# IP-BPM Progress & Planning

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- Review of IP-BPM current status & Desired improvements
- KNU Low Q IP-BPM
- Calibration of ATF extraction beam monitors
- ATF2 installation with Shintake Monitor

# Goals of IP-BPM measurement

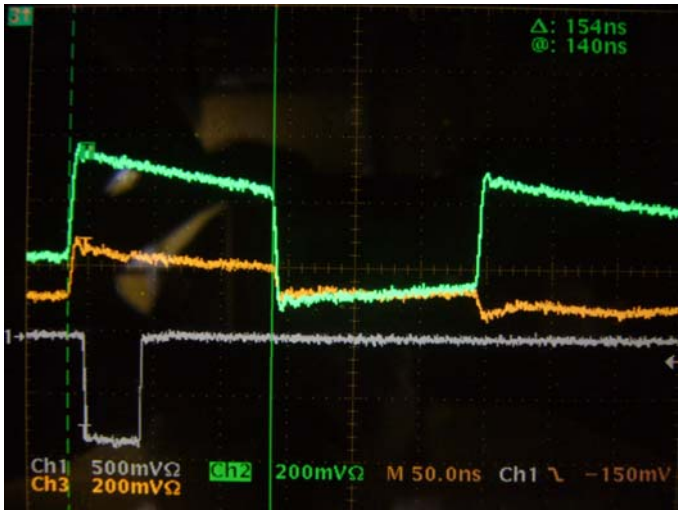
- Phase I (Shintake Mode)
  - Monitor beam jitter with ~8.5 nm resolution
- Phase II (IP-BPM Mode)
  - Demonstrate nano-meter beam stability at IP
- Before ATF2, achieve 2 nm position resolution under …
  - Single Bunch Operation
  - Multiple Bunch Operation
    - 308 ns interval (ILC like)
    - 154 ns interval

# Single Bunch Operation

- Achieved position resolution
  - 8.7(nm), dynamic range ~5 micron (2007 spring)
  - At nominal charge, 5.9 (nm) expected
- Thermal noise of electronics
  - 3.9 (nm) measured, 2.6 (nm) expected at nominal charge
- Unknown noise
  - Unknown noise equivalent to 5.4 (nm) at nominal condition
- Origin of noise?
  - Temperature drift of DR not dominant
  - Vibration of IP-BPM stage not dominant
  - Applying all the noise, resolution improves to thermal noise level in principle

# 3 Bunch Operation

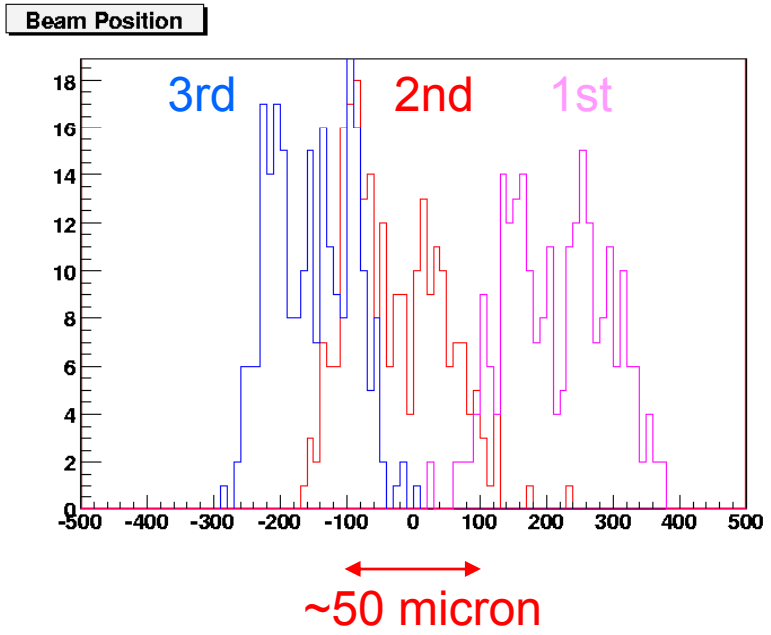
- Bunch interval > Signal Decay
  - Analog detection can be applied
    - Same with single bunch operation
- Bunch interval < Signal Decay
  - IP-BPM case for 154 ns interval
  - Digital Bunch Separation
    - Monitor wave form
  - Digital Phase Detection
    - Beam synchronized RF required
    - Detecting electronics gain have phase relation
  - Takes time for analysis




