DarkSide-50 (E-1000) Update

Dark Matter search using LArTPC

DarkSide Collaboration

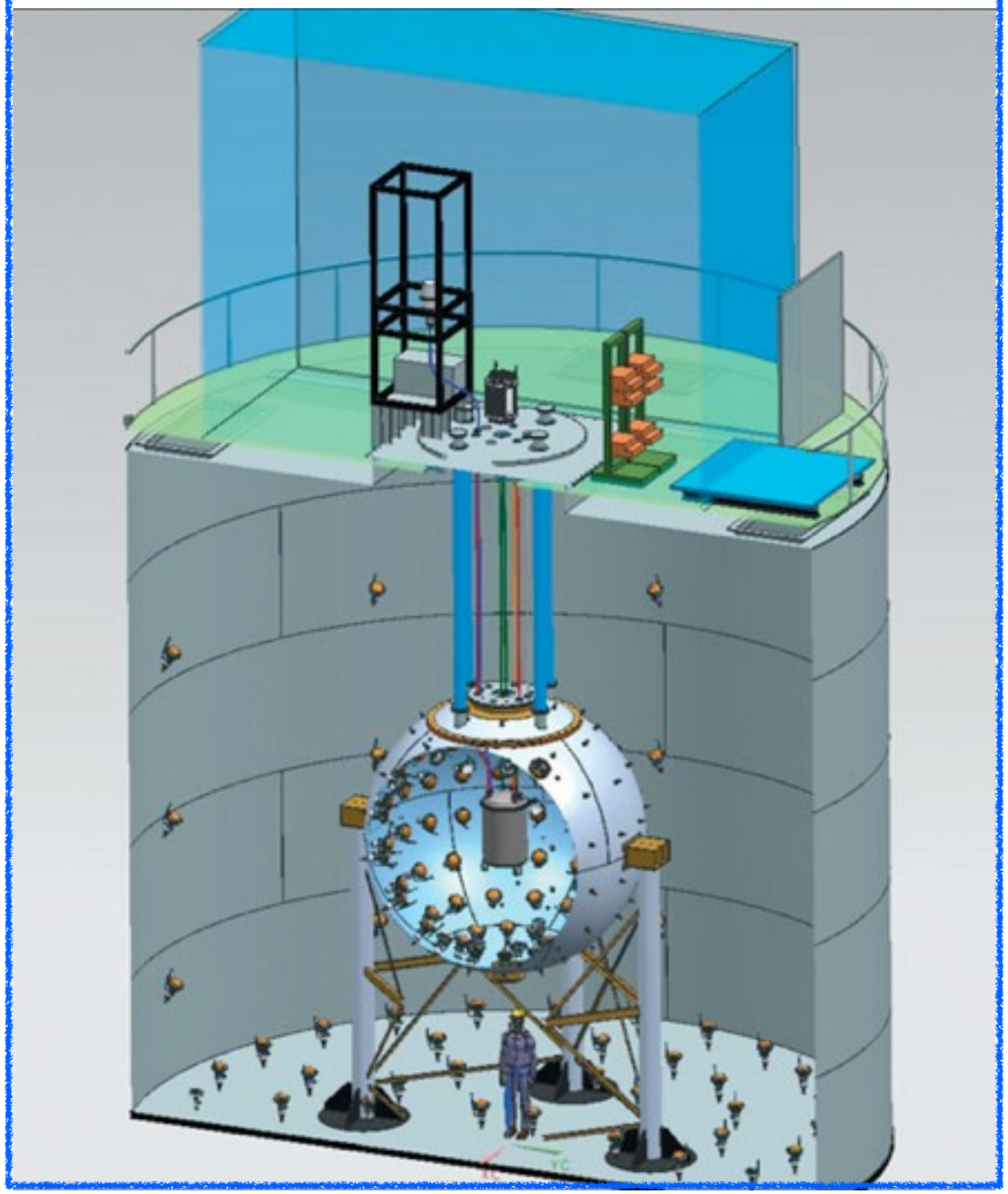
China (1), France (2), Italy(8), Poland(1), Russia (4), Ukraine (1), U.S.A.(15)

All Experimenters Meeting

2014/06/30

Darkside-50

- LArTPC (50 kg active, 150kg total) 38 PMTs
- Liquid scintillator veto (30 tons) 110 PMTs
- Water veto (1 ktons) 80 PMTs



DarkSide-50

- Sensitivity goal : 2 x 10^{-45} cm^2
- Pulse Shape discrimination
- Ionization vs scintillation based discrimination
- Underground argon (10^{-2} lower ^{39}Ar)
- Liquid scintillator neutron veto
- Water Cherenkov muon veto

