Curriculum Vitae

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- **Personal Information**

Name :	Masato Aoki
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- **Education**

2002–2006 Ph.D. in Science, University of Tsukuba, Japan
Dissertation : "Measurement of the B_c Meson Lifetime with the Collider Detector at Fermilab (CDF)"
March 2006; Adviser: Prof. Shinhong Kim

2000–2002 Master of Science, University of Tsukuba, Japan
Thesis : "Basic Characteristics of the Radiation Tolerant Silicon Detector"(written in Japanese)
March 2002; Adviser: Prof. Shinhong Kim

1996–2000 Bachelor of Science, Ibaraki University, Japan.
Thesis : "Multi-body Simulation of Astronomical Objects around Black Hole" (written in Japanese)
March 2000; Adviser: Prof. Toshihisa Ishizuka

- **Professional Experience**

November 6, 2006–
Research Associate, Fermilab DØ Experiment.
(Pine Street and Kirk Road, PO Box 500, Batavia, IL 60510-0500, U.S.A.)

May 1, 2006–October 31, 2006
Postdoctoral Fellow, Institute of Physics, University of Tsukuba.
(Ten'noudai 1-1-1, Tsukuba-shi, Ibaraki-ken, 305-8571, Japan)

April 1, 2005–March 31, 2006
Research Assistant, Institute of Physics, University of Tsukuba.
(Ten'noudai 1-1-1, Tsukuba-shi, Ibaraki-ken, 305-8571, Japan)

June 30, 2003–June 30, 2005
Guest Scientist, Fermilab - CDF Experiment.
(Pine Street and Kirk Road, PO Box 500, Batavia, IL 60510-0500, U.S.A.)

April 1, 2000–March 31, 2002
Teaching Assistant, Institute of Physics, University of Tsukuba.
(Ten'noudai 1-1-1, Tsukuba-shi, Ibaraki-ken, 305-8571, Japan)

- **Computer Skills**
  C/C++, Fortran, ROOT, Perl, VHDL, ANSYS, LATEX,
  Tcl/Tk, Python, JavaScript, HTML, Microsoft Word and Excel.

- **Research Experience**

  Research Associate, Fermilab DØ Experiment(2006–)

  The DØ is a general purpose detector designed to study $p\bar{p}$ collisions at the Fermilab Tevatron. My work involves the silicon detector operations and a search for the $B_s^0 \to \mu^+\mu^-$ rare decay at DØ.

  - **Search for the rare decay $B_s^0 \to \mu^+\mu^-$**

    The branching fraction of a rare decay mode is an important quantity to measure because the contribution from physics beyond the standard model (SM) which may be sizable in rare decay modes. The branching fraction of the pure leptonic flavor-changing neutral current (FCNC) processes such as $B_s^0 \to \mu^+\mu^-$ in the SM is heavily suppressed: $\mathcal{B}(B_s^0 \to \mu^+\mu^-) \approx 3.4 \times 10^{-9}$. $B^0 \to \mu^+\mu^-$ decay is further suppressed by a factor $|V_{td}/V_{ts}|^2 \approx 0.04$ in the CKM matrix elements leading to a SM predicted branching fraction of O(10^{-10}). The current best published limit on $\mathcal{B}(B_s^0 \to \mu^+\mu^-)$ is given by CDF using 2 fb^{-1} of Run II data, which is $\mathcal{B}(B_s^0 \to \mu^+\mu^-) < 4.5(5.8) \times 10^{-8}$ at the 90%(95%) confidence level (C.L.). DØ has a preliminary result using the same exposure, which is $\mathcal{B}(B_s^0 \to \mu^+\mu^-) < 7.3(9.3) \times 10^{-8}$ at 90%(95%) C.L.

    Using 4.8 fb^{-1} of dimuon trigger data collected by the DØ detector, I extracted an expected upper limit on the branching fraction $\mathcal{B}(B_s^0 \to \mu^+\mu^-) < 4.3(5.3) \times 10^{-8}$ at 90%(95%) C.L. This was a comparable sensitivity with the current world best published result. The signal box remained blinded at this time since we expected some improvements. This result with the signal box blinded was presented at many conferences as one of the 2009 winter results.

