St
Child Health Institute of New Jersey CHI
EAST FRANKLIN
French St
Suydam St
Jersey Ave
Livingston
George St
RARITAN GARDENS
Burnet St
Sandford St
Loree Classroom/Office Building
Ruth Dill Johnson Crockett Building
John B. Smith Classroom Building
Cook Douglass Recreation Center
Round House
New Brunswick High School
How Ln
Georges Rd
Rutgers Gardens
Riders Ln
Hort Farm 2 - Ralph Geiger Turfgrass Education Center
Livingston Ave
Hermann Rd
Rutgers Technology Center 3
Hort Farm 3 - Irrigation Pump
N Main St
Duclos Ln
Cedar Ln

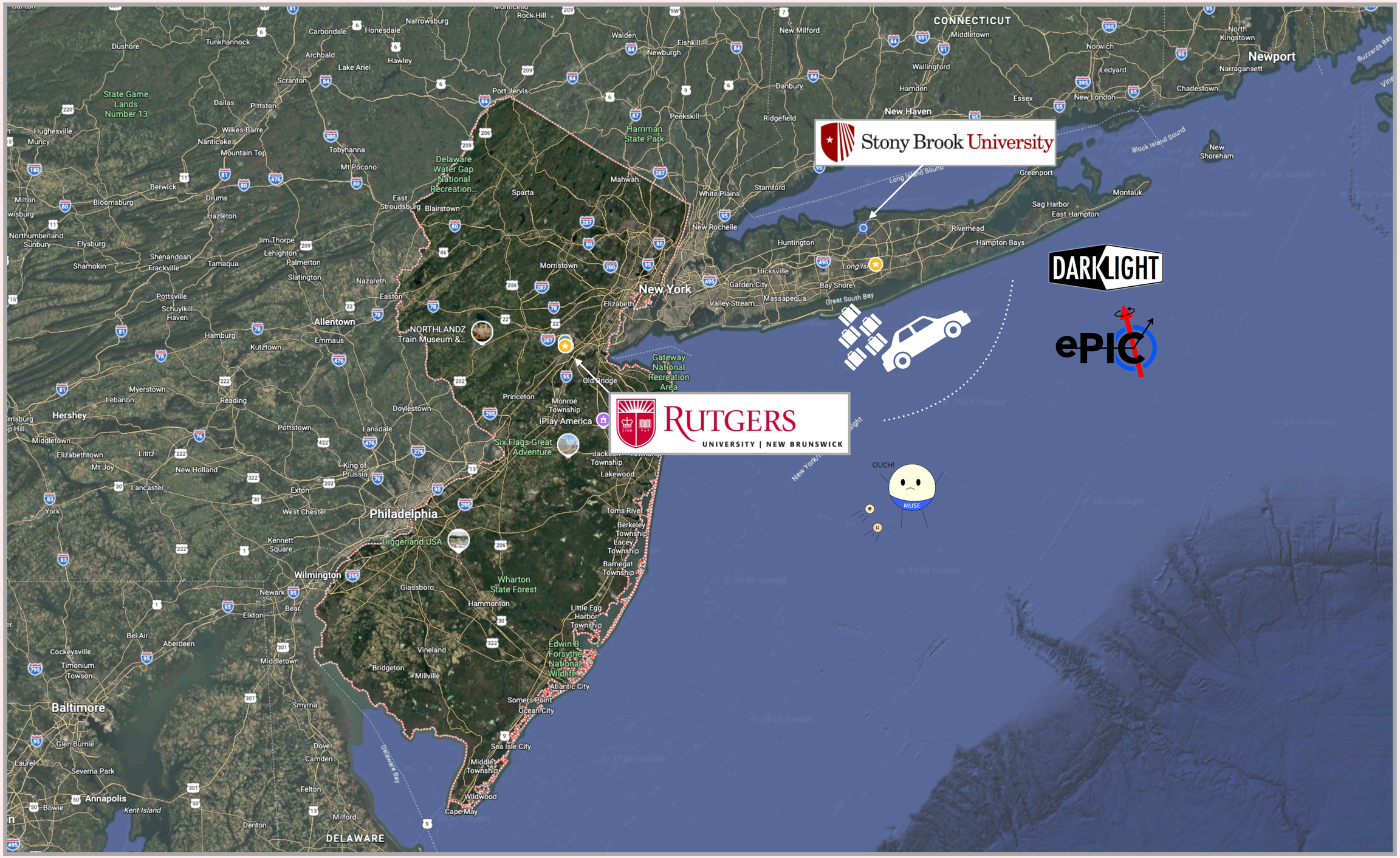




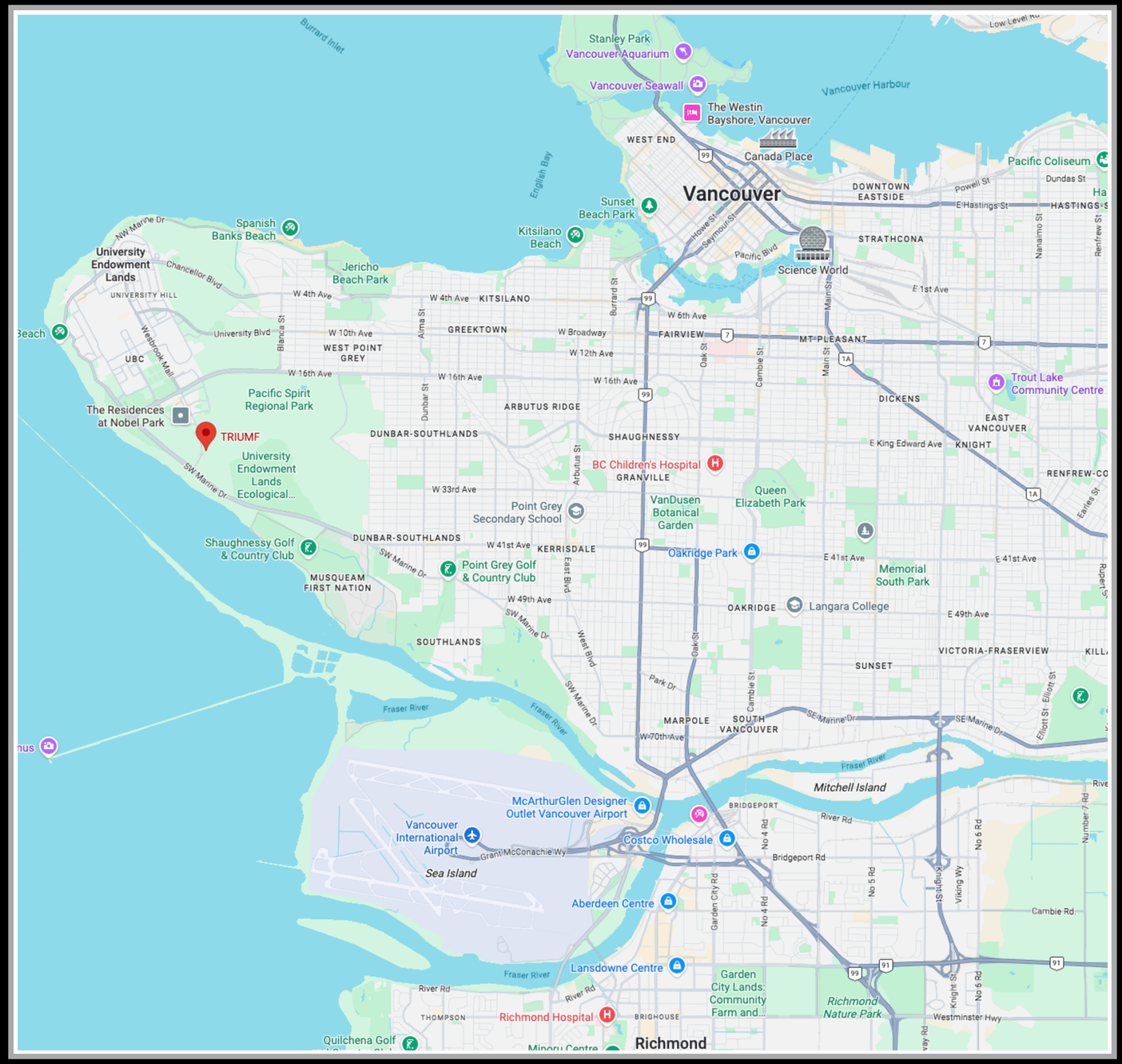

THE HEIGHTS
SOCIETY HILL
Morris Ave
Ethel Rd W
Gordon Road Office Building
Gruninger Storage 1
Suttons Ln
Hoes Ln E
Metlars Ln
Rd 2
Kilmer Rd
RUTGERS BUSCH CAMPUS
Waksman Institute of Microbiology
Busch Student Center BSC
RWJBarnabas Health Athletic Performance Center
Livingston Recreation Center
Silvers Community Center
Raritan River
River Rd
RIVERVIEW MANOR
Easton Ave
SHI Stadium and Hale Center
BEAST Center for Adv Infrastructure & Transportation CAIT
RARITAN LANDING
888 Easton
Johnson Park
Schenkmeyer Park
Landing Ln
Buccleuch Park
Brett Hall
Franklin Blvd
Saint Peter's University Hospital
Voorhees Hall / Zimmerli Art Museum
120 Albany
Highland Montgomery Apartments
SOMERSET
Hamilton St
Child Health Institute of New Jersey CHI
French St
Suydam St
Livingston Ave
George St
EAST FRANKLIN
Jersey Ave
Burnet St
RARITAN GARDENS
Loree Classroom/Office Building
Ruth Dill Johnson Crockett Building
Sandford St
New Brunswick High School
John B. Smith Classroom Building
Cook Douglass Recreation Center
Round House
Rutgers Gardens
Georges Rd
Riders Ln
How Ln
Hort Farm 2 - Ralph Geiger Turfgrass Education Center
Livingston Ave
Hermann Rd
Rutgers Technology Center 3
Hort Farm 3 - Irrigation Pump
N Main St






Stony Brook University
DARKLIGHT
ePIC
RUTGERS
UNIVERSITY | NEW BRUNSWICK
OUCH!
MUSE
CONNECTICUT
New York
Philadelphia
Wilmington
Allentown
Hershey
Baltimore
Annapolis
DELAWARE
Newport
New Haven
Long Island Sound
Great South Bay
Block Island Sound
Delaware Bay
Harriman State Park
Delaware Water Gap National Recreation...
Gateway National Recreation Area
Six Flags Great Adventure
Wharton State Forest
Edwin B. Forsythe National Wildlife
Diggerland USA
NORTHLANDZ Train Museum &...
State Game Lands Number 13

TRIUMF

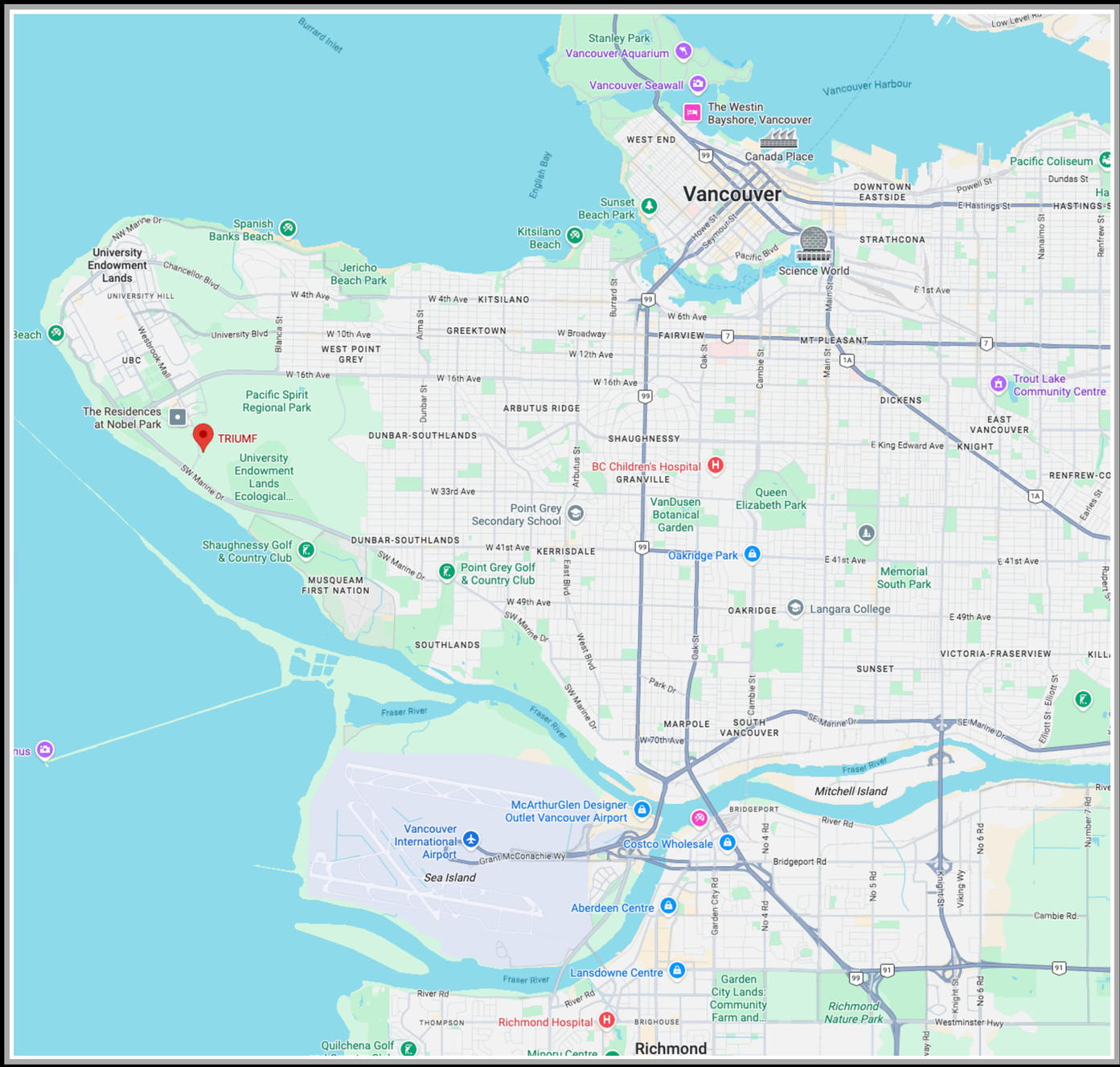


Stanley Park
Vancouver Aquarium
Vancouver Seawall
The Westin Bayshore, Vancouver
Canada Place
Vancouver Harbour
WEST END
Vancouver
DOWNTOWN EASTSIDE
Pacific Coliseum
Sunset Beach Park
Kitsilano Beach
Science World
STRATHCONA
Spanish Banks Beach
University Endowment Lands
Jericho Beach Park
UNIVERSITY HILL
KITSILANO
GREEKTOWN
FAIRVIEW
MT PLEASANT
WEST POINT GREY
UBC
Pacific Spirit Regional Park
The Residences at Nobel Park
TRIUMF
University Endowment Lands Ecological...
ARBUTUS RIDGE
DUNBAR-SOUTHLANDS
SHAUGHNESSY
GRANVILLE
BC Children's Hospital
Trout Lake Community Centre
DICKENS
EAST VANCOUVER
KNIGHT
Queen Elizabeth Park
VanDusen Botanical Garden
Point Grey Secondary School
Shaughnessy Golf & Country Club
KERRISDALE
Oakridge Park
Point Grey Golf & Country Club
MUSQUEAM FIRST NATION
Memorial South Park
OAKRIDGE
Langara College
SOUTHLANDS
VICTORIA-FRASERVIEW
SUNSET
MARPOLE
SOUTH VANCOUVER
Fraser River
Mitchell Island
McArthurGlen Designer Outlet Vancouver Airport
BRIDGEPORT
Vancouver International Airport
Costco Wholesale
Sea Island
Aberdeen Centre
Lansdowne Centre
Garden City Lands: Community Farm and...
Richmond Nature Park
Richmond Hospital
BRIGHOUSE
THOMPSON
Richmond

