12GeV CEBAF Commissioning

Arne Freyberger

Operations Dept.
Accelerator Division

JLAB

2014-04-08/09/10

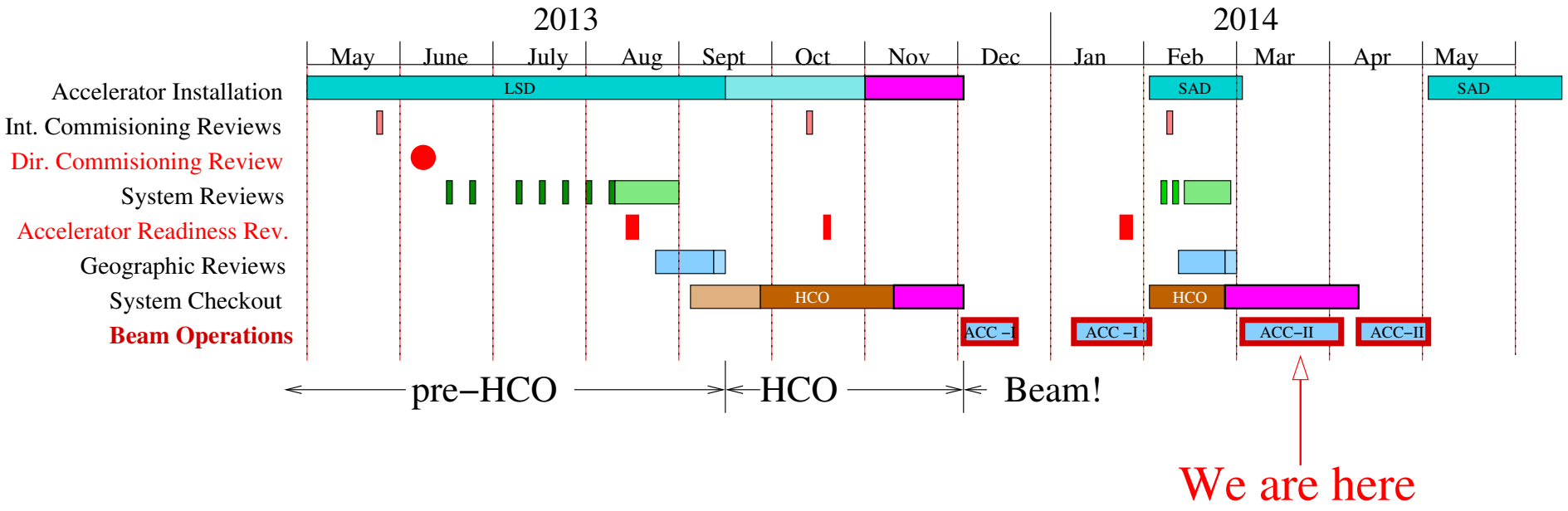
Accelerator Operations Department

Jefferson Lab
Thomas Jefferson National Accelerator Facility

Outline

1. Process
   - Integrated Process Overview
   - Accelerator Readiness Review Process
   - Internal Reviews/Process
   - Process Recap
2. Beam Commissioning Schedule and Execution
3. Summary

Integrated Process Overview



- Review process start in May-2013 with the first *Commissioning Advisory Board* review (internal) which preceded the external Dir. Commissioning Review in June-2013.
- Installation activities on-going in parallel with review process.
- Internal reviews at the system and *geographic* level.
- Hot Check Out (HCO) process validates hardware at the *element level*

ARR Highlights

2013-Jun Director's Review of the 12GeV commissioning plan.
External review of the beam commissioning plan in preparation for the upcoming ARR reviews.

2013-Aug ARR Phase IA
CEBAF beam commissioning up to 5.5 passes. Focus on process, planning and documentation.

2013-Oct ARR Phase IB
Complete Phase I review, pre-start findings defined and local team formed to verify resolution of pre-start findings. Focus on hardware and staff readiness for operations.

2013-Jan ARR Phase II
Reviewed beam commissioning (including CW beam) to Hall-A including Hall-A experimental readiness and beam commissioning to the Tagger Vault.

All *findings* from these reviews have been closed, with the exception of the pre-start sign-off on the remaining beamline sections.

ARR pre-start sign-offs
aka "The Green Team"

ARR review resulted in pre-start findings. A local team formed to verify that pre-start findings have been closed.

Composition:

Mike Epps	DOE Site-office.
Harry Fanning	ARR committee representative, Accelerator Division Safety Officer.
Steve Smith	Green team facilitator, EHS&Q Quality Assurance Continuous Improvement Manager.

Scope:

ABIL	Verify that all hardware by-passes (*jumpers*) are appropriately documented.
ATLis	Verify that applicable work planning tasks are documented and closed.
HCO	Verify that Hot Check Out has been completed up to the proposed beam destination.

Green Team Frequency

To date pre-start sign offs:

2013-Dec-10 Beam to end of the injector (inline dump).

2014-Jan-14 Beam to 1R dumplette (half-pass).

2014-Jan-24 Beam to 2R dumplette (one-pass).

2014-Mar-11 Beam to 6R dumplette (three-pass).

2014-Mar-20 Beam to Hall-A, ready to start commissioning with beam in Hall-A.