    This analysis was updated using 6.1 fb^{-1} of DØ, maximizing the acceptance and with better understanding of data. The new expected upper limit on the branching fraction extracted from this data set is $\mathcal{B}(B_s^0 \to \mu^+\mu^-) < 3.2(4.0) \times 10^{-8}$ at 90%(95%) C.L. Since I made a number of improvements, we opened the signal box. The observed number of events was consistent with the expected number of background events. The upper limit on the branching fraction obtained from the observed number of events is $\mathcal{B}(B_s^0 \to \mu^+\mu^-) < 4.2(5.1) \times 10^{-8}$ at 90%(95%) C.L. This new result was presented at many conferences as one of the 2010 summer results.

  - **DØ Silicon Microstrip Tracker**

    The Silicon Microstrip Tracker (SMT) is composed of four layers of double-sided and single-sided sensors organized in six barrels and two sets of seven disks in the forward and backward regions. In addition, Layer 0, one layer of single-sided sensor consisting of eight barrels, was installed at a very small radius during the spring of 2006. I was a co-leader of the SMT group between July 2007 and June 2009.

    Aging studies

The full depletion voltage of the silicon sensor changes with the radiation dose. DØ regularly performs the depletion voltage scans for the sensors. The depletion voltage is measured by looking at the charge collection efficiency and noise changes as a function of the bias voltage. As a result of the studies, a bulk carrier-type reversal was observed in the innermost layer of the original detector, Layer 1, after 1.5 fb^{-1} of integrated luminosity. These studies indicate that the Layer 1 silicon sensors cold be fully depleted through an integrated luminosity of 8 fb^{-1}. Then those silicon sensors will start to be inefficient because the sensors are not fully depleted. Nevertheless, this loss is believed to be compensated by the more recently installed Layer 0. The bias voltages have been adjusted accordingly based on these studies.

SMT recovery project

On August 30, 2006 part of the DØ Trigger Framework tripped off. During the next few minutes the crew in the control room noticed high current alarms in many of the SMT High-Density Interconnects (HDI). After this incident, there were 41 additional HDI's that didn't download or read out data. An effort led by Marvin Johnson (Fermilab) began to determine what happened and to devise a recovery plan if possible. The cause of the high chip currents was a system clock failure, and that broke wire bond carried +5 Volts to the DVDD pad of one of the SVX chips on the HDI. To recover such failed HDI's we designed a new Adapter Card in which we can restore power that was lost due to the broken wire bond via the data bus and mode control lines.

During the 2007 Tevatron shutdown, we installed in total 68 new Adapter Cards to recover such failed modules. I participated in this installation. Unfortunately initial operation with the new Adapter Cards showed many channels with very large pedestals or large numbers of zero data readings. 136 HDI's were affected by this problem. After additional months of investigation by Marvin Johnson (Fermilab), Mike Utes (Fermilab) and me, we found a noise problem in the new Adapter Card. We decided to modify all the new Adapter Cards, but we had to wait another shutdown because the Adapter Cards are mounted on the central calorimeter ends where they are not accessible until we open the end-cap calorimeter. While we were waiting for the shutdown, we downloaded new firmware to reduce the readout problem and we modified spare new Adapter Cards. I tested most modified cards at the test stand so that there should be no additional new problems.

During the 2008 10-day shutdown we replaced all the new Adapter Cards with modified ones successfully. It was very challenging to complete the replacements in such a short period. I organized this activity. All the cards are functioning and behaving as expected. We resolved the noise problem, and finally the recovery project was completed.

During the 2009 shutdown we tried the modified new Adapter Cards on other failed HDI's and generated additional recoveries. We installed additional 19 modified new Adapter Cards. I was involved in this activity as well. Eventually we enabled more than 90% of the HDI's, this fraction of enabled modules is higher than ever achieved since the beginning of Run II.