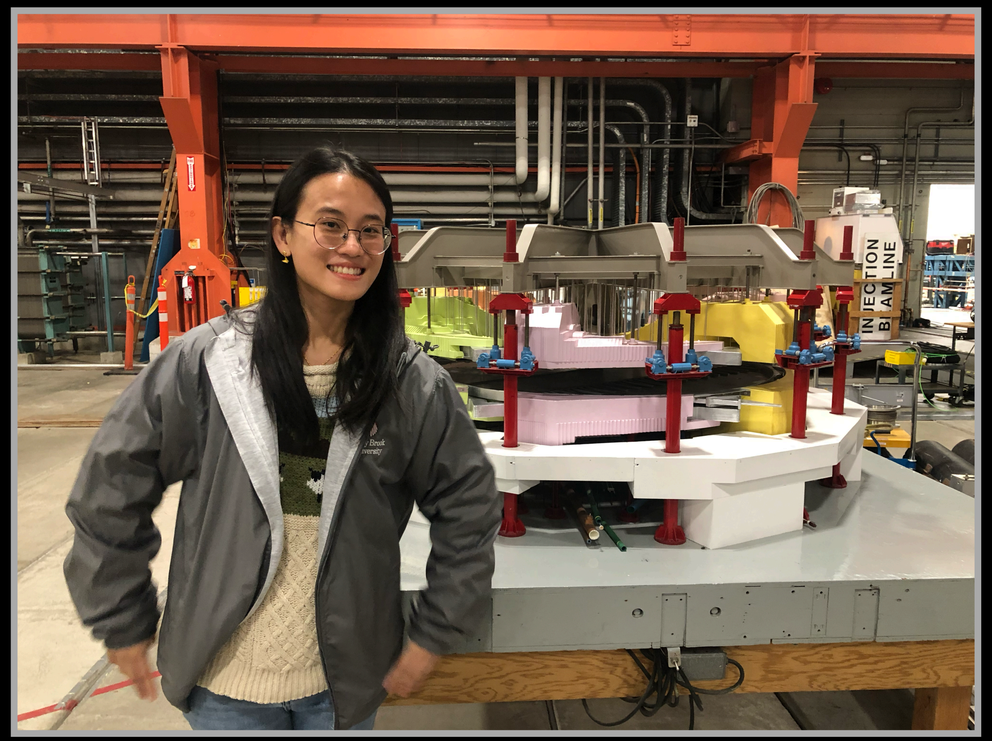
TRIUMF

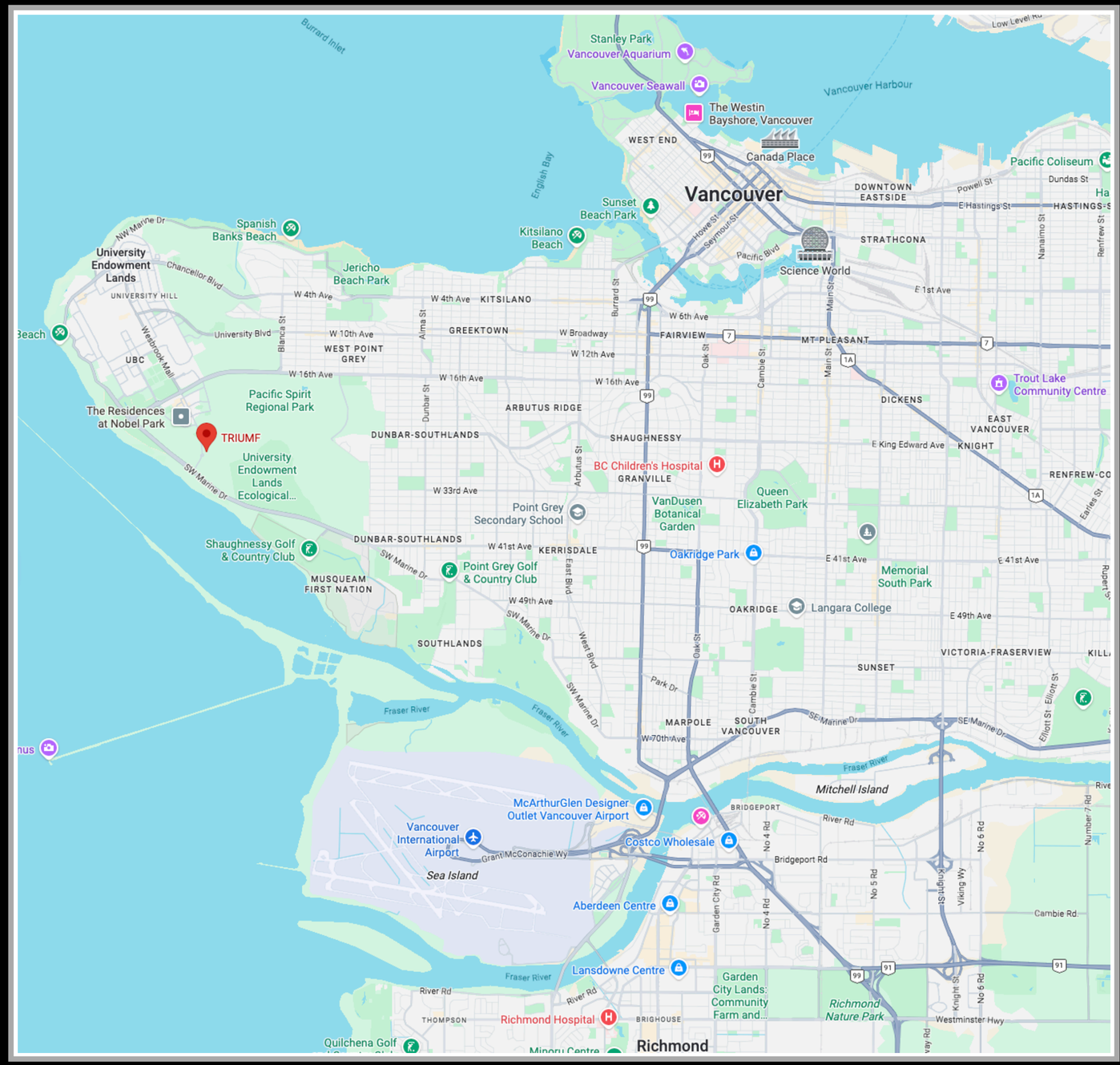





Burrard Inlet
Stanley Park
Vancouver Aquarium
Vancouver Seawall
Vancouver Harbour
The Westin Bayshore, Vancouver
WEST END
Canada Place
Pacific Coliseum
Vancouver
DOWNTOWN EASTSIDE
Sunset Beach Park
Kitsilano Beach
Spanish Banks Beach
University Endowment Lands
Jericho Beach Park
STRATHCONA
Science World
KITSILANO
GREEKTOWN
FAIRVIEW
MT PLEASANT
UBC
WEST POINT GREY
Trout Lake Community Centre
Pacific Spirit Regional Park
The Residences at Nobel Park
TRIUMF
ARBUTUS RIDGE
DUNBAR-SOUTHLANDS
SHAUGHNESSY
DICKENS
EAST VANCOUVER
KNIGHT
BC Children's Hospital
GRANVILLE
University Endowment Lands Ecological...
Point Grey Secondary School
VanDusen Botanical Garden
Queen Elizabeth Park
Shaughnessy Golf & Country Club
Point Grey Golf & Country Club
KERRISDALE
Oakridge Park
MUSQUEAM FIRST NATION
Memorial South Park
OAKRIDGE
Langara College
SOUTHLANDS
SUNSET
VICTORIA-FRASERVIEW
MARPOLE
SOUTH VANCOUVER
Fraser River
Mitchell Island
McArthurGlen Designer Outlet Vancouver Airport
BRIDGEPORT
Vancouver International Airport
Costco Wholesale
Sea Island
Aberdeen Centre
Lansdowne Centre
Garden City Lands: Community Farm and...
Richmond Nature Park
Richmond Hospital
THOMPSON
BRIGHOUSE
Quilchena Golf
Richmond

TRIUMF


INJECTION BEAMLINE

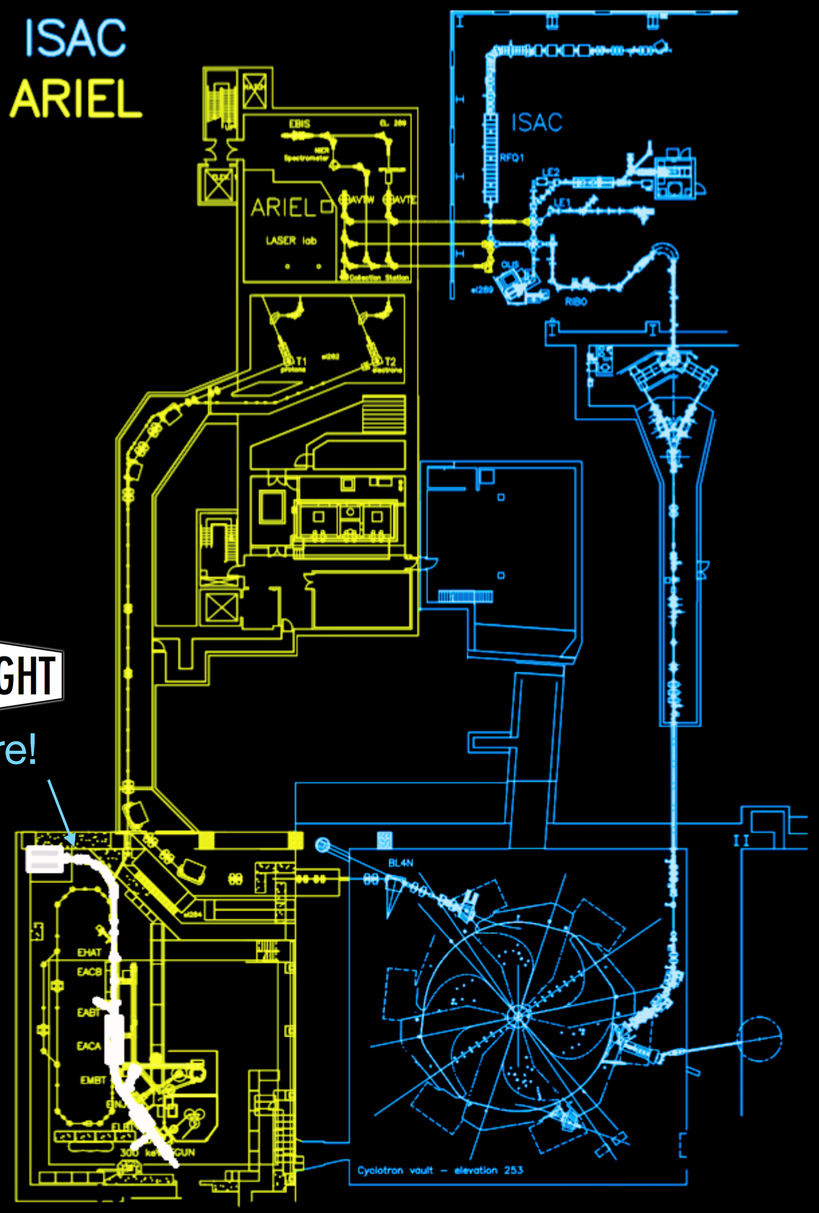

Burrard Inlet
Stanley Park
Vancouver Aquarium
Vancouver Seawall
The Westin Bayshore, Vancouver
Vancouver Harbour
WEST END
Canada Place
Pacific Coliseum
Vancouver
DOWNTOWN EASTSIDE
Sunset Beach Park
Kitsilano Beach
Spanish Banks Beach
STRATHCONA
Science World
University Endowment Lands
Jericho Beach Park
UNIVERSITY HILL
KITSILANO
GREEKTOWN
FAIRVIEW
MT PLEASANT
UBC
WEST POINT GREY
Trout Lake Community Centre
Pacific Spirit Regional Park
The Residences at Nobel Park
TRIUMF
ARBUTUS RIDGE
DUNBAR-SOUTHLANDS
SHAUGHNESSY
DICKENS
EAST VANCOUVER
KNIGHT
BC Children's Hospital
GRANVILLE
University Endowment Lands Ecological...
Point Grey Secondary School
VanDusen Botanical Garden
Queen Elizabeth Park
Shaughnessy Golf & Country Club
Point Grey Golf & Country Club
KERRISDALE
Oakridge Park
MUSQUEAM FIRST NATION
Memorial South Park
OAKRIDGE
Langara College
SOUTHLANDS
SUNSET
VICTORIA-FRASERVIEW
MARPOLE
SOUTH VANCOUVER
Fraser River
Mitchell Island
McArthurGlen Designer Outlet Vancouver Airport
BRIDGEPORT
Vancouver International Airport
Costco Wholesale
Sea Island
Aberdeen Centre
Lansdowne Centre
Garden City Lands: Community Farm and...
Richmond Nature Park
Richmond Hospital
THOMPSON
BRIGHOUSE
Quilchena Golf
Richmond

Beamline:

TRIUMF ARIEL
ADVANCED RARE ISOTOPE LABORATORY







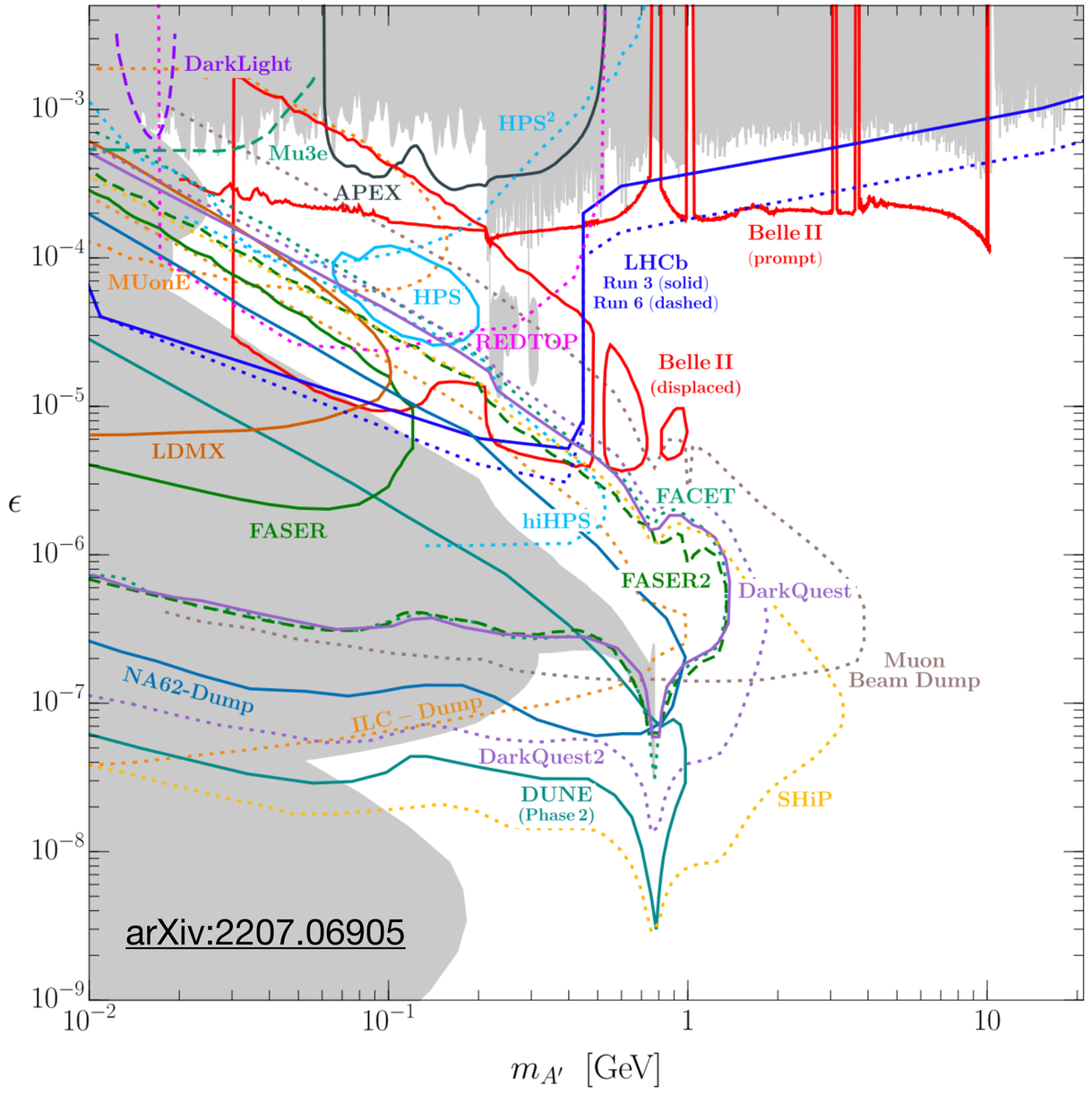
DARKLIGHT is here!

Electron linac

Experimental goal



Dark Matter

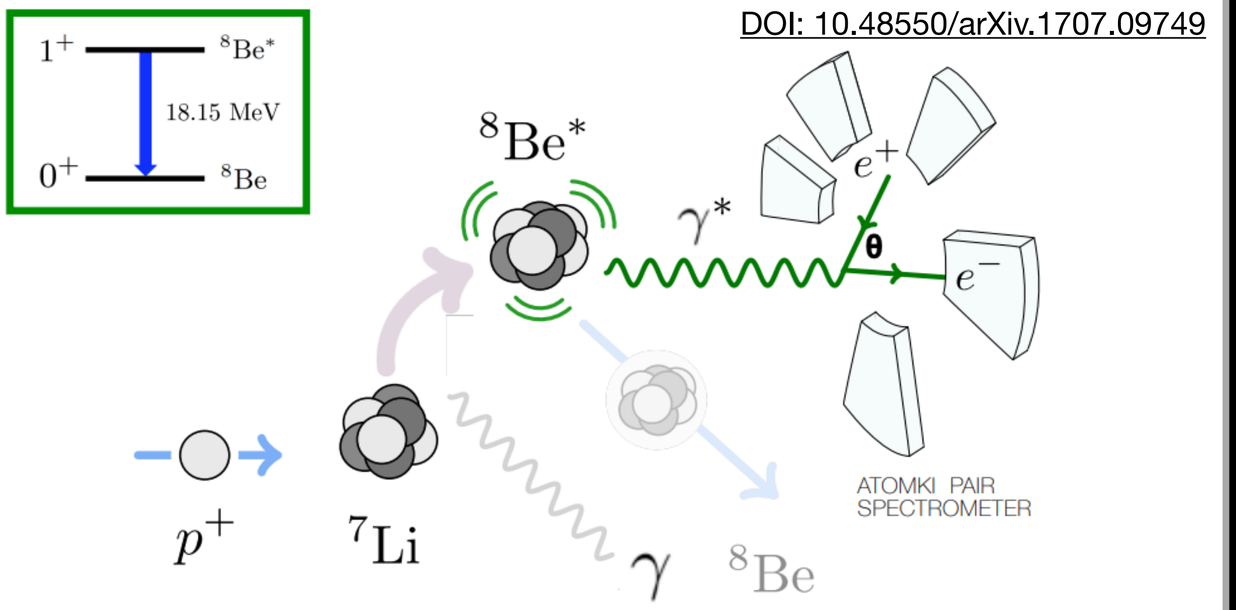


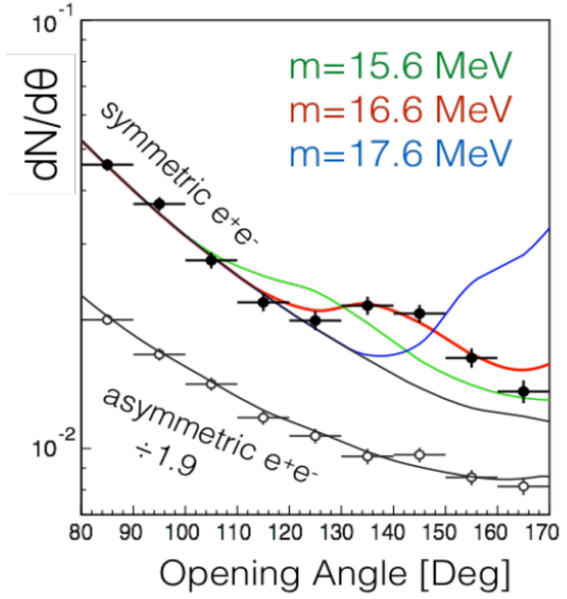
Visible Matter

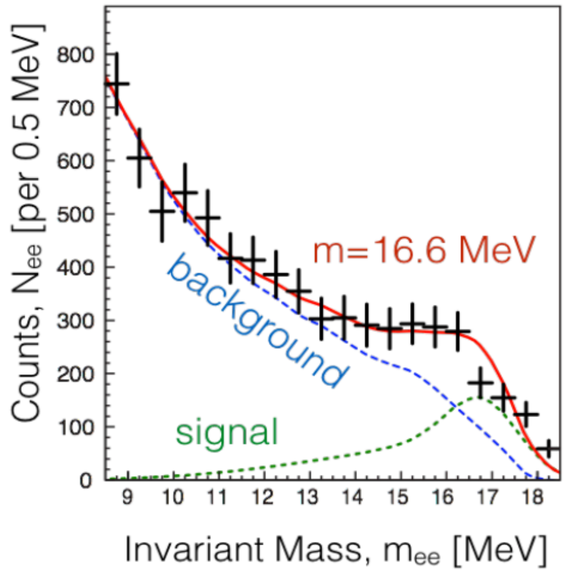
X17:
The ATOMKI Experiment

- New boson with mass 17 MeV?
- Protophobic

DOI: 10.1103/PhysRevLett.116.042501
DOI: 10.48550/arXiv.1707.09749







X17:
The ATOMKI Experiment

- New boson with mass 17 MeV?
- Protophobic
- Similar observations in ^{4}He, ^{12}C decays with independent apparatus:

  DOI: 10.1103/PhysRevC.104.044003

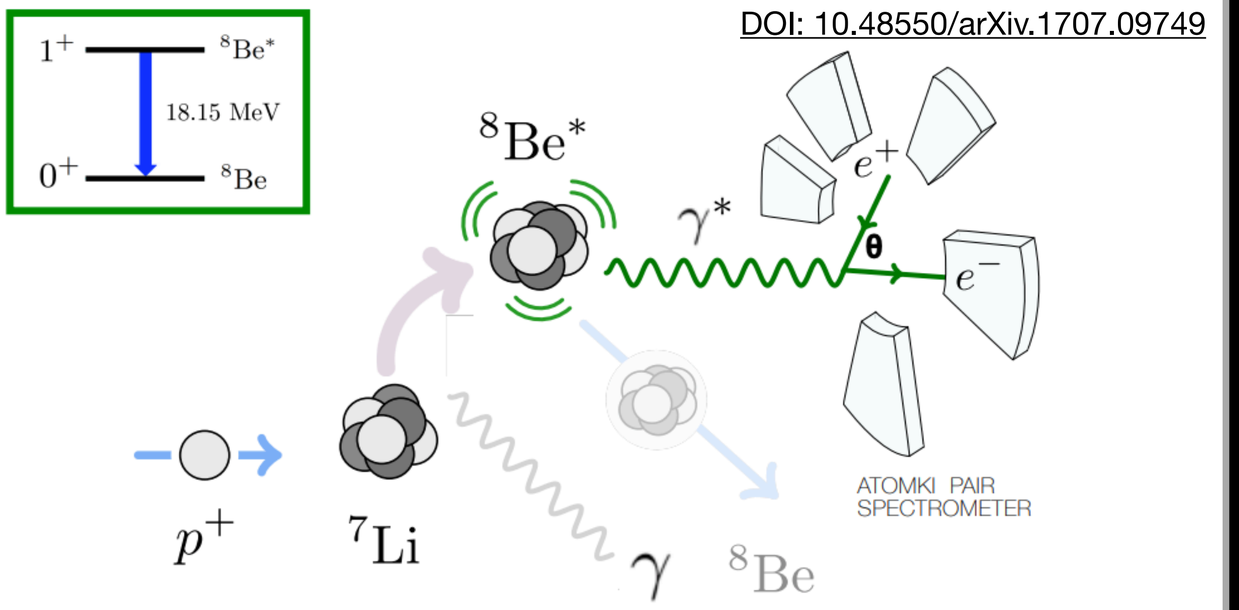
  DOI: 10.1103/PhysRevC.106.L061601

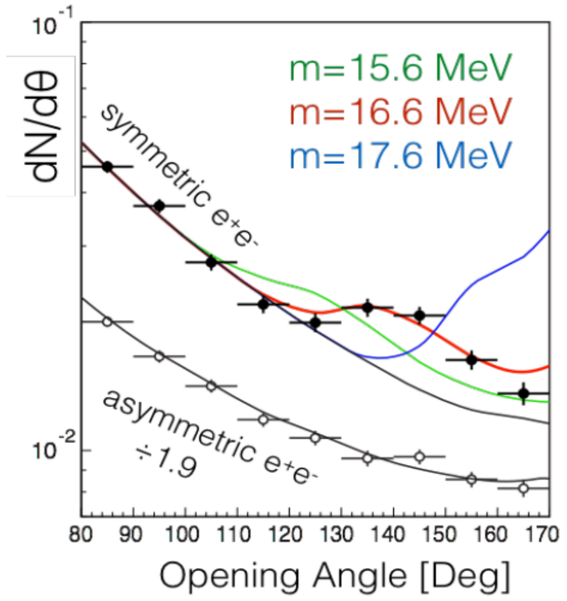
  and in pC, dC, dCu interactions:

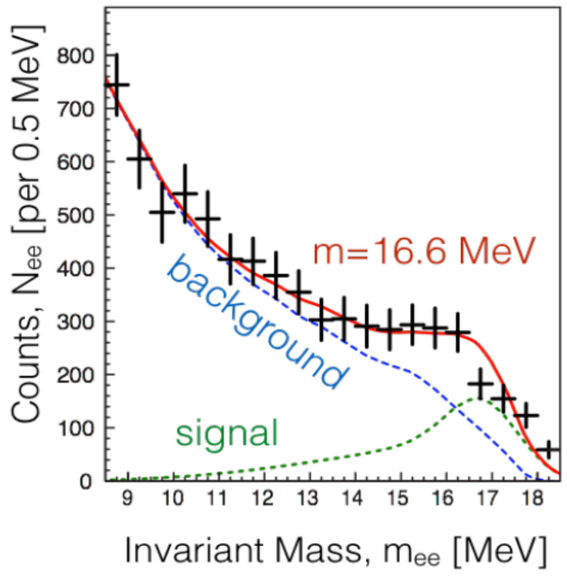
  DOI: 10.48550/arXiv.2311.18632

DOI: 10.1103/PhysRevLett.116.042501

DOI: 10.48550/arXiv.1707.09749



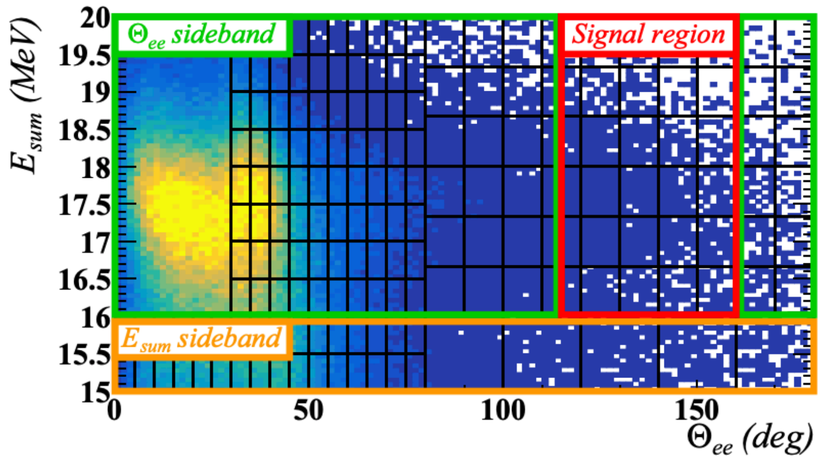


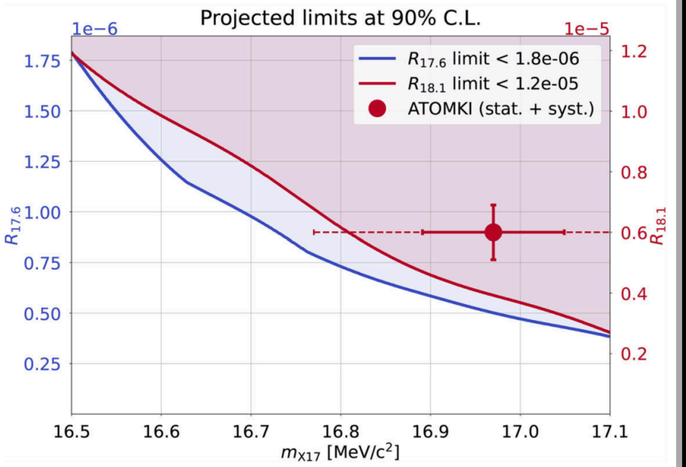


X17:
Recent measurements

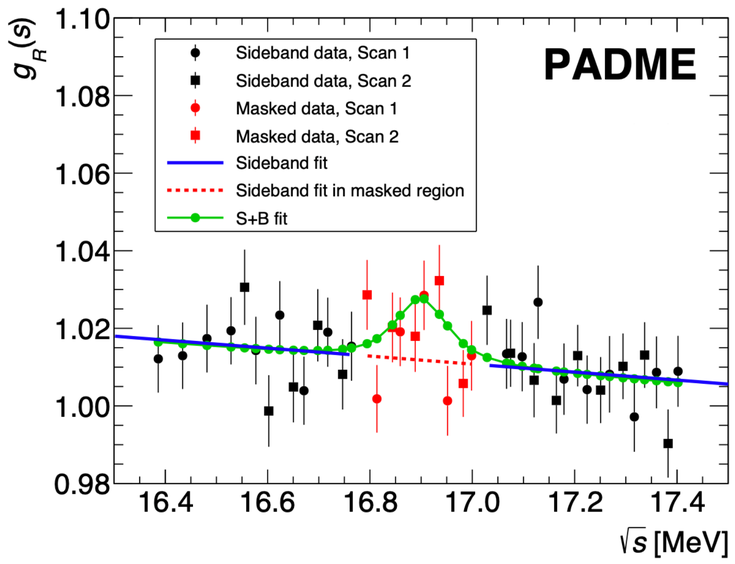
- MEGII @ PSI
  - $^{7}\mathrm{Li}(\mathrm{p}, \mathrm{e}^{+}\mathrm{e}^{-})^{8}\mathrm{Be}$
  - No observation of X17
  - Signal range is at the edge of acceptance
- PADME @ INFN-LNF
  - $e^{+}e^{-} \rightarrow \gamma A$
  - 1.6σ excess

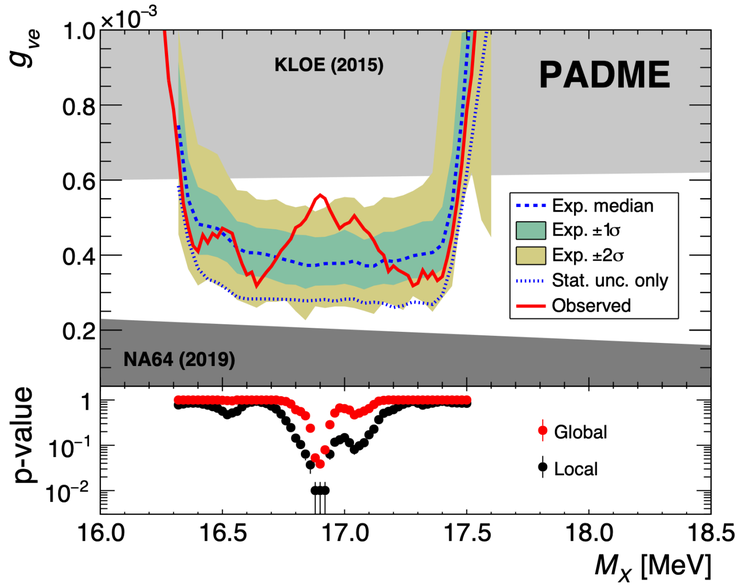
https://doi.org/10.1140/epjc/s10052-025-14345-0





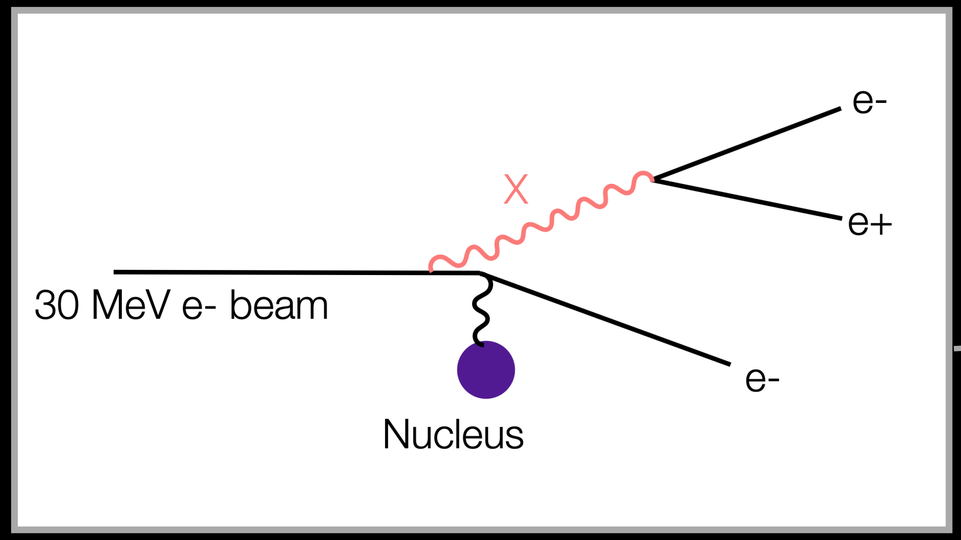
https://arxiv.org/pdf/2505.24797

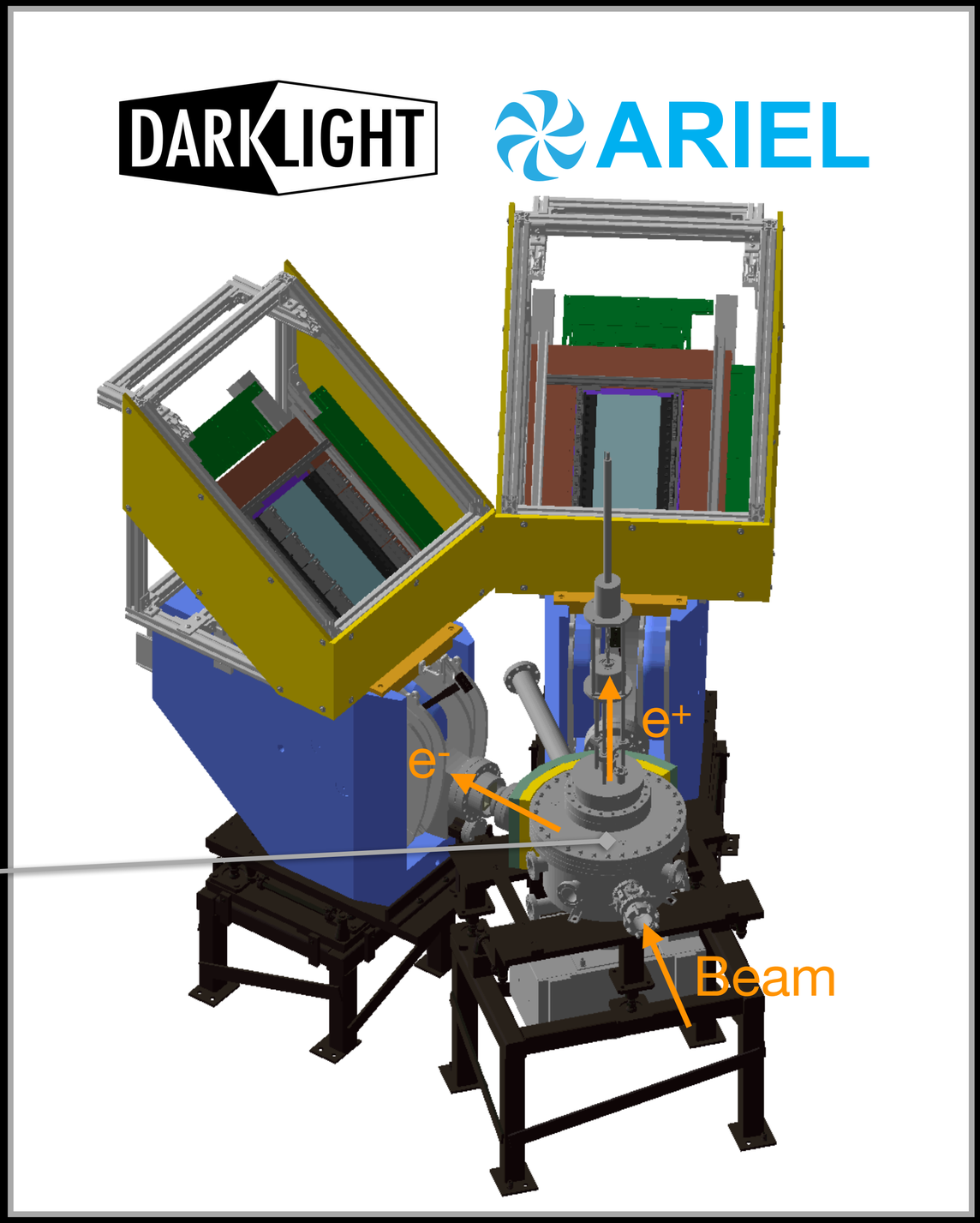




DarkLight Experiment

- Two-spectrometer setup
- Tantalum foil target



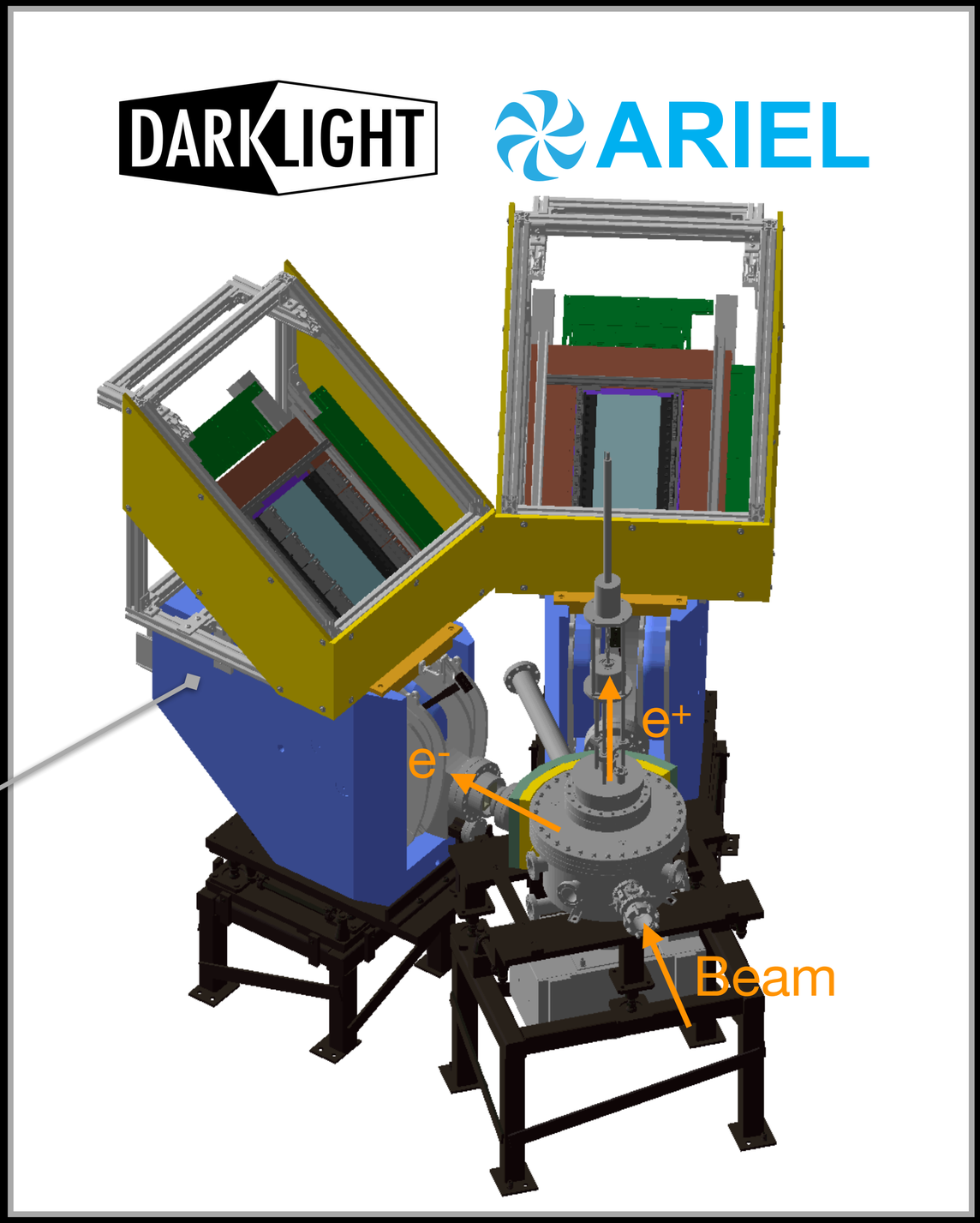


Detector setup:

- **Magnetic spectrometers**

- $\pm 1.35^{\circ}$ in-plane, $\pm 5^{\circ}$ out-of-plane angle
- $\pm 20\,\%$ momentum