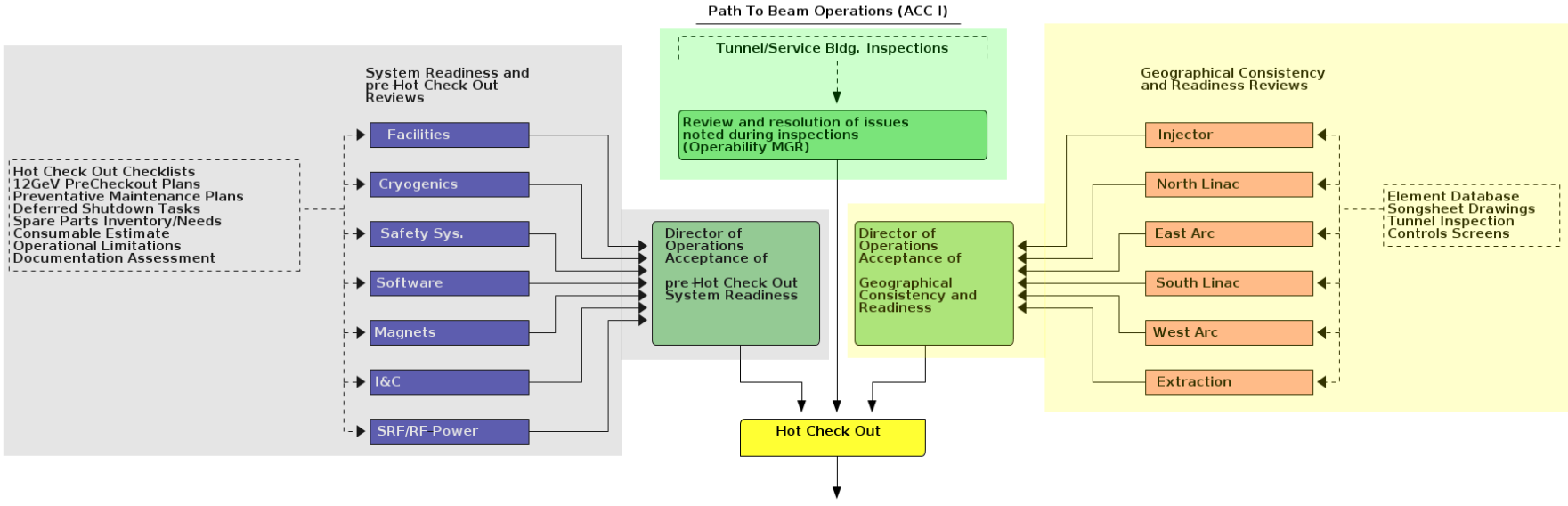
Anticipated pre-start sign offs::

2014-Apr Beam to Hall-D tagger vault (5.5pass)

2014-Sep If required, post ARR-III. Readiness to begin beam commissioning and operations in Hall-D.

2016-Jan If required, post ARR-IV. Readiness to begin beam commissioning and operations in Hall-B and Hall-C.

System Readiness: Three Layers



Inspections Frequent inspections of the tunnel and service buildings. Issues tracked.

System Reviews Each system to undergo a review before the ARR. Recommendations tracked.

Geographical Reviews Each geographical section to undergo a review before the ARR. Recommendations tracked.

Hot Check Out

System checkout and tracking at the **element** level.

Provides one-stop shopping to check the hardware status for all elements up to a specified beam termination.

Component View:

Found 5,819 Components in Beam Destination "Beam to Hall A (3 pass)" (181 Masked Components)

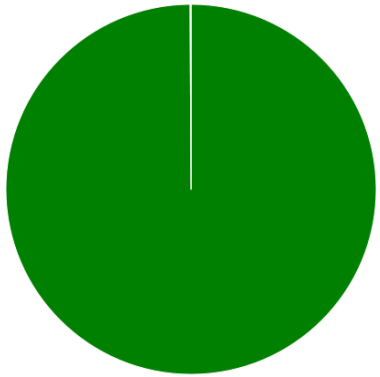
- CEBAF
  - Beam Dumps
  - Control System
  - Cryo
  - Diagnostics
  - Facilities
  - Gun/Laser
    - Gun
      - Gun HV
        - Gun 2 HV
          - Gun
          - SSG
        - Gun 3 HV
      - Gun Photocathode
    - Laser
  - Info Systems
  - Magnets
  - Operations
  - RF
  - Radiation Controls
  - Safety Systems
  - Vacuum

Status Key
- Ready
- Checked
- Not Ready
- Masked

Node Key
- Category/System
- Subsystem
- Component
- Group

Sign-off View:

