TRIUMF

Photons for Astro-particle physics and Applied Research

Fabrice Retière (TRIUMF)

Discovery, accelerated

nEXO

- Neutrino-less double beta search in liquid Xenon
- Completion date: CD1 + 5 year
- Funding
  - CFI IF-10 awarded but split into 2 parts, ~4+4M$ for UBC/TRIUMF
    - Need BCKDF confirmation
  - CFI IF-11 request expected to go in
    - Mostly supporting work at SNOLAB with ~1M$ for LXe & light detector equipment at TRIUMF
- #1 risk: No DOE funding

- TRIUMF's contribution
  - Silicon photo-multiplier development
    - Vacuum Efficiency Reflectivity and Absorption (VERA) and Microscope for the Injection and Emission of Light (MIEL) setups with IF-9 and IF-10
  - SiPM mass testing
    - New clean room and cryogenic probe station with IF-10
  - LXe light detection development
    - System level with the Light only Liquid Xenon (LoLX) experiment with Carleton, McGill
    - Cryogenic Liquid Efficiency Absorption and Reflectivity (CLEAR) setup with IF-11

DarkSide-20k

- WIMP interaction search in the >50GeV/c2 range
  - Comparable to LZ and XENONnT sensitivity but with LAr
- Completion date 2026?
- #1 risk: physicist-heavy management
  - Difficult decision making process

- TRIUMF's contribution
  - Responsible for data Acquisition system
    - Funded by CFI IF-10 with Queen's U. About 4M$. About 1M$ for manpower
    - Aim to complete project in 2025 no matter what
  - Contribution to SiPM testing

ARGO

- WIMP interaction search in the >50GeV/c2 range in Lar
  - Sensitivity x10 DarkSide-20k, comparable to DARWIN (Lxe)
- Completion date 2035?
- #1 risk: >100M$ cost
  - Unclear collaboration structure
  - R&D to reduce cost

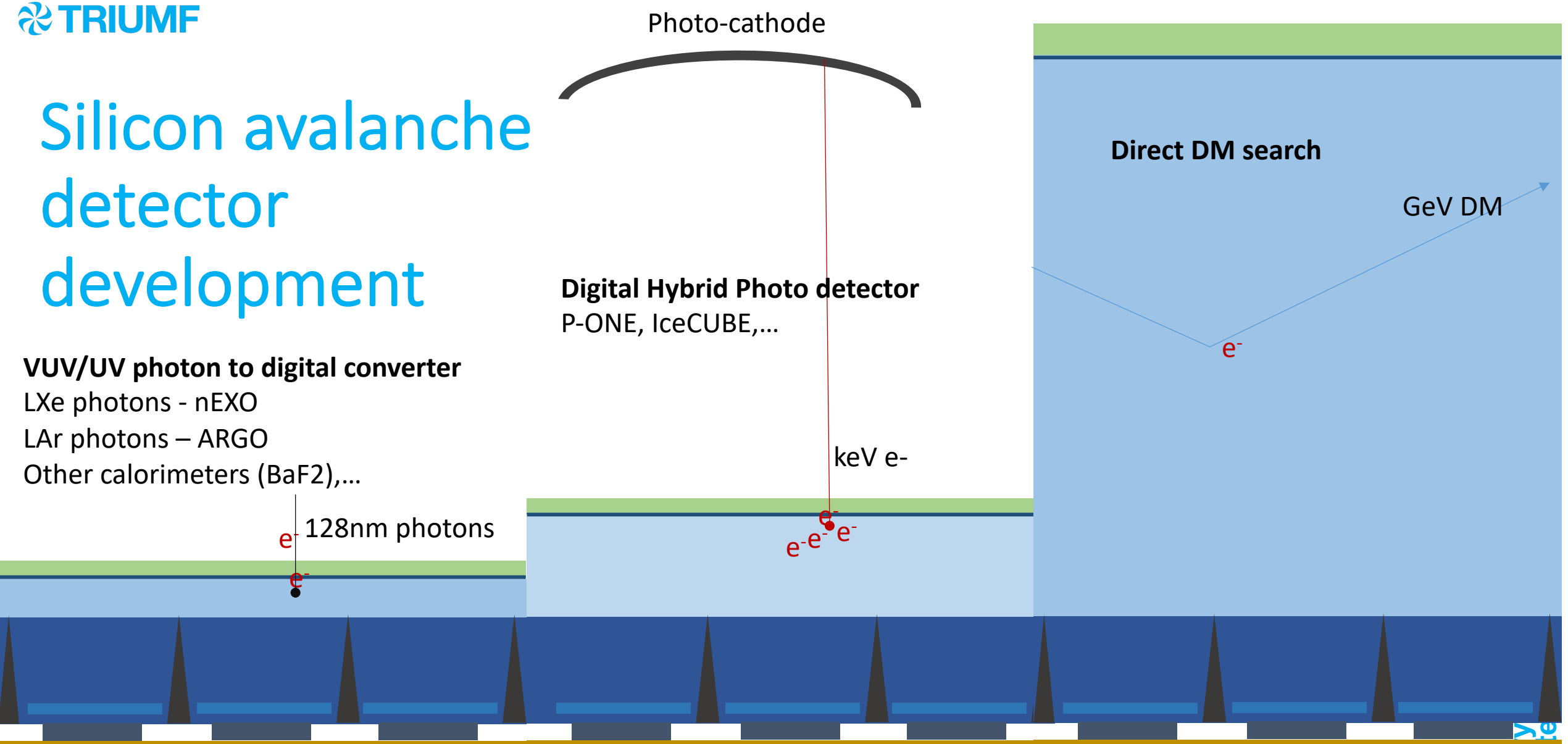
- TRIUMF's contribution
  - Photon to Digital Converter
    - Integrated photon detector and electronics. Cheaper and easier to handle in large quantity
  - Back-side illuminated photon detector (for PDC)
    - Easier to build and tailor
    - Focus on direct detection of LAr scintillation at 128nm. Hard!