Fermilab's Contribution

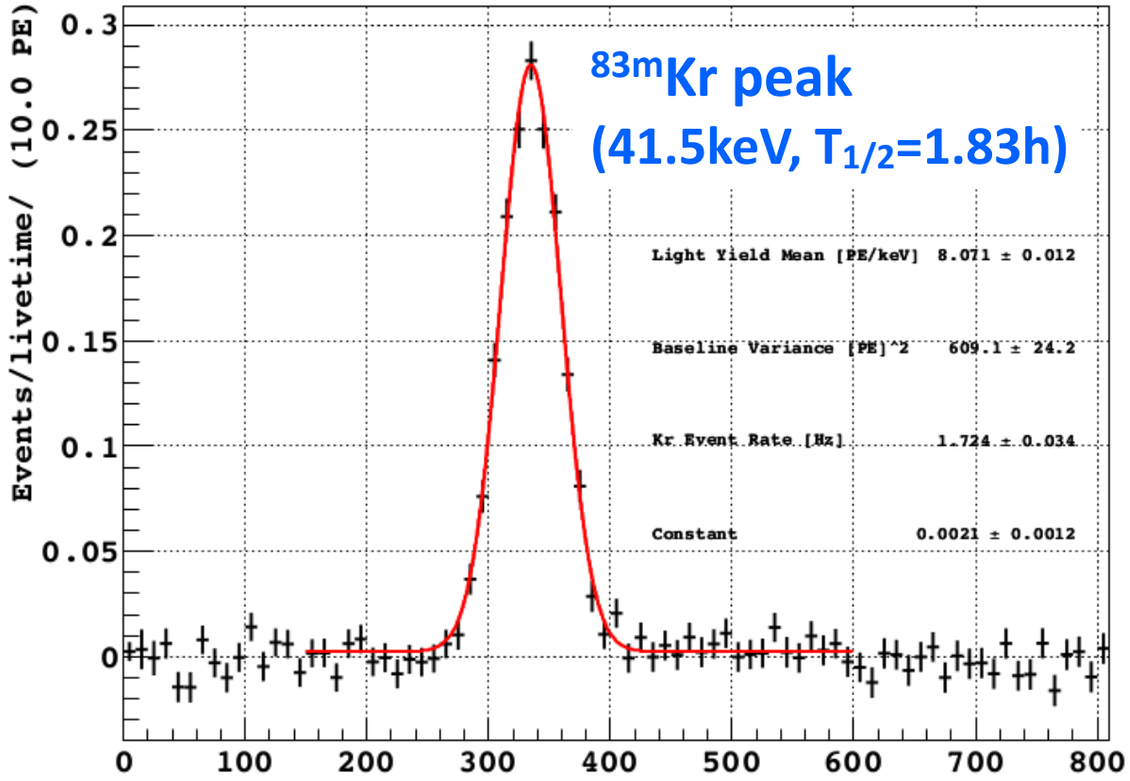
- Project management
- Technical/engineering support (argon handling)
- Underground argon purification (PAB)
- DAQ hardware (trigger) and software (artDAQ)
- Data transfer from LNGS to Fermilab (SAM)
- Data processing & analysis (FermiGrid)

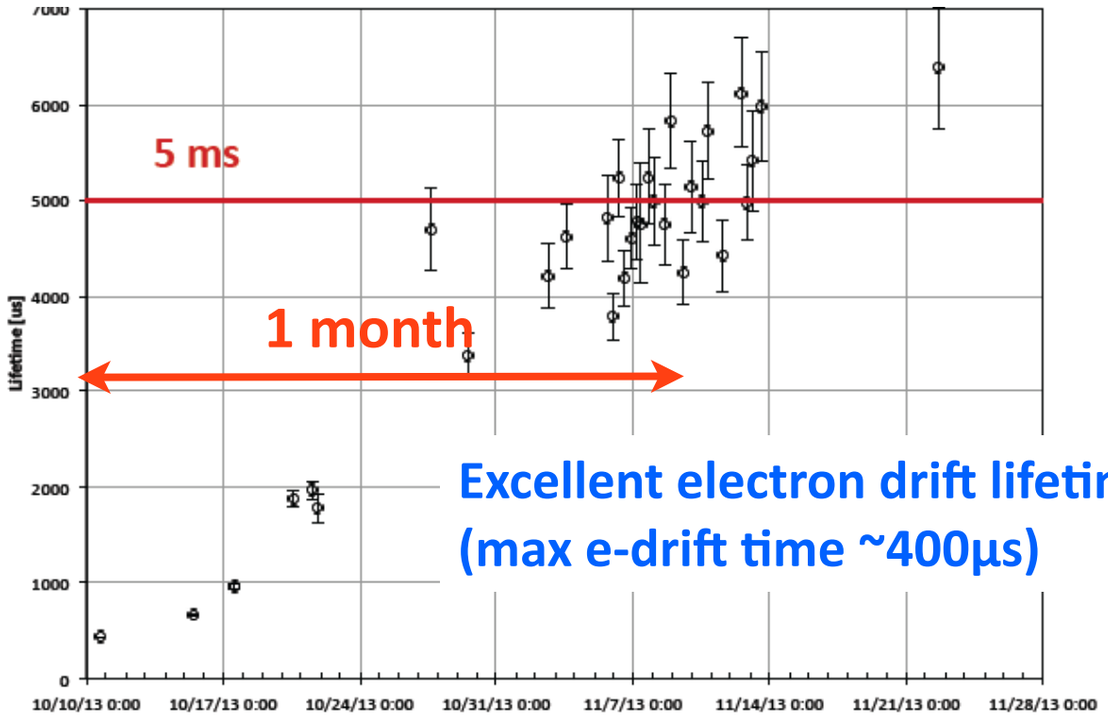
Milestone

- Detector construction complete
- DarkSide-50 TPC is running since Oct. 2013
  with atmospheric argon (AAr)
- Veto detectors are operating
  → high ^{14}C rate observed in LS veto

