

An Idealist



Before



After

A Scientist



Before



After

A non-conformist



His (4b 1g)

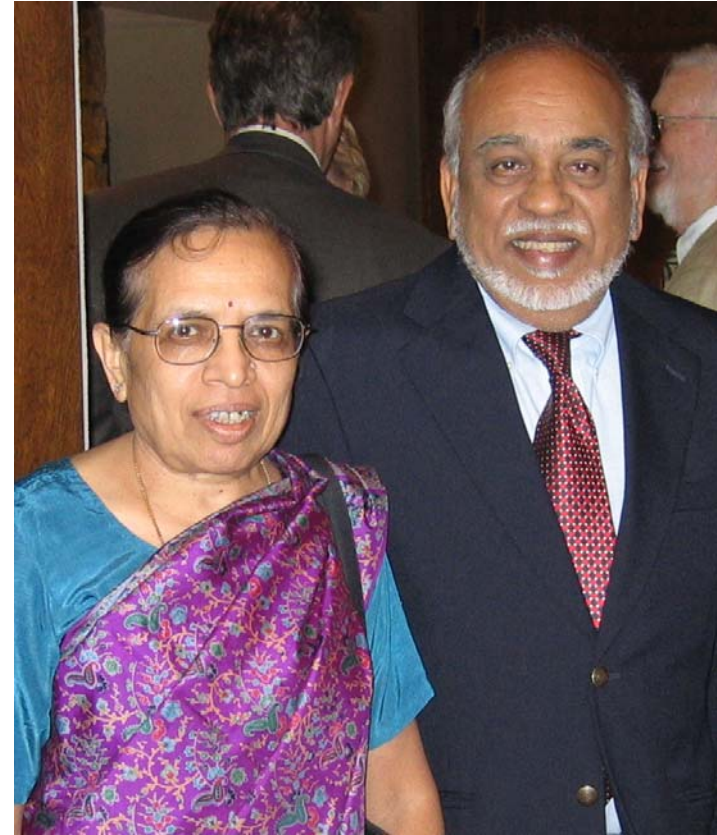


Hers (5g 1b)