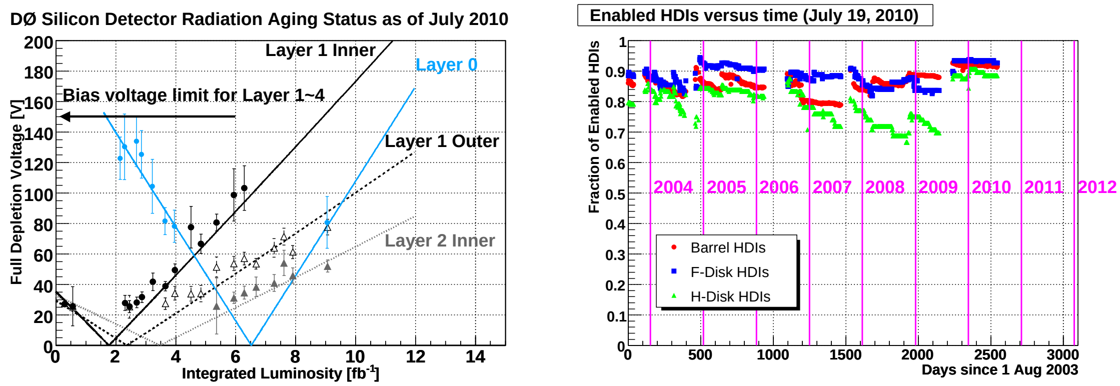

Figure 1: Left plot : Full depletion voltage of the DØ silicon sensors as a function of delivered integrated luminosity. Right plot : Fraction of enabled DØ silicon readout modules (HDI's) as a function of time since August 2003.

Other activities regarding SMT Operations

- ∗ Carrying the on-call papger by rotation, typically for one week every month.
- ∗ Developping online monitoring tools.
- ∗ Taking the tracking detector operations shift.
- ∗ Training of new shifters.

Masters and Doctoral Research, University of Tsukuba (2000 - 2006)

The Collider Detector at Fermilab (CDF) is a general purpose detector designed to study $p\bar{p}$ collisions at the Fermilab Tevatron. The properties of the B hadrons are ones of the primary interests at CDF. My thesis work involves the detector upgrades and measurement of the B_c meson properties.

- ○ **Measurement of the B_c Meson Properties** (2002–2006)

The B_c meson is the ground state of charm-bottom quark bound system. The B_c meson is unique because of its structure; both bottom and charm quarks are heavy, the dynamics is similar to $c\bar{c}(J/\psi$, etc.) and $b\bar{b}(\Upsilon$, etc.) system rather than other B mesons (B_u, B_d, and B_s). Since both quarks have different flavor, only weak decays are allowed. The B_c meson has a specific feature in its decay since the charm quark decay contribution is as large as the bottom quark. Also the charm-bottom annihilation decay is not negligible. Therefore the lifetime is expected to be shorter than those for other B mesons.

The B_c meson was first observed at CDF Run I with 110 pb^{-1} of data, using $B_c^+ \to J/\psi \ell^+ \nu_\ell$ events. The production, mass and lifetime were studied using approximately 20 signal events.

With the much large data sample of CDF Run II, more precise measurements of the B_c meson properties were anticipated. I studied the B_c meson characteristics using $B_c^+ \to J/\psi e^+ \nu_e$ channel with 360 pb^{-1} of CDF Run II data. The J/ψ's were reconstructed from dimuon trigger data. Electrons were identified using the calorimeter information and the energy deposit information (dE/dx) in the tracking chamber. First, a decay length cut was applied to the $J/\psi e$ pair so as to clean up the signal, and the background events in the B_c^+ signal region

