IP-BSM   Status and Plan

11th ATF2 Project Meeting

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Menlo Park, California

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layout

- Beam time results of Nov /Dec of 2010
  - 2-8 degree mode
  - 30 degree mode
    - reasons we could not detect modulation

- **Laser system status**
  - **Laser focusing problem**
    - What happened?
    - possible causes
  - **Laser timing problems**
    - Timing system renewal
  - **detector gate timing**

- **Plan from 2011 Jan~**

Laser Problems (last beam time)

Thur (12/16) → Fri. (12/17):

Attempting **30 deg mode** directly from 6 deg

(1) laser timing messed up

➢ **Beam and laser interference fringe ceased to collide**

➢ *Lost modulation*

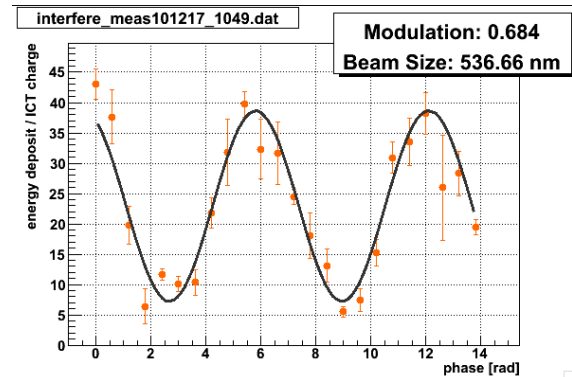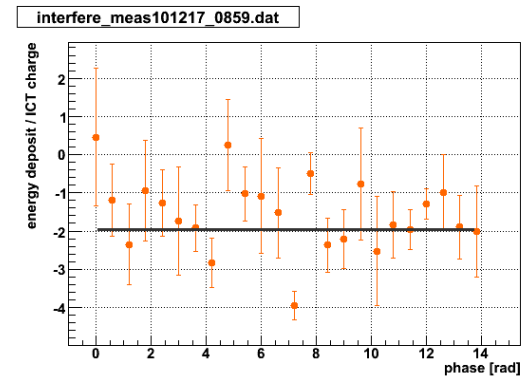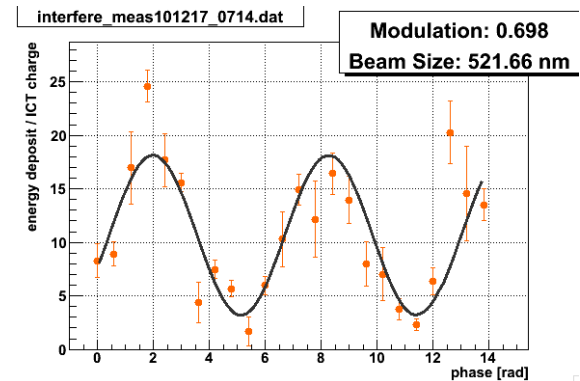**(2) Unfocused laser spot size at IP**

  low S/N

Switched back to 7.79 deg

- tried to control laser timing

- **Re-conducted laser wire scan, z – scan**

➔ collision temporarily resumed

BUT modulation get lost on and off

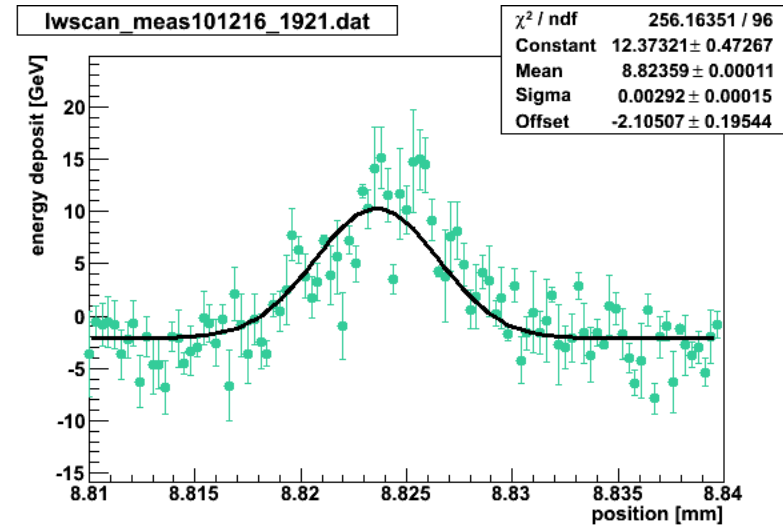- beam intensity and laser timing remained unstable

Unfocused Laser

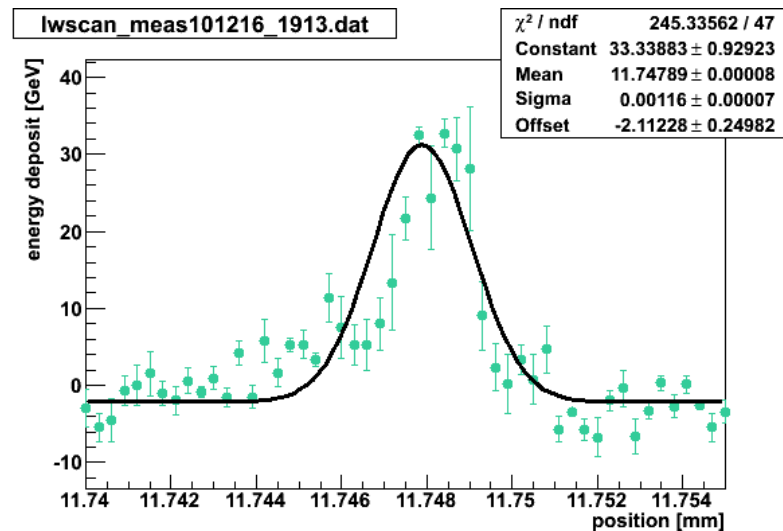**lower laser path unfocused :**

$\sigma_{laser\ 2}(30°\ )= 28.03\ \mu m$

➤ Wide laser wire scan peaks

c.f.   design size ~ 10 μm

Upper path :

$\sigma_{laser1}(30°\ ) = 11.13\ \mu m$

Where to blame for unfocused laser??