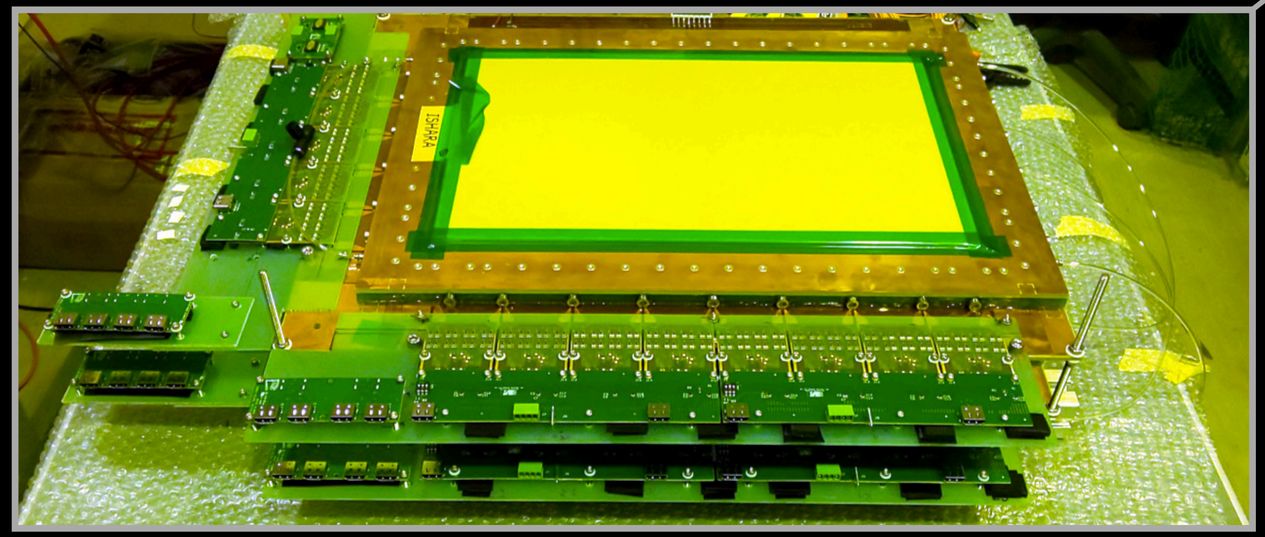


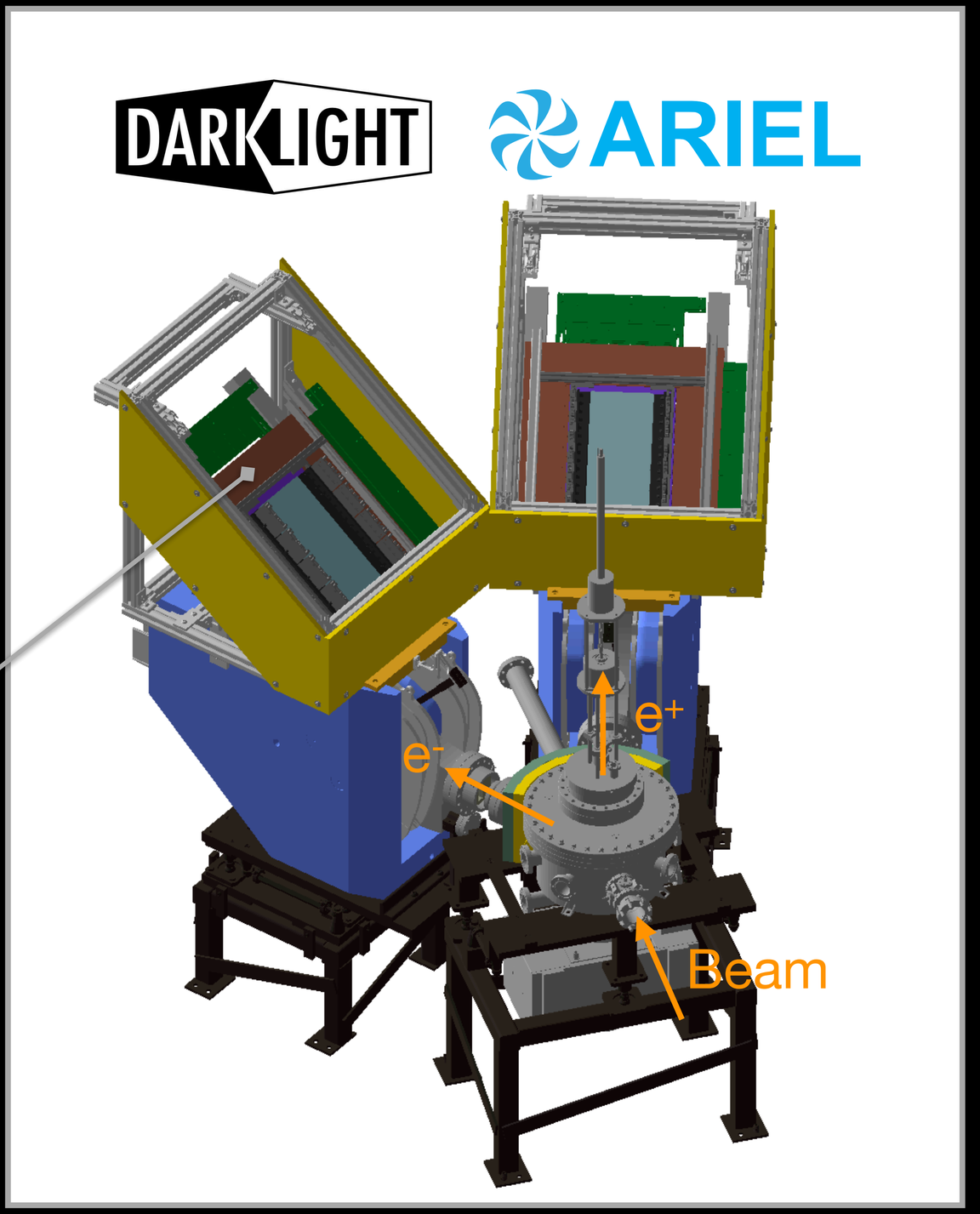


Detector setup:

- **GEM trackers**

- 25 x 40 cm triple layer GEMs
- 2 planes per spectrometer arm
- APV + MPD4 readout



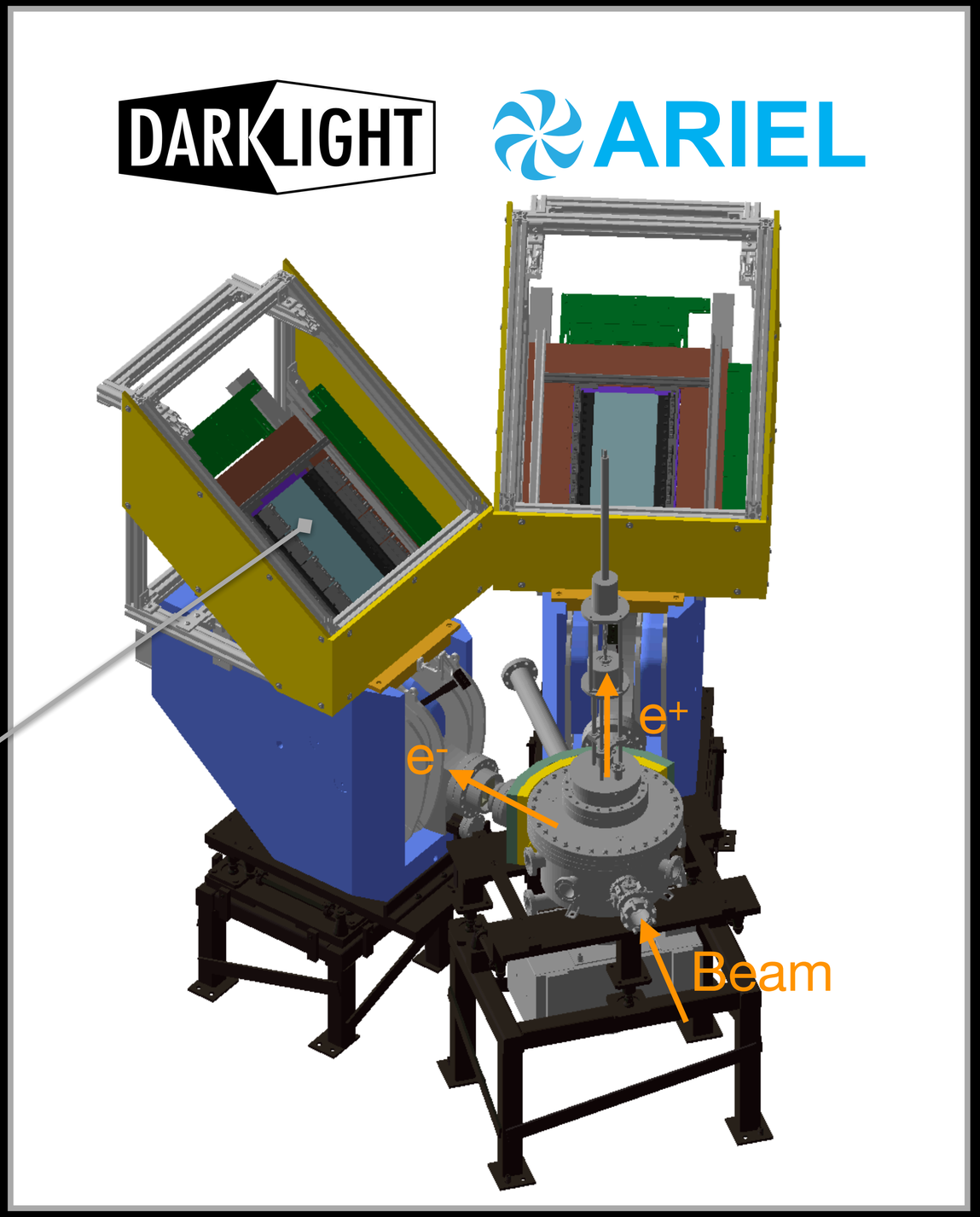


Detector setup:

- **Scintillator triggers**

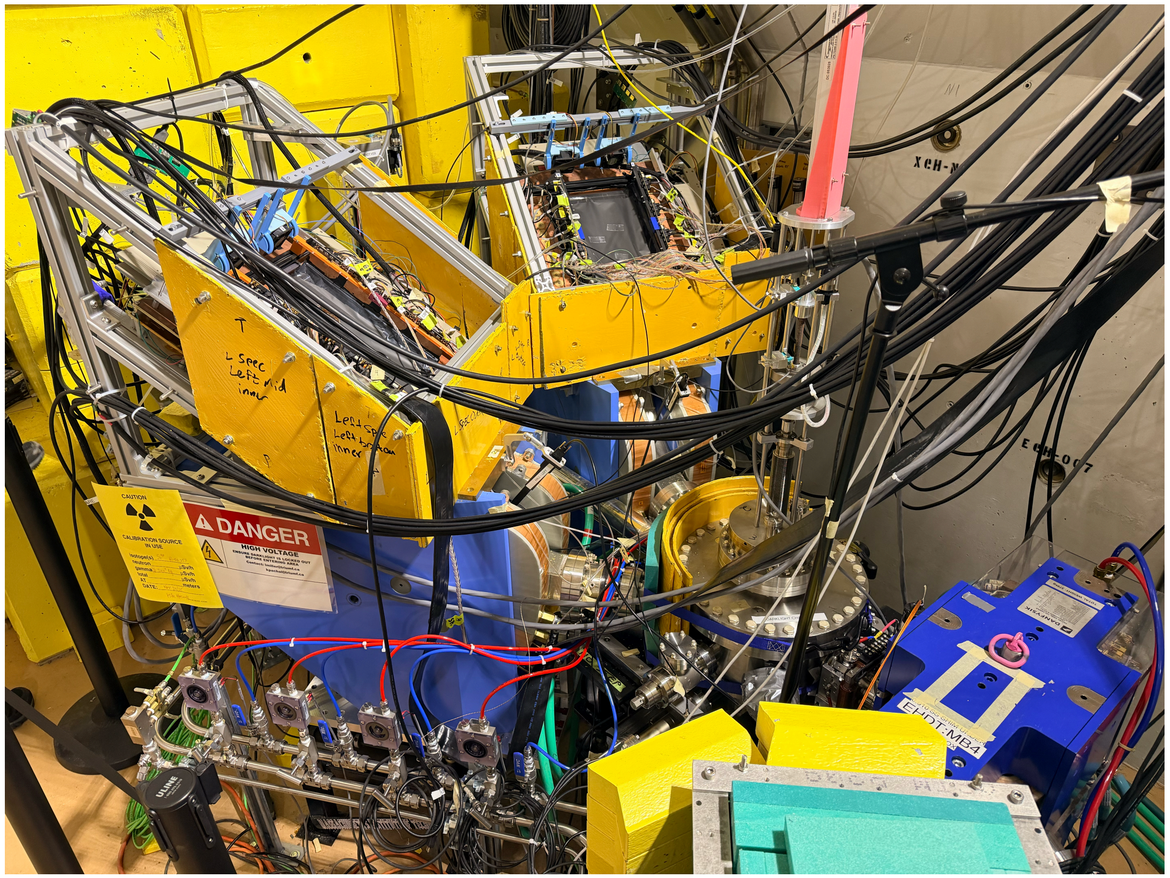
- 8 paddles per spectrometer
- Plastic scintillators, SiPM readouts





Full setup:

- Installation in Fall 2025

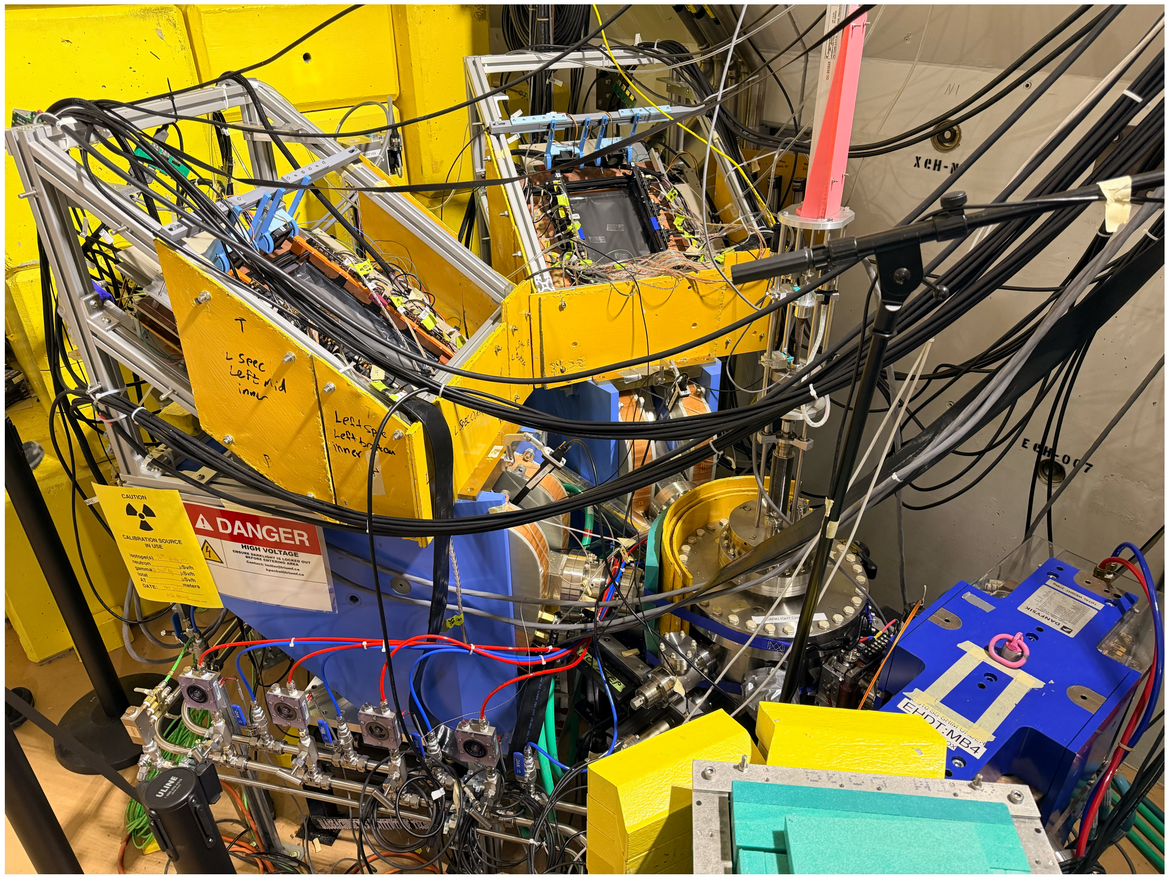


Full setup:

- Installation in Fall 2025



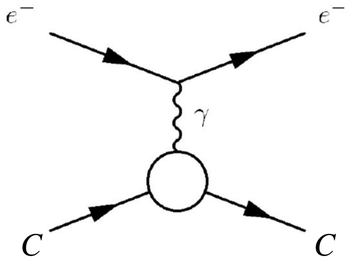
DARKLIGHT ARIEL



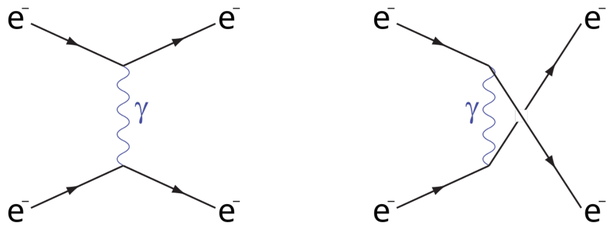
Commissioning:

- Installation in Fall 2025
- Fall 2025 - Jan 2026
  Commissioning with
  10 to 30 MeV beam

Physics processes for commissioning data



eC scattering

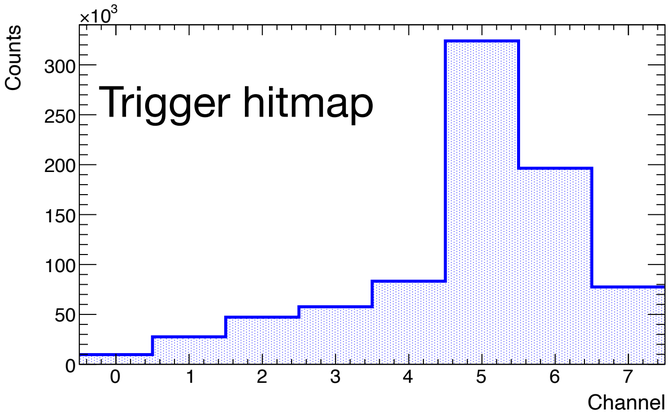


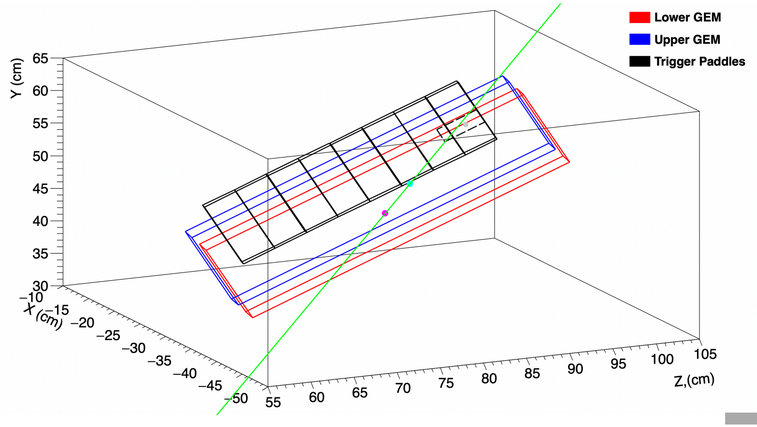
Møller scattering

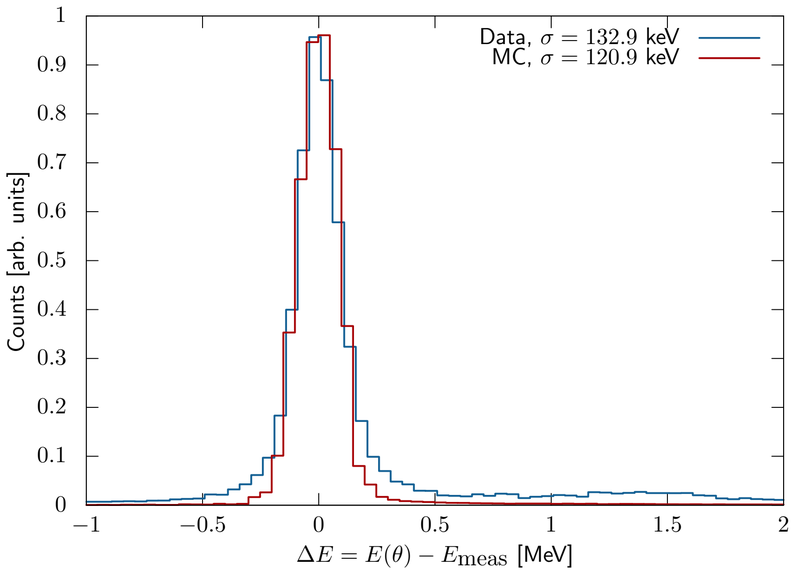
DarkLight analysis

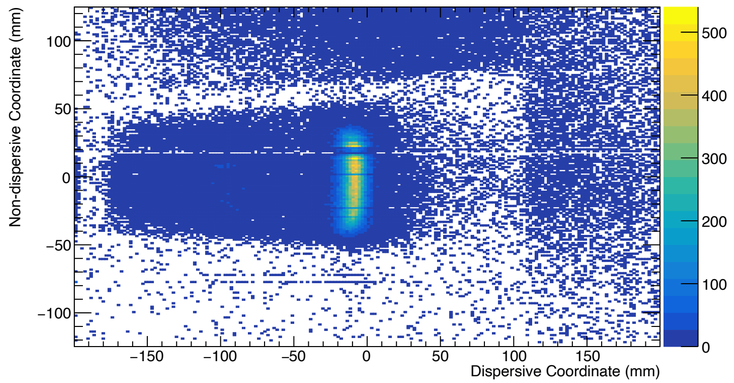
- **Event reconstruction**

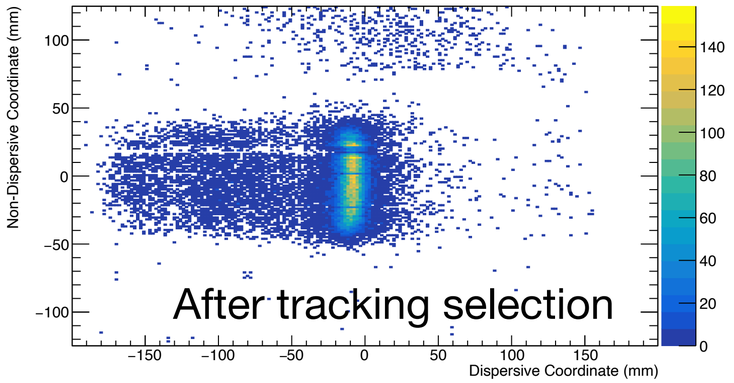
Example online analysis for 10 MeV eC scattering









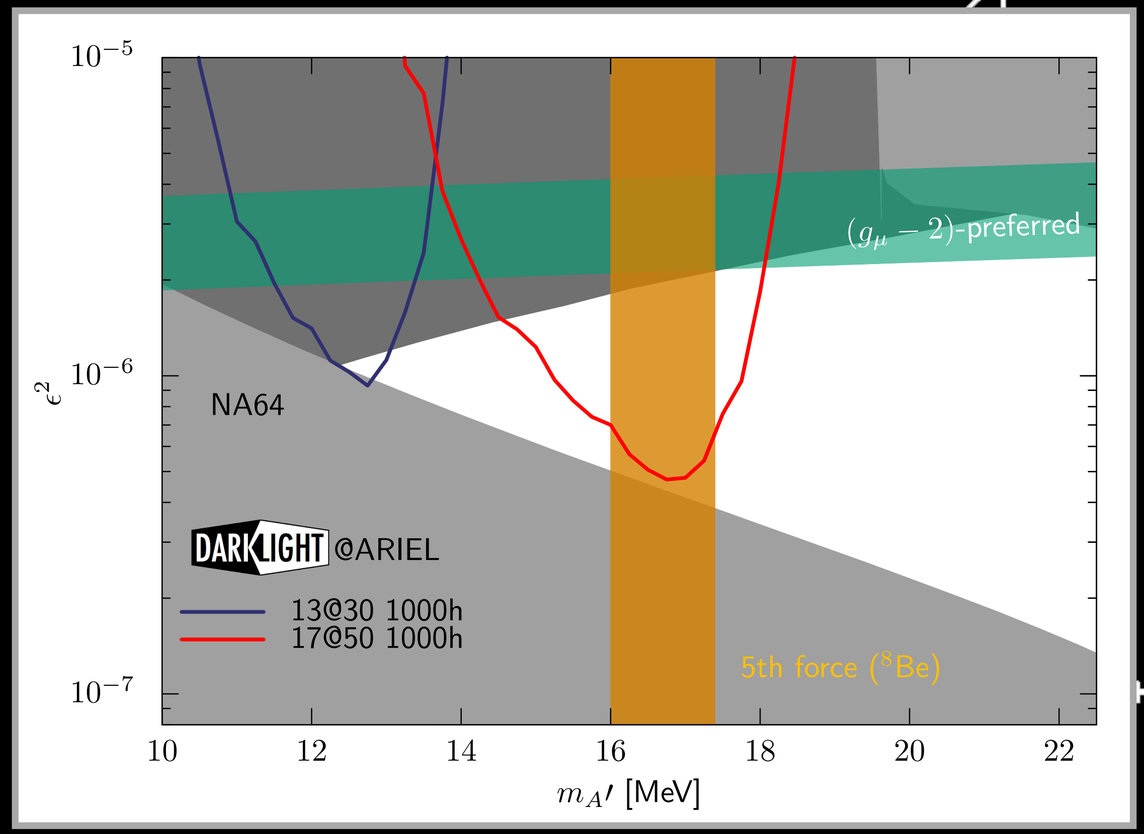


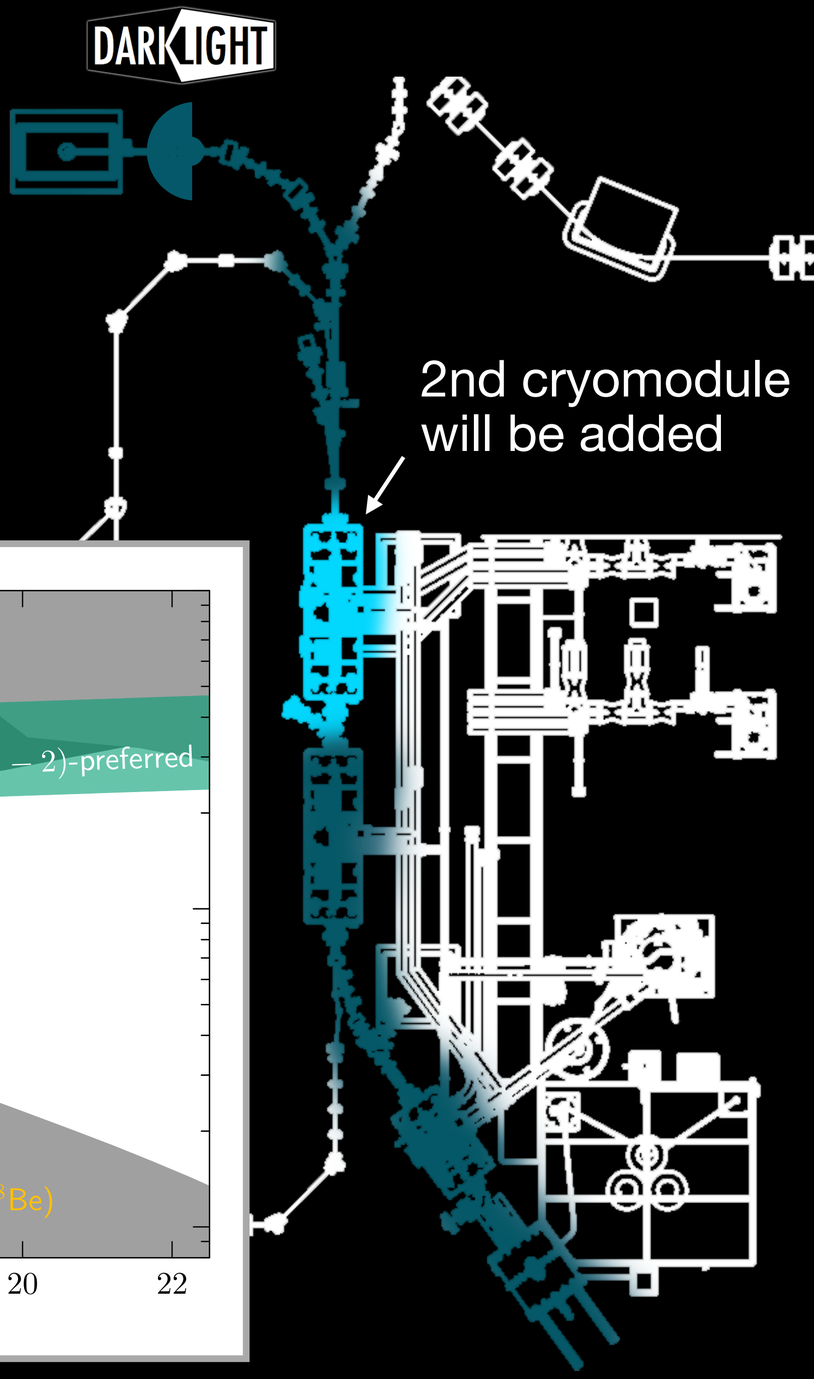
Plan for production data

- Installation in Fall 2025
- Fall 2025 - Jan 2026
- Commissioning with
- 10 to 30 MeV beam

ARIEL shutdown

- (Jan 2027: 30 MeV production data)
- Beamline upgrade
- 2027/2028: 50 MeV production data





