

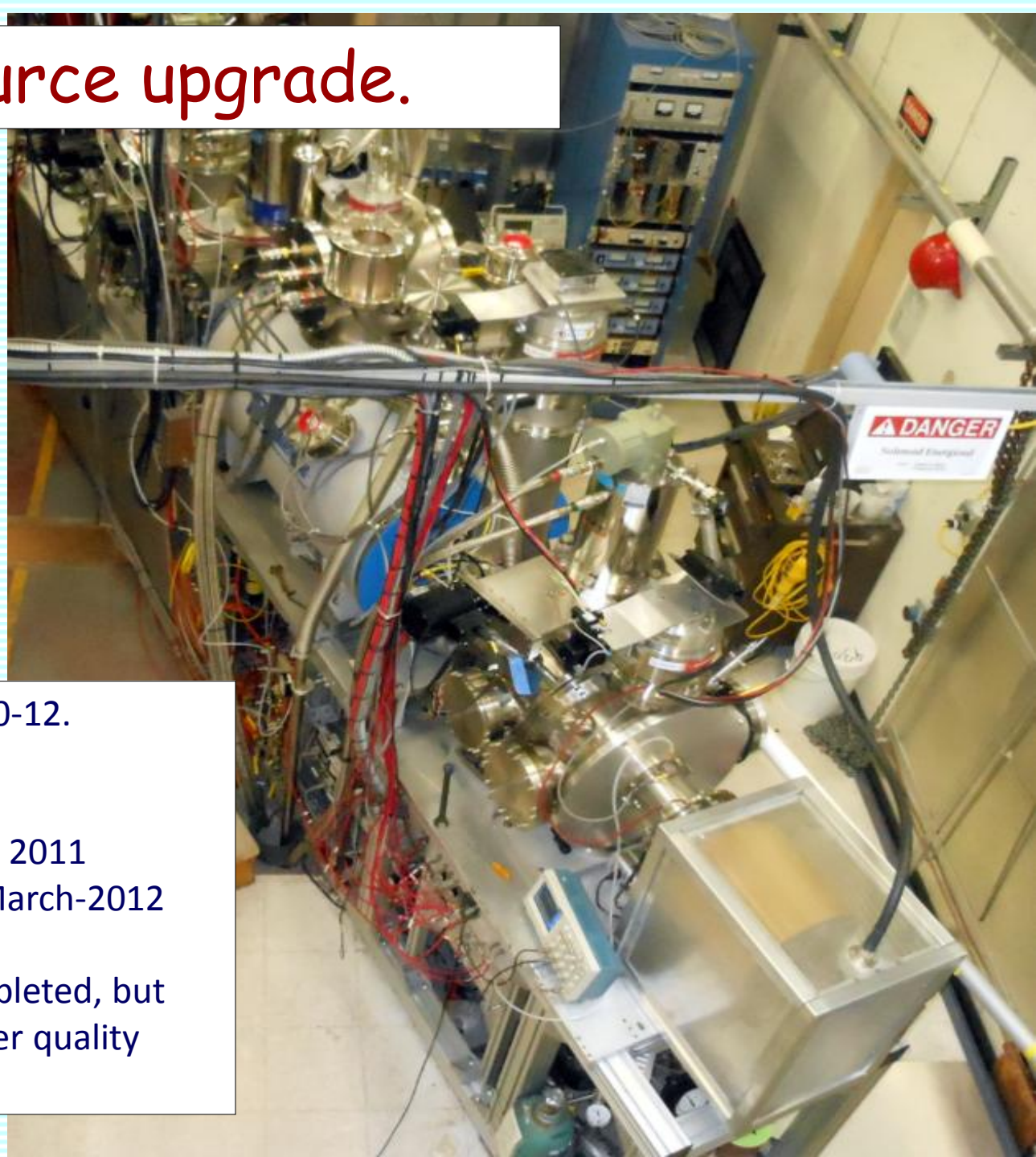
Polarized source upgrade.