(1) **cooling water suddenly fell below safety line** → **interlock gave off**

➤ **Air bubbles got in** during replenishing

May have…..

- blocked excitation lamp, disturbed seeder

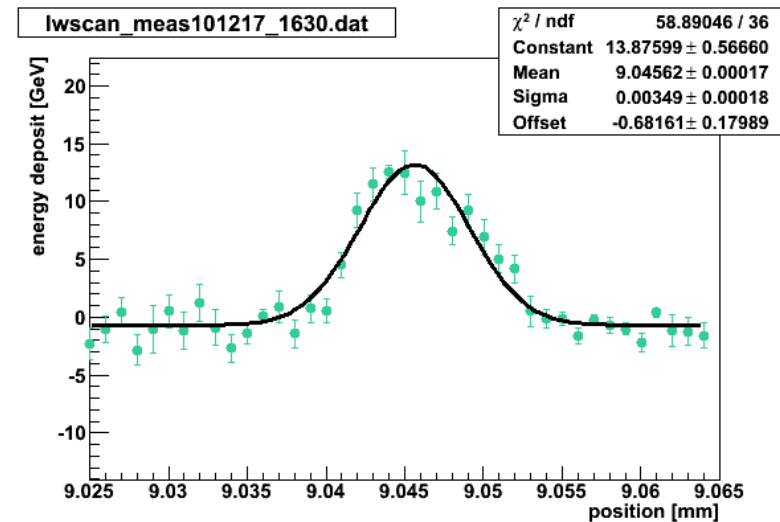➤ re-circulated (> 50 times)

(2) abrupt interlock stop → **took time to recover**

➤ affected upper path also (recovered later)

(3) Changed lower path lens at 30 deg

(possibly in wrong direction)

➤ However is 8 deg focused??

σ_{laser2} = (7.79°) = 27.9 μm

| lwscan_meas101217_1630.dat		
χ^2 / ndf		58.89046 / 36
Constant		13.87599 ± 0.56660
Mean		9.04562 ± 0.00017
Sigma		0.00349 ± 0.00018
Offset		-0.68161 ± 0.17989

More on Cooling Water

Startup day: tank 1/5 full

- couldn`t find leak
- ☐ Evaporate rapidly if used over 10 hrs everyday, esp. during dry climate

- *must be cautious from now on*
- **New tank** (see next slide)

Checked: **cooling water purity is not the problem**

in fact, purer than ATF purified water sample

resistivity: [Ω·cm]   IP-BSM :   1.57 x 10^6   ATF sample: 7.72 x 10^5
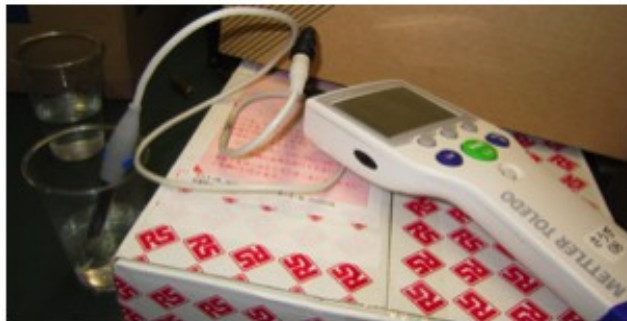
External cooling water tank

(1) **Fast evaporation** due to unclosed system

- extend two hoses to outside of power source
- Connect to **new tank**
- Tank **lid sealed tight** with rubber
- **insulate hose and tank**   (laser sensitive to temperature)

(2) **water level judged only visually**

    no alarm: abrupt interlock stop

- Switch interlock connections from current tank to new tank
- New tank has monitors: constant display   +   alarm
- ➢ **Water level monitor** : connection to current water level interlock
- ➢ **Flow monitor** : interlock connection to laser power source

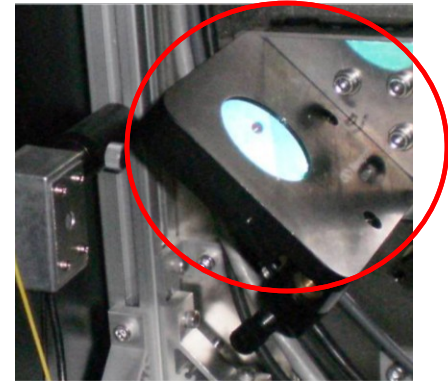(3) **Air bubbles** get in during refill or exchange