A Husband



Before



After

A Visionary

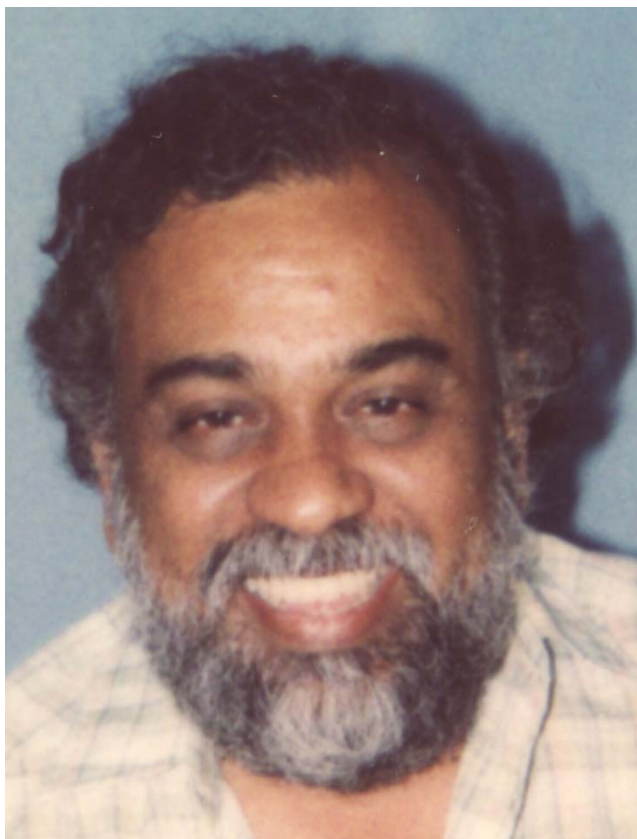


Before



After

A Chemistry Lab Rat



“revolutionary” mode

A Leader



Borexino



Geoscience

A Neutrino Driven Man

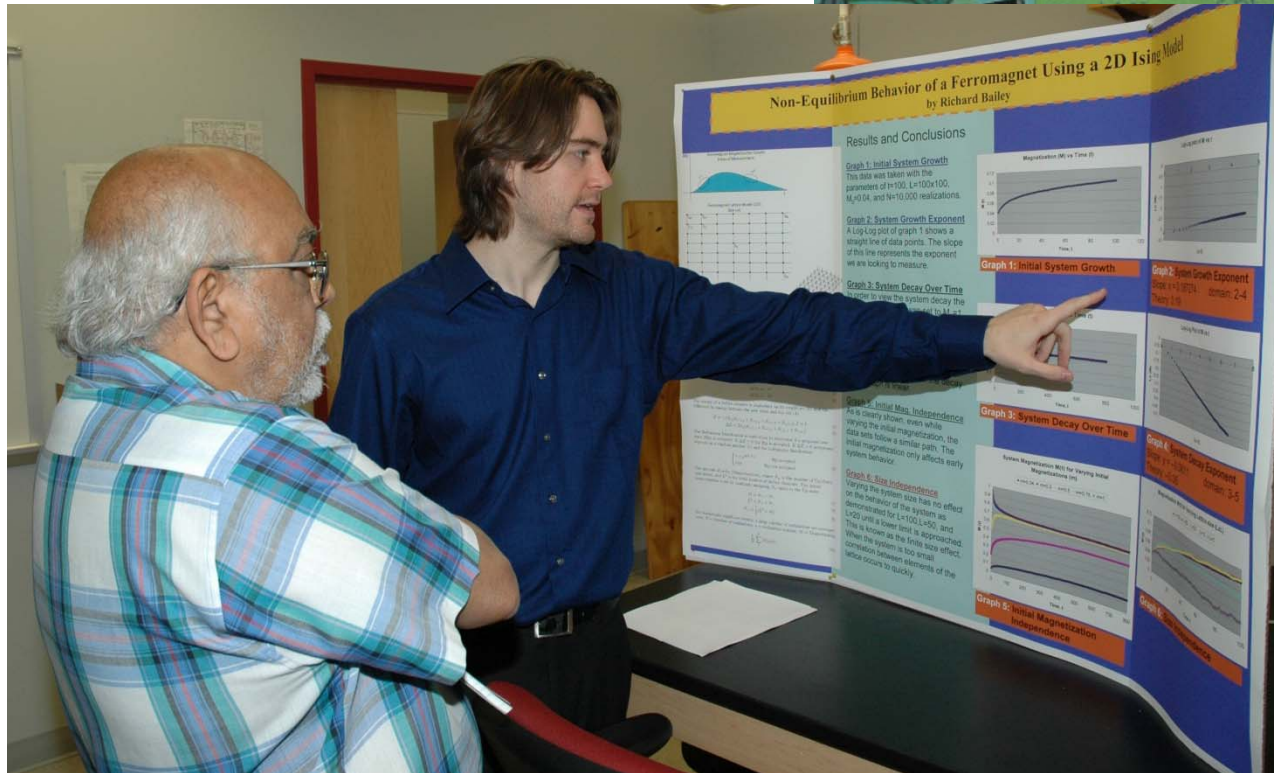


Before



After

A Professor



An Advisor



Before



After

What it took to get him to VT?

- **For Raju – simply a drive-in underground laboratory suitable for LENS**
- **For the University, a broader plan to perhaps host an NSF national laboratory**

Kimballton Laboratory

R. Bruce Vogelaar
February 3, 2004
vogelaar@vt.edu

- an underground science and engineering opportunity

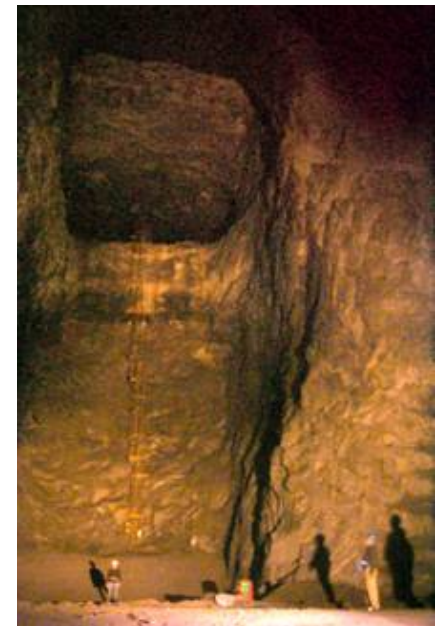
National and International Underground Science and Engineering Programs have been very successful and well funded.