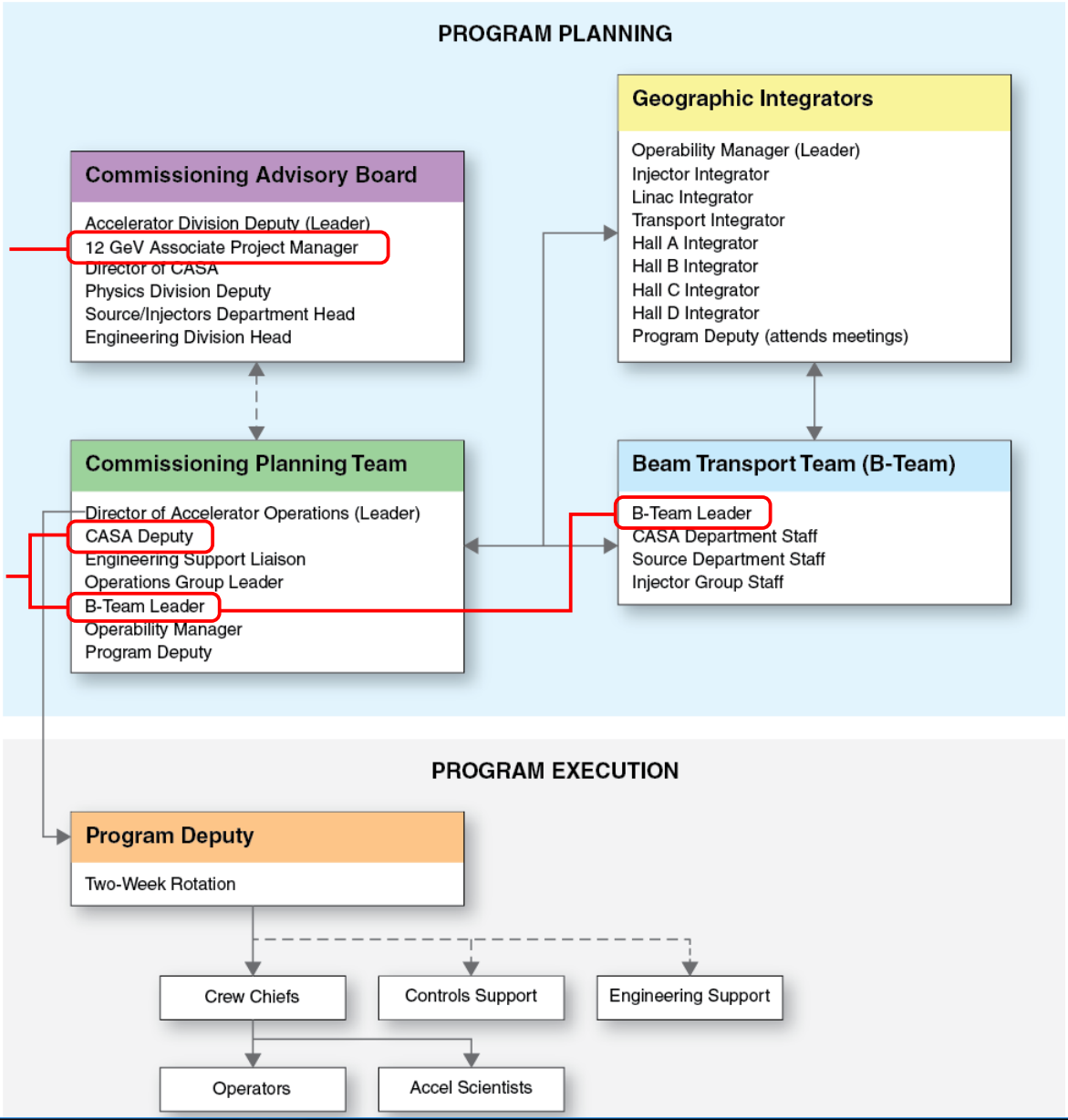
Found 12,334 Signoffs in Beam Destination "Beam to Hall A (3 pass)" (181 Masked Components)



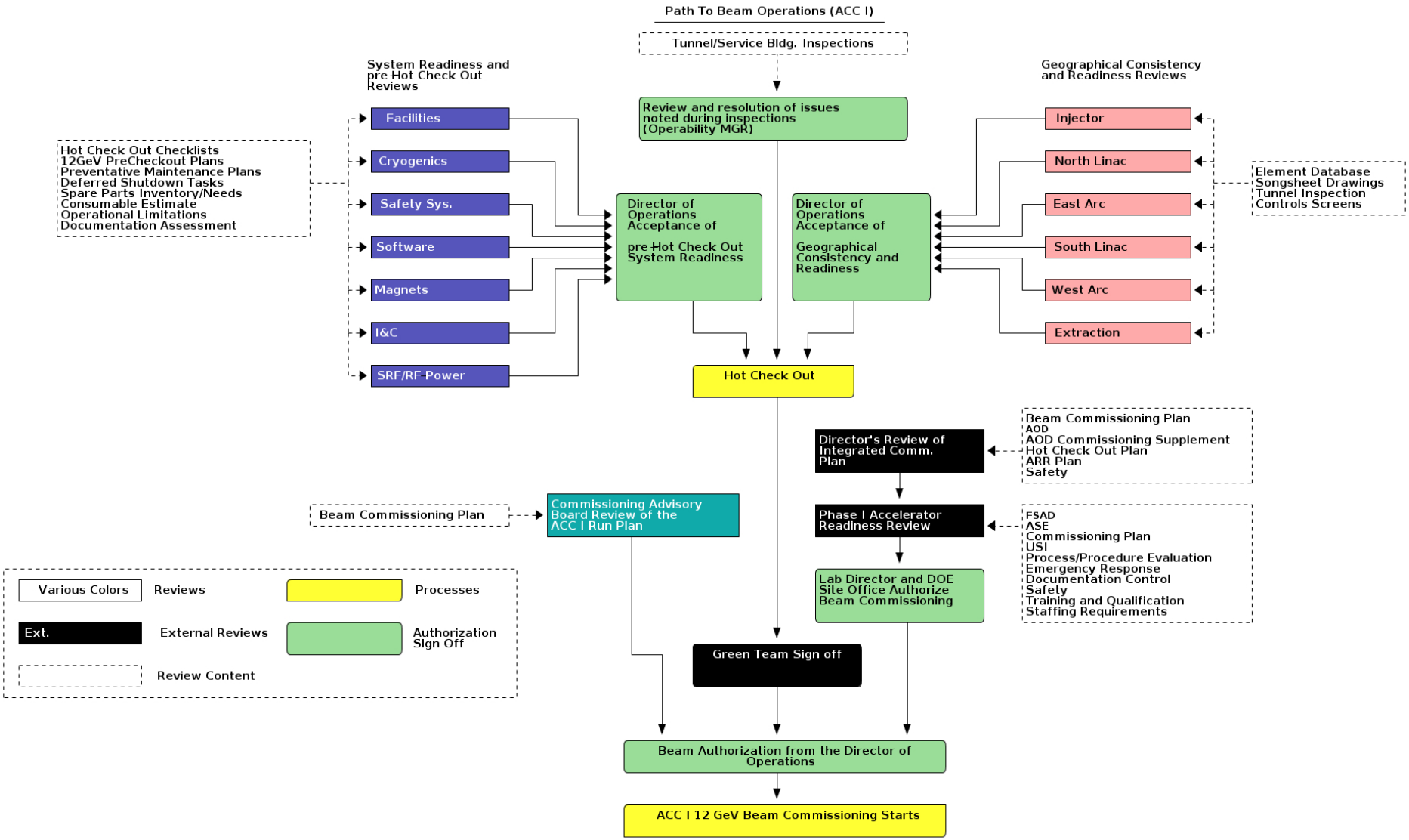
Ready
(~100%)