Darkside-50: commissioning with AAr

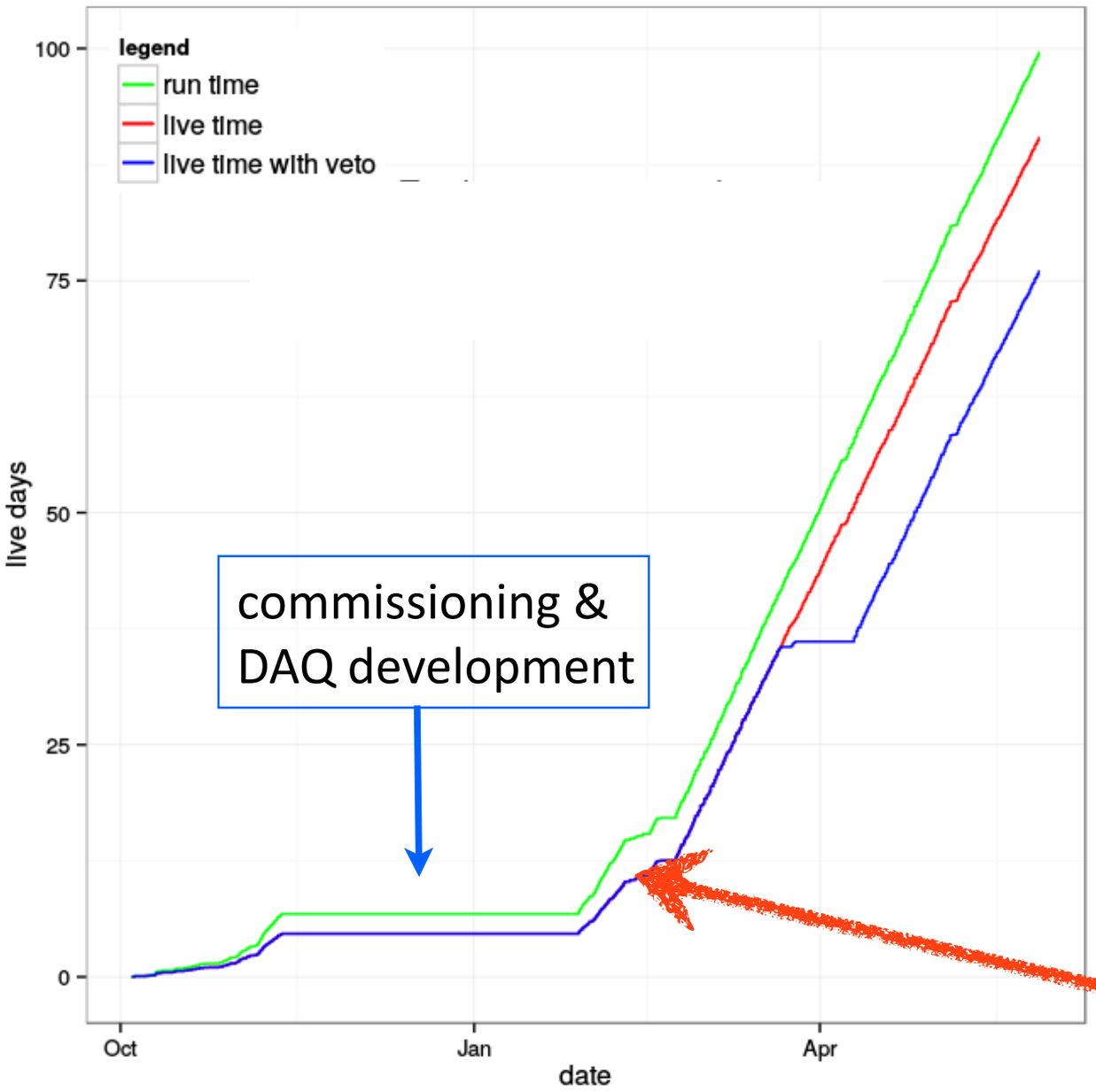
Light collection: 8PE/keVee @ 0-field





Excellent electron drift lifetime (max e-drift time ~400µs)

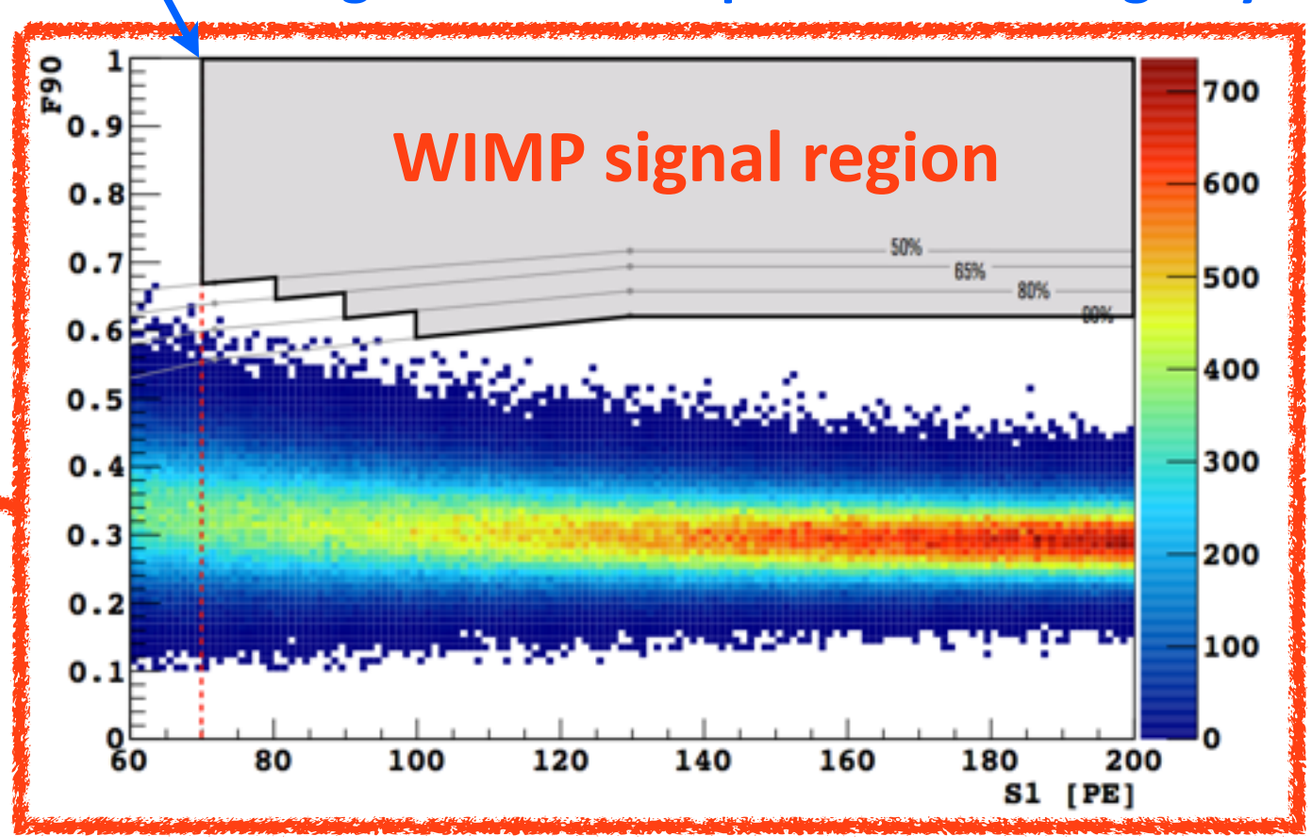
Darkside-50: data collection with AAr



Demonstrated PSD@ 200V/cm can suppress the ER backgrounds equivalent to 2.6 yr of DS-50 UAr run