Need for a new US underground facility identified by:

National Academy of Sciences
National Research Council
Nuclear Science Advisory Committee LRP



Virginia
Tech can
address
this
request.



<http://www.phys.vt.edu/~kimballton>

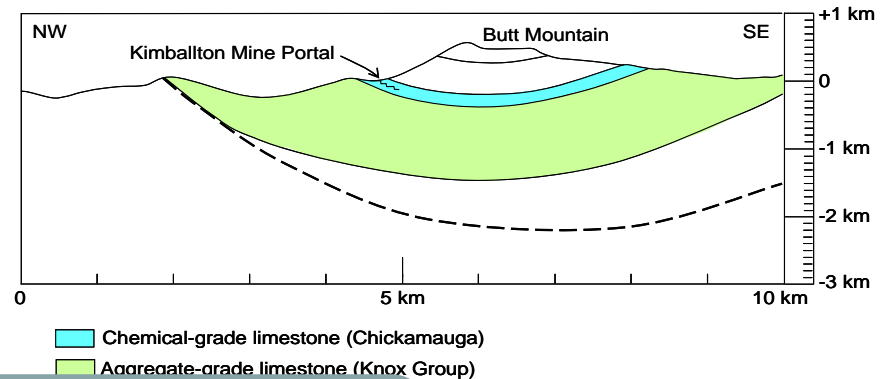
VT NUSEL investment

- check 7000 ft depth
 - map geology
 - preliminary coring and interpretation
 - preliminary engineering
- environmental impact study
- verify cost estimates
- prepare full proposal
- optimize VT involvement
- build external collaboration
- create management team

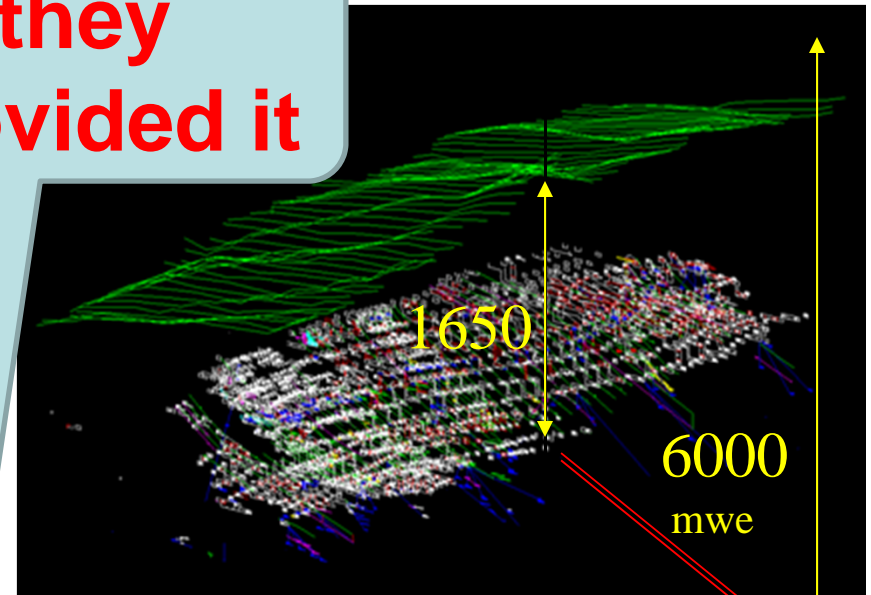
TIME CRITICAL

- use experience of existing proposals
- fund initial study with VT resources
- could help pave way for LENS at Kimballton