	Status	Count	Percent
	Ready	12,324	~100%
	Checked	10	~0%
	Not Ready	0	~0%

Program Planning and Execution



Process Overview



Outline

1. Process
2. Beam Commissioning Schedule and Execution
   - Schedule and Goals: To Date
   - Progress: To Date
   - Remaining Schedule and Goals: AccII
   - Schedule and Goals: AccIII and beyond
3. Summary

Beam Commissioning Schedule

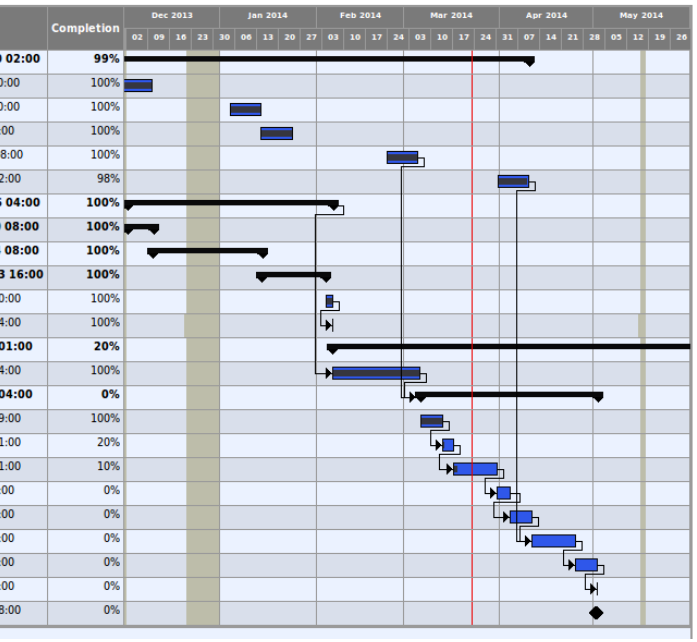
Beam Commissioning is schedule in "Run Periods" with Scheduled Accelerator Downs (SAD) periods between run periods.

Each run period has specific goals, nominally 12GeV project goals, but also OPS goals.

Each run period builds on the progress made in the previous operations, cannot commission 5.5passes until 1-pass is accomplished.

Accelerator Run Period I & II Plan

Index	Name	Start	End	Completion
6	**Hot Check Out**	**Mon 2012-12-31 19:00**	**Thu 2014-04-10 02:00**	**99%**
6.2	HCO Inline Dump (SLD0R08)	Tue 2013-10-29 01:00	Tue 2013-12-10 00:00	100%
6.3	HCO to 1R Dumplette	Sat 2014-01-04 00:00	Tue 2014-01-14 00:00	100%
6.4	HCO to 2R Dumplette	Tue 2014-01-14 00:00	Fri 2014-01-24 00:00	100%
6.5	HCO for multi-pass operations (up ...	Sun 2014-02-23 08:00	Wed 2014-03-05 08:00	100%
6.6	HCO for complete CEBAF, Hall-A and...	Mon 2014-03-31 02:00	Thu 2014-04-10 02:00	98%
9	**Accelerator Period I: 2.2GeV/pass to...**	**Mon 2013-12-02 08:00**	**Thu 2014-02-06 04:00**	**100%**
9.1	**Recover: Beam up to 5MeV**	**Mon 2013-12-02 08:00**	**Tue 2013-12-10 08:00**	**100%**
9.2	**Injector commissioning**	**Tue 2013-12-10 08:00**	**Tue 2014-01-14 08:00**	**100%**
9.3	**Spin up 1pass beam to 2R**	**Tue 2014-01-14 08:00**	**Mon 2014-02-03 16:00**	**100%**
9.4	Acc-I Schedule Contingency	Mon 2014-02-03 20:00	Thu 2014-02-06 00:00	100%
9.5	Termination Tasks	Thu 2014-02-06 00:00	Thu 2014-02-06 04:00	100%
10	**12GeV CEBAF Commissioning**	**Thu 2014-02-06 04:00**	**Fri 2015-06-12 01:00**	**20%**
10.1	SAD I	Thu 2014-02-06 04:00	Thu 2014-03-06 04:00	100%
10.2	**Accelerator Period II: E>1.1GeV/pa...**	**Thu 2014-03-06 08:00**	**Fri 2014-05-02 04:00**	**0%**
10.2.1	3-pass spin up (BSY)	Thu 2014-03-06 08:00	Thu 2014-03-13 09:00	100%
10.2.2	Hall-A Detector Checkout	Thu 2014-03-13 09:00	Sun 2014-03-16 21:00	20%
10.2.3	1/2/3 pass Magnet/Optics characte...	Sun 2014-03-16 21:00	Sun 2014-03-30 21:00	10%
10.2.4	AccII pre-SADII Schedule Continge...	Sun 2014-03-30 21:00	Fri 2014-04-04 06:00	0%
10.2.5	SAD-II	Fri 2014-04-04 06:00	Fri 2014-04-11 02:00	0%
10.2.6	5.5-pass spin up to D	Fri 2014-04-11 02:00	Fri 2014-04-25 02:00	0%
10.2.7	4/5/5.5 pass Magnet/Optics charac...	Fri 2014-04-25 02:00	Fri 2014-05-02 02:00	0%
10.2.8	AccII Schedule Contingency	Fri 2014-05-02 02:00	Fri 2014-05-02 04:00	0%
10.3	May 2014 Power Meter Reading	Thu 2014-05-01 08:00	Thu 2014-05-01 08:00	0%



