

Curriculum Vitae for Rafe H. Schindler –Through 2020

Position: Professor of Particle Physics and Astrophysics (At SLAC/Stanford since November 1985)

Education:

Ph.D. in Elementary Particle Physics	(May 1979)	Stanford University
	Ph.D. Advisor: Prof. Roy Schwitters	
M.A. in Physics	Stanford University	1975
B.A. in Physics	University of Rochester	1974
B.A. in Applied Mathematics	University of Rochester	1974

Leadership/Management positions:

2018 – present	Director, Technical and Operations Division of the Fundamental Physics Directorate at SLAC
2018 – present	Appointments and Promotions Committee for the Fundamental Physics Directorate
2016 – 2017	Camera lead scientist for LSST Operations Proposal
2012 – present	Named as a DES Builder [for delivery of RASICAM]
2011– 2018	Chair, Appointments and Promotions Committee of the Physics and Astrophysics Directorates; Member of the Laboratory Wide Appointments and Promotions Committee
2009 –present	Manager for RASICAM (Radiometric All-Sky Infrared Camera), DES (Dark Energy Survey) Experiment
2007– present	Full member of Kavli Institute for Particle Astrophysics and Cosmology
2006– 2019	System Manager (Subsystem Physicist) for Cryostat Subsystem, LSST (Large Synoptic Survey Telescope) Project
2001 – 2011	Chair, Panofsky Fellowship Committee
1997 – present	Professor, SLAC, Stanford University
1995 – 2004	System Manager for CsI Calorimeter, BABAR Experiment
1991 – 1997	Associate Professor, SLAC, Stanford University
1991 – 1994	Co-Spokesman International Tau-Charm Collaboration
1991 – 2010	Groupleader, SLAC Research Group E [With Prof. Martin Perl]
1985 – 1990	Co – Spokesman Mark III Collaboration at SPEAR
1985 – 1990	Co – Groupleader SLAC, Research Group D
1985 – 1991	Subsystem Manager for SLD Liquid Argon Calorimeter and member of the SLD Advisory Group
1985 – 1991	Assistant Professor, SLAC, Stanford University
1982 – 1985	Senior Research Fellow, California Institute of Technology
1980 – 1982	Fellow (Non-member state) CERN – Center For European Nuclear Research, Geneve Switzerland
1979 – 1980	Research Associate, SLAC Group C, Stanford
1974 – 1979	Research Assistant, SLAC Group C, Stanford

Research Narrative:

Prof. Schindler has been a member of the Faculty at SLAC and Stanford since 1985. Historically, he has worked primarily in the area of e^+e^- physics and accelerator physics, except for a short period of time at CERN working on R807 at CERN's Intersecting Storage Ring (ISR) and the period spent at CalTech leading the development of a liquid argon calorimeter utilizing depleted Uranium for future use at SLAC/SLD. More recently [2006] he moved into particle astrophysics-instrumentation working on DES (the Dark Energy Survey) and the Vera C. Ruben LSST camera projects.

During the period from 1985 to 1990 he co-managed Experimental Group D which built and operated the Mark III detector at SPEAR, and served as Co-Spokesman [With then Prof. Walter Toki] of the Mark III Collaboration until 1990. His early seminal discoveries on charmed meson decays in Mark I, Mark II, and Mark III detectors at SPEAR formed the experimental basis of the modern theory of elementary hadronic and semi-leptonic weak decays of heavy mesons.

From 1985 to 1989 Prof. Schindler managed at SLAC the mechanical design, vacuum and cryogenic system, installation and testing of the (\$17M) 900 ton lead liquid -argon barrel calorimeter that was part of the SLD detector at the SLC (SLAC's Single Pass Linear Collider). He also worked during that period on parts of the SLC including the ultra high vacuum polarized electron gun, and the superconducting final focus alignment. He headed up the SLD Heavy Flavor physics group that produced the first published results from SLD on b-quark production at the Z^0 confirming Standard Model predictions at the time. In 1991 he became the research group leader of Experimental Group E at SLAC.