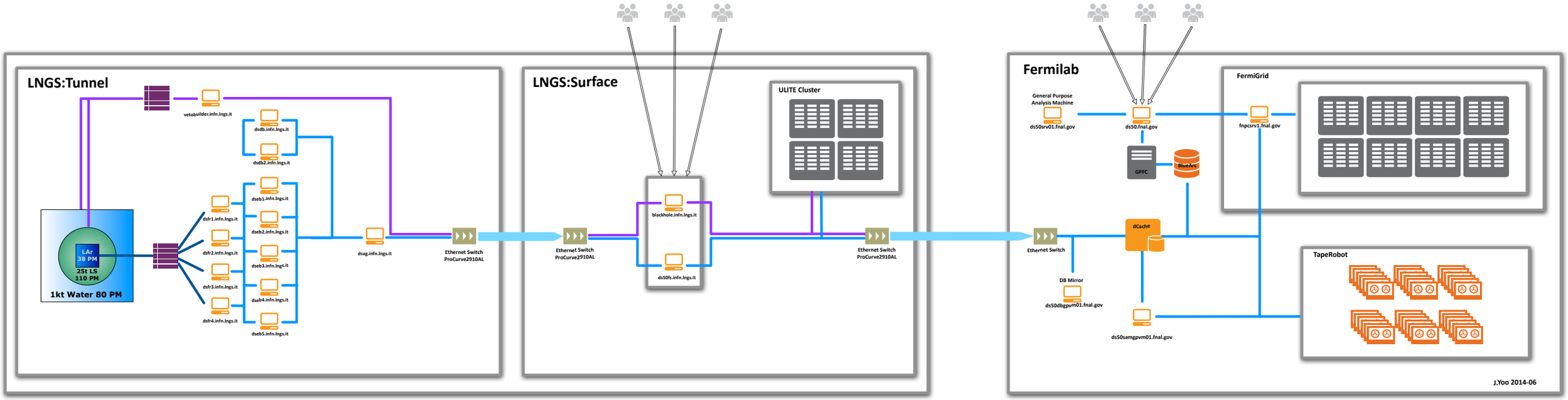
70PE = 35 keVr (200V/s) analysis threshold (based on SCENE measurement)

Background free exposure of 280 kg-day



Shown at UCLA2014

Darkside-50: data flow



LNGS tunnel

- Darkside-50 detectors
- DAQ hardware
- ARTDAQ
  - Fragment receivers
  - Event builders
  - Data aggregator
- Run database
- Online monitor

LNGS surface

- Data collectors
- Computing cluster
- DarkART
  - Realtime processing
  - Data validation
  - Offline monitor

Fermilab

- Data storage
  - Bluearc disk buffer (25TB)
  - dCache & tape robot
- Offline processing
  - FermiGRID (25 CPUs assigned)
  - Opportunistic CPUs in OSG
- File database (SAM)
- Run database mirror
- GPVM service for user (analysis)
- General purpose server for user

Data transfer: LNGS → FNAL

- Normal file transfer rate (LNGS→FNAL) : 40MB/s to 60MB/s
- Sometimes the rate become slower than 10MB/s
- File transfer monitoring service (webpage)
- Total transferred data at FNAL: 334TB (as of 2014-06-29)