Silicon avalanche detector development

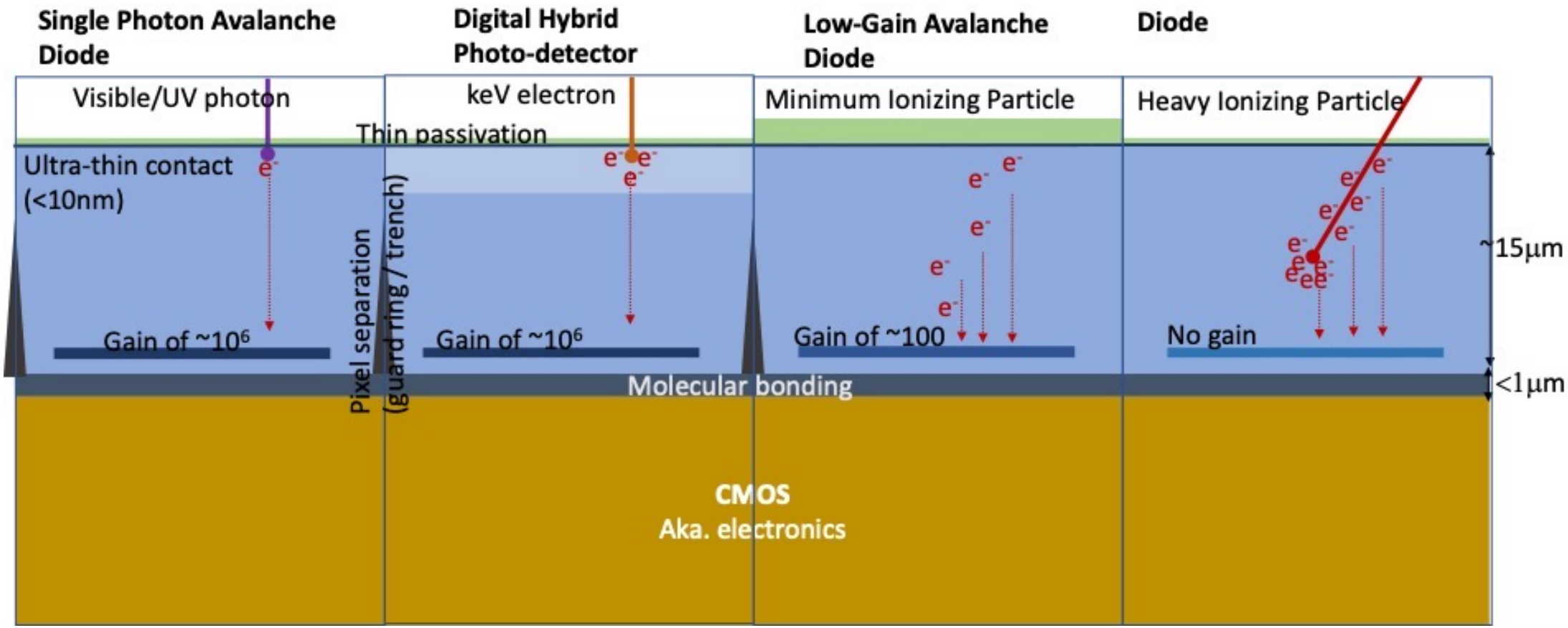
VUV/UV photon to digital converter
LXe photons - nEXO
LAr photons – ARGO
Other calorimeters (BaF2),…