Reference Cavity Signal

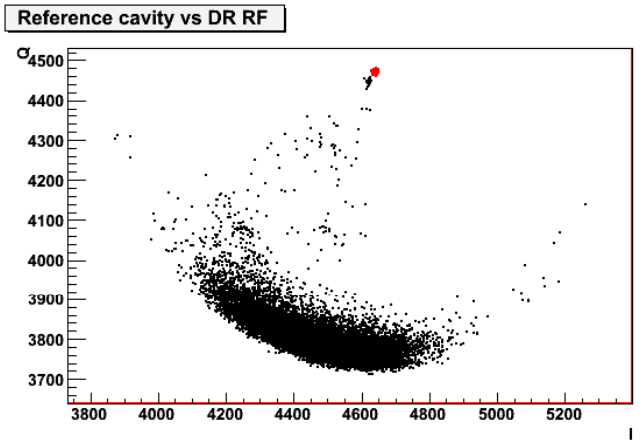
# Result of Digital Detection

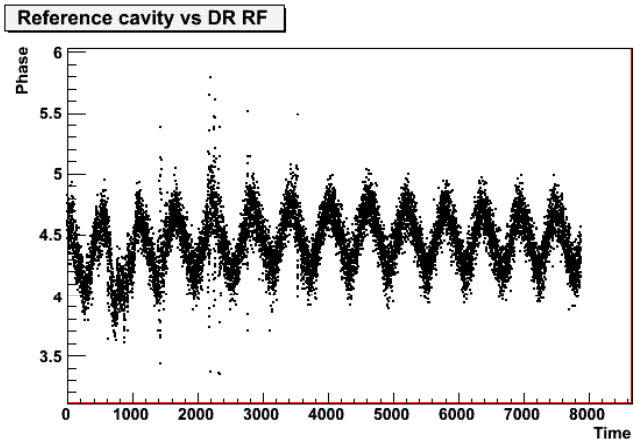
- Proved ~1.5 micron position resolution under 40 dB attenuation
  - Simply extrapolated to 0dB, resolution is under 10 nm at nominal charge
  - Improvement is difficult due to large bunch to bunch jitter
  - Charge differ among 3 bunches



# Beam Synchronized Reference Signal

- Digital detection with beam locked LO
  - ~1rad phase drift in DR 714MHz
  - Originate from cable length change due to temperature drift?
    - 5mm length change with ~50m cable
  - Temperature stabilization or feed back needed




- Analog detection with reference cavity
  - Short decay time, low Q required
  - Maintaining position sensitivity, dynamic range limited
    - Crucial considering angle jitter at IP