Recent FTP Transfers

fndca.fnal.gov/cgi-bin/dcache_files.py#darkside

darkside

Time	User	Type	Oper	File	Node	dT 1	File Size	dT 2	Status	Details
2014-06-8 22:49:53	darkside	gsiftp	write	/pnfs/fnal.gov/usr/darkside/raw/commissioning/lsv/ODRun00xxxx/ODRun00847x/ODRun008475_014.dat	blackhole.lngs.infn.it	0	NOT_FINISHED	0	NOT_FINISHED	
2014-06-8 22:49:31	darkside	gsiftp	write	/pnfs/fnal.gov/usr/darkside/raw/commissioning/lsv/ODRun00xxxx/ODRun00847x/ODRun008475_013.dat	blackhole.lngs.infn.it	16	1000035850	0	OK	
2014-06-8 22:49:07	darkside	gsiftp	write	/pnfs/fnal.gov/usr/darkside/raw/commissioning/lsv/ODRun00xxxx/ODRun00847x/ODRun008475_012.dat	blackhole.lngs.infn.it	17	1000055914	0	OK	
2014-06-8 22:48:44	darkside	gsiftp	write	/pnfs/fnal.gov/usr/darkside/raw/commissioning/lsv/ODRun00xxxx/ODRun00847x/ODRun008475_011.dat	blackhole.lngs.infn.it	16	1000075518	0	OK	
2014-06-8 22:48:05	darkside	gsiftp	read	/pnfs/fnal.gov/usr/darkside/raw/commissioning/Run00xxxx/Run00845x/ds50_r008452_sr025_20140606T140711.root	ds50gpvm01.fnal.gov	42	6890299712	0	OK	
2014-06-8 22:48:22	darkside	gsiftp	write	/pnfs/fnal.gov/usr/darkside/raw/commissioning/lsv/ODRun00xxxx/ODRun00847x/ODRun008475_010.dat	blackhole.lngs.infn.it	16	1000030866	0	OK	
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2014-06-8 22:47:28	darkside	gsiftp	write	/pnfs/fnal.gov/usr/darkside/raw/commissioning/lsv/ODRun00xxxx/ODRun00847x/ODRun008475_008.dat	blackhole.lngs.infn.it	17	1000025124	0	OK	
2014-06-8 22:47:06	darkside	gsiftp	write	/pnfs/fnal.gov/usr/darkside/raw/commissioning/lsv/ODRun00xxxx/ODRun00847x/ODRun008475_007.dat	blackhole.lngs.infn.it	15	1000105026	0	OK	
2014-06-8 22:46:40	darkside	gsiftp	write	/pnfs/fnal.gov/usr/darkside/raw/commissioning/lsv/ODRun00xxxx/ODRun00847x/ODRun008475_006.dat	blackhole.lngs.infn.it	19	1000035672	0	OK	
2014-06-8 22:46:18	darkside	gsiftp	write	/pnfs/fnal.gov/usr/darkside/raw/commissioning/lsv/ODRun00xxxx/ODRun00847x/ODRun008475_005.dat	blackhole.lngs.infn.it	16	1000112016	0	OK	
2014-06-8 22:45:35	darkside	gsiftp	write	/pnfs/fnal.gov/usr/darkside/raw/commissioning/lsv/ODRun00xxxx/ODRun00847x/ODRun008475_004.dat	blackhole.lngs.infn.it	36	1000049464	0	OK	
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2014-06-8 22:44:47	darkside	gsiftp	write	/pnfs/fnal.gov/usr/darkside/raw/commissioning/lsv/ODRun00xxxx/ODRun00847x/ODRun008475_002.dat	blackhole.lngs.infn.it	16	1000049010	0	OK	
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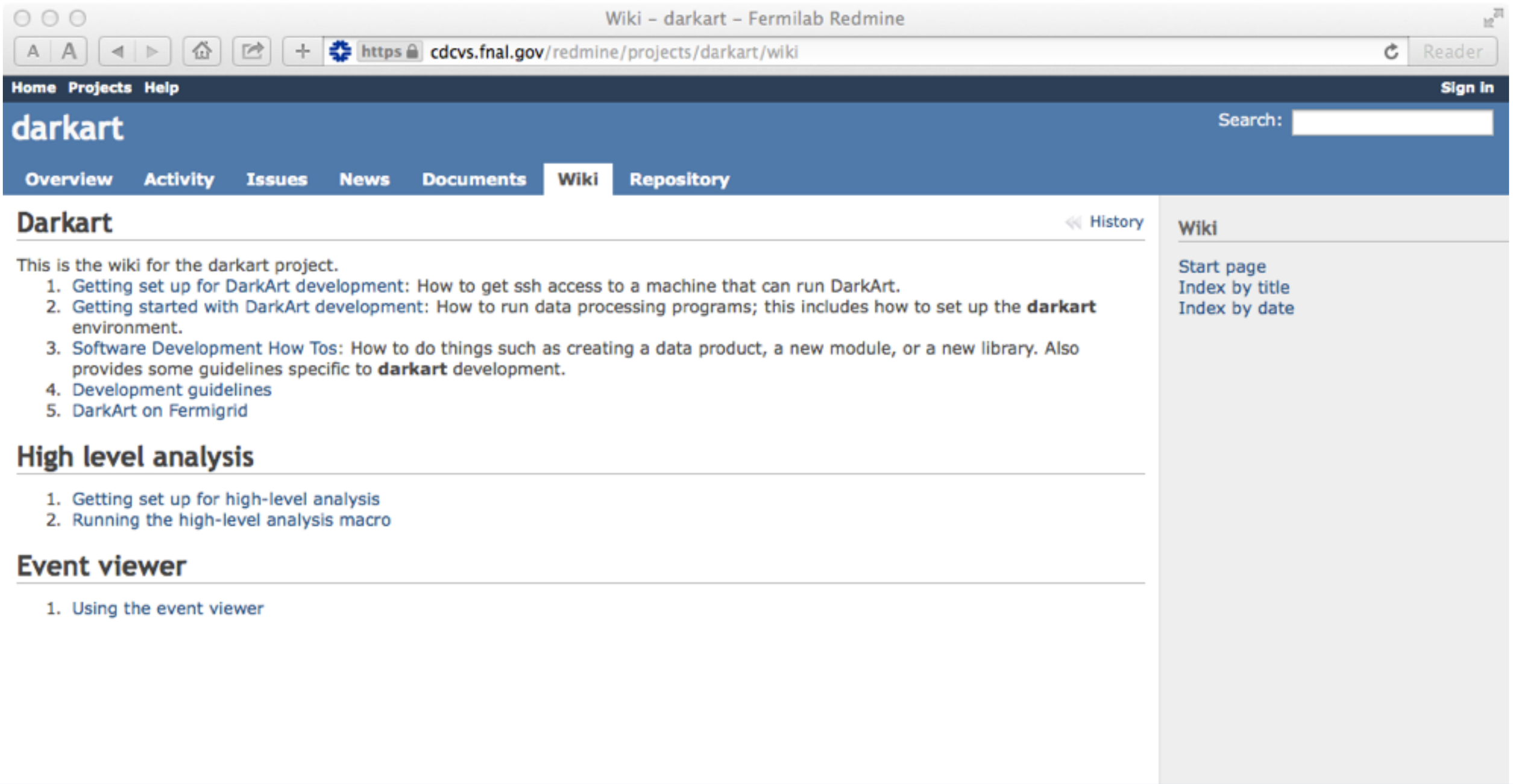
2014-06-8 22:43:12	darkside	gsiftp	write	/pnfs/fnal.gov/usr/darkside/raw/commissioning/lsv/ODRun00xxxx/ODRun00847x/ODRun008474_022.dat	blackhole.lngs.infn.it	17	1000112036	0	OK	
2014-06-8 22:42:50	darkside	gsiftp	write	/pnfs/fnal.gov/usr/darkside/raw/commissioning/lsv/ODRun00xxxx/ODRun00847x/ODRun008474_021.dat	blackhole.lngs.infn.it	15	1000067012	0	OK	
2014-06-8 22:40:58	darkside	gsiftp	read	/pnfs/fnal.gov/usr/darkside/raw/commissioning/Run00xxxx/Run00845x/ds50_r008452_sr018_20140606T133307.root	ds50gpvm01.fnal.gov	45	6846573457	0	OK	
2014-06-8 22:35:33	darkside	gsiftp	write	/pnfs/fnal.gov/usr/darkside/raw/commissioning/Run00xxxx/Run00847x/ds50_r008475_sr015_20140608T164401.root	ds50fs.lngs.infn.it	0	NOT_FINISHED	0	NOT_FINISHED	
2014-06-8 22:33:19	darkside	gsiftp	read	/pnfs/fnal.gov/usr/darkside/raw/commissioning/Run00xxxx/Run00845x/ds50_r008452_sr027_20140606T141654.root	ds50gpvm01.fnal.gov	47	6891164598	0	OK	