Acc-I and Acc-II Run Period Goals

Acc-I 2013-Dec-13→2014-02-06

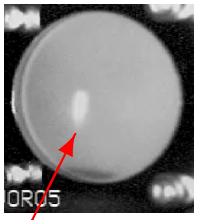
- ✓ 1-pass beam to 2R dumplette (2014-Jan-31)
- ✓KPP Demonstrate 2.2GeV/pass of energy gain with acceptable availability (2014-Feb-05)

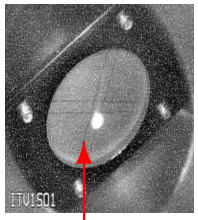
Acc-II 2014-03-07→2014-05-02

- ✓ Demonstrate full injection design energy of 123MeV. (2014-Mar-10)
- ✓ Establish multi-pass beams in CEBAF for the first time in the 12GeV era. (2014-Mar-15)
- ✓ Establish CW operations to Hall-A, first CW operations beyond the injector. (2014-Mar-26)
- ✓MS 2-09 Establish 3-pass beam to Hall-A with $E_{beam} > 6$GeV. (2014-04-01)
- MS 2-03 Establish 5.5pass to the Hall-D dumplette with $E_{beam} > 10$GeV. (Scheduled for Apr-25)

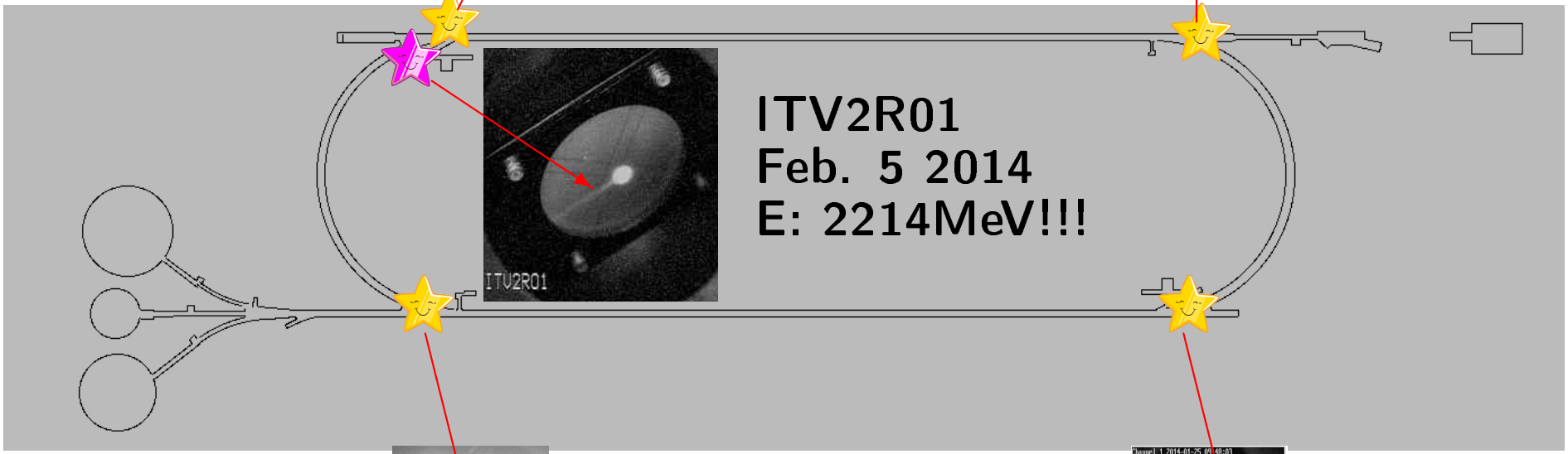
January 31 2014: Beam to 2R Dumplette!!