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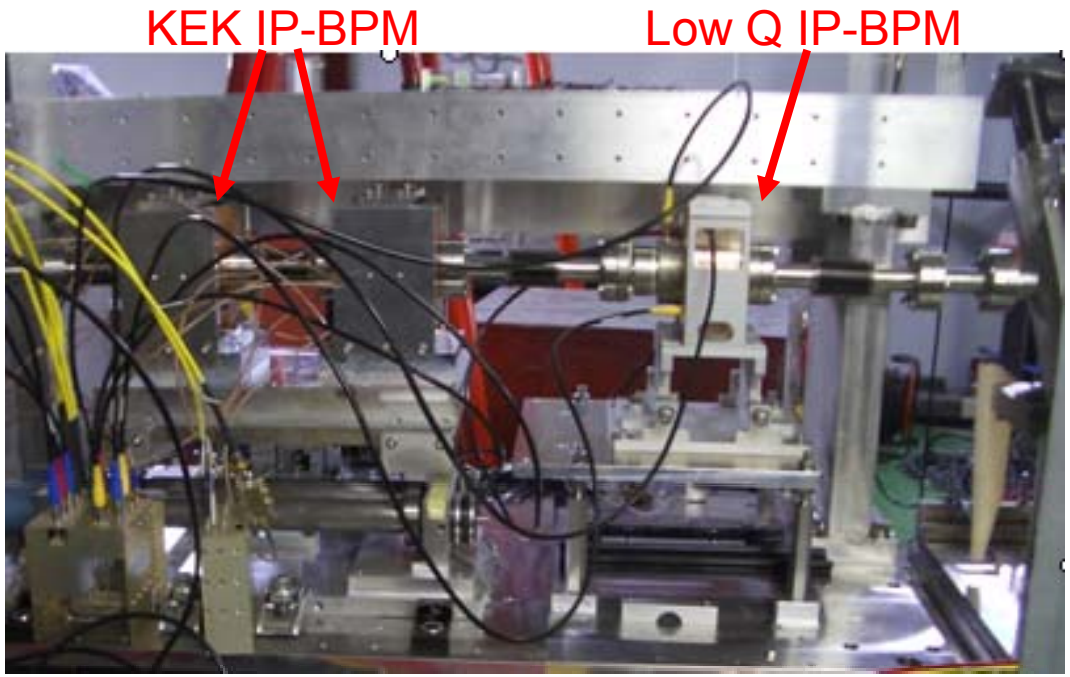
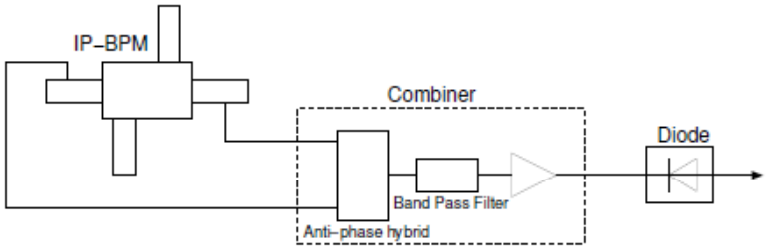
# KNU Low Q IP-BPM

- Fast signal decay for multiple bunch operation
- Applied for fast feed back system?
- Installed at ATF extraction line, upstream of KEK IP-BPM



# Beam Test Results

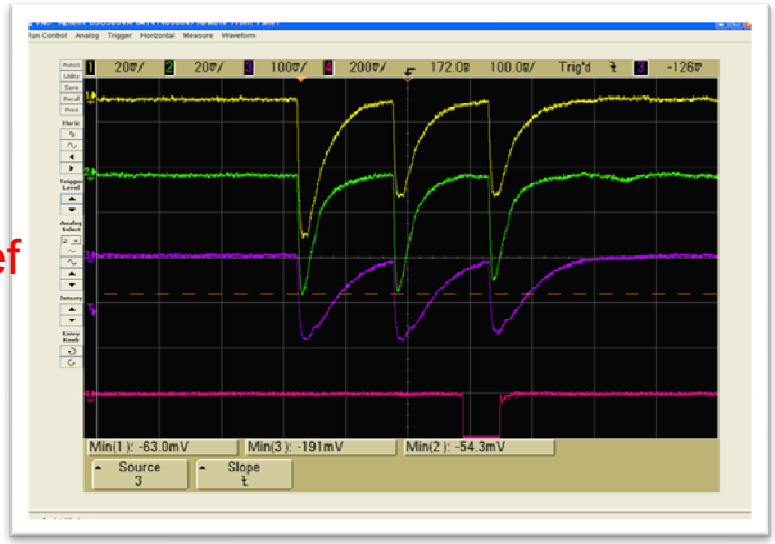


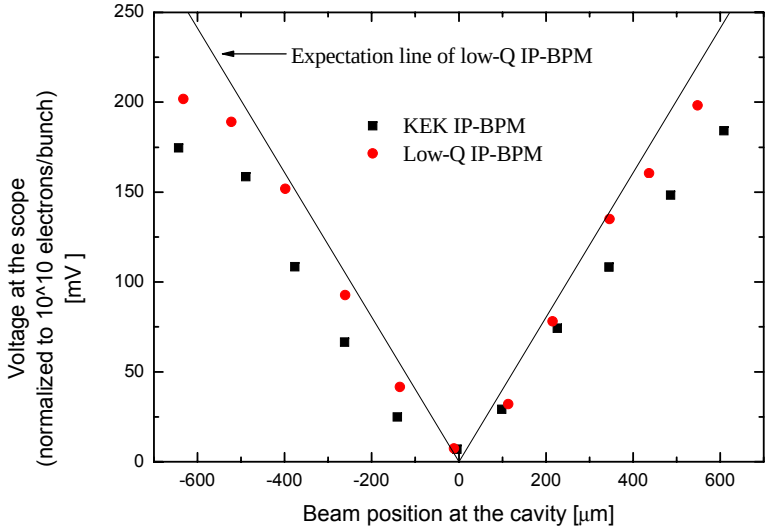

- Position sensitivity test performed, consistent with expectation
- Bunch separation achieved in 154 ns interval