- Hand-powered **valves** on hose connector: **seal tight during refill**

laser –beam timing: 97 ns difference required

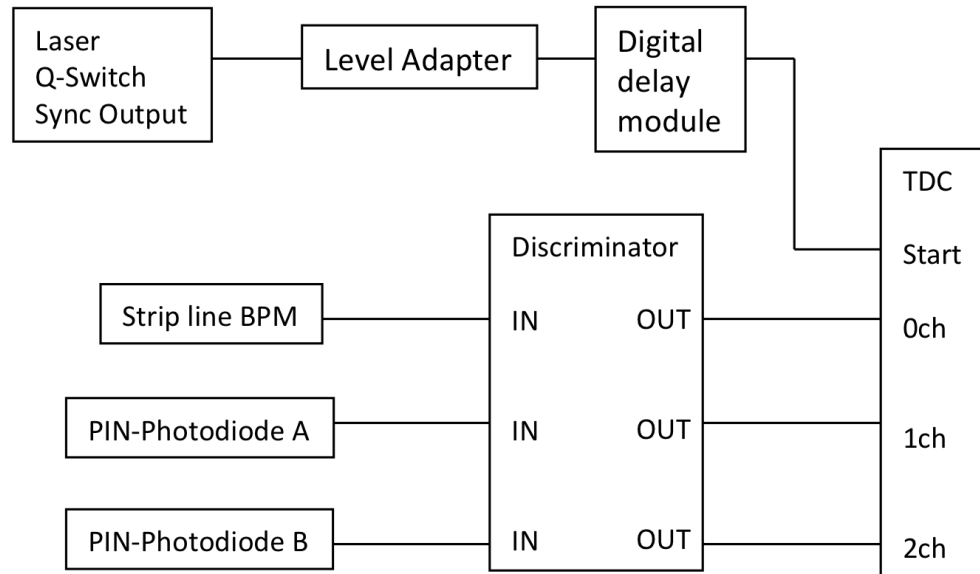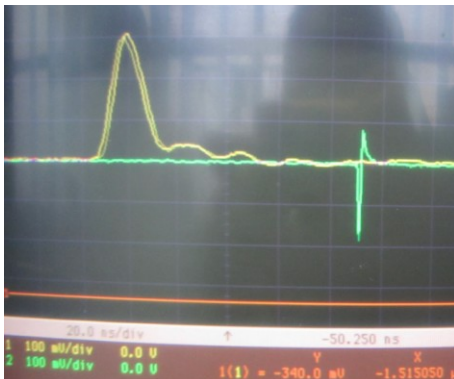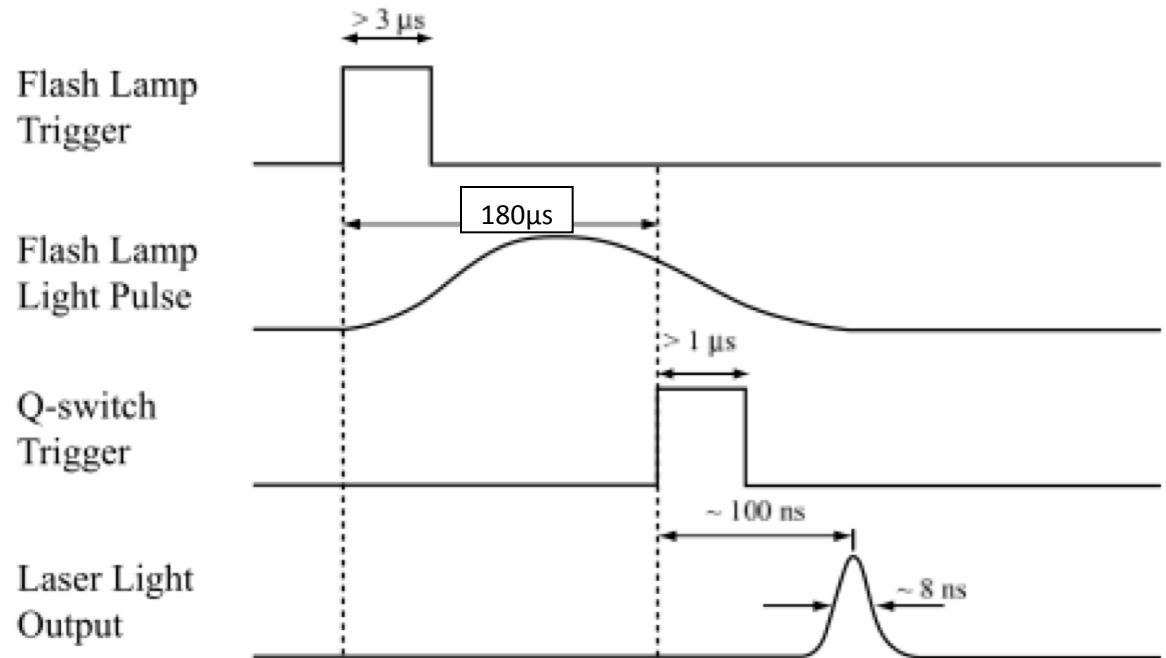**Beam: stripline timing BPM** (upstream)
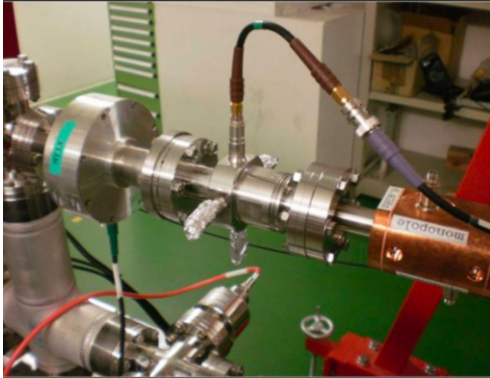
Laser: PIN-Photodiode