Darkart: Data reconstruction and analysis

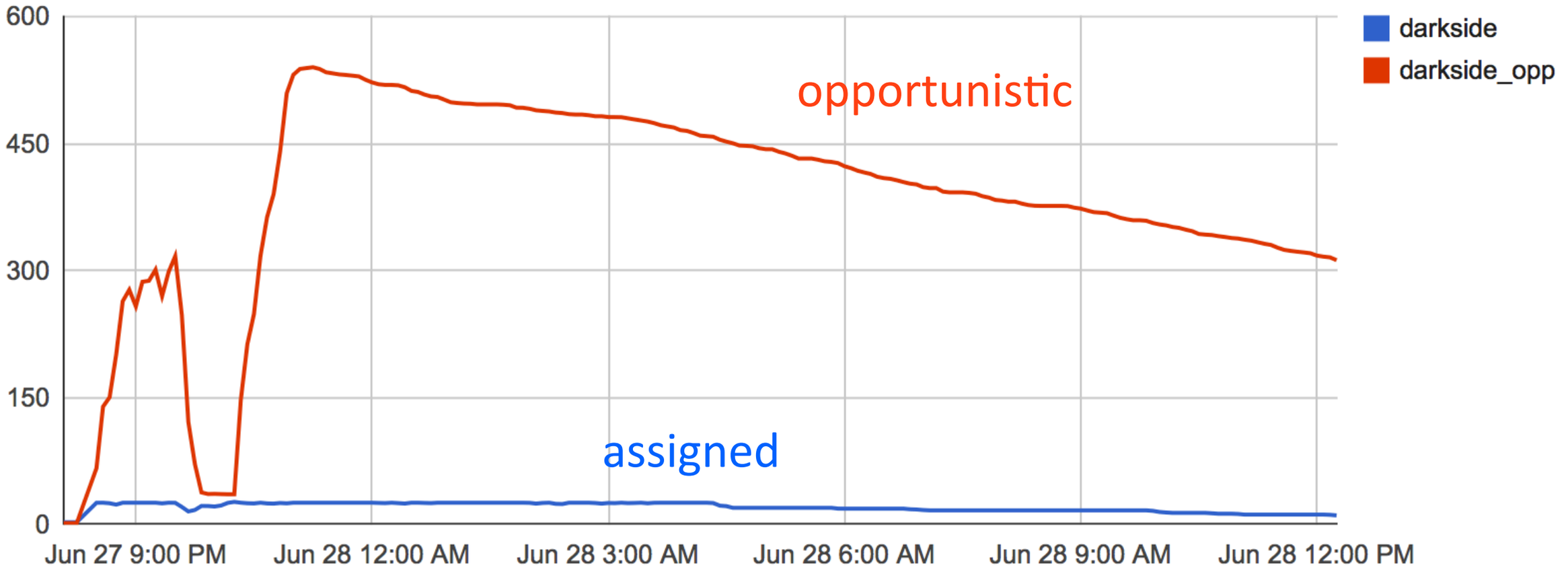
- Darkart: Darkside-50 data analysis package (based on *art* architecture)
- Modular programming of data analysis (good flexibility)
- Integration with other Fermilab product (artDAQ and SAM)



Data processing on FermiGrid

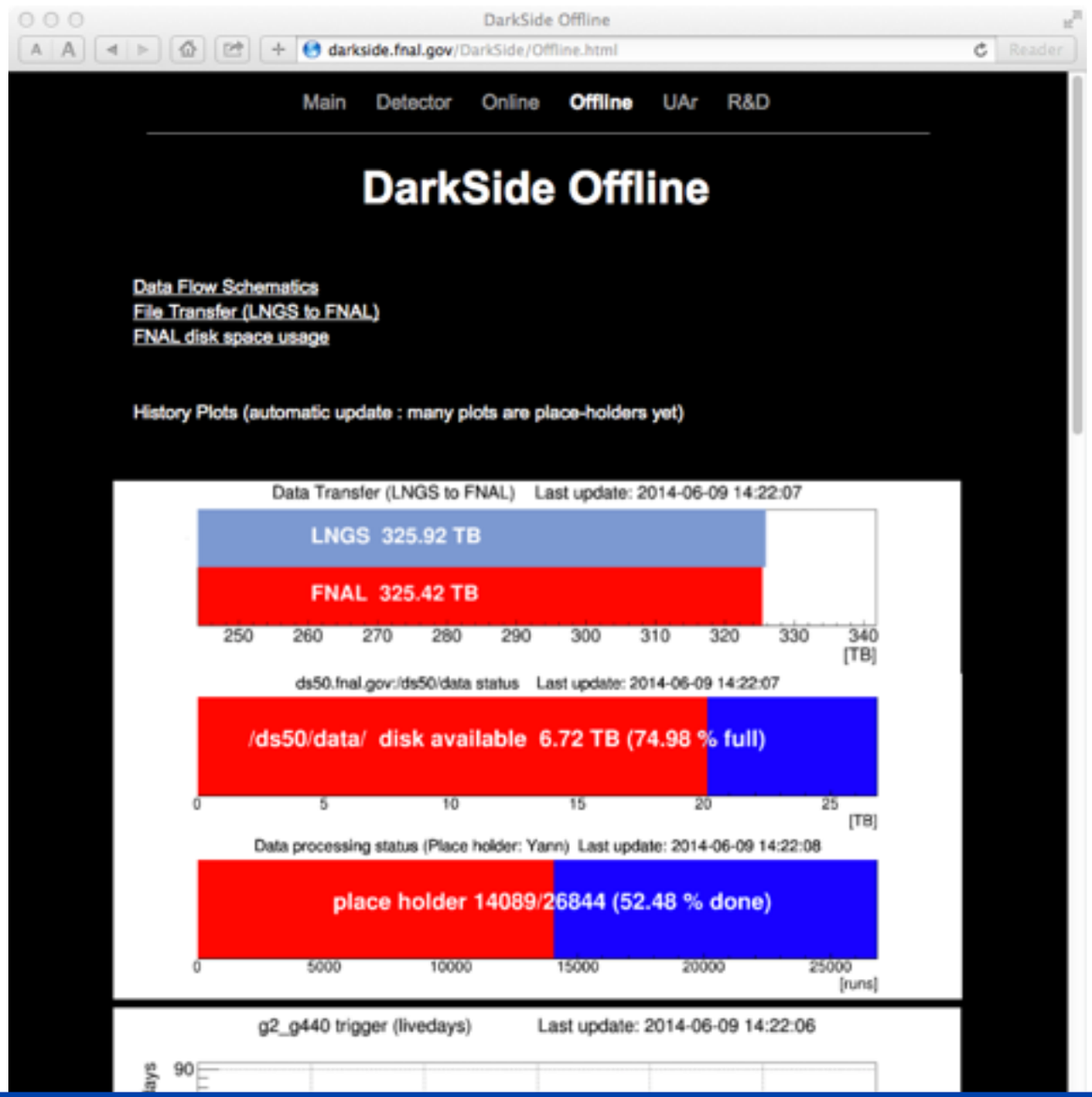
- Regularly processing both TPC and Veto data files; usually getting a few hundred opportunistic slots
- Starting reprocessing of full dataset; will make heavy use of FNAL resources