Geological Cross Section (Approximate) at Kimballton Mine

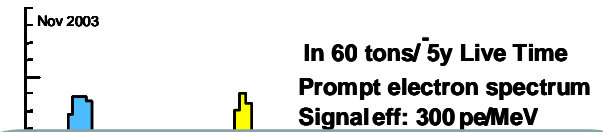


they
provided it

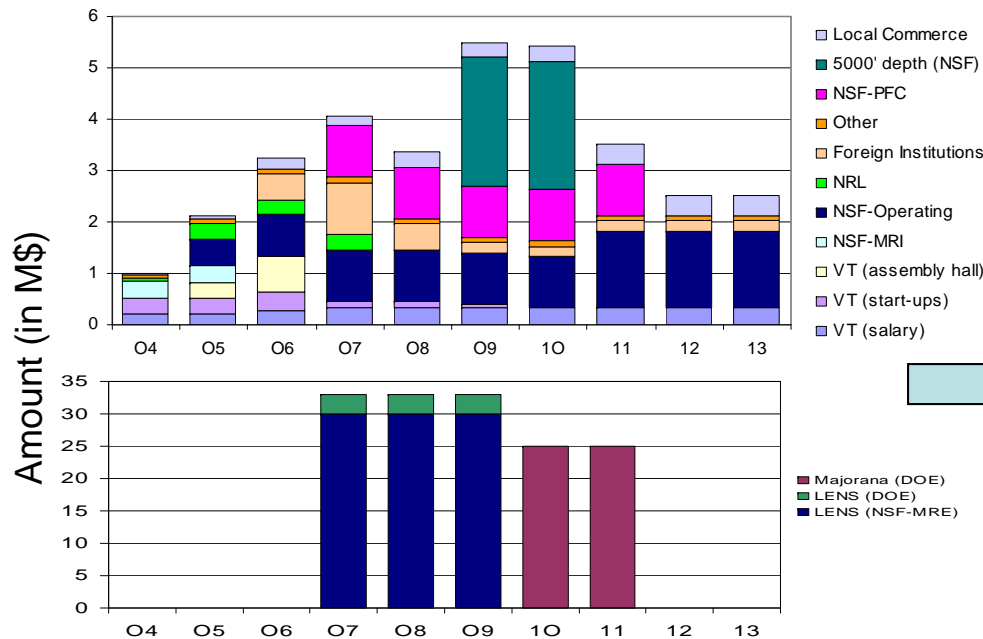


VT neutrino investment

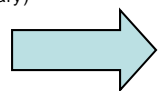
- NSF – MRI program
(we competed internally with 14 proposals, and were selected as one of the three which were allowed to go forward)
- Senior Hire (Raju Raghavan, immediate)
- 3 Junior Hires (1 to start this fall)
- Assembly Hall