ITV0R05
Dec. 13 2013
E: 34MeV



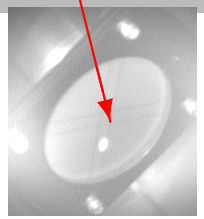


ITV1S01
Jan. 16 2014
E: 1124MeV



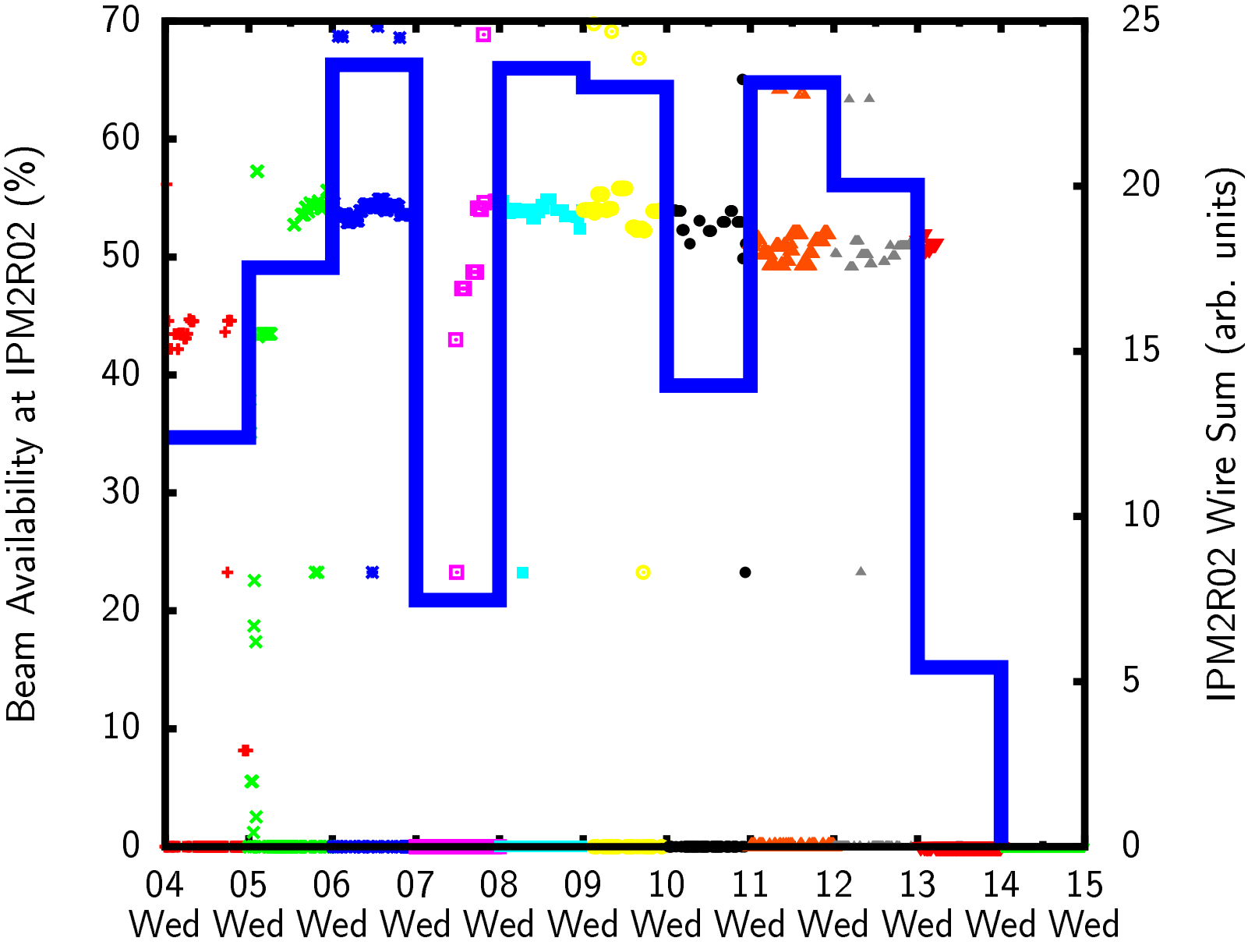
ITV2R01
Feb. 5 2014
E: 2214MeV!!!

ITV2S01
Jan. 26 2014
E: 2214MeV



ITV1R01
Jan. 18 2014
E: 1124MeV

February 5 2014: 2.214GeV beam availability



RF gradients Feb. 5 2.2GeV/pass

RF and ARC1:p/ARC2:p status at: 2014-02-05 09:05

Linac	Type	Ncav	<GMES> (MV)	$GMES_{RMS}$ (MV)	Min-Max (MV)	Egain (MeV)
Inj	C25	10	6.72	0.81	5.86-8.63	33.6
NL	C25	119	7.19	1.64	2.97-11.71	427.6
NL	C50	40	11.03	1.49	6.34-13.45	220.7
NL	C100	38	17.59	2.40	9.80-20.77	467.9
SL	C25	108	7.05	1.40	4.78-10.56	380.7
SL	C50	47	10.06	1.90	6.41-12.36	236.4
SL	C100	40	16.66	2.75	9.70-20.00	466.4

Linac	Egain (MeV)	Σ_E (MeV)	Spectrometer	Momentum (MeV/c)
Injector	33.58	33.58	INJ:p	33.41
North	1116.15	1149.73	Arc1:p	1124.03
South	1083.44	2233.17	Arc2:p	2214.51

Injector Beam Current(IBC0R08): 8.88

Inj. RF gradients Mar. 10: $E_{inj} = 123$ MeV

RF and INJ:p status at: 2014-03-10 21:50

Linac	Type	Ncav	<GMES> (MV)	$GMES_{RMS}$ (MV)	Min-Max (MV)	Egain (MeV)
Inj	C25	10	6.59	0.88	4.76- 8.19	33.0
Inj	R100	8	18.11	1.86	14.00-20.00	101.4

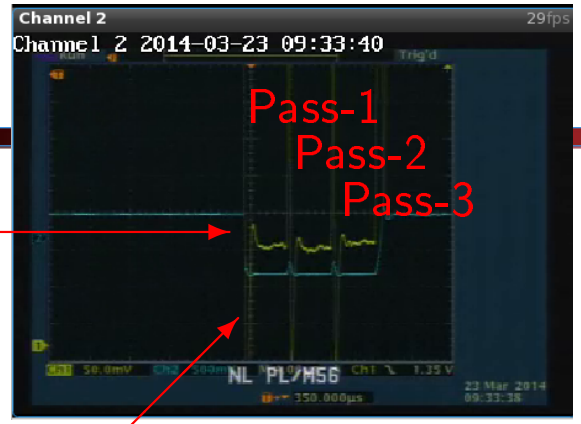
Linac	Egain (MeV)	Σ_E (MeV)	Spectrometer	Momentum (MeV/c)
Injector	134.39	134.39	INJ:p	121.93

Injector Beam Current(IBC0L02): 99.8981

Multi-pass operation

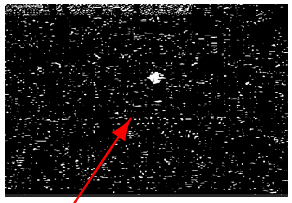
3-Pass beam to 6R!