Digital Hybrid Photo detector
P-ONE, IceCUBE,…

Direct DM search

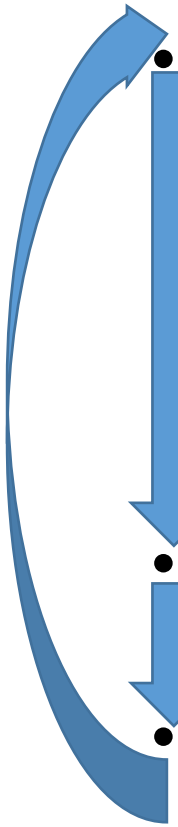


Beyond photon detection



Discovery, accelerated

Made in Canada development strategy



- **Design**. Joint Avalanche Detector Development Endeavor (JADDE) collaboration
  - Currently: Alberta [Yanez, Hallin] (DHPD – Water Cerenkov, VUV - ARGO), RHUL [Agnes, Monroe] (direct DM), SFU [Poley] (LGADs - collider), Sherbrooke [Charlebois, Pratte] (Photon to Digital Converter), TRIUMF [Retiere] (everything…)
  - Seek funding outside project specific grants fostering synergies
- **Manufacturing**: Teledyne-DALSA for sensor and 3D assembly
  - Access managed by Sherbrooke but with support from MRS or/and CFREF
- **Characterization**: *best* in the world tools at TRIUMF
  - Operation is now the main limitation
  - Feed simulation through collaboration with ANSYS

“Designed in Vancouver” development strategy

- Design and prototyping
  - Expand expertise in conceptual design and using fab toolkits
  - Build upon characterization strengths
    - E.g. Mitacs project with ANSYS
- Prototyping at SFU 4D labs
  - For new structures and concepts
  - Aim to transfer technology to Fab

- Fab – industrial facilities
  - Sensor (silicon):
    - Teledyne-DALSA (Bromont, QC)
    - Teledyne-e2v (UK)
    - … Others? Fraunhofer? Korea?
  - Post-process, e.g. Anti-reflective coating
  - CMOS (electronics layer)
    - TSMC,… through Canadian Microsystem Corporation
  - 3D integration
    - Teledyne-DALSA + C2MI

Beyond PHAAR – World leading detector R&D by Canadian SAP community by focusing…

- My proposal is to take advantage of the facilities and expertise in Canada
  - For Collider R&D that would mean shift focus to 3D integrated LGADs… i.e. LGADs pixels
  - For EIC people (Manitoba), it would mean switch away from Monolithic Active Pixel Sensors
    - Can we make ultra-thin integrated sensors?
- JADDE for sharing design and characterization effort
  - Not purely Canadian
  - May be together with UK
- Partnership with Canadian industry for manufacturing
  - Take advantage of political context to strengthen capabilities (more than Moore's focus)

Detector R&D & Detector construction
Detector physics & engineering at TRIUMF

- Detector construction is TRIUMF historic strengths
  - T2K, ALPHAg, DEAP-3600 DAQ, GRIFFIN electronics,…
- Critical mass of Sci Tech is key
  - Less than 20 P&S + TECH would force major compromises
- Weakening “engineering support” capability is ill-advised…
  - It is TRIUMF’s most visible contribution to supporting the Canadian SAP community

- … And not necessary to strengthen R&D
  - External funding is available
    - CFI (IF+IOF) though requires university support
    - CFREF with Astro-particle physics
    - NSERC SAP… Will JADDE (project) and DALSA support (MRS) get funded?
    - NSERC ALLIANCE for tech transfer (First Nation, General Fusion, …)
    - NSERC ALLIANCE International
    - MITACS
  - Need space and admin support from TRIUMF
    - Though could rely on university partners…

The end with a “political” observation

We are likely to see detector development centers coalescing at Montreal-Bromont-Sherbrooke and Kingston-Ottawa (+possibly Toronto)

We need to think along the same lines as TRIUMF does not enjoy the same access to funding as universities. So? **TRIUMF-SFU**-UBC-UVic-Alberta?

And lets think about addressing our space limitation and affordability issues by relocating some (or most) detector capabilities elsewhere…