



Applied Science Working Group

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Jin Chang

Applied Science (what we have done)

- 2 pre workshops
 - April 19th Hornet's Nest (WH8) 9:00-11:00 AM
 - April 26th Racetrack (WH7XO) 9:00-11:00 AM
- 7 Presentations
 - Arthur Apresyan – CMS and other applications of AS WG
 - Vadim Rusu – EED / PPD AS WG opportunities
 - Petra Merkel – Detector R&D and Facilities at the Lab
 - Ronald Lipton – Detector R&D Applied Science
 - Luciano Elementi – TD AS WG opportunities
 - CHARles Thangaraj – IARC Roadmap
 - Jin Chang – Computing applications
- 11 follow up discussions
 - Anna Pla-Dalmau, Patricia McBride, Vadim L Rusu, Luciano Elementi, Ron Lipton, Bob Kephart, Harry Cheung, Petra Merkel, Jonathan Lewis, Brendan Casey, Pushpalatha Bhat

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$WG(as) \Rightarrow \neg \square core(i) \wedge \exists \{ value(science, i) \vee value(industry, i) \}$

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 $\wedge intention(i)$*

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 $\wedge intention(i)$
 $\wedge opportunity(i)$*

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Applied Science –

$$\neg \Box core(i) \wedge \exists \{value(science, i) \vee value(industry, i)\}$$

- Fermilab's vision is to solve the mysteries of matter, energy, space and time for the benefit of all. We strive to:
 - ✓ lead the world in neutrino science with particle accelerators
 - ✓ lead the nation in the development of particle colliders and their use for scientific discovery
 - ✓ advance particle physics through measurements of the cosmos
- Our mission is to drive discovery by:
 - ✓ building and operating world-leading accelerator and detector facilities
 - ✓ performing pioneering research with national and global partners
 - ✓ developing new technologies for science that support U.S. industrial competitiveness

Applied Science – *intention(i)*

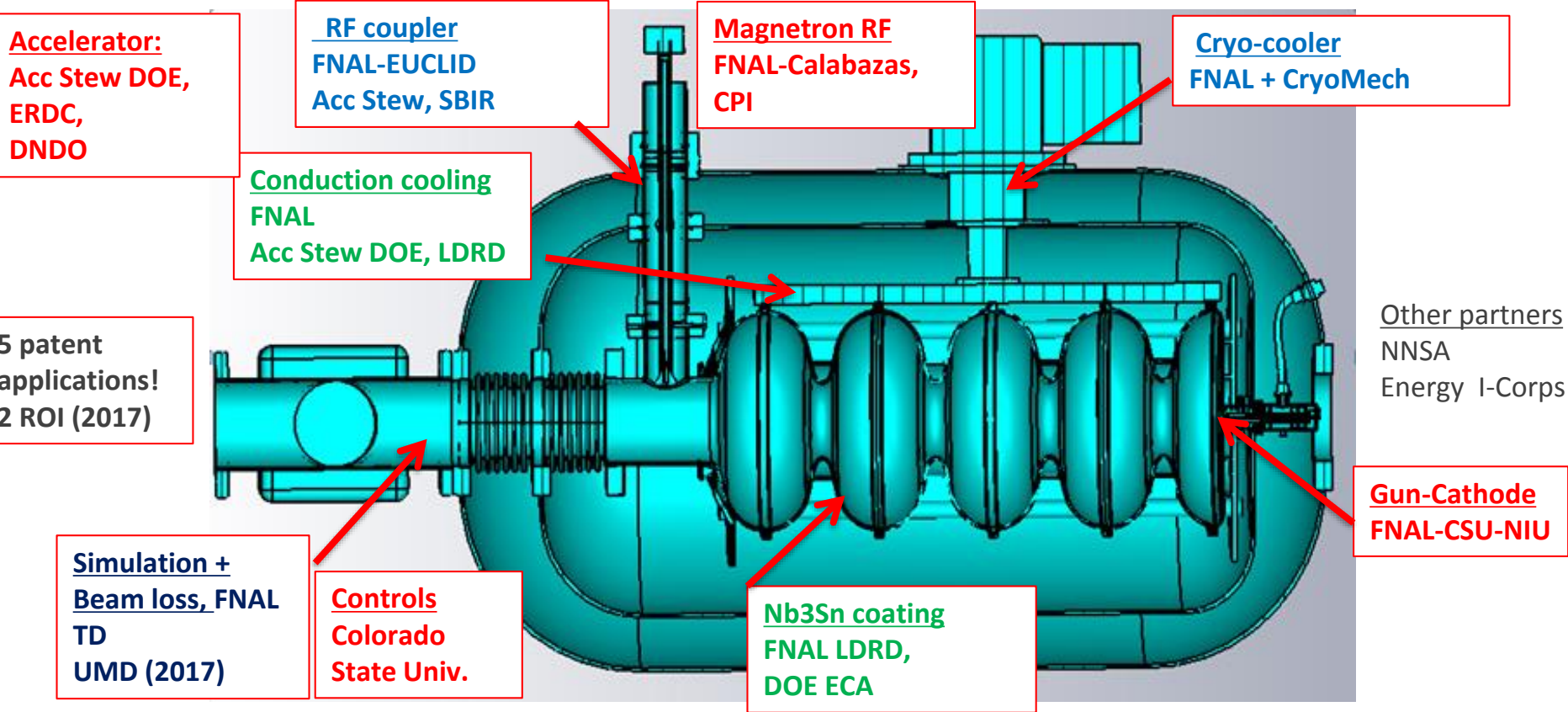
- There are many hurdles in realizing applied science (e.g., CRADA, research collaboration or technology commercialization)
 - ✓ Onus is on the scientist to understand novelty of their discovery
 - ✓ Funding conundrum
 - ✓ Limited connection to customers and industry
 - ✓ Unstructured or opaque model to follow
 - ✓ No time and limited accountability
 - ✓ Entrepreneurship opportunity cost
- In the case of ORNL Technology Innovation Program (TIP):
 - ✓ Call for proposals, pre and full proposal focus on economic impacts,
 - ✓ Typically fund 5 or 6 proposals first year and review second year
 - ✓ ~\$200K without overhead
 - ✓ ~10 years to begin realizing meaningful market / revenue
 - ✓ Encouragement and Direction important more than \$\$\$
 - ✓ \$3.5M last year, 15% to inventor