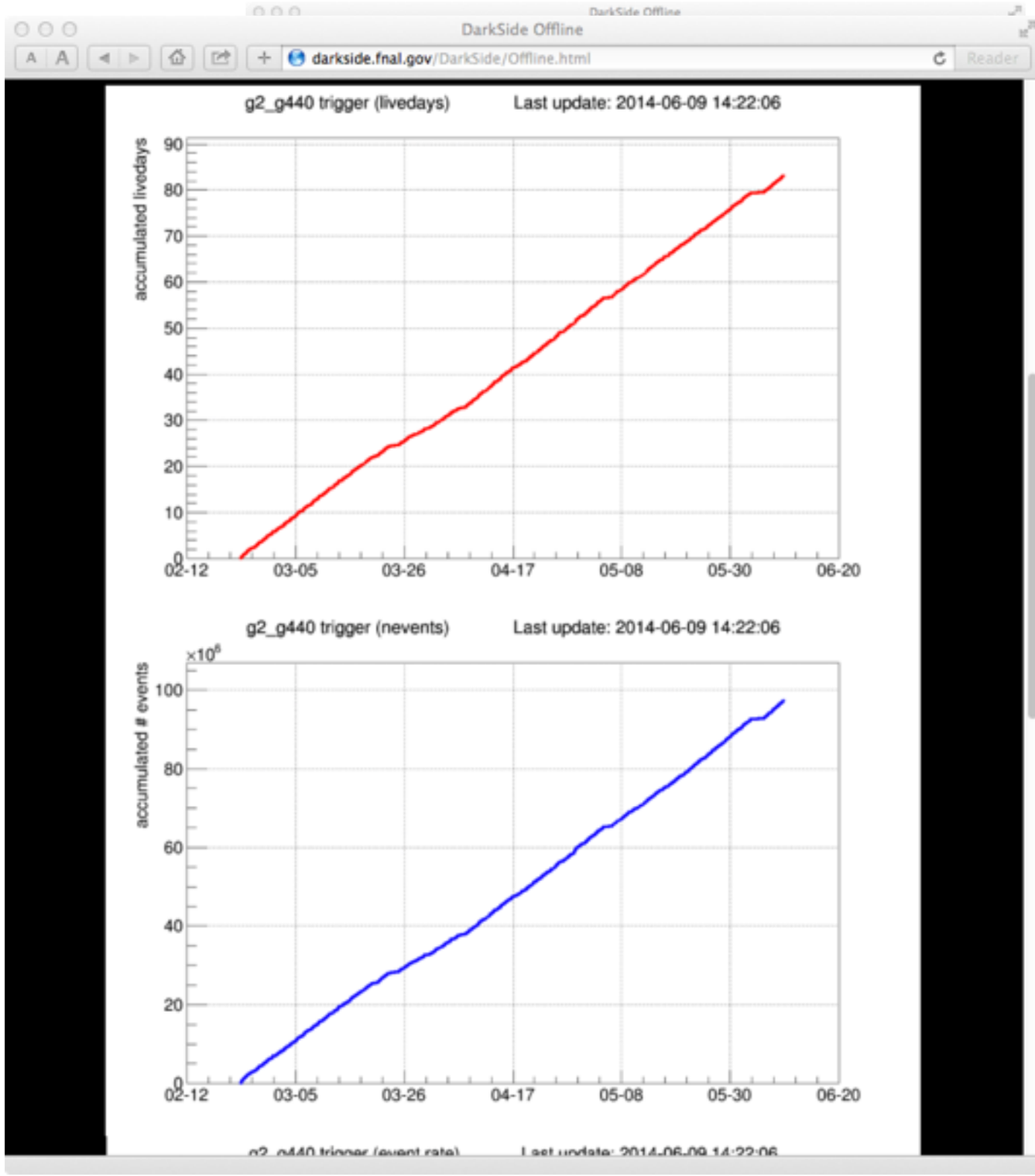
Usage of number of CPUs for DS-50 data processing



