CCTF/01-32b

NRC Canada

Report to the 15th Session of the CCTF June 2001

Cesium Clocks

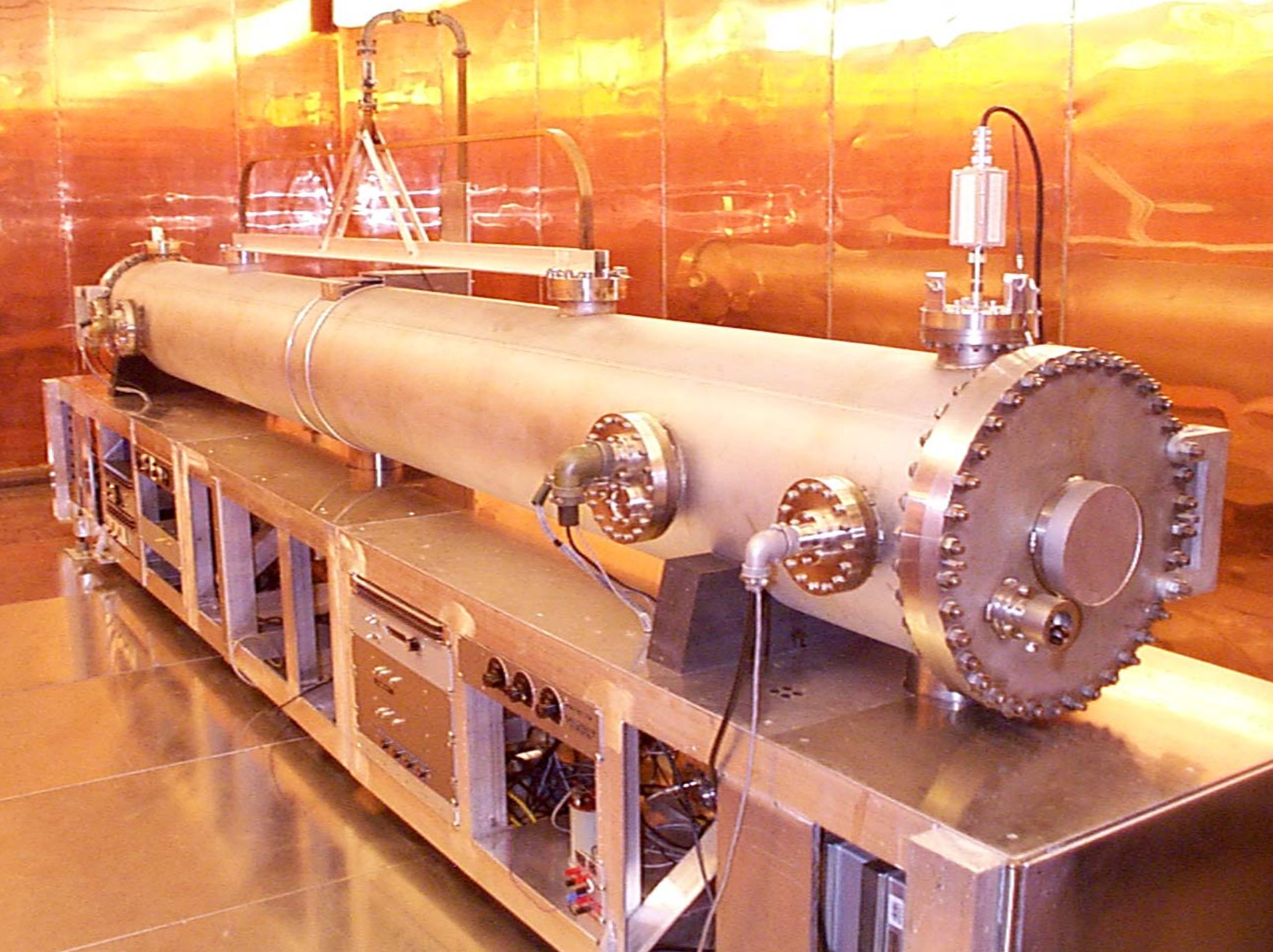
- CsVIA, CsVIC, CsV

  CsVIA ->phase shifter->UTC(NRC) to track UTC within 100 nanoseconds.

- Analogue servos -> digital servos.

  correct for the infrequent but still disruptive bursts of the detector current.

  automatic measurement of some parameters using one cycle from time to time.