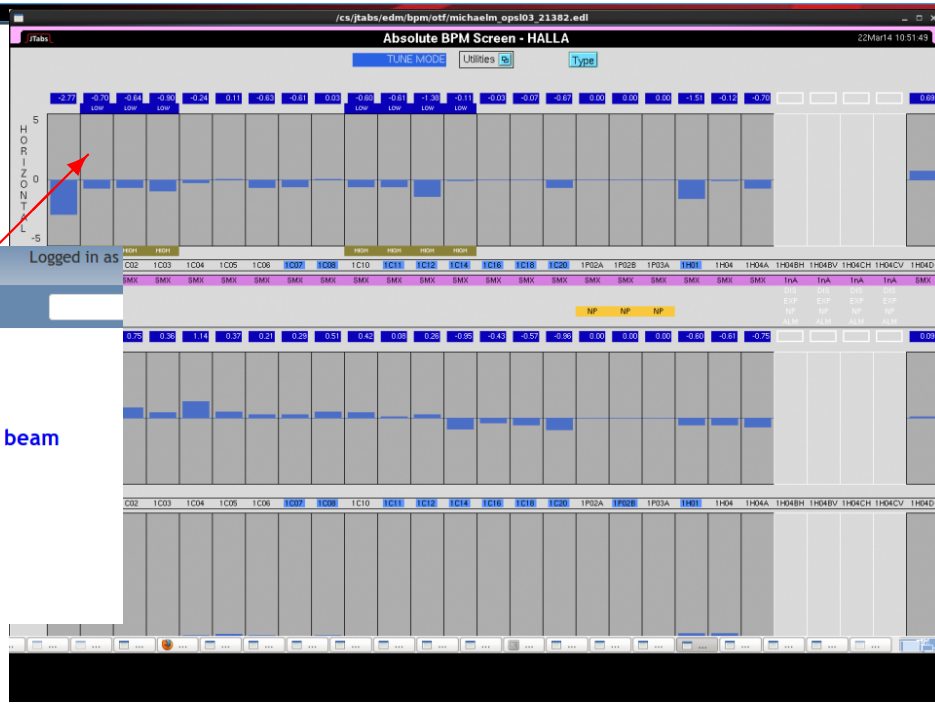
Pathlength monitors (yellow trace) measures the phase difference of each pass to the Master Oscillator reference (10mV/degree).



Beam-Target Interactions in Hall-A

Beam on viewer at entrance to A-Dump





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Start_Run_20236,Run_type=Commission,target_type=Carbon,comment_text=c,5microAmp tuned beam

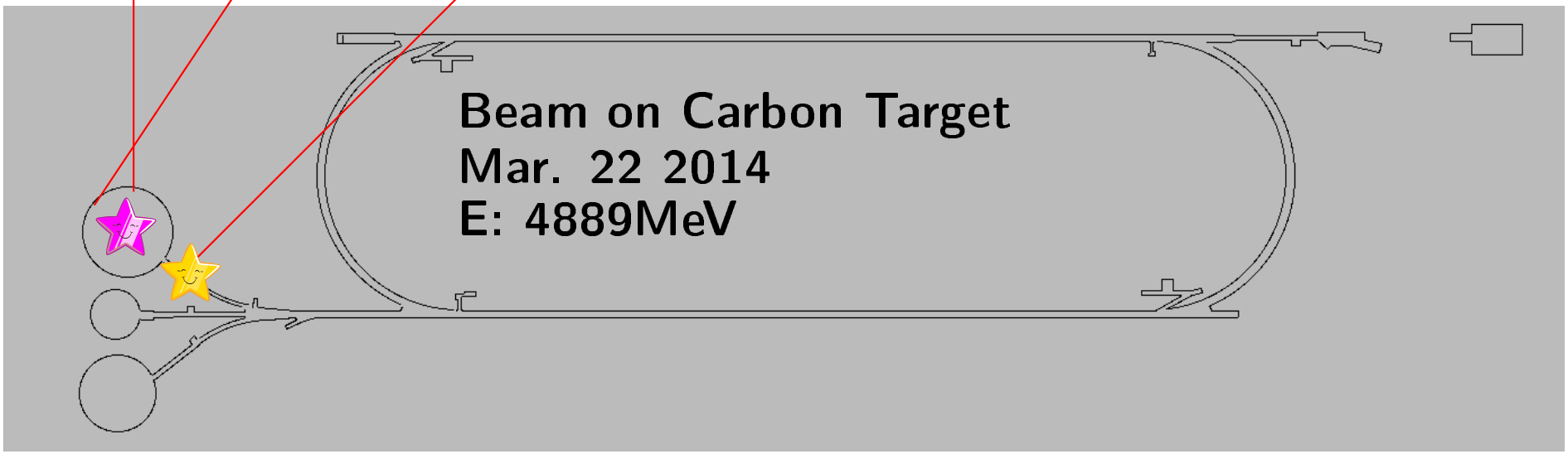
Lognumber 3276292. Submitted by adaq on Sat, 03/22/2014 - 20:06.

Last updated on Sat, 03/22/2014 - 20:06

Logbooks: HALOG

Tags: StartOfRun

User name adaq



Beam-Target Interactions with $E_{beam} > 6$ GeV

Start_Run_20354,Run_type=Commission,target_type=Carbon,comment_text=Run type: Comm., Carbon tgt,I=1 micro A, ps1=1, no raster, sieves out

Lognumber 3279524. Submitted by adaq on Tue, 04/01/2014 - 22:35.