Beginning in 1989, Prof. Schindler began an early design effort of a detector for a Tau-Charm Factory then under discussion by the international e^+e^- community. From 1991-1994 he was co-spokesman of the International Tau Charm Collaboration, and also formally managed the R&D and design of the CsI calorimeter for that project. This expertise was subsequently carried over to the BABAR detector at PEP-II where he was System Manager for the (\$25M) CsI calorimeter, whose construction was completed in 1999. He continued work on BABAR and led the SLAC subgroup that built and installed the novel Muon System upgrade to BABAR. During the final run of BABAR, he, his graduate student and members of his research group helped produce and publish the discovery and subsequent confirmation of the η_b meson.

Since 2006 he has been primarily involved in LSST (~\$750M project funded by the US Department of Energy and the National Science Foundation), and subsequently in 2009 joined the Dark Energy Survey Collaboration, a \$35M "prototype" experiment for LSST.

On DES he completed the development, delivery and installation at the Chilean site, of a state-of-the-art 10 μm infrared all-sky camera for CTIO, as part of

his/SLAC DES contribution. This work was conducted with one of his Stanford graduate students and a Senior S&E Associate SLAC. In 2012 he was named a "DES Builder." RASICAM has continued to be used as an integral part of the observing program of DES, and is still operating following the initial 5 year observing period. In 2014/2015 he has guided the refurbishing of RASICAM, delivering two new gold coated mirror systems (a primary and a secondary, and one spare). The final installation of the new secondary was completed in mid 2016.

On LSST he has guided the R&D to develop aspects of the camera's Cryostat sub-system, precision metrology, and a novel cryogenic cooling system and is continued to be the Cryostat subsystem manager (Subsystem Physicist). This project passed its preliminary design review in August 2014 and CD-2 review with US Dept of Energy in November 2014. It passed Final Design review (for critical path components) in June 2015. LSST had a successful CD-3 review in August 2015 and funding for construction of LSST camera was approved. In November 2016 LSST passed its Refrigeration Subsystem Preliminary Design Review and later in 2017 its Refrigeration Final Design Review. Several elements remained in final design phases and were pending final design review or manufacturing readiness review in late 2017. Several longer lead time elements of the system were in fabrication or delivered in late 2017/early 2018 when assembly of the Cryostat began.

In 2018 the assembly of the cryostat and vacuum system was completed and turned over to the I&T group. In 2019 the testing of the I&T refrigeration systems (and a portion of the TMA system) was completed and turned over to the I&T and Commissioning groups. Parts of the TMA refrigeration system were shipped to Chile in late 2019 including the Pathfinder system.

Work on refrigeration system fabrication and testing continued through 2019-mid 2020 on pieces that are part of the camera's Utility Trunk and others that reside on the Telescope Mount Assembly[TMA]. These include the HeX system that resides in the Utility Trunk of the camera itself and commissioning of the TMA system in Chile, for the commissioning camera (COMCAM). While most of the onsite-hardware has now been turned over to I&T/Commissioning, he remains active in supporting the I&T/Commissioning effort when problems have arisen with this hardware.

At the end of 2018, Prof. Schindler accepted the role of Director of the Technical and Operations Division of the Fundamental Physics Directorate. There he oversees the engineering and technical resources of the directorate and the support for experiments entering or in operation.

Selected Publications (from approximately 1200 Journal and Conference Proceedings)

