

# NRC F&T Group

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SIM TCTF Meeting May 26, 2021

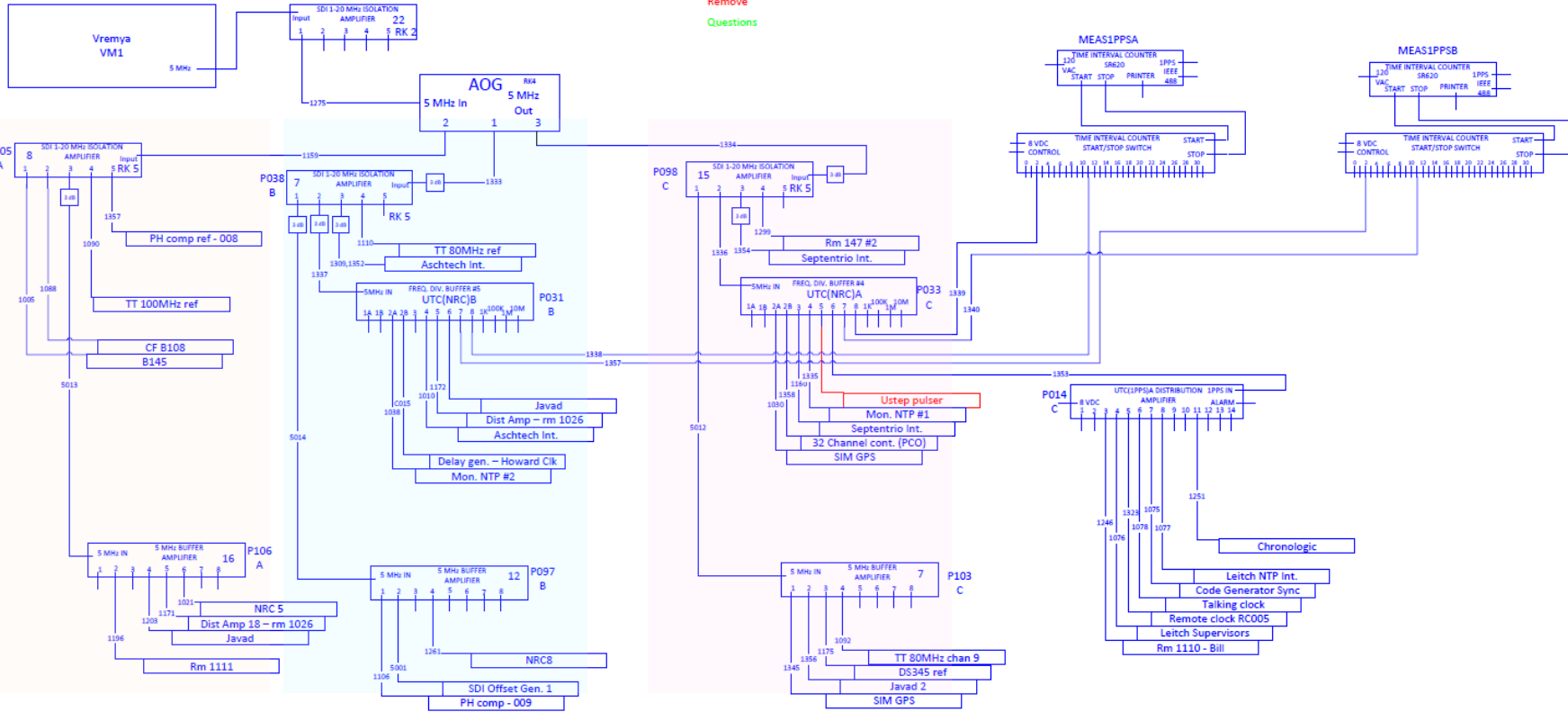


# F&T Project Updates

- UTC(NRC) – replacement of clock from Cs to HM
- FCs2 – Primary SI second standard reporting to BIPM
- POC – Portable Sr Ion Optical Clock
- Frequency combs
- TimeLink – remote dissemination and calibration at *ns* level