TDC START:

laser output synchronized with Q-switch

laser Q-switch timing

> 3 μs

Flash Lamp Trigger

180μs

Flash Lamp Light Pulse

> 1 μs

Q-switch Trigger

~ 100 ns

Laser Light Output

~ 8 ns

- Triggered Flash Lamp creates light pulse

- **Max Laser power extraction if Q-Sw triggered ~180 μs after FL trigger**

- Output ~ 100 ns after Q-switch trigger

- **laser pulse width = 8 ns** (FWHM)   after   SHG (1064 →532 nm)
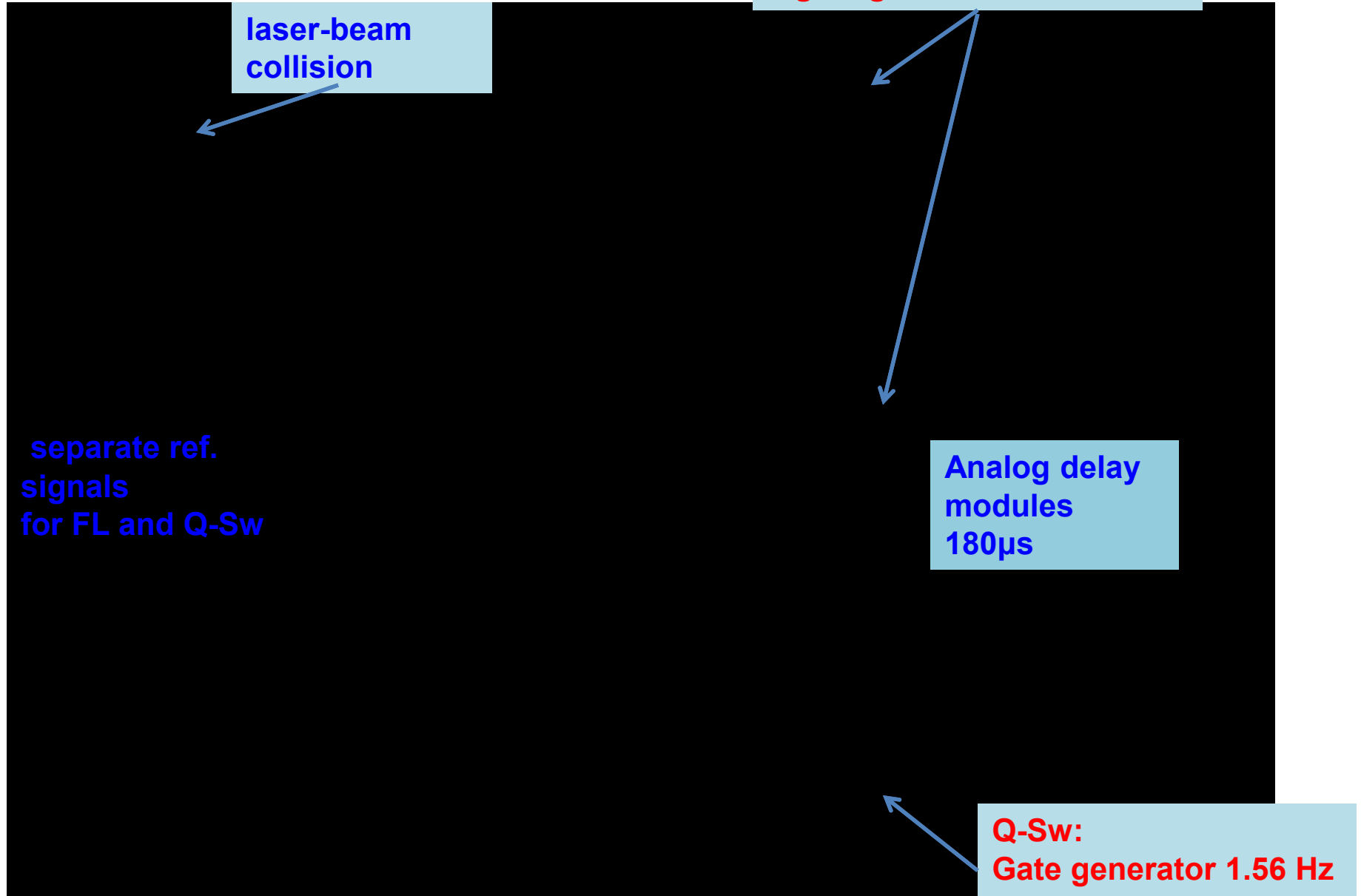
Old timing system

laser-beam
collision

FL: Pulse generator
+ gate generator 6.25Hz

separate ref.
signals
for FL and Q-Sw

Analog delay
modules
180μs

Q-Sw:
Gate generator 1.56 Hz

Laser Timing Problems

FANIN/FANOUT of gate generators taken for Laser Q-switch

① **6.25 Hz** (laser ~ 10 Hz) ② **1.56 Hz** (beam at 1.56Hz)

◆ **laser pulse timing disturbed by few hundred ns jitter**

➡ **prevented beam – fringe collision**
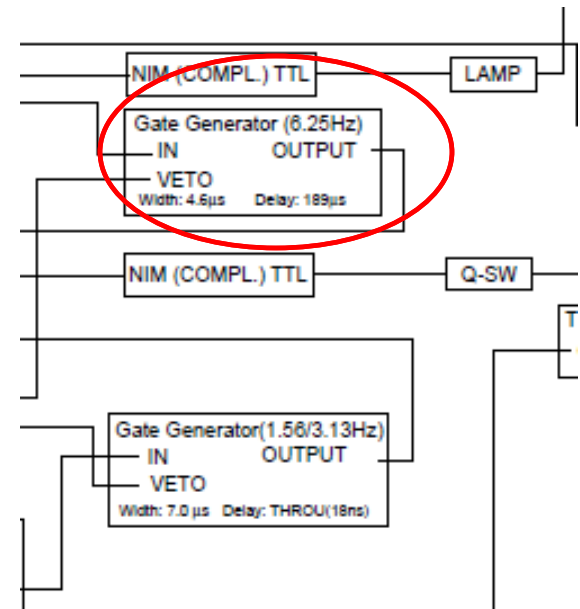
few ns scale control required