Time meeting, June 4

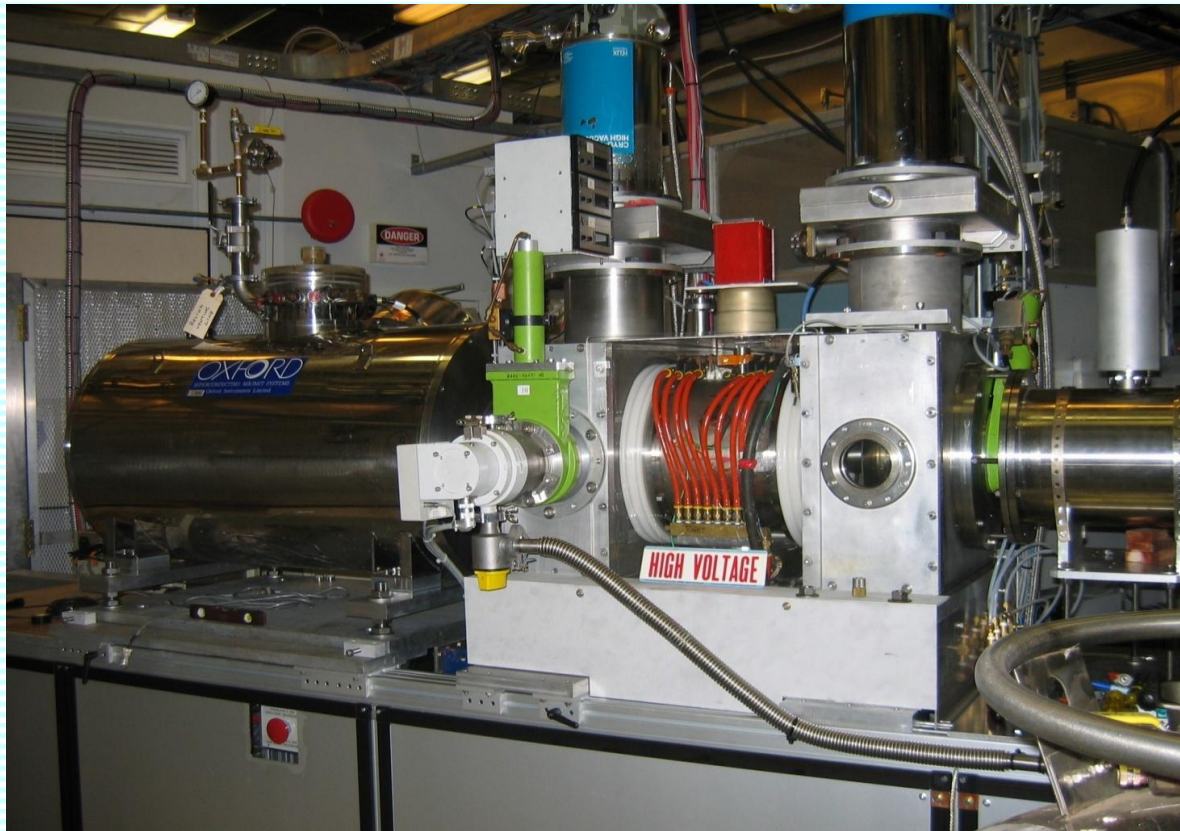
Source upgrade project -2010-12.

Main component delivery:
Atomic Beam Source- August 2011
Superconducting solenoid- March-2012

The development is not completed, but
the new source delivers better quality
beam in this Run-13.



Operational Polarized H⁻ Source at RHIC.



RHIC OPPIS produces reliably 0.5-1.0mA polarized H⁻ ion current. Polarization at 200 MeV: P = 80%.

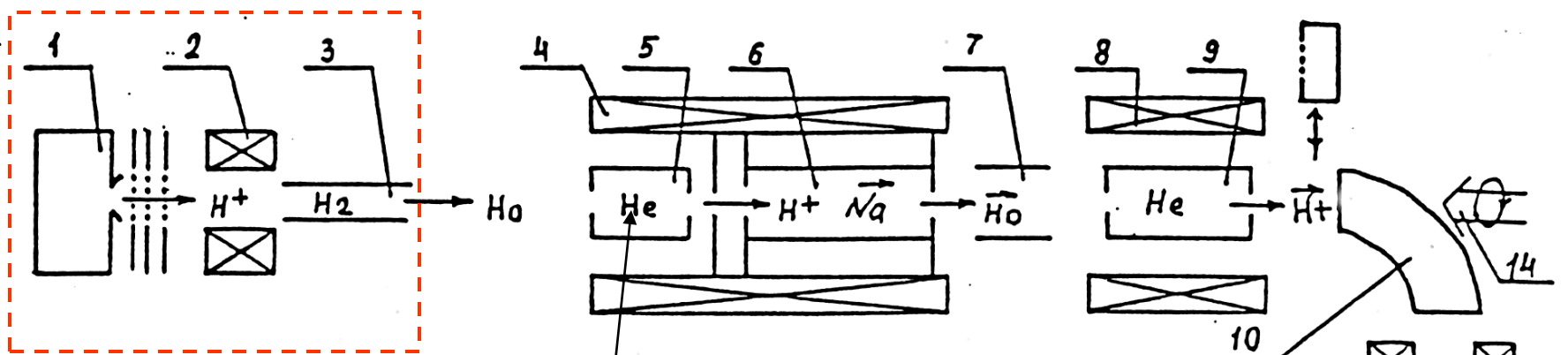
Beam intensity (ion/pulse) routine operation:

Source	- 10^{12} H ⁻ /pulse
Linac	- $5 \cdot 10^{11}$
AGS	- $1.5-2.0 \cdot 10^{11}$
RHIC	- $1.5 \cdot 10^{11}$ (protons/bunch).

A 29.2 GHz ECR-type source is used for primary proton beam generation. The source was originally developed for dc operation.

A ten-fold intensity increase was demonstrated in a pulsed operation by using a very high-brightness Fast Atomic Beam Source instead of the ECR proton source .

Pulsed OPPIS with the atomic hydrogen injector at INR, Moscow, 1982-1990.