# UTC(NRC) – Cs replaced with HM

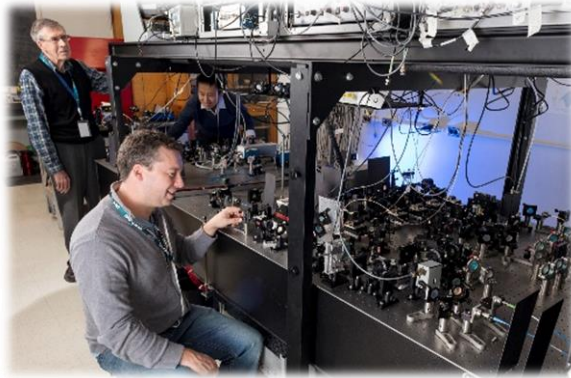
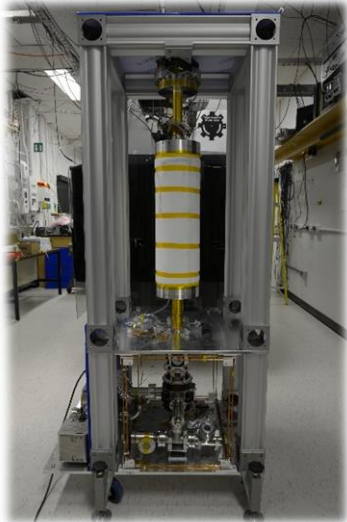
UTC(NRC) Source change ver. 7  
Dec 3, 2020



# UTC(NRC) performance



# NRC FCs2 – Caesium Fountain atomic clock



uncertainty:  $u_B = 2.3 \times 10^{-16}$

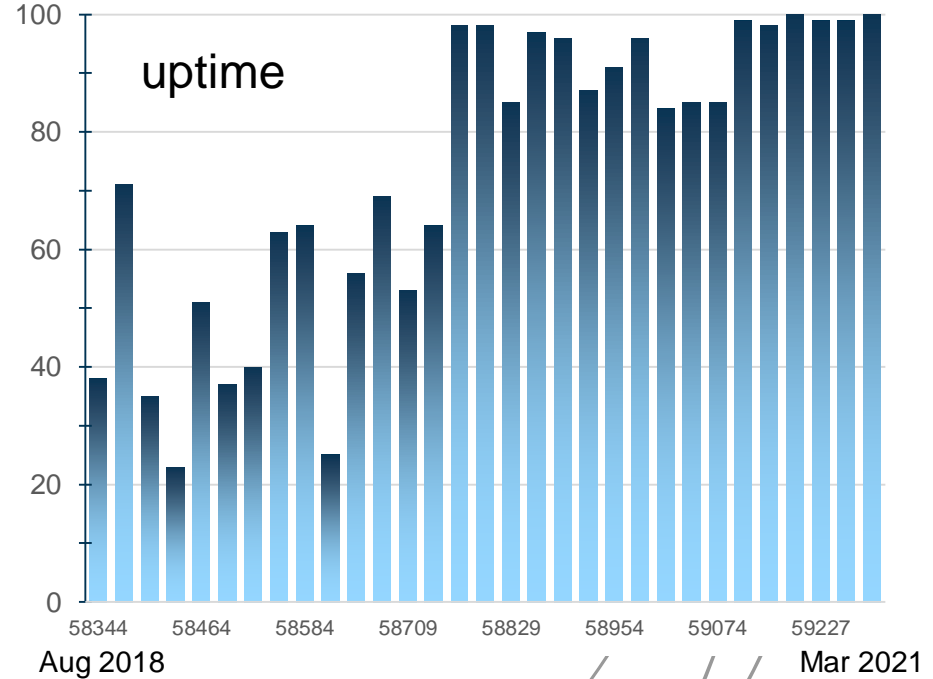
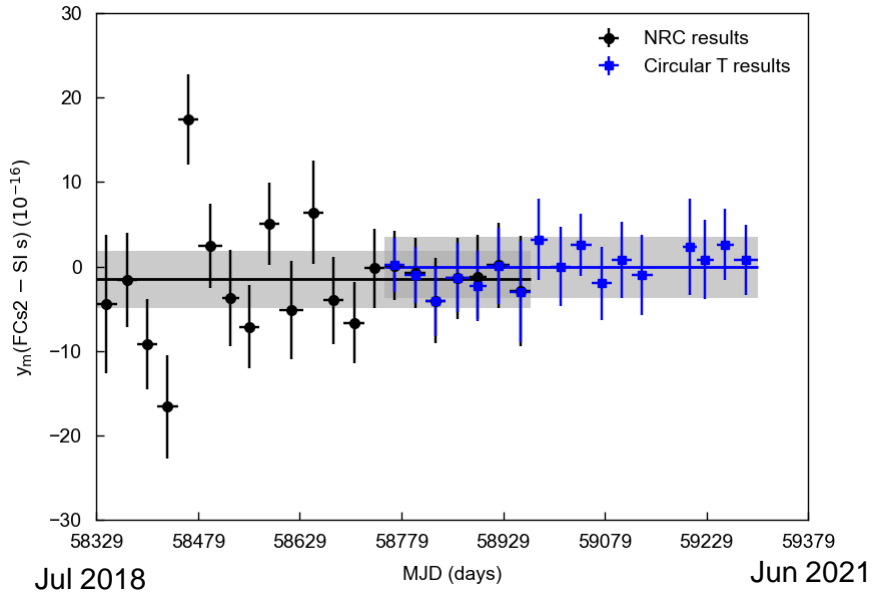
stability:  $\sigma_y = 1.7 \times 10^{-13} \tau^{-\frac{1}{2}}$