ALCAN

Hydrogen Masers

- H3 and H4 built ten years ago
- new electronics (can't find parts to repair!)
- 100 MHz outputs available
- H3 used as pseudo-local oscillator for CsVIC
  - Cs clock digital servo uses phase comparator to get short-term error signal for the quartz.

Phase comparators, distribution systems

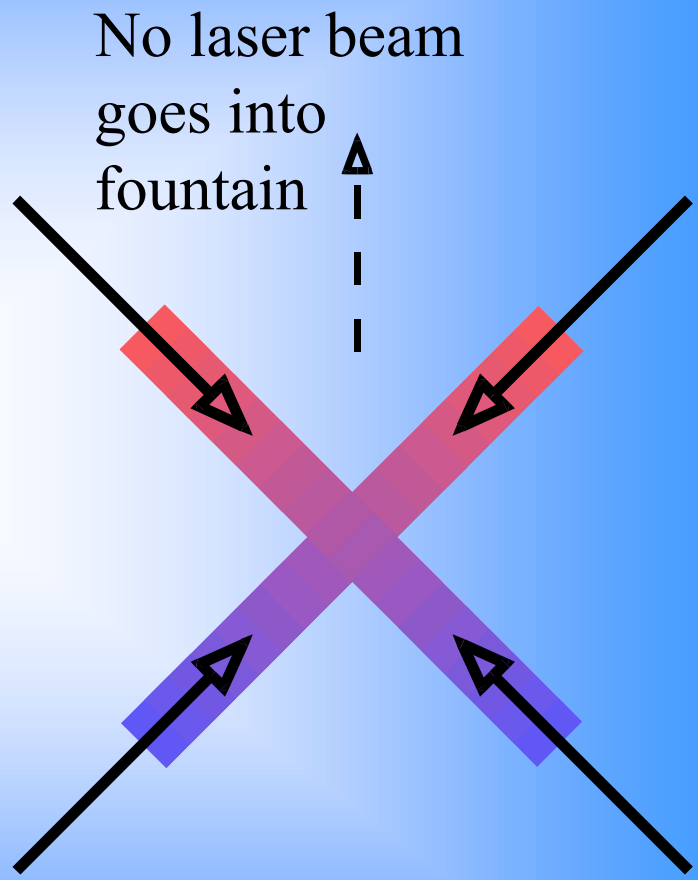
- Better cables to reduce effects of
  - mechanical vibrations
  - temperature variations
- higher frequency (5 => 100 MHz)
  - with some more modifications:
  - reduces the uncertainty ($5\text{-}8\times10^{-13}$ => $<10^{-14}$)
  - needed for caesium fountain and frequency comb