Additional physics

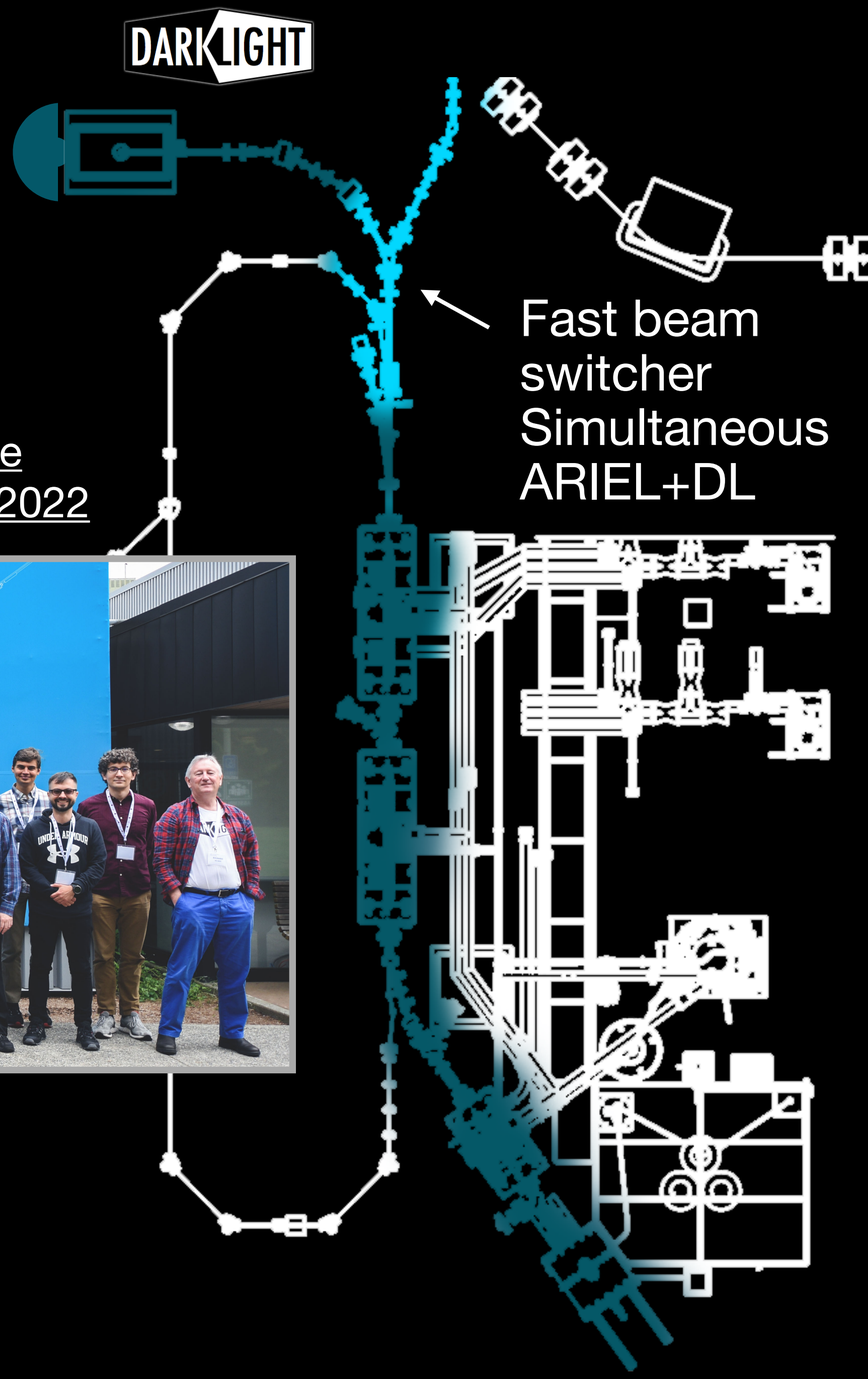
- Radiative Møller scattering
- $^{16}\mathrm{O}(\mathrm{e}, \mathrm{e}'\alpha)^{12}\mathrm{C}$
- Radii of nuclei
- Axial form factor

…

New Scientific Opportunities with the TRIUMF ARIEL e-linac, May 25-27, 2022



DOI: 10.1088/1742-6596/2391/1/012001





Summary:

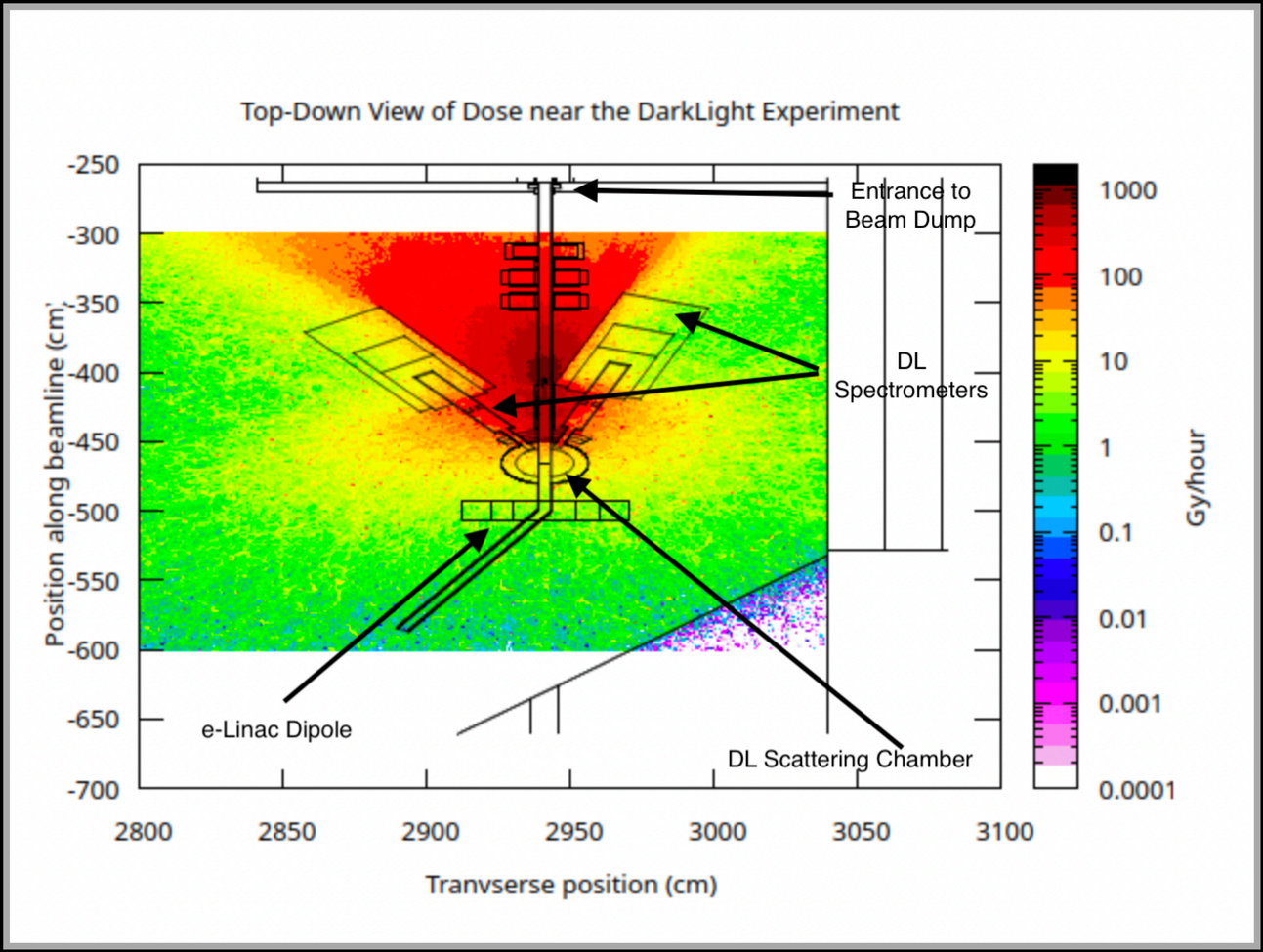
- DarkLight is searching for X17
- Installed and commissioned
- Processing commissioning data
- 50 MeV production data will come after beamline upgrade
- Exploring other physics opportunities

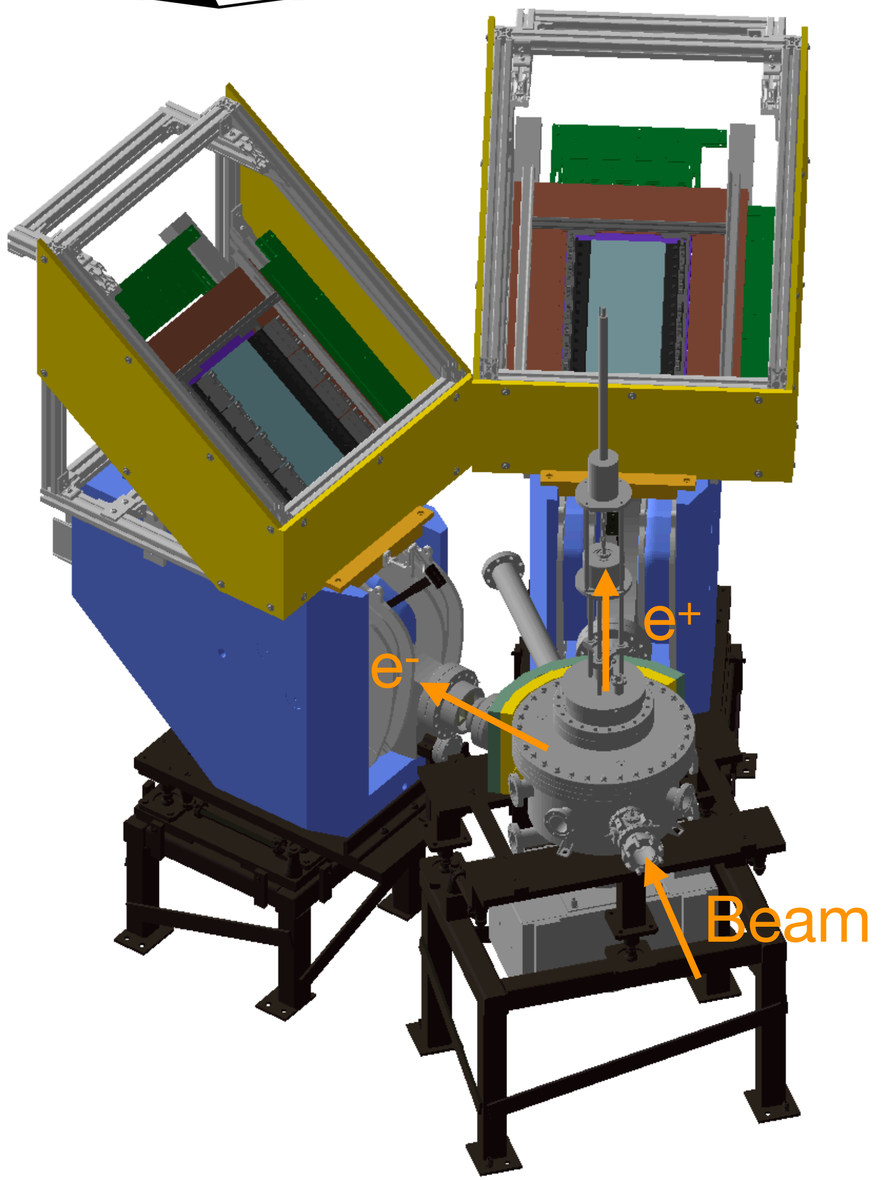
Timelapse video of installation: link

Slides ++

Detector setup:

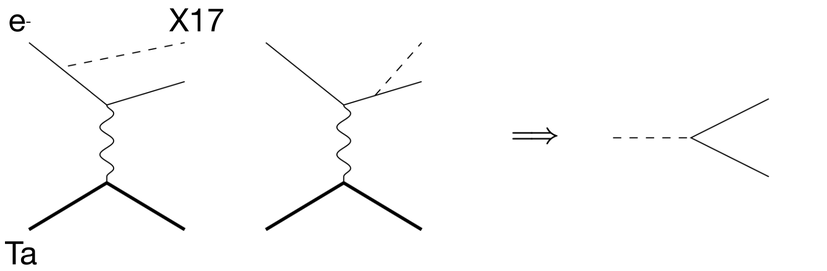
- Shielding for γ and n



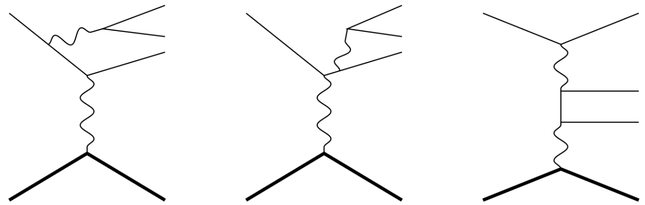


Detector setup:

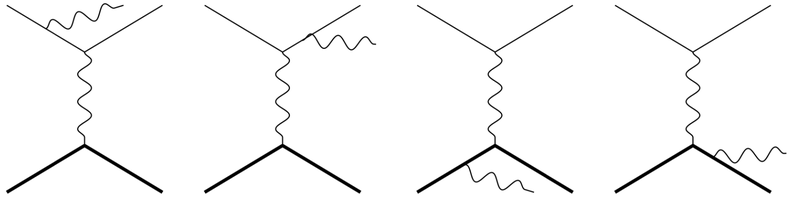
- **Asymmetric spectrometers**



Signal

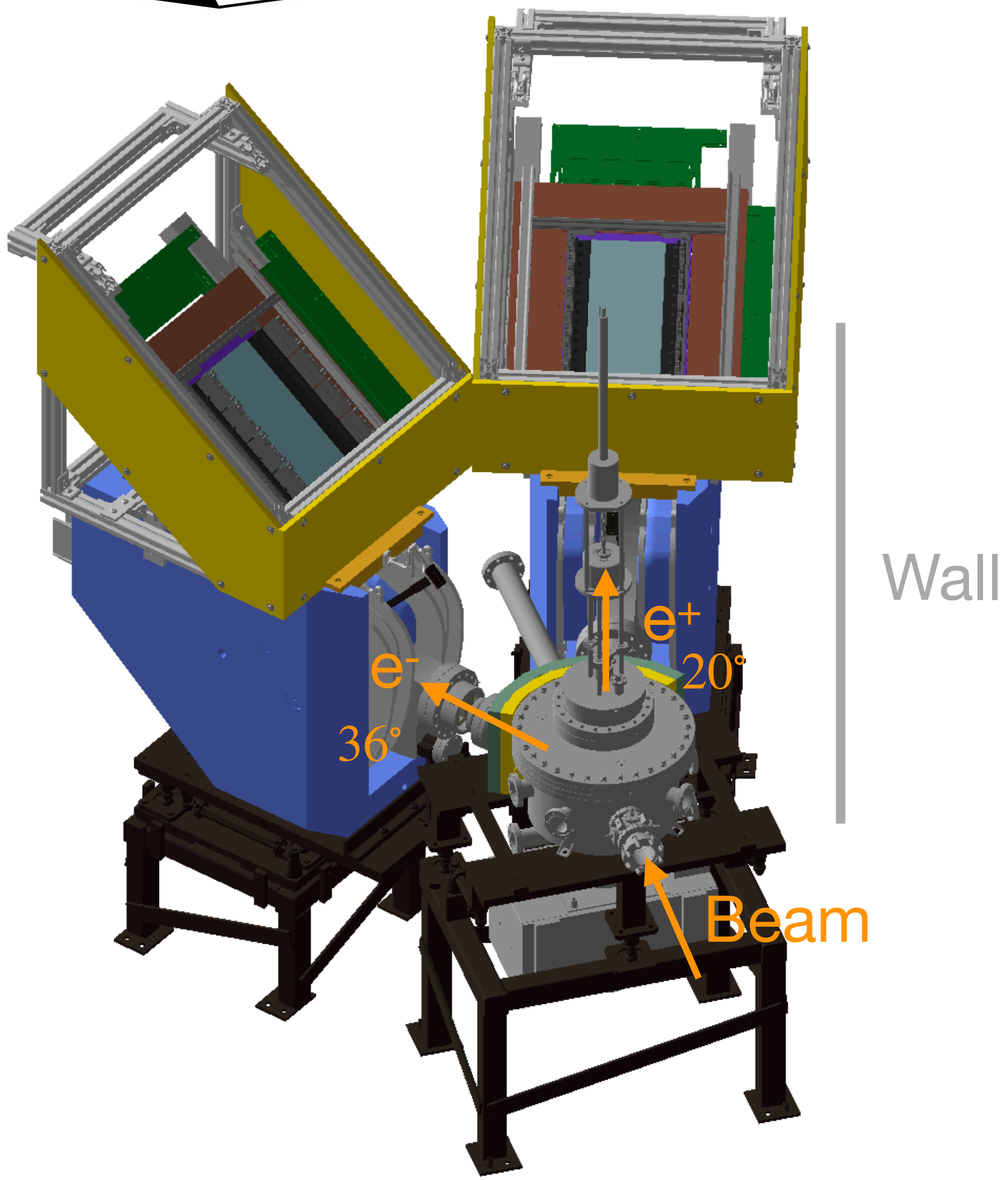


Irreducible background



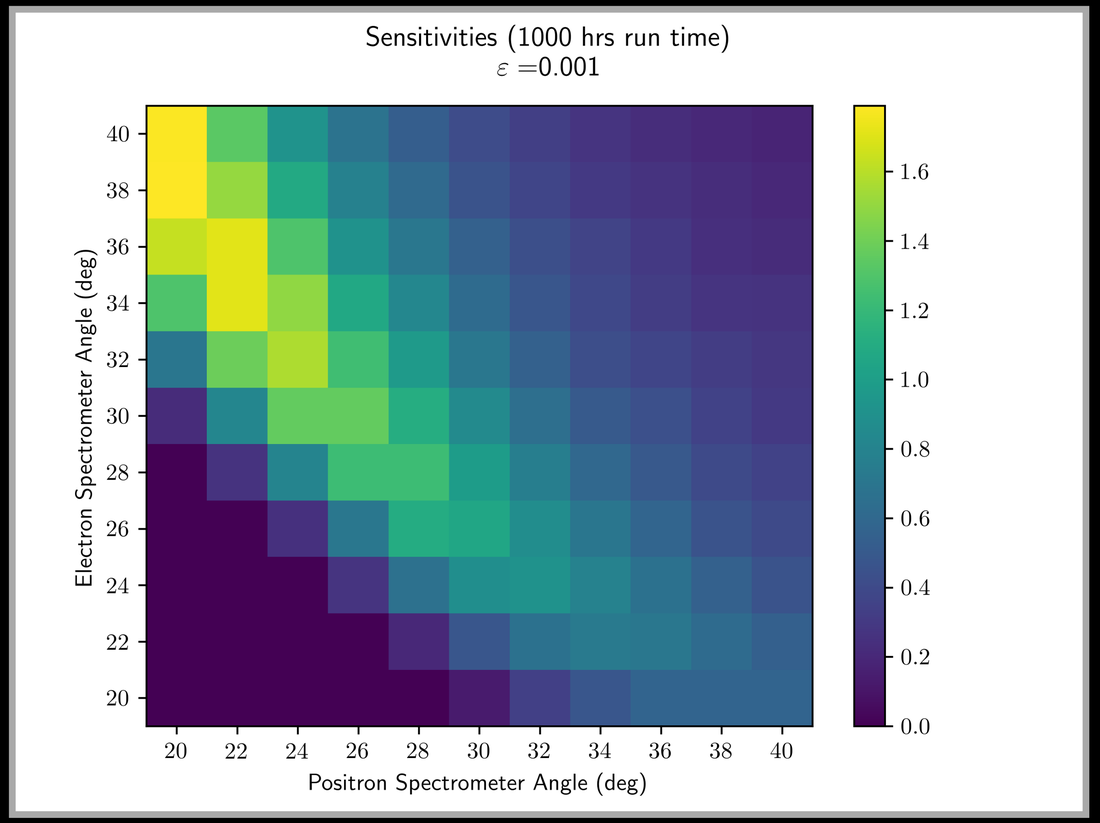
Combinatorial background

Physics processes in production runs



Detector setup:

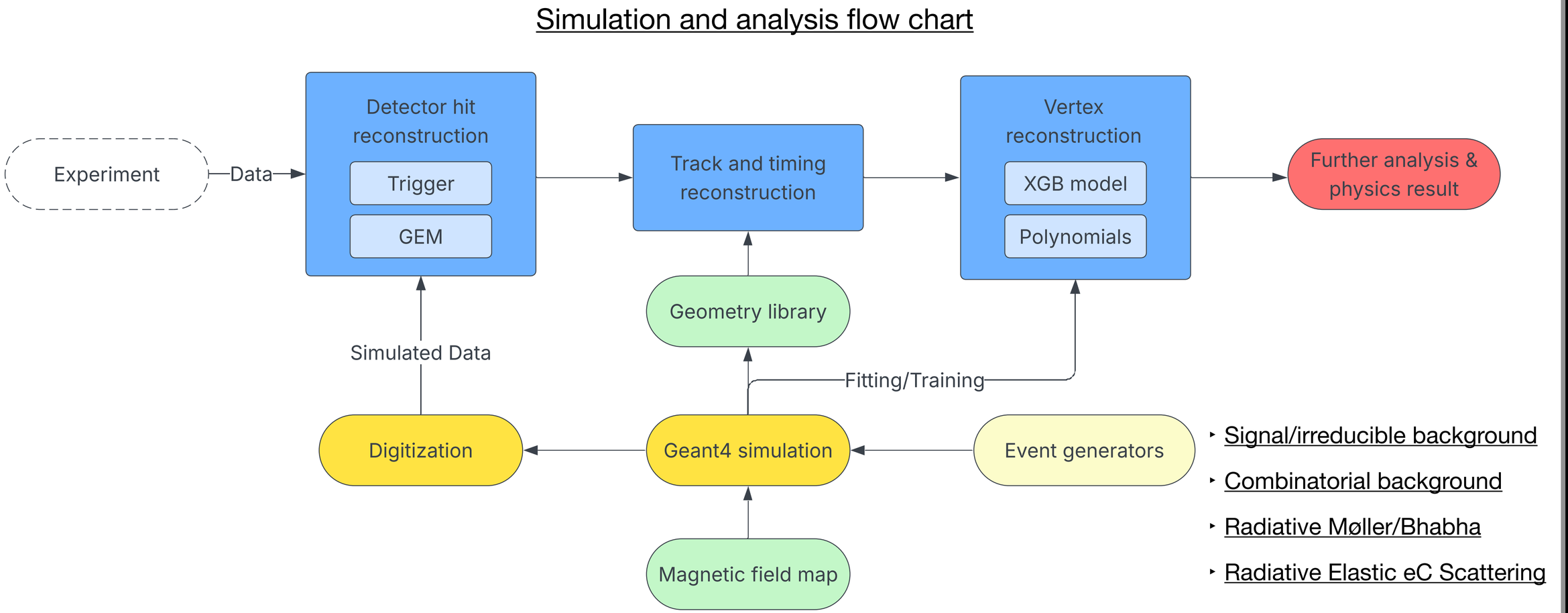
- **Asymmetric spectrometers**





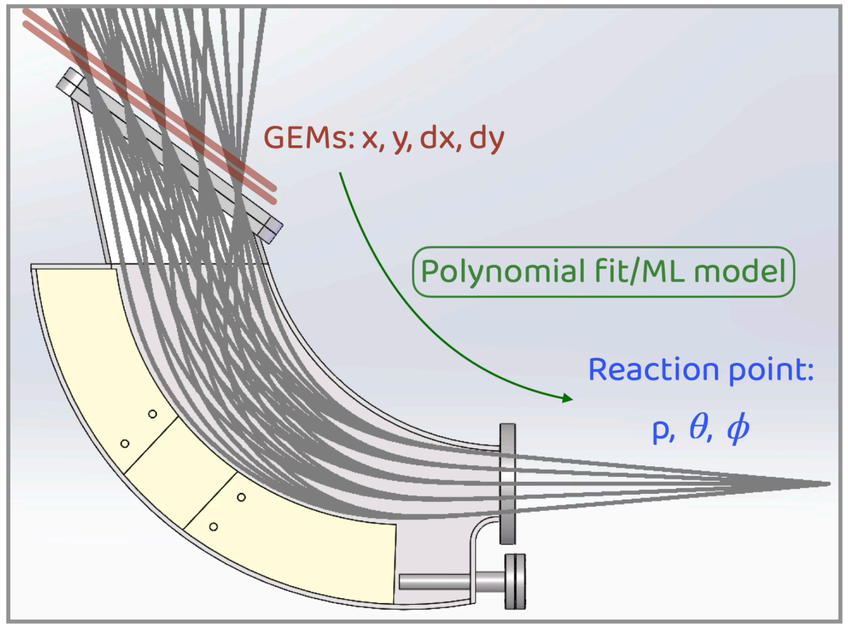
DarkLight analysis

- **Framework overview - COOKER**

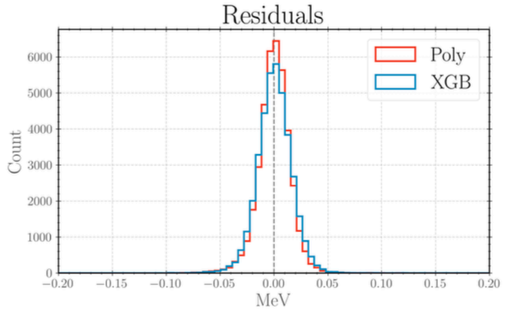


DarkLight analysis

- **Vertex reconstruction and machine learning study**

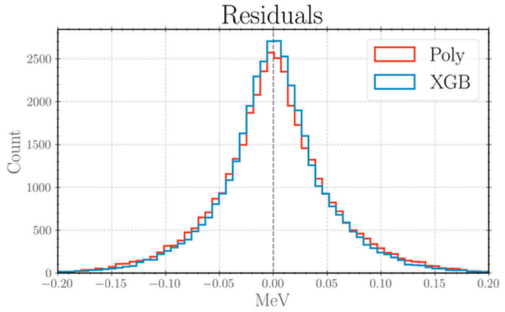


Model	MSE
Polynomial	0.00196
XGB	0.00178



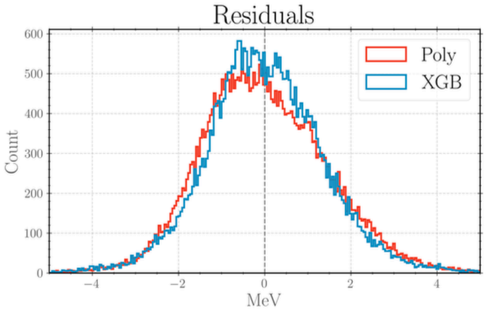
Momentum

Model	MSE
Polynomial	0.00574
XGB	0.00459



In-Plane Angle

Model	MSE
Polynomial	2.299
XGB	1.928

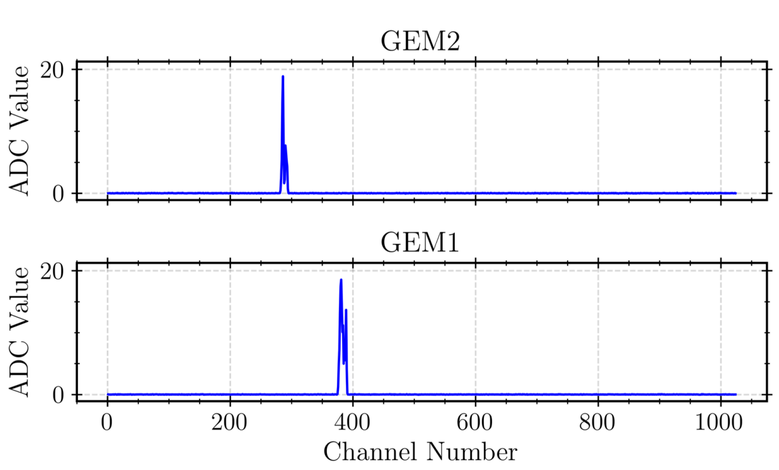


Out-of-Plane Angle

DarkLight analysis

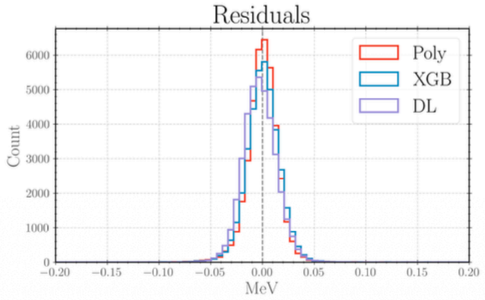
- **Vertex reconstruction and machine learning study**

Event display of a simulated large angle track



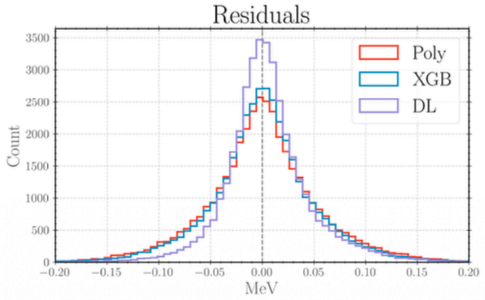
ADC ⟶ Kinematics

Model	MSE
Polynomial	0.00196
XGB	0.00178
DL	0.00192



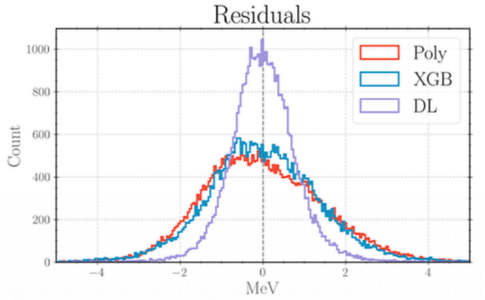
Momentum

Model	MSE
Polynomial	0.00574
XGB	0.00459
DL	0.00377



In-Plane Angle

Model	MSE
Polynomial	2.299
XGB	1.928
DL	0.714



Out-of-Plane Angle