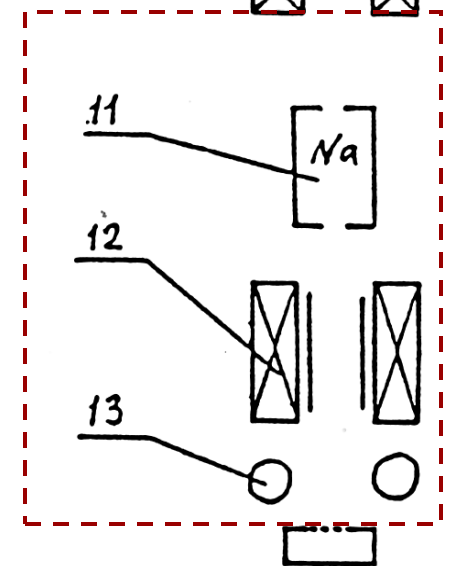


Atomic H injector

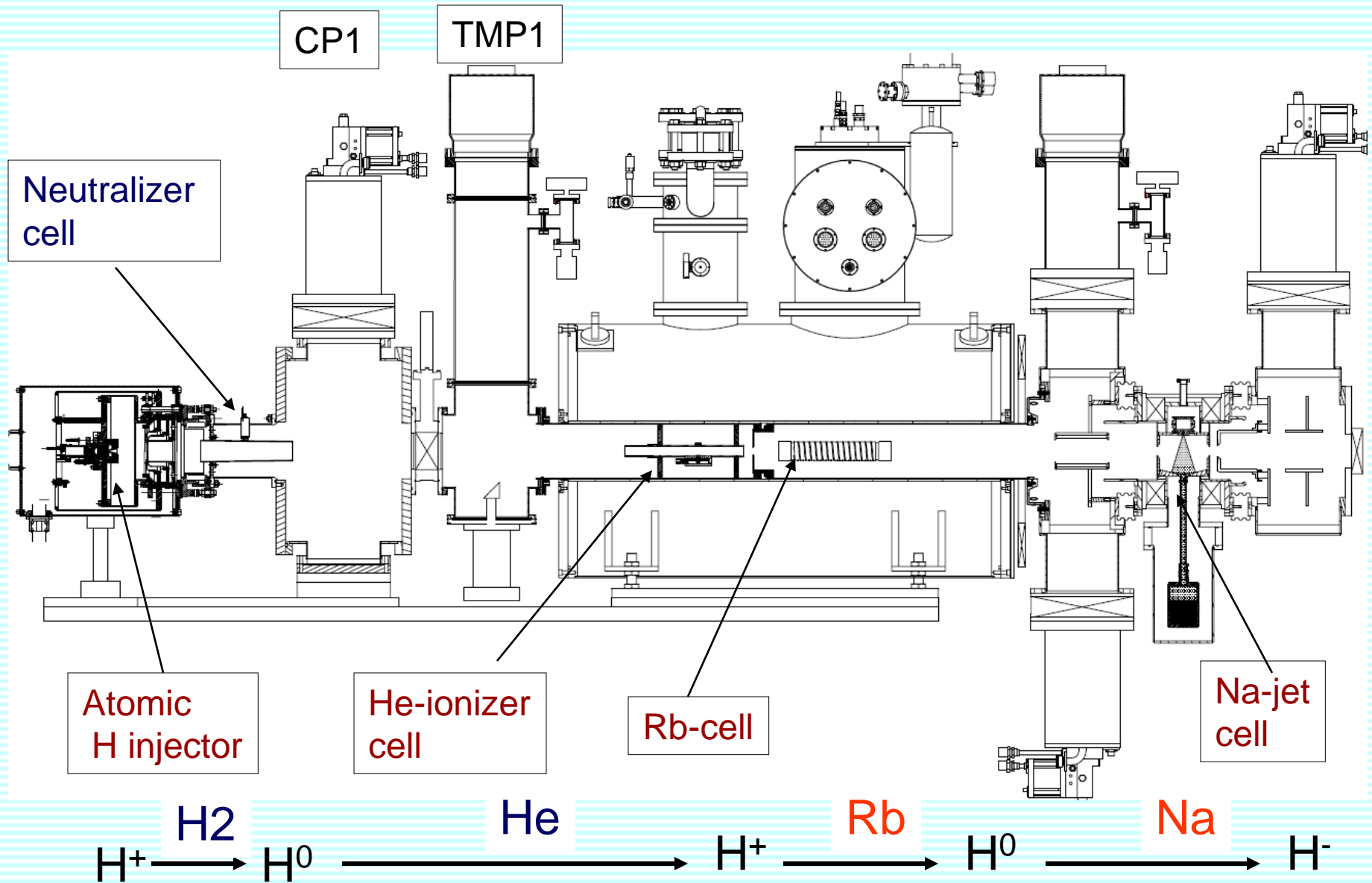
Helium ionizer cell
~80% ionization
efficiency.