NRC-F1

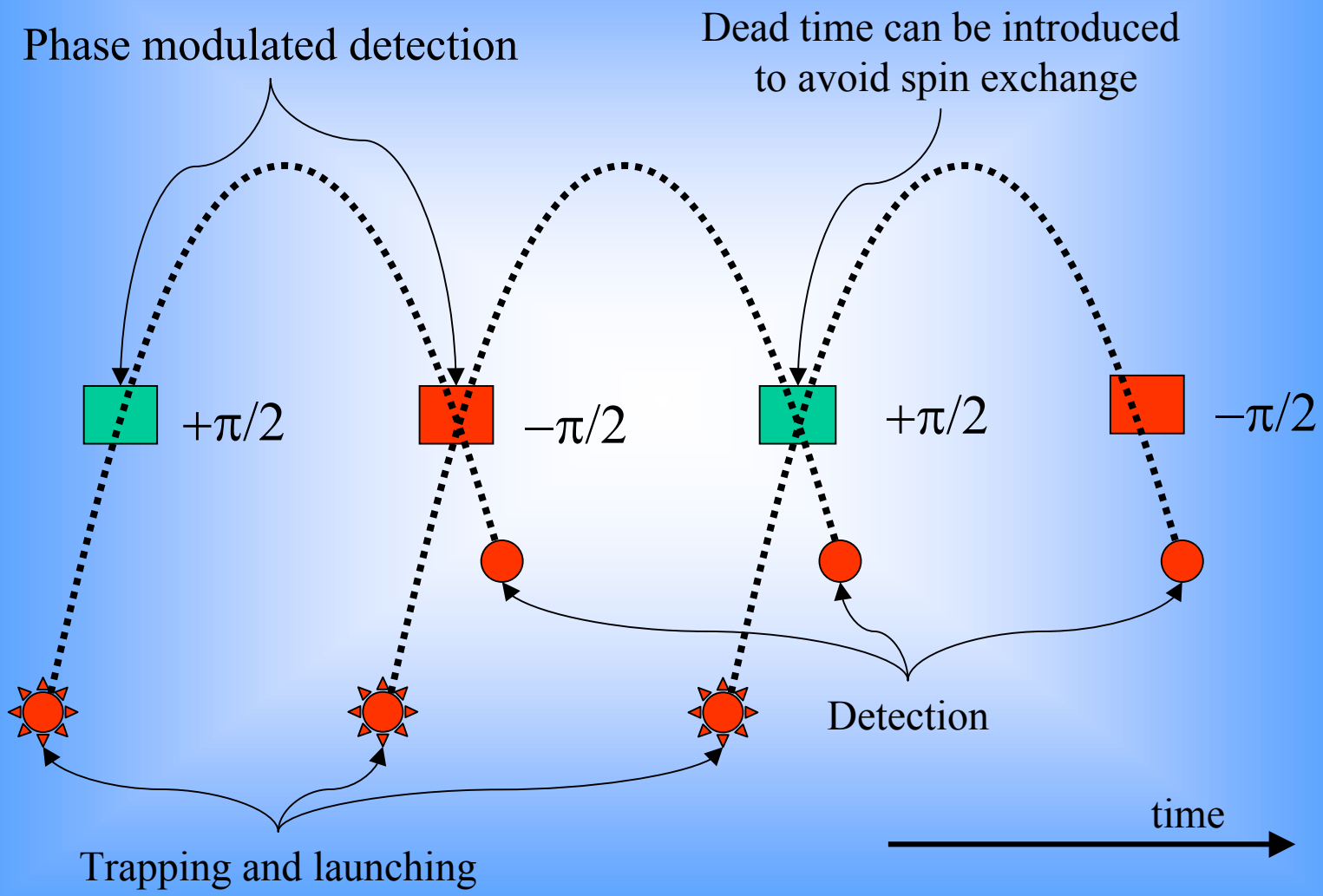
6-beam configuration
(+/- 45° and horizontal)

Use of rotating shutters

Magnetic lens to reduce transverse velocity



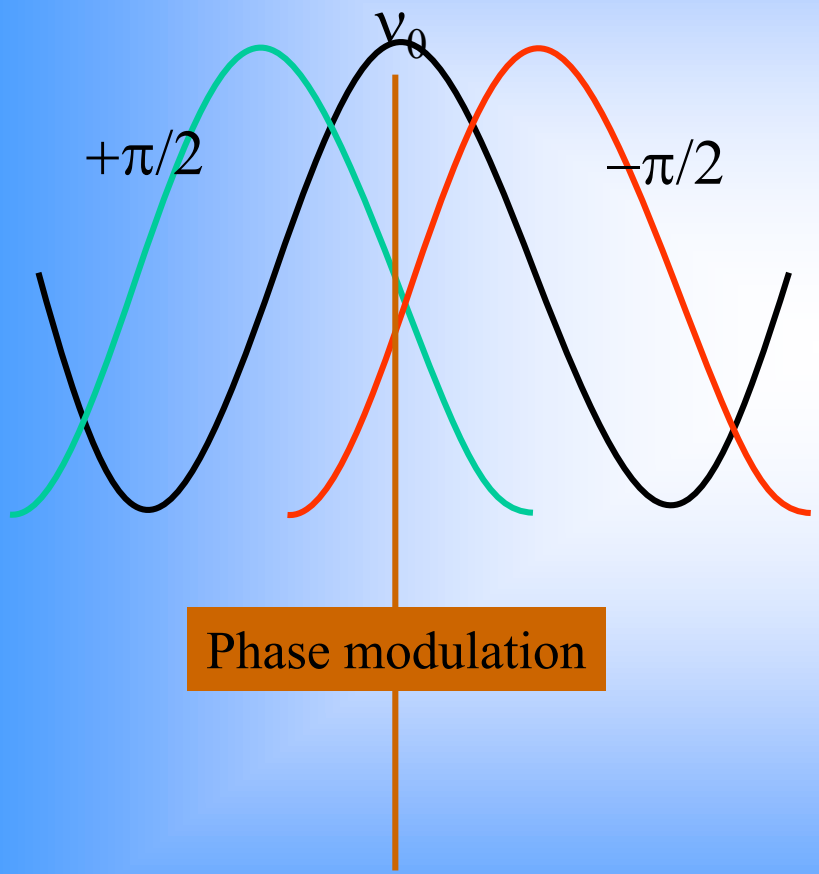
Continuous phase measurement



NRC · CNRC

Phase modulation:

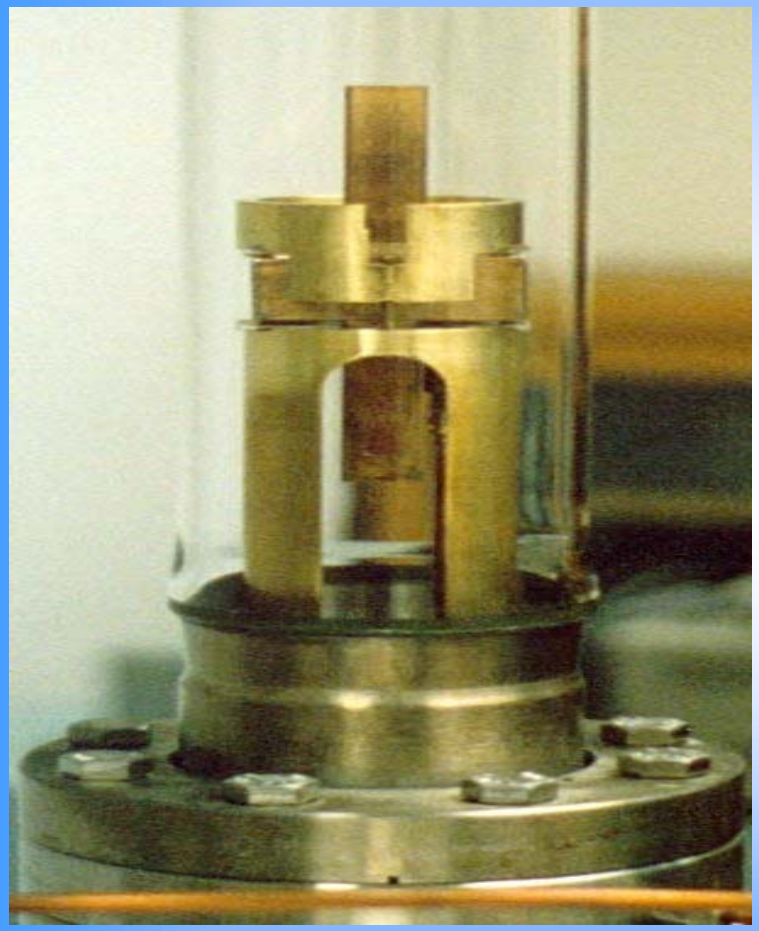
phase measurement of the local oscillator