($4 < M_{J/\psi e} < 6$ GeV/c^2) were precisely estimated using data with support of Monte Carlo simulation while keeping the signal region blinded. And then opening the blinded region, we found about 100 $B_c^+ \to J/\psi e^+ X$ signal events, clearly establishing a B_c^+ signal. Next, we released the decay length cut and performed a maximum likelihood fit with the decay length distribution of $J/\psi e$ events to extract the B_c^+ meson lifetime. In my Ph.D. thesis, I reported a new result of the B_c meson lifetime, $\tau_{B_c} = 0.463\ ^{+0.073}_{-0.065} \pm 0.036$ ps. The result is a factor of ~ 2.5 better than the Run I CDF result and agrees well with theoretical predictions in which all three major decay diagrams ($\bar{b} \to \bar{c}$, $c \to s$, $c\bar{b} \to f\bar{f}'$) play important roles. From studying the $B_c^+ \to J/\psi e^+ \nu_e$ decay, I learned the technique of electron identification and developed it by introducing the electron-likelihood. From the background studies, I also learned how to remove the hadron-faking electrons, photon conversion events, and studied the $b\bar{b}$ quark pair production and their correlation.

- **Secondary Vertex Trigger Upgrade** (2004–2006)
  Secondary Vertex Trigger (SVT) was developed to tag high impact parameter tracks coming from B hadrons. The expected increase in luminosity in Run IIb requires significant upgrades to the CDF trigger and data acquisition system. The goal of SVT upgrade is to reduce the processing time and thereby increase the physics capability of CDF. The SVT consists of several boards. I contributed to the development and the operation of one of the boards, the Hit Buffer. The function of the Hit Buffer is to store the track hit information from the silicon vertex detector (SVX-II) and combine relevant hits with the track pattern information coming from the extremely fast tracker (XFT). The pattern information is put to the Track Fitter to obtain the final track fits.

  I wrote VHDL firmware code for one of chips on the Hit Buffer board. The boards were successfully installed and they are running fine.

- **R&D of Silicon Microstrip Detector for High Radiation Environment** (2000–2004)
  The current inner silicon detectors (SVX-IIa and L00) at CDF Run II will not tolerate the radiation dose associated with high luminosity running (> 15 fb^{-1}). The CDF Run IIb Silicon Vertex Detector (SVX-IIb) was designed to tolerate such high radiation environment. I belonged to the upgrade group from the beginning through the termination of the project. I analyzed the module from its thermal and mechanical viewpoint using ANSYS analysis tool. I also tested the quality of silicon sensor itself.

Undergraduate, Ibaraki University (1996–2000)

I studied astrophysics at Ibaraki University, supervised by Prof. Toshihisa Ishizuka, where I learned general relativity, evolution of the universe, radio astronomy, solar activity, and chaos. I performed some computer simulations to study astronomical multi-body behavior around black hole.

- **Talks**
  - **Tevatron results on $B \to \mu\mu$, $B \to K^*\mu\mu$**
    2010 Flavor Physics and CP Violation, Torino, May 2010.
  - **Measurements of Rare B Decays at Tevatron**
    2009 Rencontres de Moriond QCD and High Energy Interactions, La Thuile, March 2009.
  - **The lifetime of the DØ Silicon Microstrip Tracker and Experiences at the Tevatron**
    2008 IEEE Conference, Dresden, October 2008.
  - **B_c mass, lifetime and BR's at CDF**
    International Workshop on Heavy Quarkonium, Brookhaven National Laboratory, June 2006.
  - **Study of the B_c Meson at CDF Run II**
    Japan Physical Society meeting, Ehime/Matsuyama University, March 2006.
  - **$B_c \to J/\psi eX$ Decay at CDF**
    American Physical Society meeting, Tampa Florida, April 2005.
  - **Search for the Decay $B_c \to J/\psi eX$**
    American Physical Society meeting, Denver Colorado, April 2004.
  - **R&D of the CDF High Radiation Tolerant Silicon Detector III**
    Japan Physical Society meeting, Okinawa International University, September 2001.
  - **R&D of the CDF High Radiation Tolerant Silicon Detector I**
    Japan Physical Society meeting, Niigata University, September 2000.
- **Awards**
  - **FY 2009 Fermilab Exceptional Performance Recognition Award**
    "Masato Aoki is awarded an Exceptional Performance Recognition Award for his leadership of and important contributions to the efficient operation of the DZero Silicon Microstrip Tracker, including innovations in monitoring tools, monitoring of radiation damage, and various optimizations of detector operations which have enhanced detector performance."