H⁺ current 0.4mA, P=65%

Lamb-shift
polarimeter



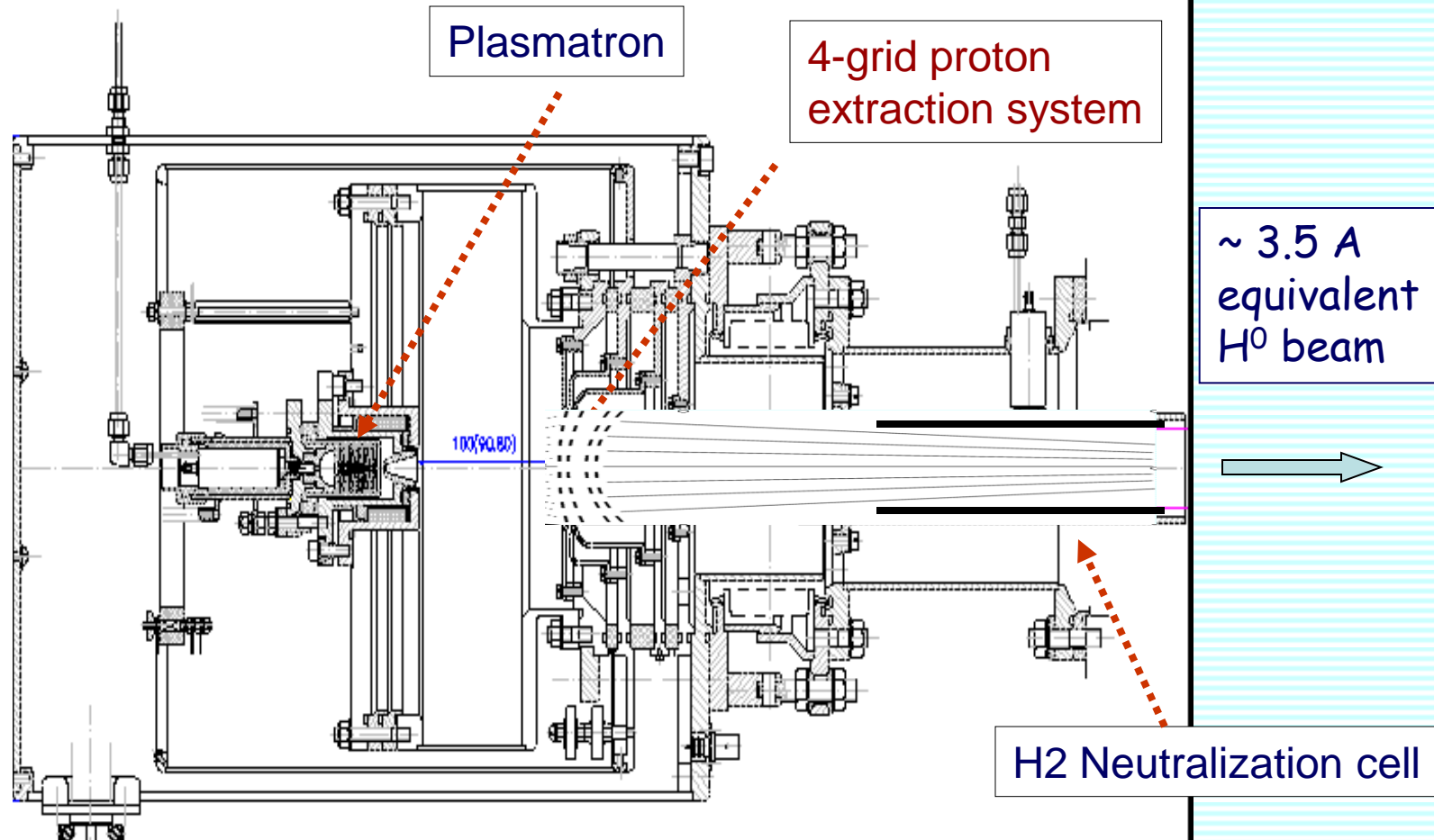
OPPIS with atomic H injector layout.



A result of this "upgrade" is practically a new source.