X

Y

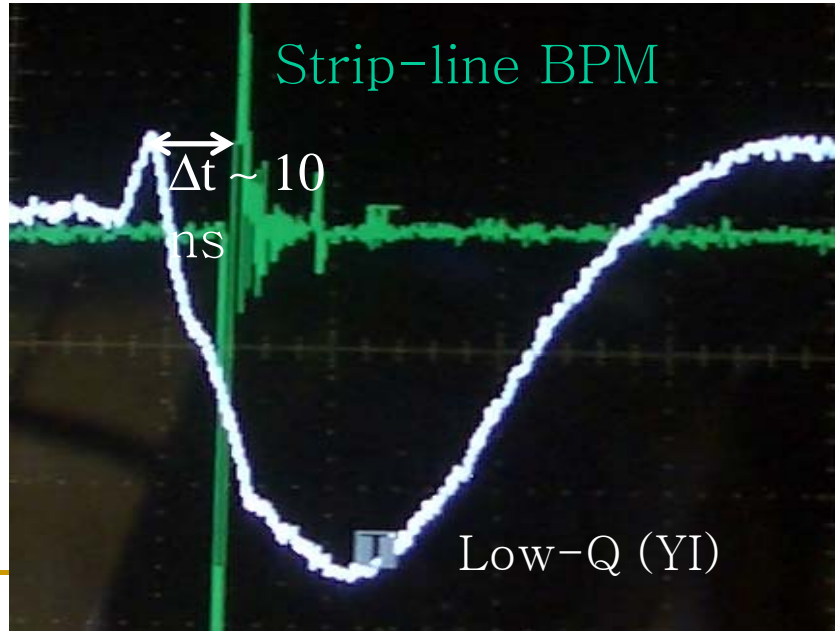
Ref



# Signal Processing Time

- Single down conversion
  - ~13ns compared with stripline BPM
- Double down conversion
  - ~37ns compared with stripline BPM
- Applicable for fast feed back system by installing system near by cavity



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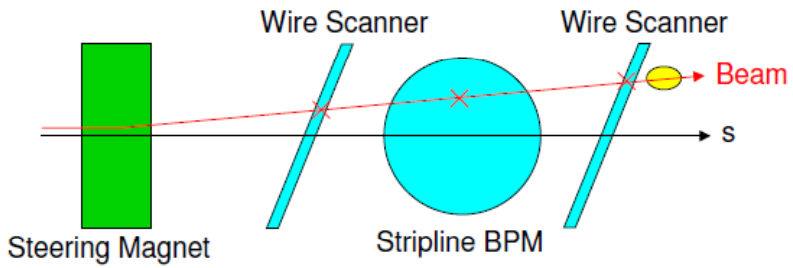
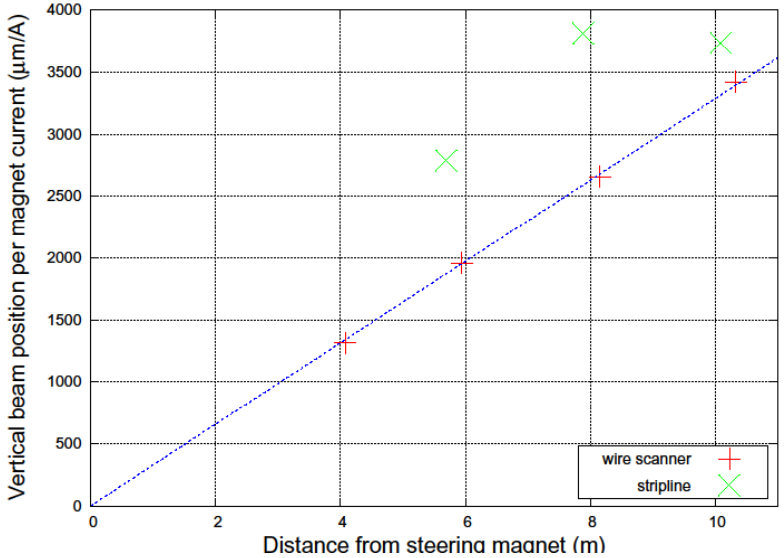
# Stripline BPMs