**Table 1.** Uncertainty budget of NRC-FCs2 listing the systematic effects, as well as the associated frequency biases and uncertainties, given in parts in  $10^{16}$ . Effects with frequency biases and associated uncertainties  $< 10^{-17}$  are neglected.

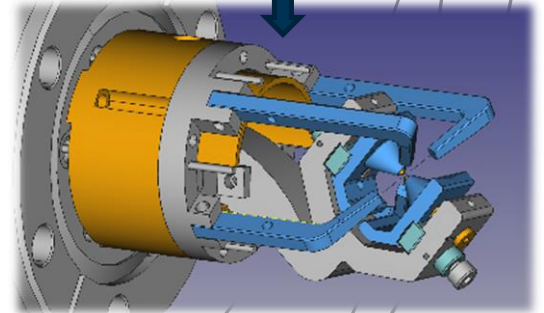
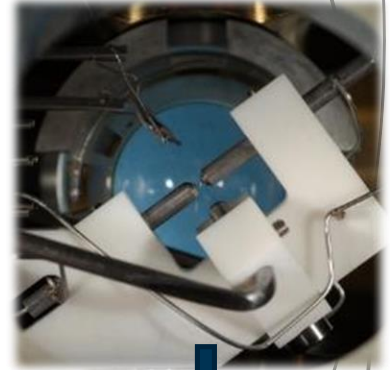
Effect	Bias	Uncertainty
Zeeman Effect	724.6	0.2
Blackbody radiation	-162.3	0.7
Gravitational redshift	104.52	0.03
Cold collisions <sup>a</sup>	10	1
Microwave leakage	0.1	1.0
Synchronous phase transients	-	0.8
DCP m=0	0.07	0.36
DCP m=1	-	1.3
DCP m=2	-	0.2
Microwave Lensing	0.6	0.2
Total	677.6	2.3

<sup>a</sup>A typical value for normal operation.

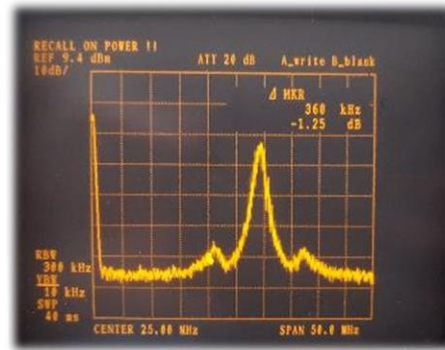
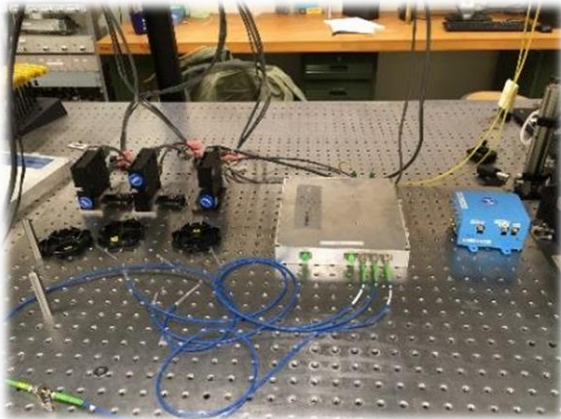
# NRC FCs2 performance