Last updated on Tue, 04/01/2014 - 22:35

Logbooks: HALOG

Tags: StartOfRun

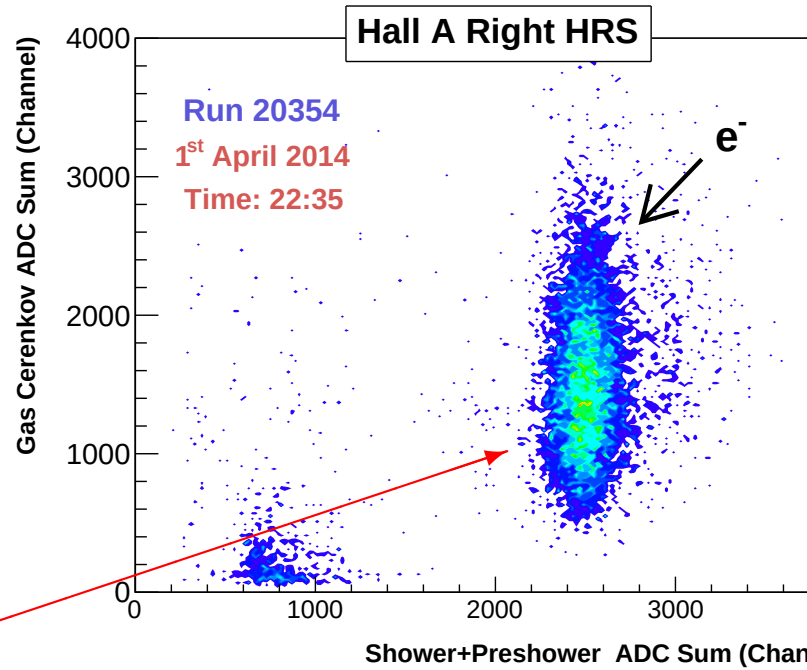
User name adaq

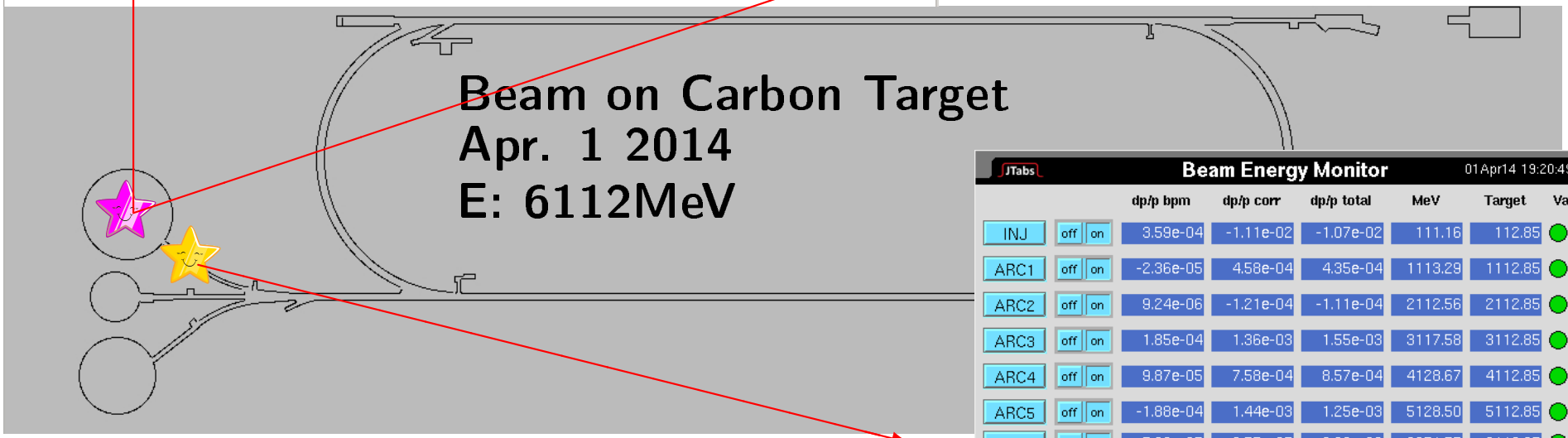
Log entry time 22:35:56 on April 1, 2014

Entry number 388530

keyword=Start_Run_20354,Run_type=Commission,target_type=Carbon,comment_text=Run type: Comm., Carbon tgt,I=1 micro A, ps1=1, no raster, sieves out

Run Timestamp: Tue Apr 1 22:32:46 EDT 2014
Beginning-of-run EPICS data for Run Number 20354 at Tue Apr 1 22:35:36 EDT 2014





JTabs **Beam Energy Monitor** 01Apr14 19:20:49

		dp/p bpm	dp/p corr	dp/p total	MeV	Target	Valid
INJ	off on	3.59e-04	-1.11e-02	-1.07e-02	111.16	112.85	
ARC1	off on	-2.36e-05	4.58e-04	4.35e-04	1113.29	1112.85	
ARC2	off on	9.24e-06	-1.21e-04	-1.11e-04	2112.56	2112.85	
ARC3	off on	1.85e-04	1.36e-03	1.55e-03	3117.58	3112.85	
ARC4	off on	9.87e-05	7.58e-04	8.57e-04	4128.67	4112.85	
ARC5	off on	-1.88e-04	1.44e-03	1.25e-03	5128.50	5112.85	
HALLA	off on	-5.92e-05	6.75e-05	8.28e-06	6051.77	6112.85	

Future: Near Term

Remaining goals for Acc-II run period:

MS 2-03 Establish 5.5pass to the Hall-D dumplette with $E_{beam} > 10$GeV. (Scheduled for Apr-25)

Future: AccIII and beyond

Fall2014, Oct→Dec. 2014: **Acc-III**

KPP Hall-D detector commissioning

- RF separation, establish multi-beam capability for the first time in 12GeV CEBAF era.

Spring2016, Dates and Run Period Name TBD

KPP Commission with beam the Hall-B transport line and start Hall-B detector commissioning.

KPP Commission with beam the Hall-C transport line and start Hall-C detector commissioning.

Outline

1. Process
2. Beam Commissioning Schedule and Execution
3. Summary
   - The Summary Slide

Summary

- 12GeV CEBAF Beam Commissioning has had a very successful start.
  - 2.2GeV/pass energy gain has been demonstrated.
  - Injector has been commissioned at design energy.
  - Multi-pass operations have been established.
  - Beam transported to Hall-A end-station.
  - Beam-target interactions have been recorded in Hall-A, Hall-A has started their commissioning process.
- With a bit less than 9weeks of beam operations, significant progress has been made.
- Beam has been transported through 55% of CEBAF proper and 25% of the transport lines to the halls.
  - Plan is to have beam through 100% of CEBAF proper and 50% of the hall transport lines by end of Acc-II (2014-May).
- Systematic, thorough, detailed check-out and documentation of the accelerator hardware has resulted in generally efficient use of beam operations.