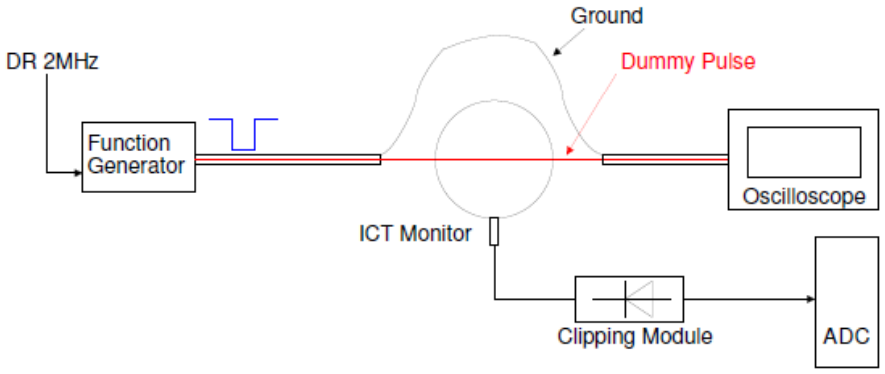
- IP-BPM beam study operated using ML11X, ML12X, ML13X
- Calibrated in relation to wire scanners
- Factor 1.3 ~ 1.5 different in vertical & horizontal
- Origin??

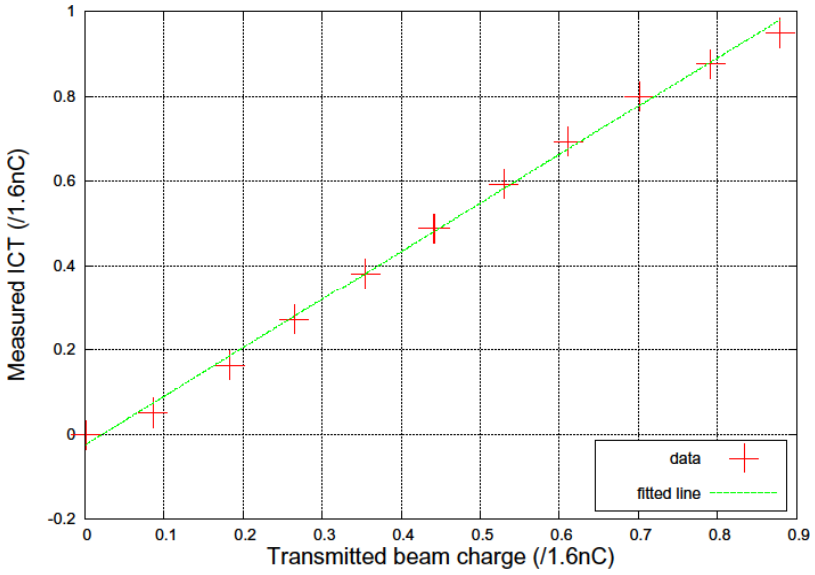


# ICT Monitor

- Reference cavity calibrated in relation to ICT monitor
- Beam charge increase compared to DR??
- ~10% over estimation at ICT monitor?