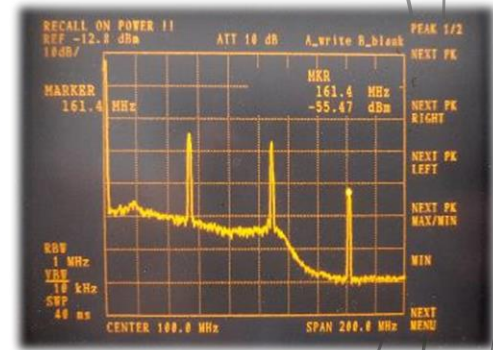
# Sr<sup>+</sup> Portable Optical Clock



# Frequency combs



$f_{\text{CEO}}$  beat



beat with 1550 nm laser



# Next Steps

- **Develop automated steering of UTC(NRC) with FCs2**
- **Complete the development of Sr<sup>+</sup> POC**
- **Measure Sr<sup>+</sup> POC against FCs2 with the new frequency combs**
- **Further upgrades to system automation and monitoring**

# Automation and Monitoring

**ZABBIX** Monitoring Inventory Reports Configuration Administration

Host groups Templates Hosts Maintenance Actions Event correlation Discovery Services

### Triggers

All templates / FCs Applications / Items / Triggers / Graphs / Screens / Discovery rules Web scenarios

Host groups: type here to search  Select

Hosts:  Select

Name:

Severity:  Not classified  Information  Warning  Average  High  Disaster

State:  All  Normal  Unknown

Status:  All  Enabled  Disabled

Value:   OK  Problem

Tags:   Contains  Equals  value  Remove

Inherited:  Yes  No

Discovered:  Yes  No

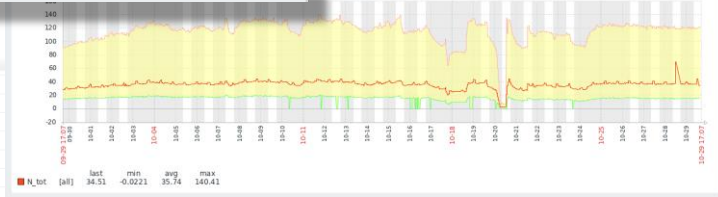
With dependencies:  Yes  No

Severity	Name	Operational data	Expression	Status	Tags
Warning	low total alarm number		Problem: {FCs:formon.data.N_tot,max[10m]}>5 Recovery: {FCs:formon.data.N_tot,max[30m]}>5	Enabled	
Average	no_data_trigger		{FCs:formon.heartbeat.available[10m]}=1	Enabled	

**ZABBIX** Latest data [refresh...]

FCs2

FCs data (13 items)	last	min	avg	max	Graph
client heartbeat					
F3					
F3P					
F3T					
F4					
F4P					
F4T					
MOT	2020-10-29 17:05:16	2.2296	-0.6304		Graph
MW	2020-10-29 17:05:16	-10.5784			Graph
MW_ADJ	2020-10-29 17:05:16	-0.52311 Hz	+0.0014 Hz		Graph
MW_PWR	2020-10-29 17:05:16	0.0019 Hz	+0.0014 Hz		Graph
N_tot	2020-10-29 17:05:16	-0			Graph
N_tot	2020-10-29 17:05:16	21.7319	-0.1422		Graph
ROW_ID	2020-10-29 17:05:16	770	+10		Graph



Discovery Services

Group: FCs clocks Host: FCs2 Graph: N\_tot View as: Graph

Zoom out: Last 30 days

Time Range	Value
Last 2 days	Yesterday
Last 7 days	Day before yesterday
Last 30 days	This day last week
Last 3 months	Previous week
Last 6 months	Previous month
Last 1 year	Previous year
Last 2 years	This year
	This year so far
	Last 15 minutes
	Today so far
	This week
	Last 30 minutes
	This week so far
	Last 1 hour
	Last 3 hours
	This month so far
	Last 6 hours
	Last 12 hours
	Last 1 day

F&T on-site - TIC and PCO TimeLink RC

time5.nrc.ca/ftsaccess/AutoT/Reports/Hourly/FCs2.html

### FCs2 STATUS

File Name: 20201028\_151748.csv  
 File Processed: 2020-10-29 10:04:39  
 File Updated: 2020-10-29 10:04:38  
 High Config Mean [μHz] = 340.51  
 Low Config Mean [μHz] = 477.21  
 f\_EXTP Mean [μHz] = 508.34

# NRC F&T Team



# THANK YOU

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