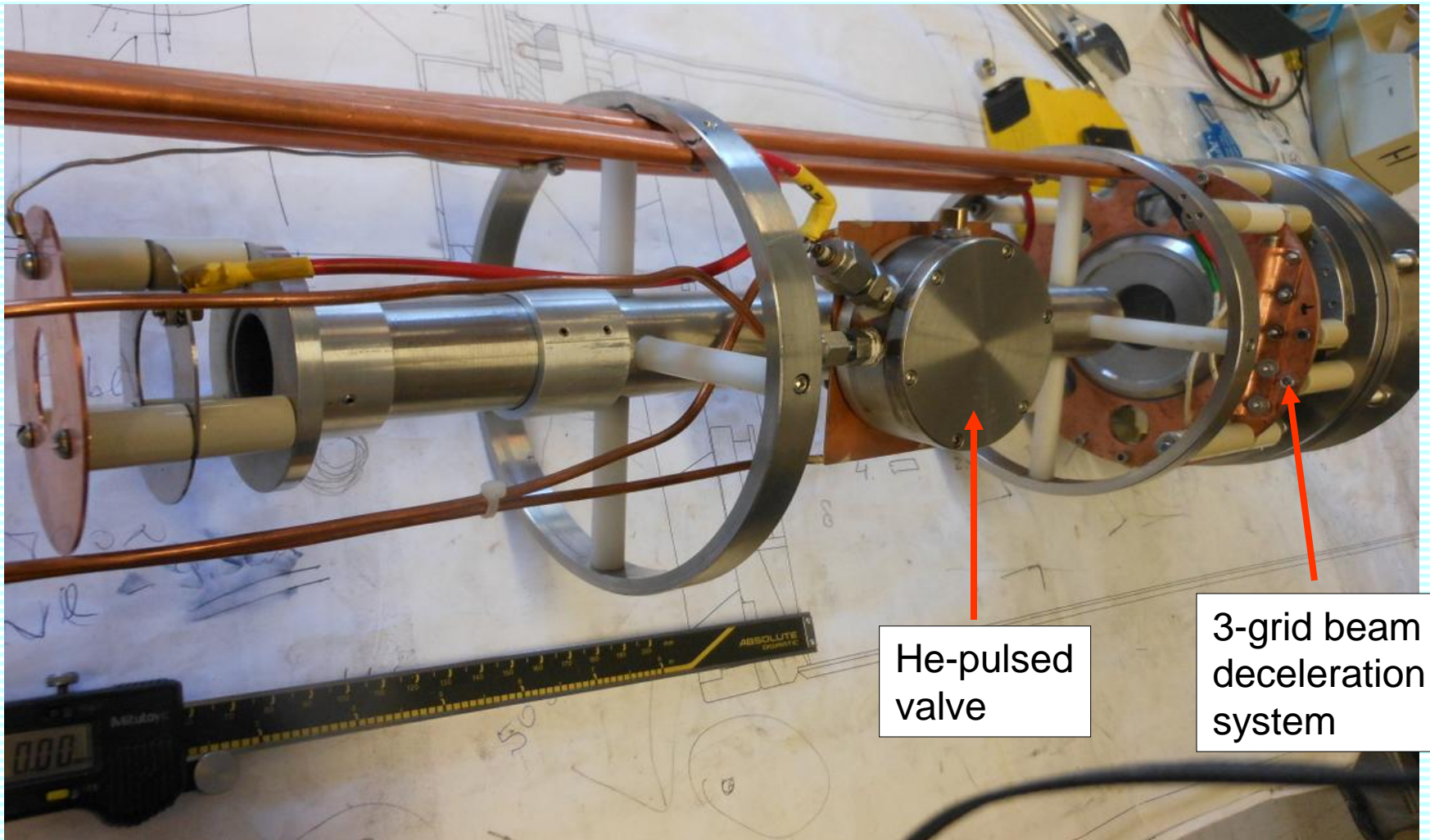
- A new superconducting solenoid.
- A new atomic hydrogen injector.
- A new vacuum system.
- A new H-ionizer cell, energy separation system and pulsed PS system.
- A new control and interlock system.
- Major upgrades of laser system.
- Major modifications of the Low Energy Beam Transport system.
- Major upgrades in 200 MeV polarimeter.
- A new test-bench for atomic injector studies.
- Many other upgrades...

"Fast Atomic Beam Source", BINP 2011



FABS produces 200-300 mA equivalent H⁰ beam intensity
Within the Na-jet ionizer acceptance.

He-ionizer cell and three-grid energy separation system.