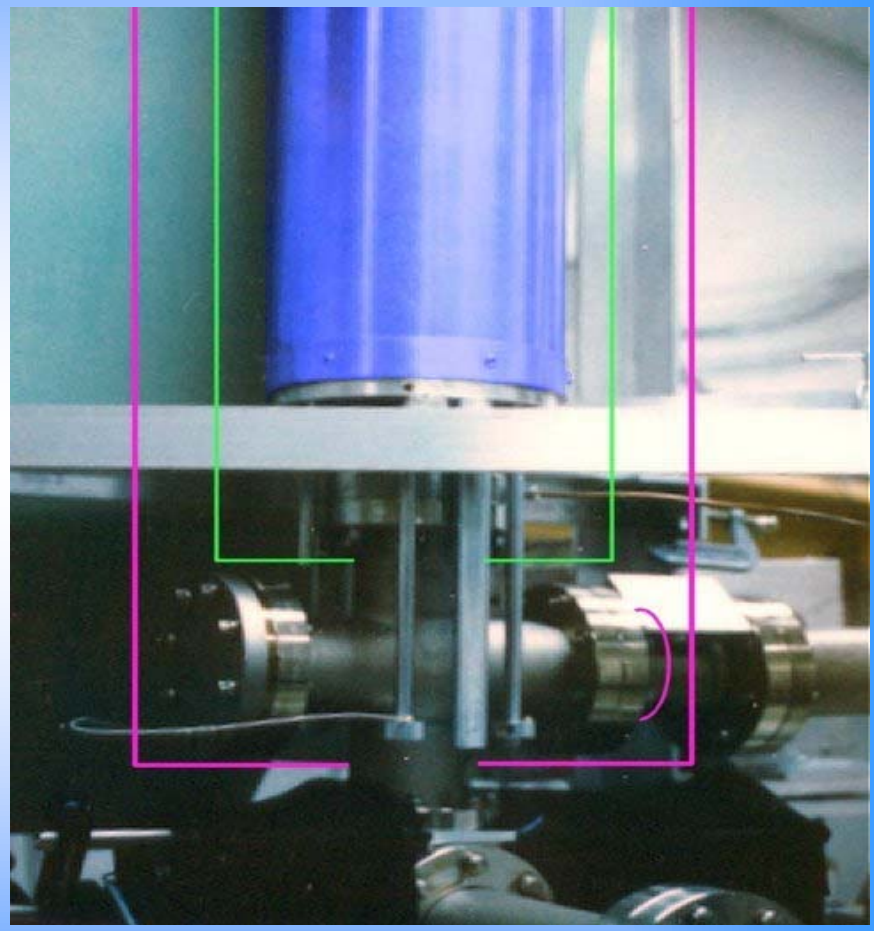


Error signal is tracking the phase of the local oscillator wrt. the atomic ensemble

Ref: R.J. Douglas and J.-S. Boulanger, Proceedings of the 1992 IEEE Frequency Control Symposium}, pp. 6-26 (1992).