Raju attracted and VT hired: Jon Link, Patrick Huber, Camillo Mariani

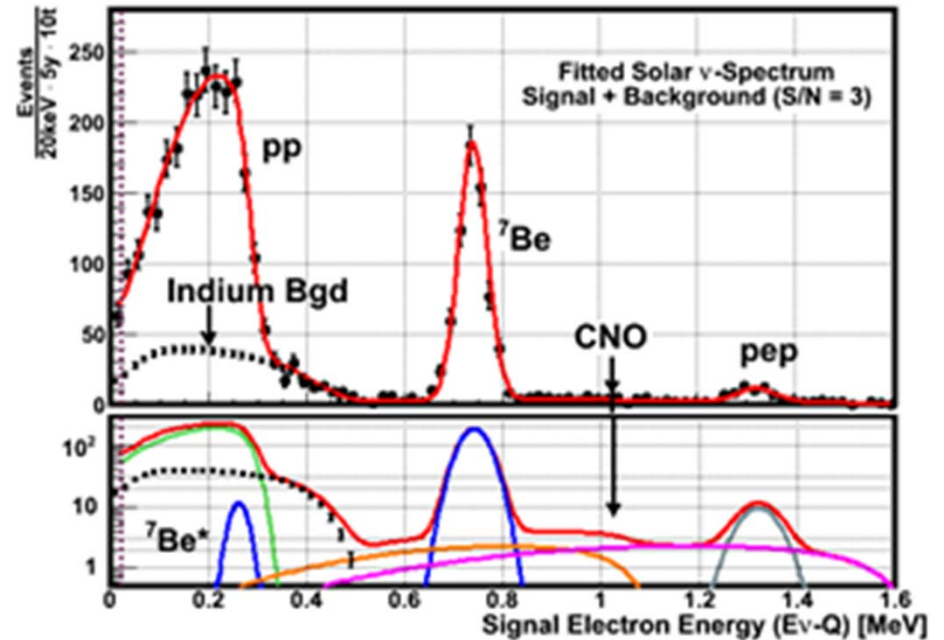
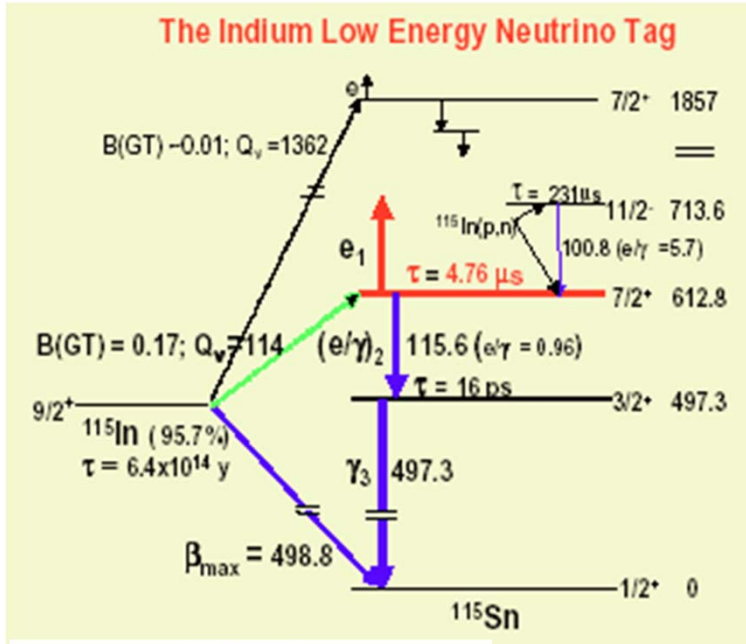


from the center of the sun, using a 3.75 kton detector at Kimballton.

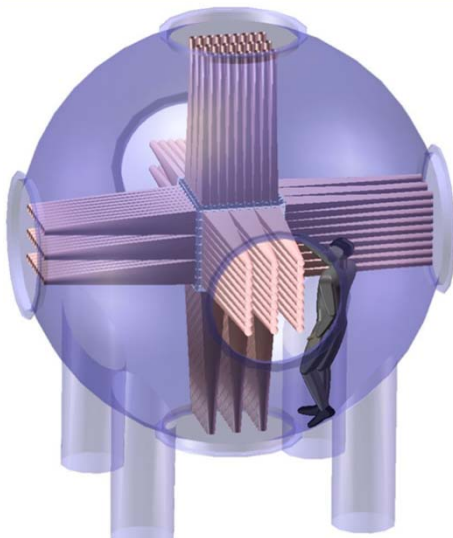


~ \$2.3M over 10 years to launch LENS & Kimballton Laboratory, ~\$183M funded expenditures, ~33% pass-thru VT grants

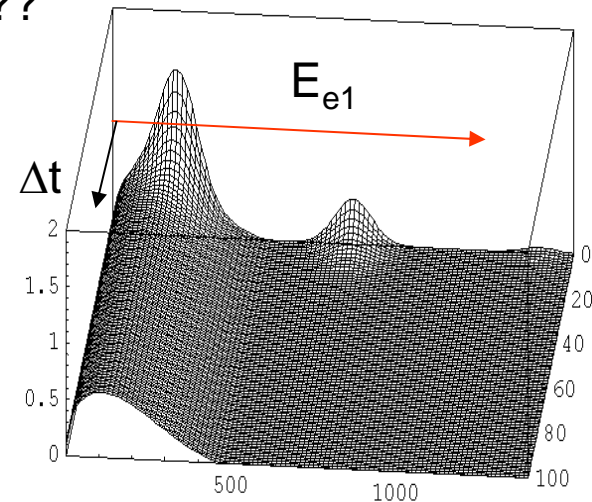
LENS as the key to completing the solar neutrino spectrum



^{13}N vs ^{15}O ??