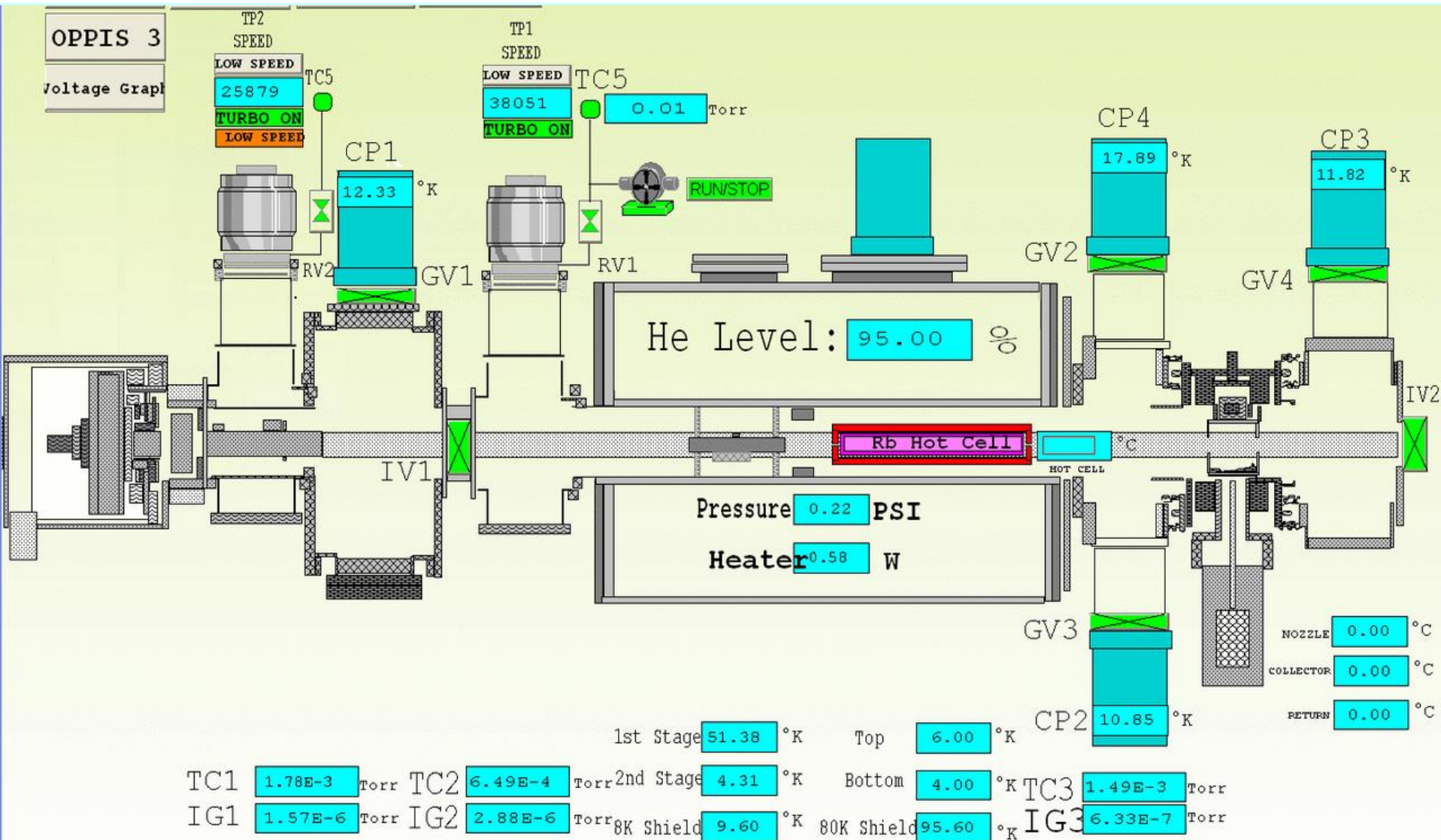


He-pulsed valve

3-grid beam deceleration system

New PLC interlock and monitoring system.

Graphics by Yuri Bezpalko



Source intensity and polarization.

- Reliable long-term operation of the source was demonstrated.
- Very high suppression of un-polarized beam component was demonstrated.
- Small beam emittance (after collimation for energy separation) and high transmission to 200 MeV.

Rb-cell, Temp., deg. C	81	86	91	96
Linac Current, μA	295	370	410	570
Booster Input $\times 10^{11}$	4.9	6.2	7.3	9.0
Pol. %, at 200 MeV	83-84	83	80.5	78

Rb-81, T9-current-295 uA (4.9×10^{11})

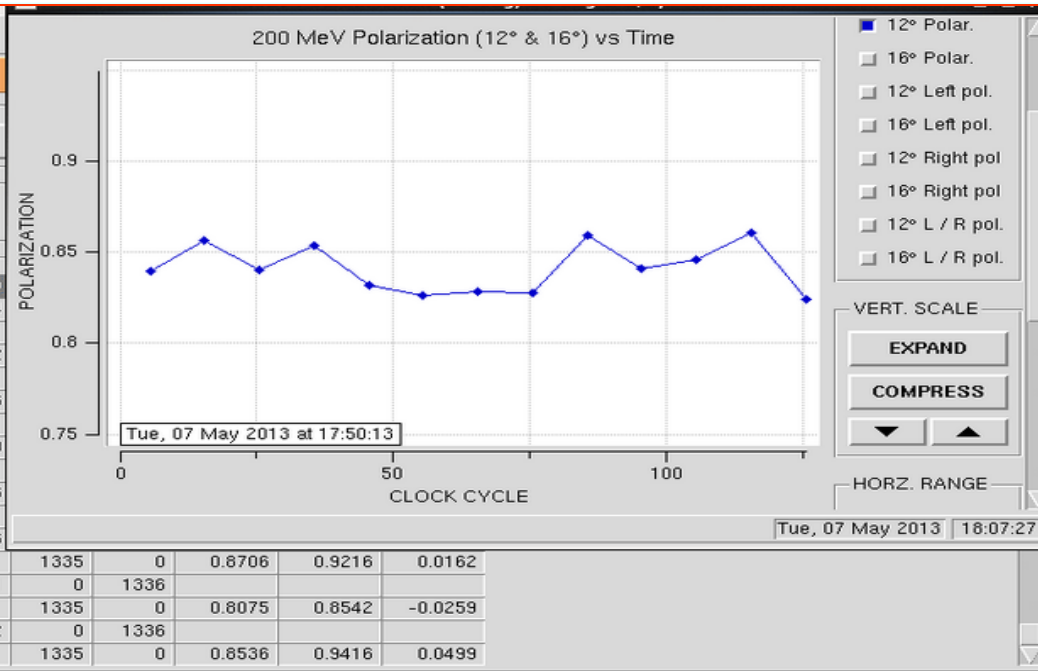
84.2 +/- 0.5%

FIXED SDEV VARIABLE SDEV

(with none, 0.27%, 4.55%, 32.7% outliers tolerated in 4, 3, 2, 1 sigma cuts)

	Points	Polarization	Left Polar.	Right Polar.
All	12	0.8424 ± 0.0053	0.8340 ± 0.0074	0.8509 ± 0.0075
4 Sigma Cut	12	0.8424 ± 0.0053	0.8340 ± 0.0074	0.8509 ± 0.0075
3 Sigma Cut	12	0.8424 ± 0.0053	0.8340 ± 0.0074	0.8509 ± 0.0075
2 Sigma Cut	11	0.8415 ± 0.0050	0.8345 ± 0.0071	0.8484 ± 0.0070
1 Sigma Cut	6	0.8322 ± 0.0056	0.8258 ± 0.0079	0.8385 ± 0.0079