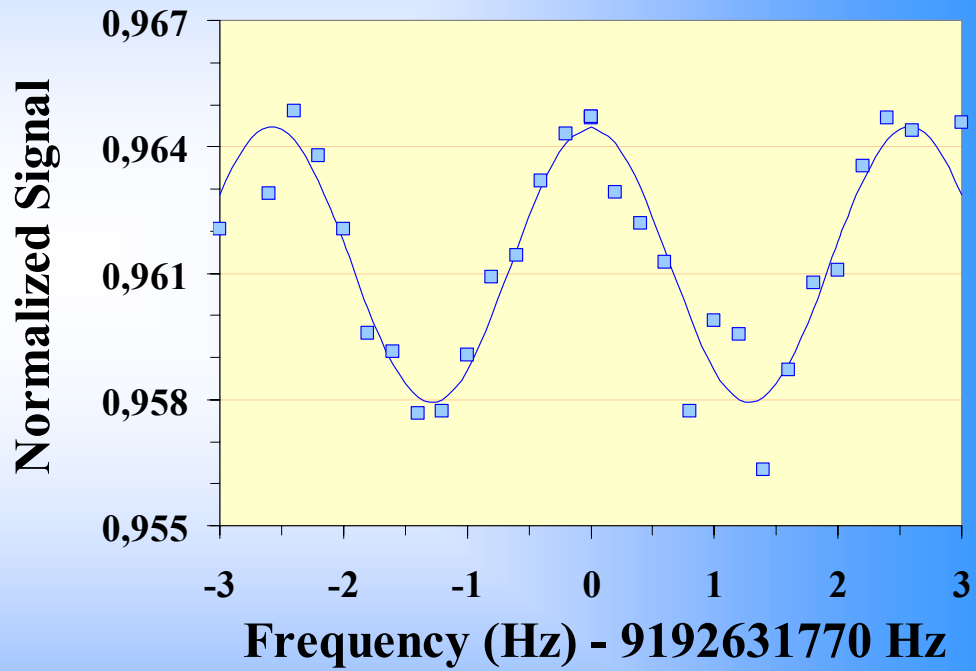
NRC-F1





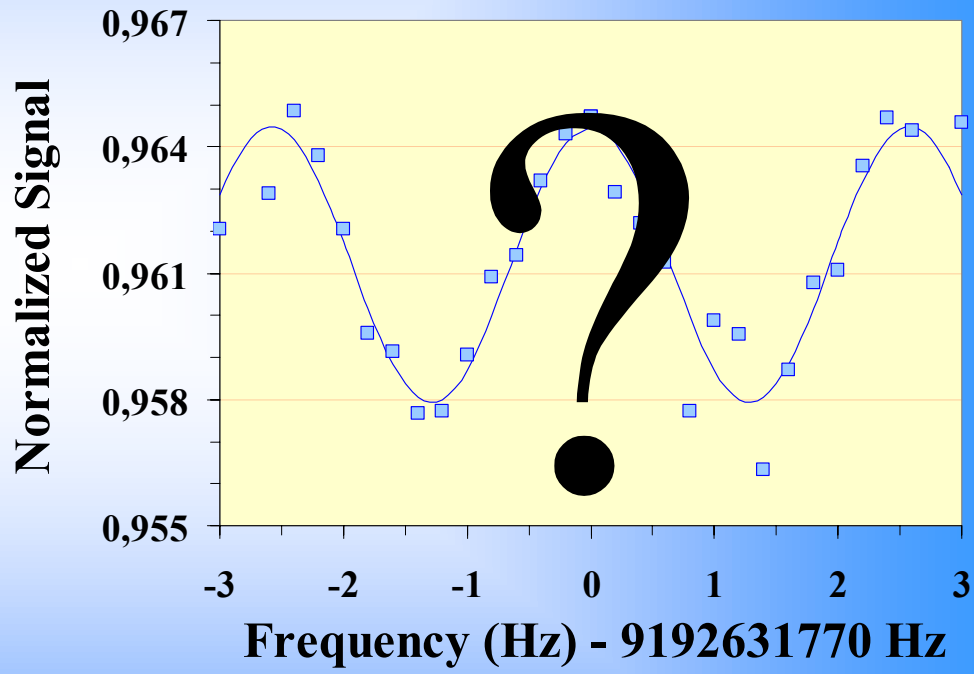
End of 99

- Fountain Heigth:
  19 cm
- Atomic Temperature:
  40 μK
- Trapping/launching:
  10^7 atoms
- $\Delta\nu = 1.3$ Hz