- **Delay on analog modules**

  Incompatible for fine 100ns step adjustments

(1) 6.25 Hz gate generator (~ 100 μs)

(2) pulse generator (~ 800 μs)

❖ since FL and Q-Sw had separate ref. signals
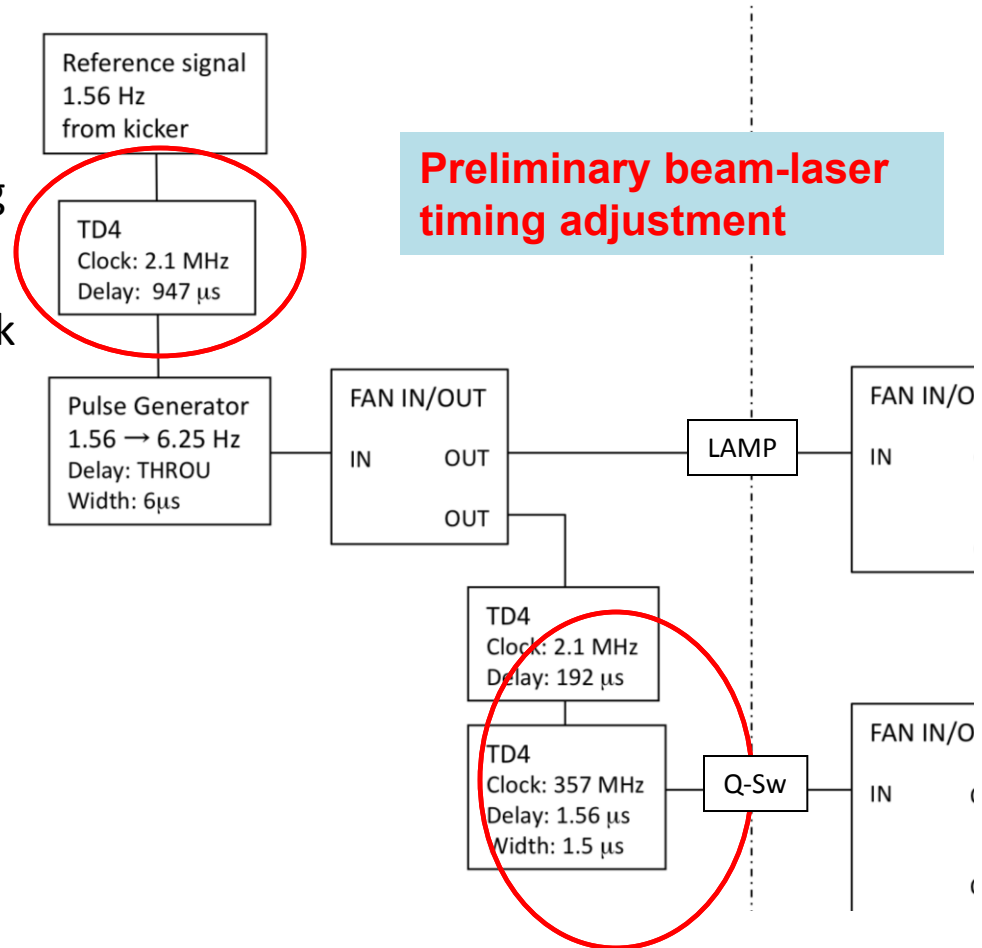
Timing System Renewal　　*precise !!　simpler!!*

- **Substitute analog module with digital TD4**

"double TD4 set"

2.1 MHz (462 ns step) TD4 : rough timing

paired with

357 MHz (2.8 ns step) TD4 : precise work

- **simultaneous control of FL and Q-Sw**
- ➢ Common upstream ref. signal

Reference signal
1.56 Hz
from kicker

TD4
Clock: 2.1 MHz
Delay: 947 μs

Preliminary beam-laser timing adjustment

Pulse Generator
1.56 → 6.25 Hz
Delay: THROU
Width: 6μs

FAN IN/OUT

IN　　OUT

OUT

LAMP

FAN IN/O

IN

TD4
Clock: 2.1 MHz
Delay: 192 μs

TD4
Clock: 357 MHz
Delay: 1.56 μs
Width: 1.5 μs

Q-Sw

FAN IN/O

IN

- **180μs delay between FL and Q-Sw**
- **Precise laser-beam timing**

Timing System Renewal

(1). Delay (~ 100 µs) 1.56Hz ref. signal with TD4

(2) Pulse generator ; **{1.56 Hz → 6.25 Hz}**   *No more pulse generator delay*
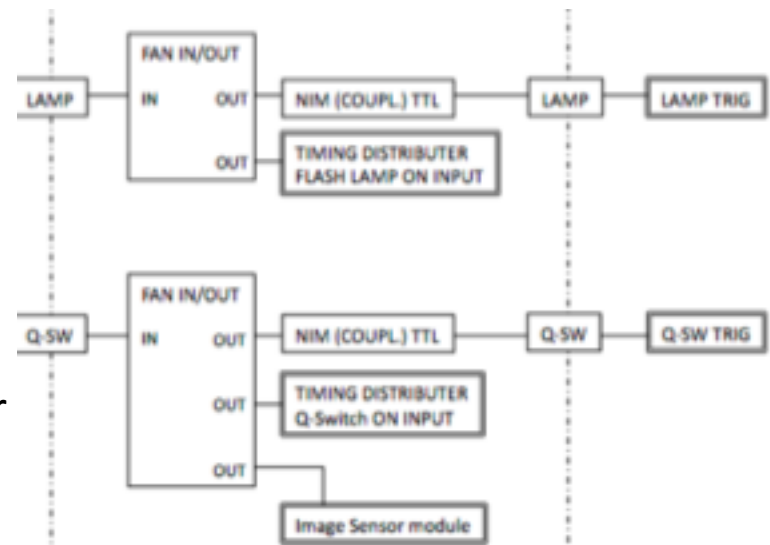
(3) **FANIN/FANOUT**:   one branch becomes **Flash Lamp trigger**