	Points	Polarization	Left Polar.	Right Polar.
All	12	0.8394 ± 0.0065	0.8406 ± 0.0104	0.8381 ± 0.0078
4 Sigma Cut	12	0.8394 ± 0.0065	0.8406 ± 0.0104	0.8381 ± 0.0078
3 Sigma Cut	12	0.8394 ± 0.0065	0.8406 ± 0.0104	0.8381 ± 0.0078
2 Sigma Cut	11	0.8390 ± 0.0067	0.8405 ± 0.0109	0.8376 ± 0.0078
1 Sigma Cut	6	0.8394 ± 0.0091	0.8417 ± 0.0147	0.8370 ± 0.0106



83.9 +/- 0.9%

254		251		76		26		2		939
255	99	252		2		32				912
256		255		73		23				896
257	81	259		3						
258		259		79		28				946
259	78	265		1						
260		276		80		23		2		961
261	105	269		2		26			934	
262		273		74		29		1		922
263	86	250		1		28				974

SETUP

12° Analyzing power **0.62** 12° Min. count (LU, RD) **30** Moving average **stack**

16° Analyzing power **0.99** 12° Min. count (LD, RU) **200** Averaging interval **10**

16° Analyzing power **0.55** Energy ave. interval **10**

ANALYSIS

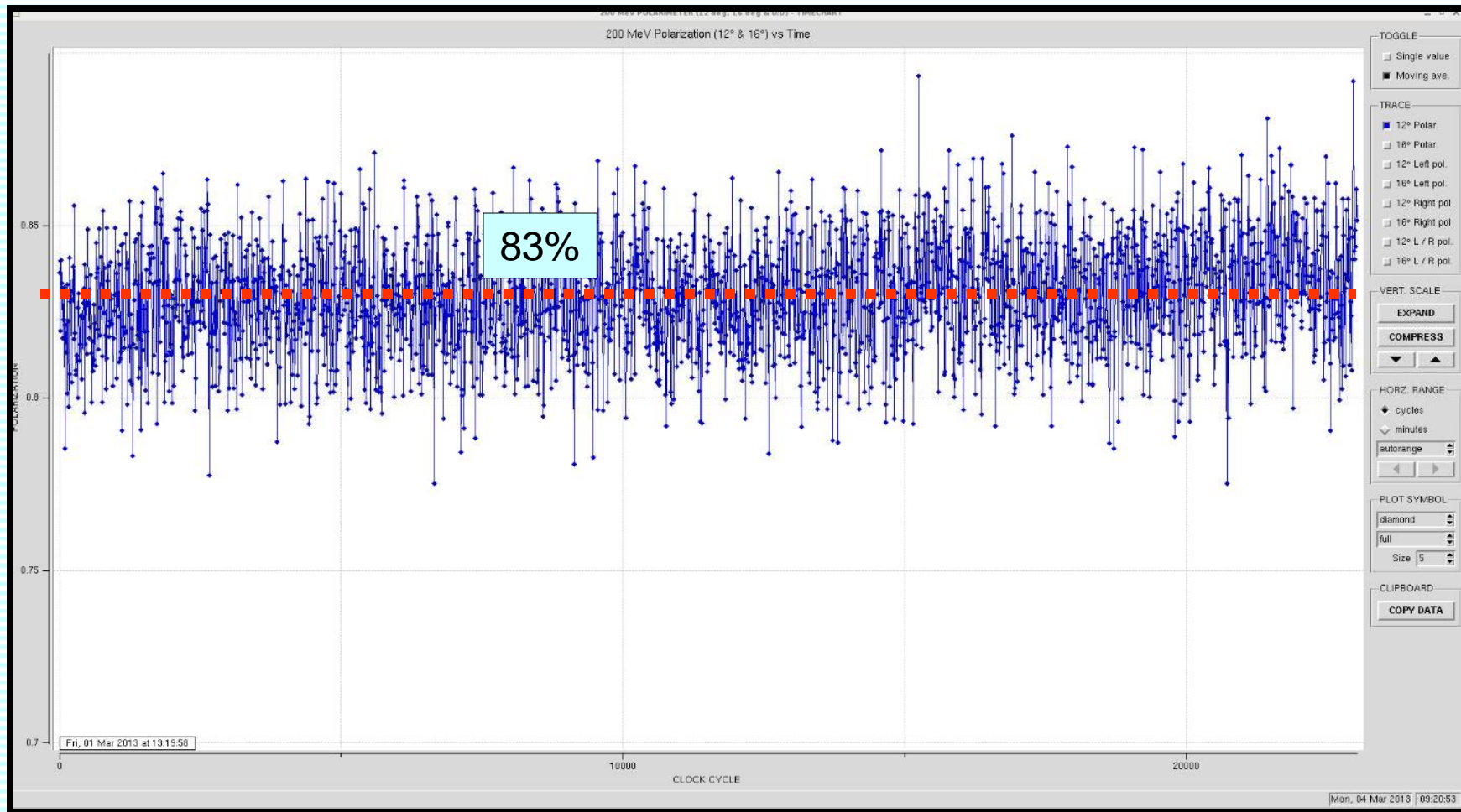
REFRESH HISTOGRAMS TIMECHARTS

ANALYZE PULSE COUNTS BEAM ENERGY

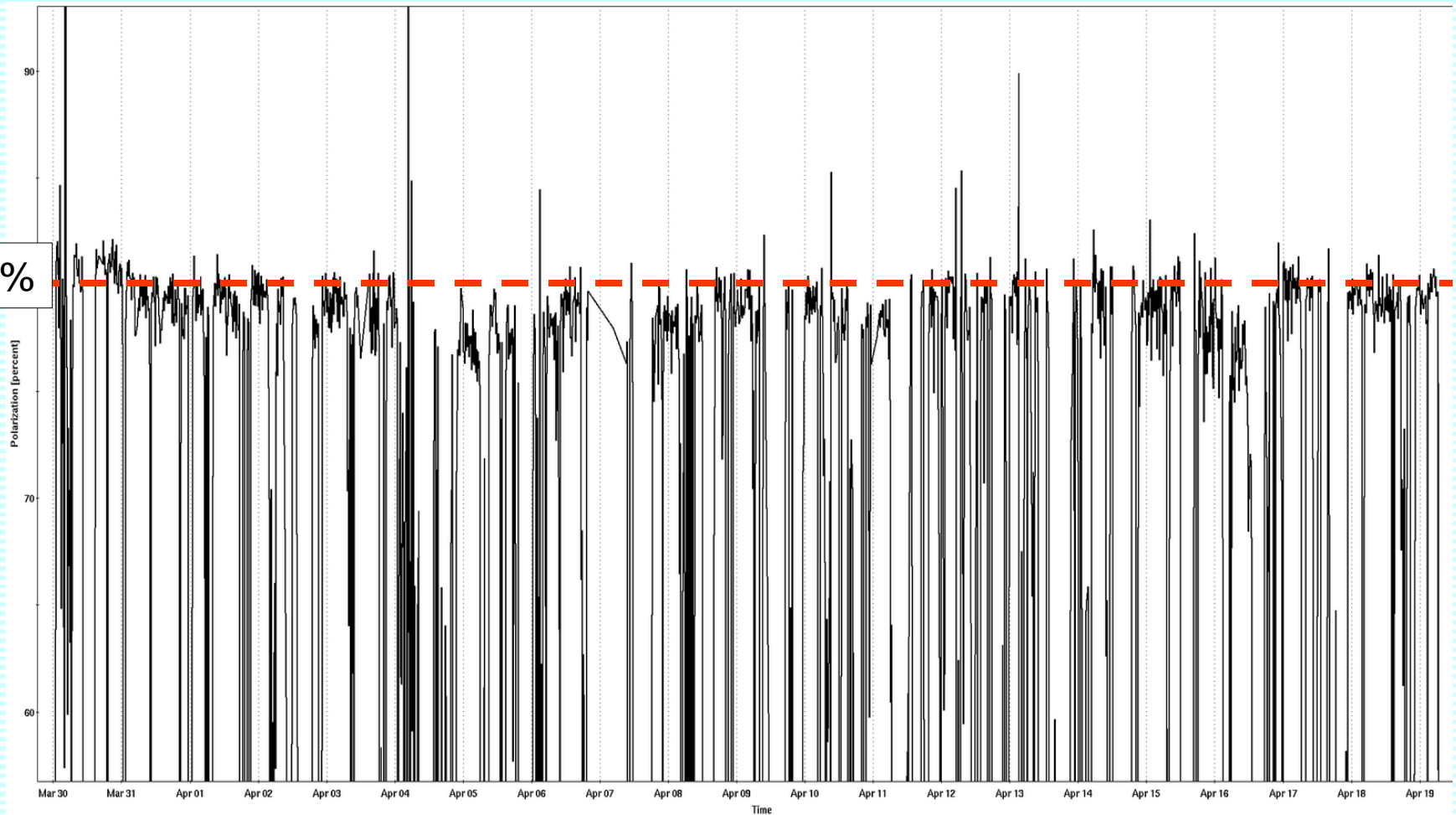
RESULTS

Comment			Averages		Moving ave.		