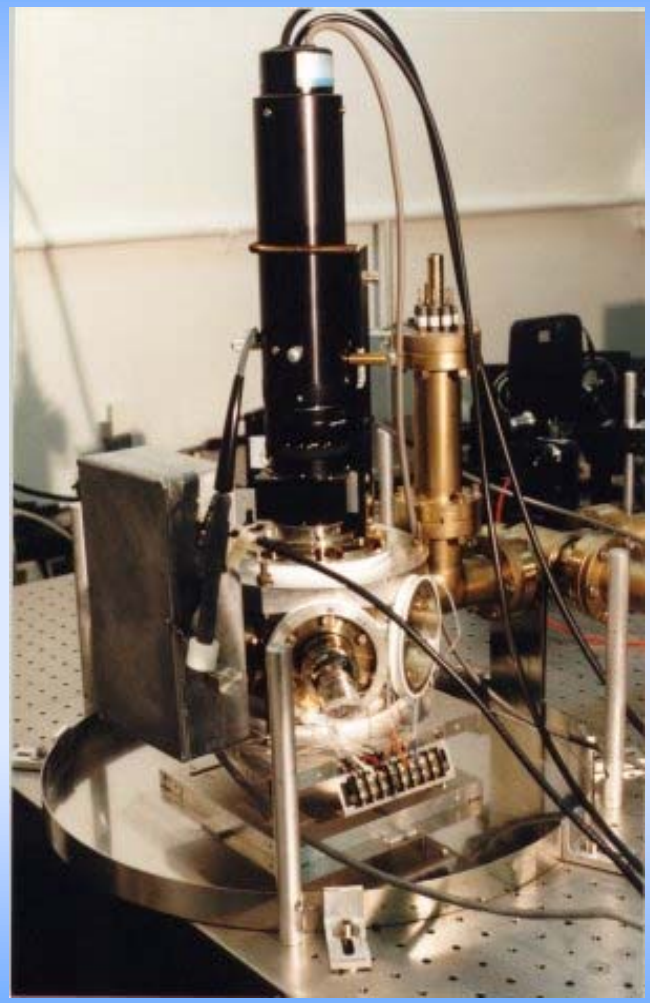


Now

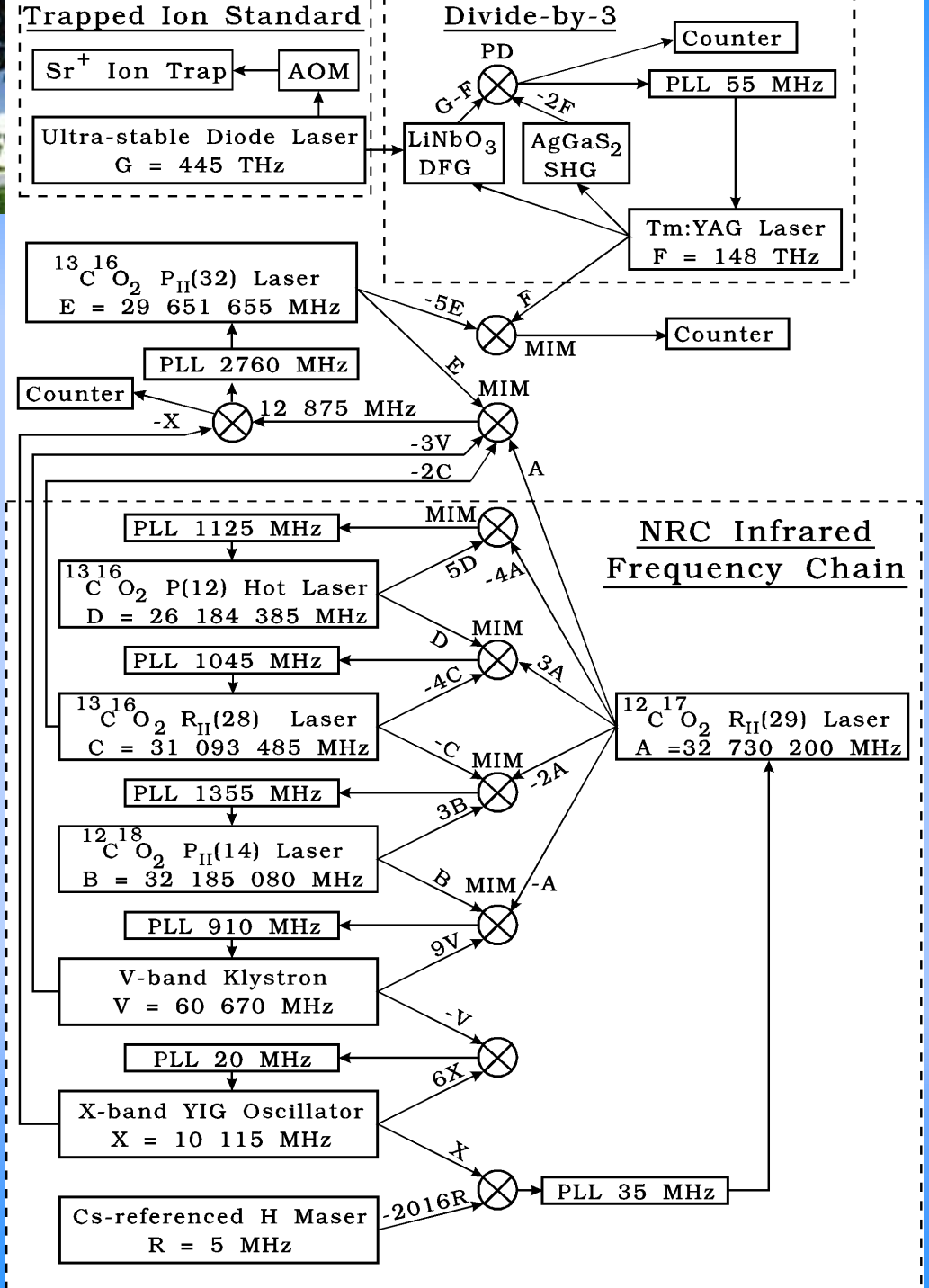
- Fountain Heigth:
  >19 cm
- Atomic Temperature:
  1.8 μK
- Trapping/launching:
  10^9 atoms
- $\Delta\nu <= 1.3$ Hz