(4) Another branch **delayed 180 µs**
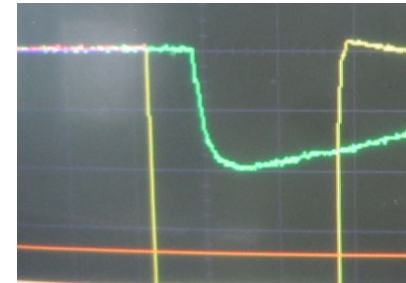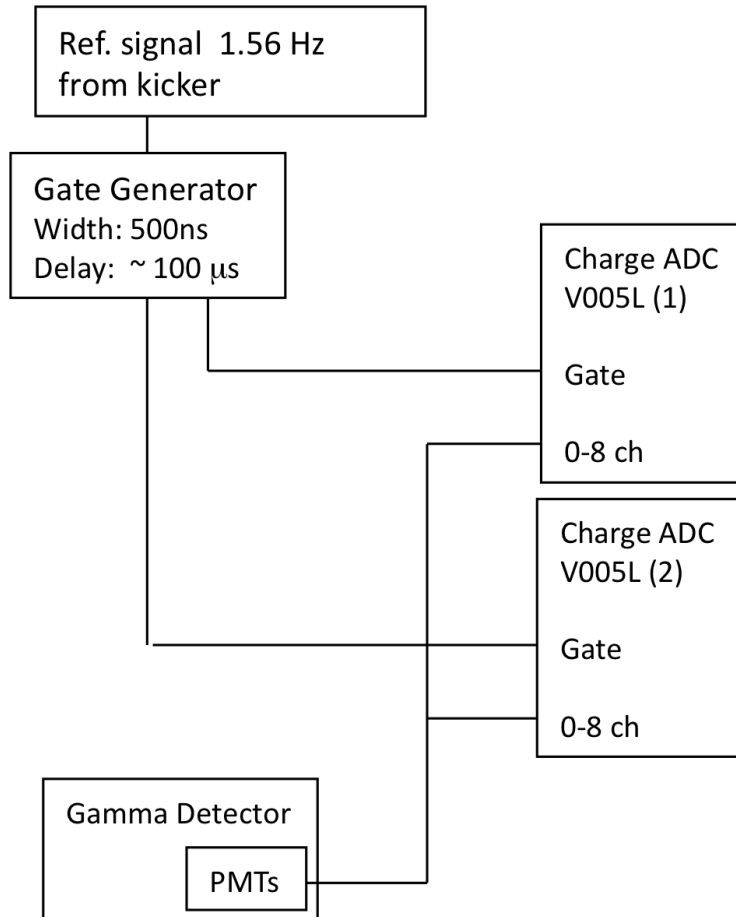   → become **Q-Switch trigger**
   essential for collision between
   beam and laser interference fringes

- FL and Q-sw triggers proceed into DAQ
- FANIN/FANOUT → use in photodiode,
   peakhold trigger, image sensor of phase monitor

Gamma detector timing

Ref. signal 1.56 Hz
from kicker

Gate Generator
Width: 500ns
Delay: ~ 100 µs

Charge ADC
V005L (1)

Gate

0-8 ch

Charge ADC
V005L (2)

Gate

0-8 ch

Gamma Detector

PMTs

- **16 chan. ADC gate**:

ref. signal from kicker

(~ 1 ms later than laser ref. signal)

delayed ~ 100 µs

Is analog module here ok?

- **Ganma detector PMT output**

Plan for Next Steps (2011 Jan ~)

IP-BSM shift:

- **Test out new laser timing system**

➢ No more jittering /drift disturbing beam-laser collision (?)

- **Detector gate timing evaluation**

- **Focus each laser path at IP at 30, 174 deg**

➢ determine real causes for previous failures

➢ Improve laser cooling system

➢ Lens adjustment

Continuous run:

- **Shift to 30 deg mode from 8 deg mode**

 (more details coming up tomorrow: "IP-BSM operation")

Back up

Unfocused laser

1. move to 30 deg

2. cannot focus bottom path, even when change reducer

    increased average to confirm cannot focus (not reliable until here)

3. changed lens of lower path

    Lens may not be the problem because not focused at at 8 deg mode either

4. lower path even fatter

5. not enough water, interlock gave off during upper path scan

6. changed lens again in opposite direction

7. now upper path cannot focus either (from here on very strange)