Applied Science – *opportunity*(*physics instrumentation*)

1. Applications involving cosmic rays
2. Applications involving (anti)neutrino detection
3. Applications which require precise time coordination of devices separated by large distances
4. Applications which use elementary particles to carry out nondestructive measurements on materials or living things
5. Applications which use elementary particles to make changes in materials or in living things
6. Applications which require detecting very low levels of visible light
7. Applications which require measuring the energy of microwave photons or gamma rays with high precision
8. Applications which require the detection of neutrons over a range of energies
9. Applications which use particle physics detectors to detect, track, and record the position of charged particles with high precision
10. Applications which require the detection of charged or neutral particle hits with precise time information or which require the measurement of charged or neutral particle energies
11. Applications which require the design and fabrication of customized electronics
12. Applications which require affordable large-area or large-volume charged or neutral particle detectors
13. Applications which require radiation-hard charged particle detectors
14. Applications which require very high-speed readout of particle interactions in detectors
15. Applications which require distributed monitoring, documentation, and control over large-scale systems
16. Applications which require access to sophisticated computing software
17. Applications which require ultralow radioactivity materials or which exploit the measurement of low radiation levels
18. Applications which require extensive project management during construction and operation
19. Applications which make use of particle physics laboratories or the infrastructure available at particle physics laboratories
20. Applications which use data about particle properties from particle physics measurements or calculations