- (1) Rafe H. Schindler, *etal.* The Design of the Refrigeration System of the Vera C. Rubin Observatory LSST Camera, Oct. 2020, 49 pp. To be published.
- (2) LIGO and DES Collaborations “Multi-messenger Observations of a Binary Neutron Star Merger” Oct 16, 2017. 59 pp. Published in *Astrophys. J.* 848 (2017) no.2, L12
- (3) DES Collaboration, “Localization and broadband follow-up of the gravitational-wave transient GW150914.” Published in *Astrophys.J.* 826 (2016) no.1, L13.
- (4) DES Collaboration, A Dark Energy Camera Search for an Optical Counterpart to the First Advanced LIGO Gravitational Wave Event GW150914 Published in *Astrophys. J.* 823 (2016) no.2, L33.
- (5) Gordon B. Bowden, Brian J. Langton, William A. Little, Jacob R. Powers, Rafe H. Schindler, Sam Spektor^b “The LSST Camera 500 watt -130 °C Mixed Refrigerant Cooling System.” Published in *SPIE Proceedings Volume 9151: Advances in Optical and Mechanical Technologies for Telescopes and Instrumentation*, Aug 2014.
- (6) J. Singal, J. Langton, R.H. Schindler, “Geant4 Applications for Modeling Molecular Transport in Complex Vacuum Geometries International”, *Journal of Modeling, Simulation, and Scientific Computing*, Accepted for publication 6-2013
- (7) J.P. Lees et al. (BaBar Collaboration), “Observation of Time Reversal Violation in the B0 Meson System”, *Phys. Rev. Lett.* 109 (2012) 211801.
- (8) A Radiometric All-sky Infrared Camera (RASICAM) for DES/CTIO. By P. Lewis, H. Rogers and R. Schindler. *Proceedings of the SPIE Astronomical Instrumentation*, San Diego, California, 27 June -2 July 2010.
- (9) Status of the Dark Energy Survey Camera (DECam) Project. By Dark Energy Survey. *Proceedings of the SPIE Astronomical Instrumentation*, San Diego, California, 27 June -2 July 2010.
- (10) Evidence for the eta(b)(1S) Meson in Radiative Upsilon(2S) Decay By BABAR Collaboration. *Phys.Rev.Lett.*103:161801,2009
- (11) Observation of the Bottomonium Ground State in the Decay Upsilon(3S) --> gamma eta(b). By BABAR Collaboration. *Phys.Rev.Lett.*101:071801,2008, Erratum-*ibid.*102:029901,2009.
- (12) Measurement of the Pseudoscalar Decay Constant f(D(s)) Using Charm-Tagged Events in e+ e- Collisions at $s^{*}(1/2) = 10.58\text{-GeV}$. By BABAR Collaboration . *Phys.Rev.Lett.*98:141801,2007.
- (13) Measurement of CP violating asymmetries in B0 decays to CP eigenstates by BABAR Collaboration, *Phys. Rev. Lett.* 86, 2001
- (14) A Measurement of R(b) using a vertex mass tag. By SLD Collaboration. *Phys.Rev.Lett.*80:660-665,1998
- (15) First measurement of the left-right cross-section asymmetry in Z boson production by e+ e- collisions. By SLD Collaboration . *Phys.Rev.Lett.*70:2515-2520,1993
- (16) Search for the Decay $D^+ \rightarrow \mu^+ \mu\text{-neutrino}$ and an upper limit of the the pseudoscalar decay constant, By J. Adler, et al., MARK-III Collaboration, *Phys.Rev.Lett.*60:1375,1988
- (17) A Reanalysis of Charmed d Meson Branching Fractions. By MARK-III Collaboration . *Phys.Rev.Lett.*60:89,1988,

- (18) Direct Measurements of Charmed D Meson Hadronic Branching Fractions. By MARK-III Collaboration. Phys.Rev.Lett.56:2140,1986,
- (19) Search for Non-Spectator Decays of the D0. By MARK-III Collaboration . Phys.Rev.Lett.56:2136,1986
- (20) A Direct Measurement of Charmed D+ and D0 Semileptonic Branching Ratios. By MARK-III Collaboration. Phys.Rev.Lett.54:1976,1985
- (21) Measurements of Cabibbo Suppressed Hadronic Decays of Charmed D+ and D0 Mesons. By MARK-III Collaboration. Phys.Rev.Lett.55:150,1985
- (22) Observation of Cabibbo Suppressed Decays D0 ---> pi- pi+ AND D0 ---> K- K+. By G.S. Abrams, et al., Phys.Rev.Lett.43:481,1979,.
- (23) Pion Production in the Regime of Target Fragmentation^[1]By R. Schindler, C. Bromberg, D. Chaney, T. Ferbel, P. Slattery, John W. Cooper, 1, J.C. Van der Velde, A. Seidl. Phys.Rev.Lett.33:862,1974,