8. many times re-circulation

9. upper path became focused

10. lower path still cannot……

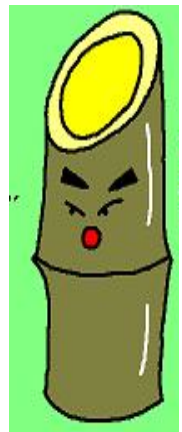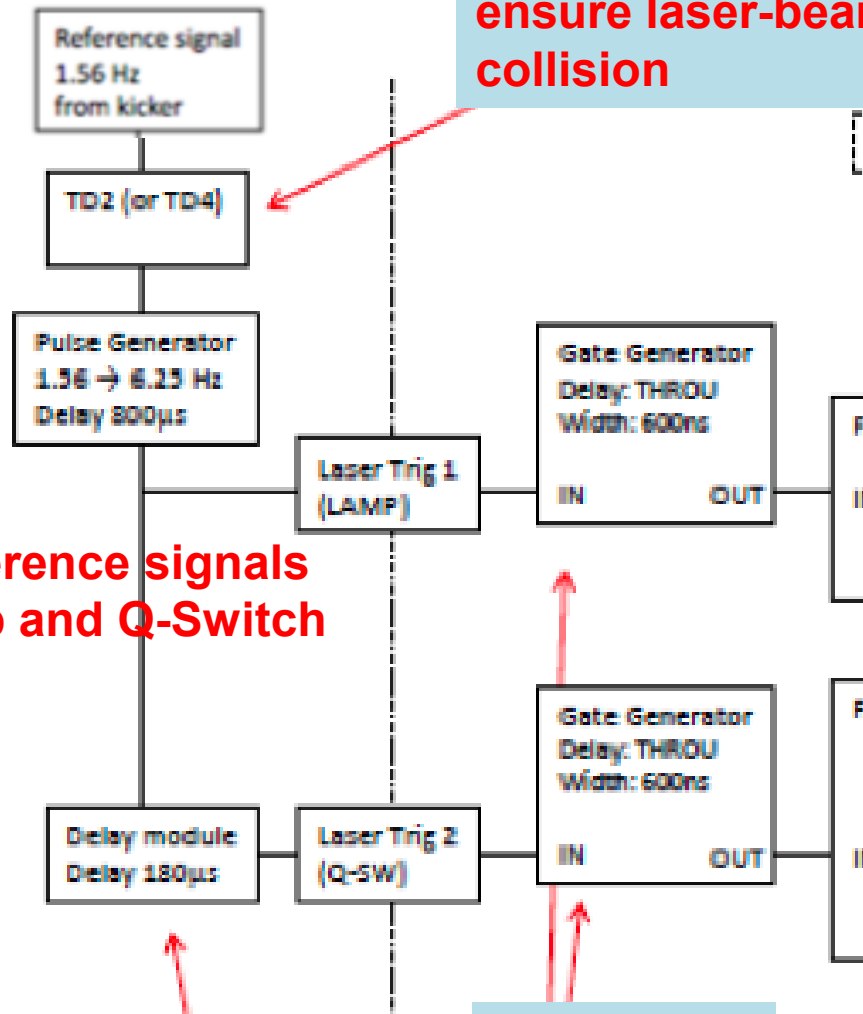- 50 ns detector jitter ????

- Entire New laser timing system
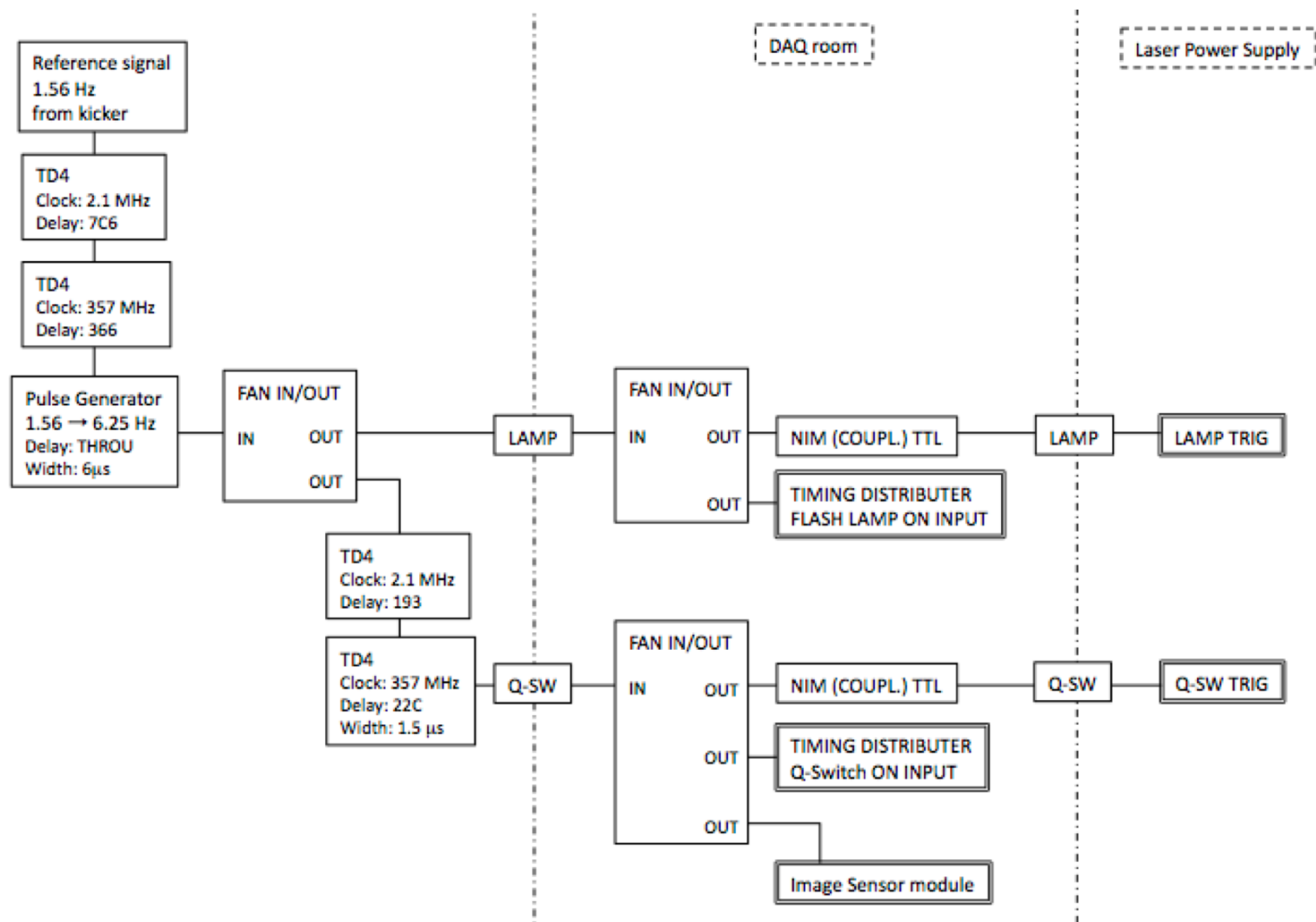
Old timing system during improvement