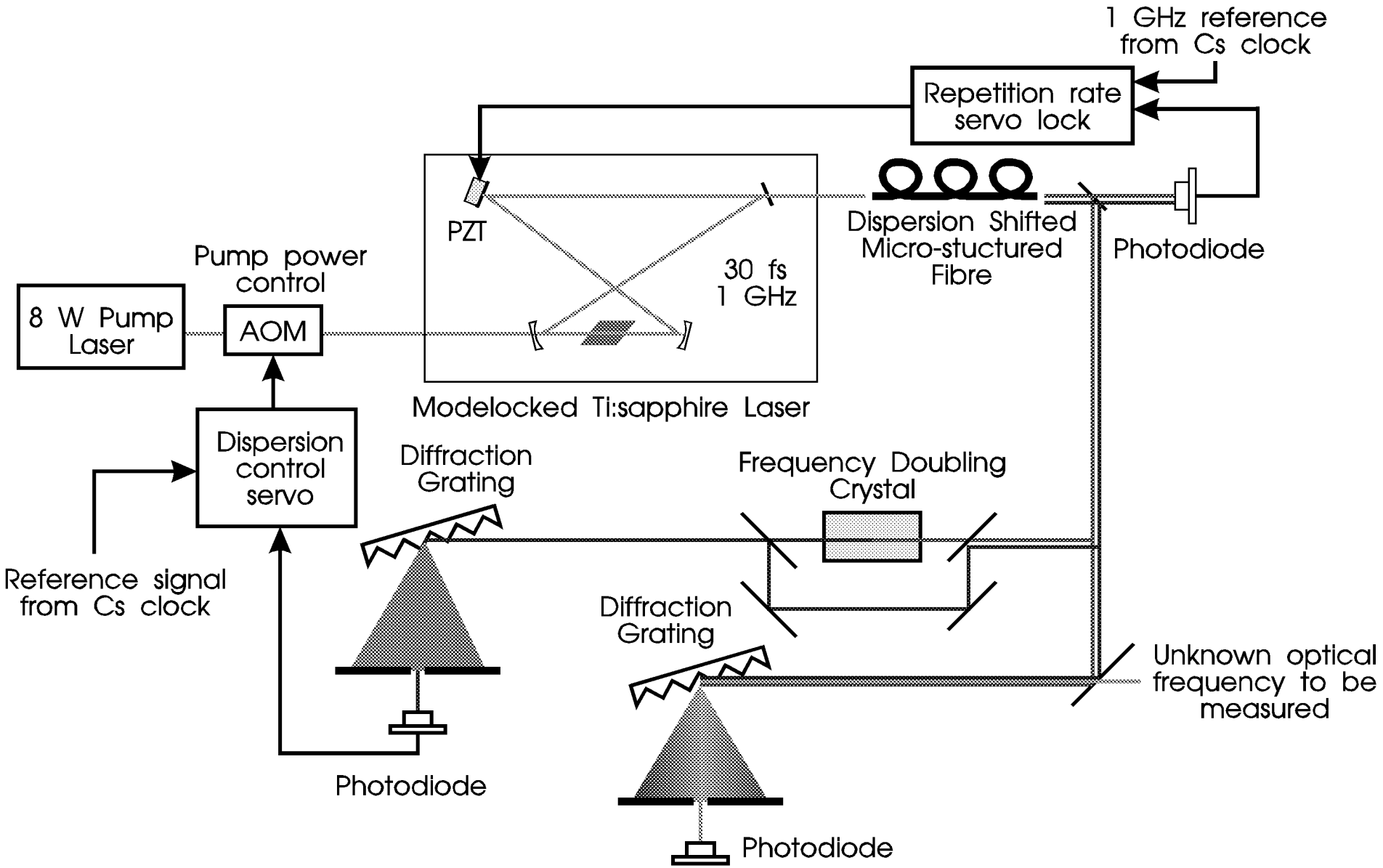
Sr+ single ion trap



NRC's HeNe lasers


Trapped Ion Standard
Sr+ Ion Trap
AOM
Ultra-stable Diode Laser
G = 445 THz
Divide-by-3
PD
Counter
PLL 55 MHz
G-F
-2F
LiNbO3
DFG
AgGaS2
SHG
Tm:YAG Laser
F = 148 THz
13C16O2 PII(32) Laser
E = 29 651 655 MHz
-5E
F
MIM
Counter
PLL 2760 MHz
Counter
-X
12 875 MHz
E
MIM
-3V
-2C
A
NRC Infrared
Frequency Chain
MIM
PLL 1125 MHz
13C16O2 P(12) Hot Laser
D = 26 184 385 MHz
5D
-4A
MIM
D
PLL 1045 MHz
3A
-4C
13C16O2 RII(28) Laser
C = 31 093 485 MHz
12C17O2 RII(29) Laser
A =32 730 200 MHz
-C
MIM
-2A
PLL 1355 MHz
3B
12C18O2 PII(14) Laser
B = 32 185 080 MHz
B
MIM
-A
PLL 910 MHz
9V
V-band Klystron
V = 60 670 MHz
-V
PLL 20 MHz
6X
X-band YIG Oscillator
X = 10 115 MHz
X
PLL 35 MHz
-2016R
Cs-referenced H Maser
R = 5 MHz

Planned femtosecond comb for measuring optical frequencies



NRC-CNRC

COMBEXP.CDR

Time distribution

- Talking clock: still >1.3×10^6 per year
- Computer clock: still hundreds of clients
- Web clock: >2500 hits per day
- NTP: >3×10^6 per day (50% increase per year)
- CHU: short-wave
  - used by some small firms to calibrate their oscillators
  - used by navigators as a check on their GPS receivers
  - used by amateur radio operators

GPS, WAAS, TWTT

- GPS using BIPM tracking schedule
  - last three days available on our web site
- Active Control Point in the CACS
- TWSTT with USNO and NIST
- Tests with WAAS