60 ton In; 5yr
 pp: 4800
 ^7Be : 4300
 pep: 220
 CNO: 930



Novel Ideas & Proposals

Particle Physics, Astrophysics (1975-) *Low Energy Neutrino Science -*

- **Evidence for Geoneutrinos in Borexino**
- Test of Time-Energy Uncertainty in Extreme Regimes (2010)
- Hypersharp Neutrino Lines—Laboratory probe for Planck Length (2008)
- **Hypersharp Resonant Capture of Antineutrinos(2008)**
- **Successful operation of Borexino:** First real time detection of ^7Be solar neutrinos (2007)
- Detecting active-sterile neutrino oscillations in LENS (2006)
- Recoilless resonant capture of Neutrinos and applications to
- Neutrino oscillation science in laboratory scale baselines (2006)
- Direct measurement of pp thermonuclear fusion and of the central temperature of the sun via LENS-Sol (2006)
- **Founded LENS Project** LENS-Sol (U.S). 2004; R&D Project in Europe,
- U.S.1999-2003; Real time spectroscopy of pp solar neutrinos by tagged neutrino capture in Indium and other targets (1998)
- **Global measurement of the earth's radioactivity by antineutrino spectroscopy in Borexino & KamLand (1998)**
- Low threshold taggable inverse-beta reactions in Yb, Gd and Se for detecting pp neutrinos from the sun (1997)
- New approach to neutrinoless double beta-decay using ton-scale Xe gas dissolved in liquid scintillator (1990, 1993).
- High resolution LiF cryogenic bolometry of low energy solar neutrinos via neutral and charged current neutrino reactions in ^7Li (1993).
- Deep search for neutrino magnetic moment via scattering of antineutrinos from megacurie Strontium-90 source using BOREXINO (1990).

- **Founded BOREXINO Project @ Gran Sasso (1989)**; Concepts for detector design, signal and background in real-time spectroscopy of low energy solar neutrinos via electron scattering in a massive liquid scintillator (1987);
- Determination of neutrino mass from laser spectroscopy of the kinematics of bound state beta decay in tritium (1987)
- Neutral current excitation of nuclear states in ^{11}B as a method for detecting solar neutrinos of all flavors (1986); BOREX project (1988).
- Liquid Argon detector for neutrinos from astrophysical and accelerator sources (the future ICARUS project) (1979, 1986)
- Chromium-51 source as a direct calibrator of low energy solar neutrino experiments (1978)
- **Tagged neutrino capture in Indium—first proposal for real-time spectroscopy of pp and low energy solar neutrinos (1976) (future LENS)**
- Diverse theoretical ideas & proposals in non-standard neutrino phenomenology:
 - - Spin Flavor Precession of Low Energy Solar Neutrinos (2005)
 - - New Model for Solar Neutrinos in manifest violation of CPT Invariance (2003)
 - - Probing non-standard interactions of tau neutrinos via electron scattering of monoenergetic ^7Be solar neutrinos (2002)
 - - Solar anti- ν_e by vacuum oscillation of anti- ν_e after spin-flavor conversion via transition magnetic moment of ν_e (1991)
 - - Solar anti- ν_e from ν_μ -decay after matter conversion $\nu_e \rightarrow \nu_\mu$ (1988)

Our community's opinion...

- “Dr. Raghavan is the very uncommon experimentalist who pops up with original, ideal and highly polished experiments...Dr. Raghavan is no doubt one of the distinguished scientists and leaders in the world neutrino physics community” **Atsuto Suzuki**
- “Some of the most creative ideas for neutrino detection during the past decades came out of Raghavan’s work. I find it very difficult to imagine the world neutrino physics community without him.” **Baha Balantekin**
- “Raju is one of the most creative physicists I ever met. His ideas are out of the mainstream. His thinking is unconventional, something that is unfortunately becoming rarer and rarer.” **Alessandro Bettini**
- “Raju is not just a great technical scientist, he is a great basic scientist also and that combination has enabled him to be a leader of the field of neutrino physics throughout his career.” **Art McDonald**



Raju Raghavan 1937-2011

- **a scientist in the deepest sense**
- **a very good friend and mentor**
- **a great contributor to the community**