12° Left Arm events (U, D)	10894 - 50	33970 - 141	83.2 - 0.4	259.3 - 1.1		87.5 - 0.7	249.9 - 1.1
12° Right Arm events (U, D)	34738 - 281	10702 - 71	265.2 - 2.1	81.7 - 0.5		268.6 - 2.0	80.4 - 0.4
12° POLARIZATION (P, dP)	0.8411	0.0046	0.8424	0.0045		0.8243	0.0168
16° Left Arm events (U, D)	313 - 2	3524 - 22	2.39 - 0.02	26.90 - 0.17		1.70 - 0.00	26.80 - 0.20
16° Right Arm events (U, D)	3483 - 14	325 - 2	26.59 - 0.11	2.48 - 0.02		27.40 - 0.00	2.70 - 0.00
16° POLARIZATION (P, dP)	0.8417	0.0064				0.8616	0.0221

Polarization measurements at 200 MeV, March 1-4



200 MeV polarization in Run-2012, high intensity operation



Summary

- The new source is working. Reliable long-term operation at steady current and polarization.
- The maintenance time is significantly reduced.
- Polarization is on average about 3% higher than ECR-based source. It is expected that polarization can be further improved to over 85%.
- The source intensity is about 5-10 mA. Due to strong space-charge effects only a fraction of this current is transported and accelerated in RFQ and Linac. These losses can be reduced.