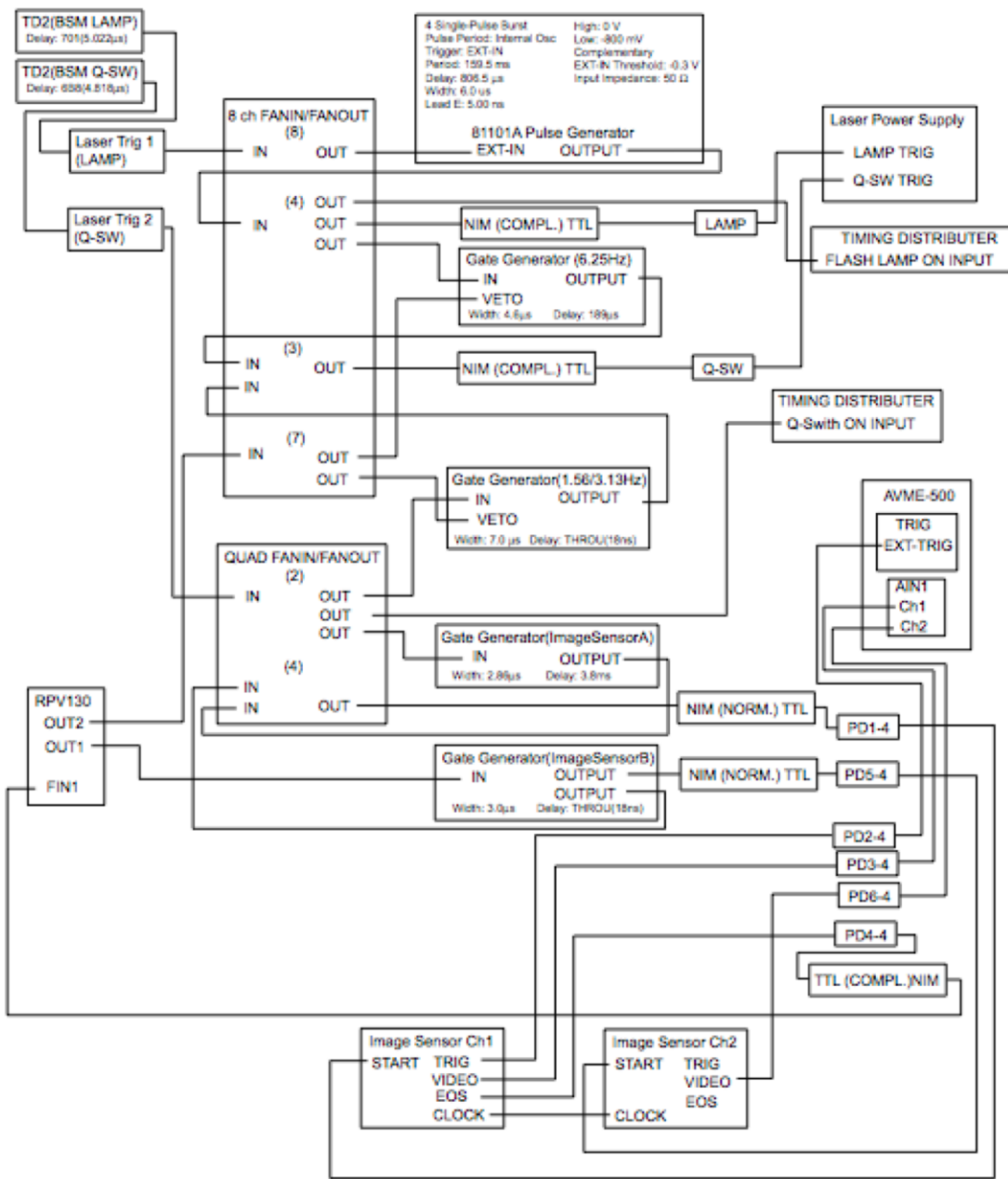this was adjusted to ensure laser-beam collision

Reference signal
1.56 Hz
from kicker

TD2 (or TD4)

Pulse Generator
1.56 → 6.25 Hz
Delay 800µs

separate reference signals for flash lamp and Q-Switch

Laser Trig 1
(LAMP)

Gate Generator
Delay: THROU
Width: 600ns

IN   OUT

F/

IN

Delay module
Delay 180µs

Laser Trig 2
(Q-SW)

Gate Generator
Delay: THROU
Width: 600ns

IN   OUT

F/

IN

180µs delay for laser output at max power

Gate generators

- Entire old laser timing system

laser Q-Switch timing

- Q-switch for **high power, high peak, short pulsed output**
- **Spontaneous change of Q value**
- Nd:YAG laser has long excitation period: large energy stored
- Laser pulse should approach beam bunch (~ 30 ps) for max. Compton signal

1. **Flash Lamp: pumping**
- Excite levels in crystal (oscillator)

2. Quenching, de-excitation: emitted light oscillate→ form inverse population

- *Keep Q value low up to here*
- Maintain high loss within oscillator, suppress resonance → larger inverse distribution

3. induced (stimulated) emission > absorption
- **boost Q value at moment of max inversion distribution,** sudden resonance