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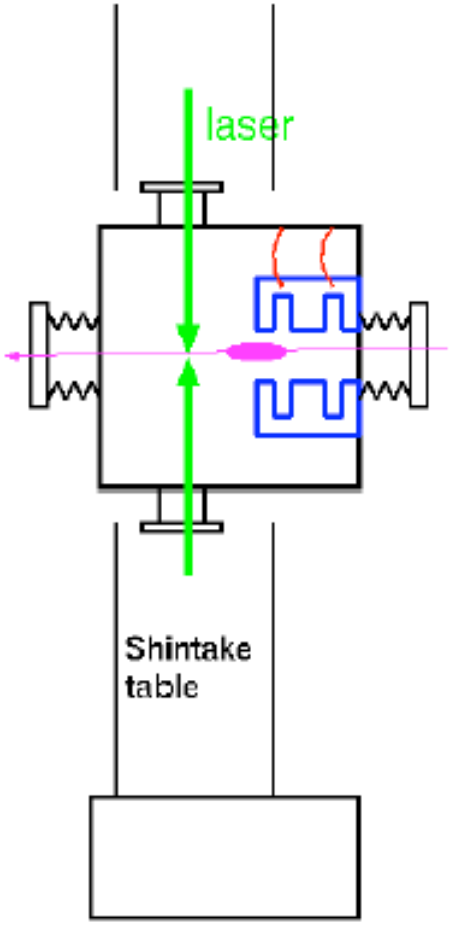
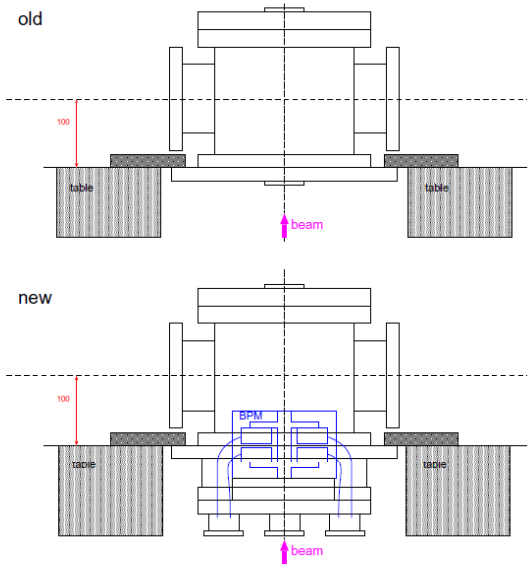
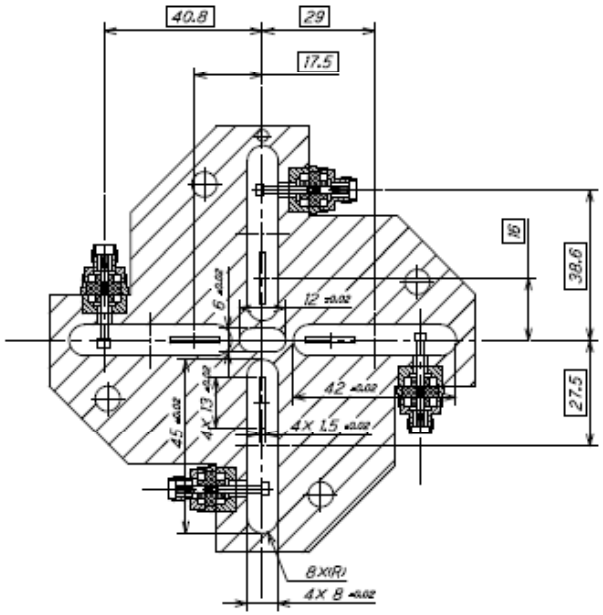
# IP-BPM for Shintake Monitor




- Phase I (Shintake Mode)
- Monitor beam jitter to confirm nano-meter beam size
- 1 block Installed in Shintake vacuum chamber
- Calibration made by stripline BPMs?



# Design Improvements




- Wave guide length optimized to vacuum chamber
  - 60mm → 45mm (X), 57mm → 42mm (Y)
- Cavity design not changed
- ~6nm position resolution at nominal charge expected

# Schedule

- 2008/2 IP-BPM for Shintake fabrication
- 2008/3~4 Bench test of Shintake IP-BPM
- ~2008/10 Installation in Shintake Chamber
- 2008/10~2009/3 Shintake Monitor commisioning
- 2009/4 Calibration of Shintake IP-BPM
- 2009/4~ Shintake mode operation

# Summary

- Position Resolution
  - 8.7 nm achieved (cf. goal: 2nm)
  - Identification of noise components desired
- Multiple Bunch Operation
  - Analog detection: KNU BPM installed for fast feed back system
  - Digital detection: Beam synchronized reference signal desired
- ATF extraction beam monitors
  - Calibration of striplines, ICT monitor necessary
- Shintake IP-BPM
  - Resolution achieved in current cavity
  - New design applied, fabrication complete at Feb. 2008