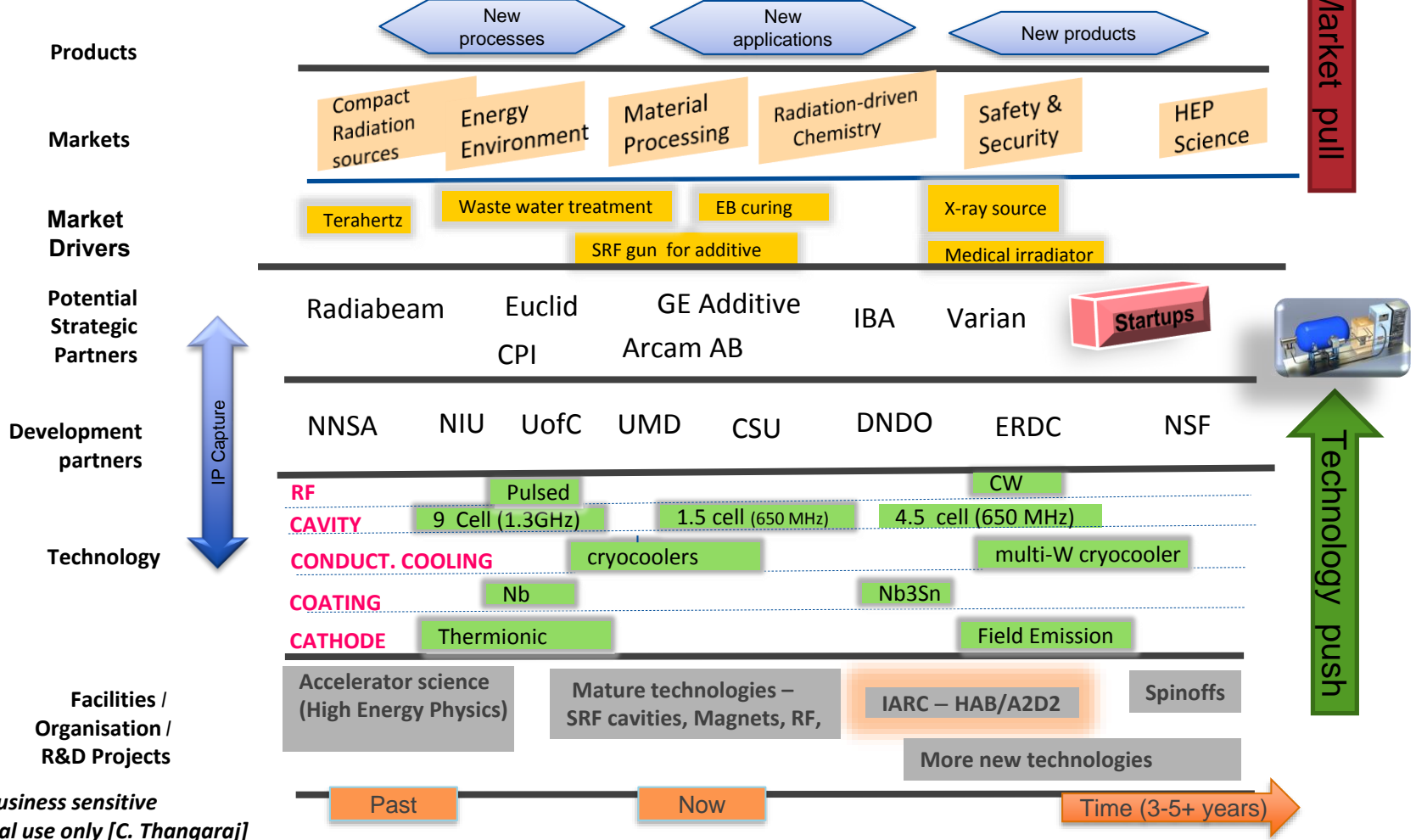
“Particle and nuclear physics instrumentation and its broad connections”
REVIEWS OF MODERN PHYSICS, VOLUME 88, OCTOBER–DECEMBER 2016

IARC SRF compact accelerator – R&D partners



Applied Science – opportunity(IARC)

IARC Technology roadmap for compact SRF



FRA Business sensitive
Internal use only [C. Thangaraj]

Applied Science – *opportunity(Computing)*

- Exascale Computing
- Quantum Computing
- High Performance Network (Terabit, SDN)
- Big Data Analytics
- Cyber security scanning & intrusion detection monitoring

Applied Science – *opportunity(others)*

- IoT (Internet of Things)
- FPGA
- ASIC
- Scintillator
- Robot cavity assembly
- 3D SiPM
- Silicon strip detector
- X-ray imaging / detection
- ... many others

Applied Science (charge questions)

Draft a list of possible long-term lab goals (not prioritized)

- ~10% of our research funding comes from applied science
- Meaningful revenues (> \$1M) from technology transfer or licensing
- Robust Fermilab + { industry vendor, research } partnerships for applied science

Outline any input and/or additional work that would be required to prioritize each goal

- Identification of the viable, promising opportunities
- More transparent and readily available model addressing “difficulties” outlined previously
- Catalytic roles, cultural shift, commitment

Provide a rough summary of any upgrades to the accelerator complex or lab facilities required to accomplish these goals.

- ...