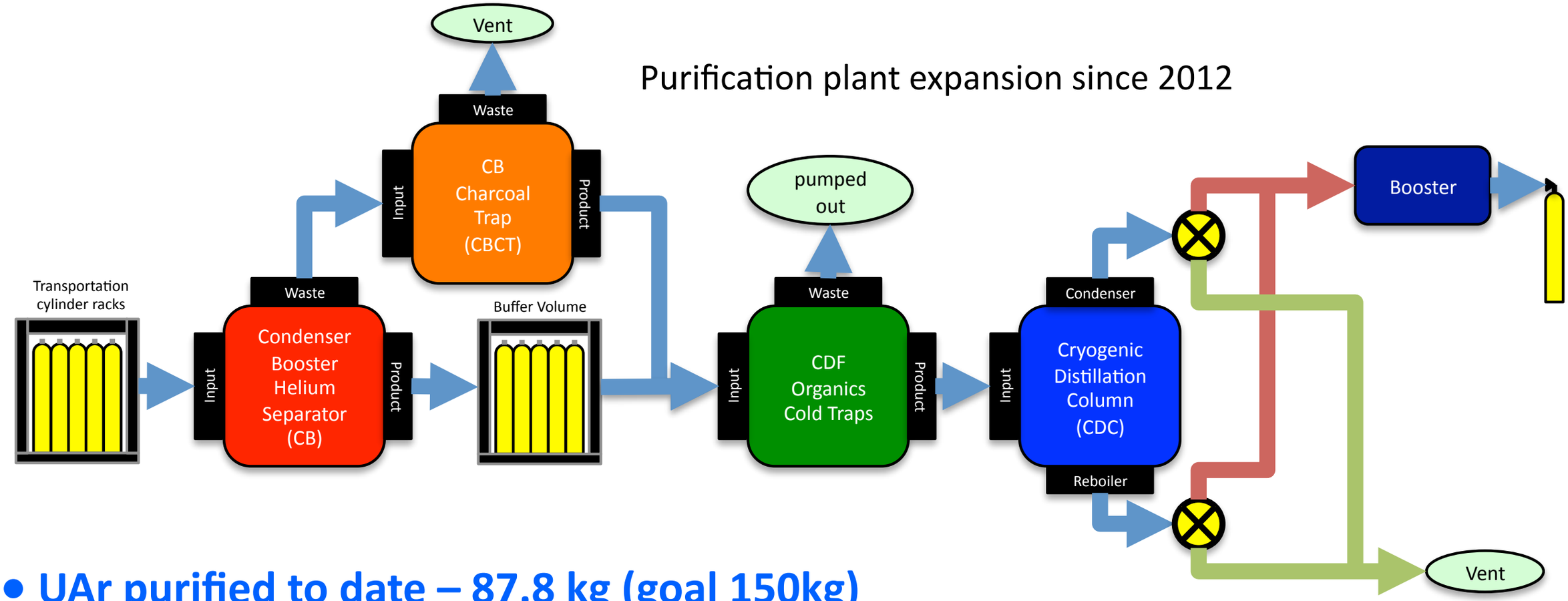
Data flow monitoring

- Fermilab has the data almost real time
  → database mirror
  → data processing monitor
  → data validation
  (updates every 10min)





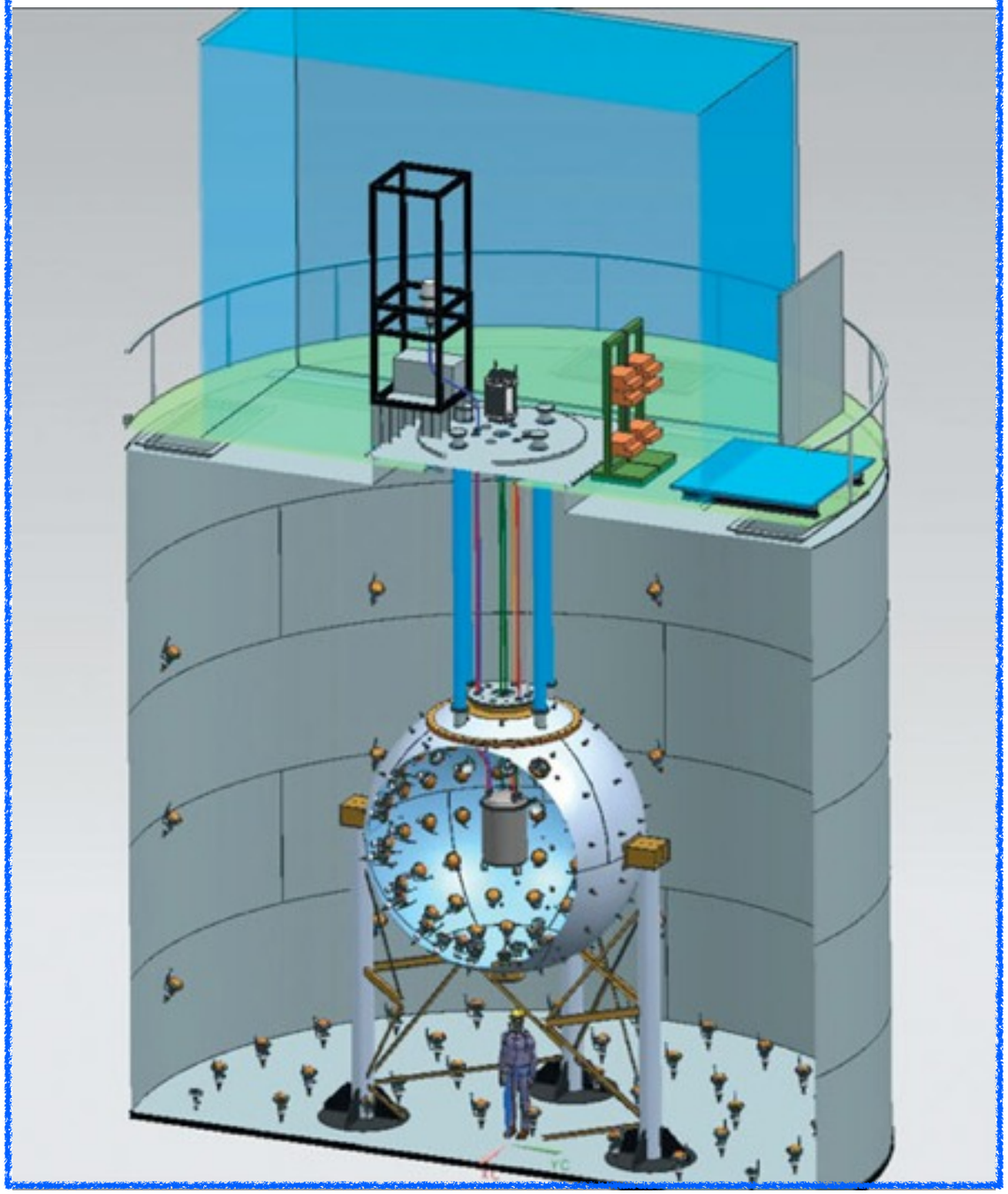
Underground argon purification at Fermilab (PAB)



- **UAr purified to date – 87.8 kg (goal 150kg)**
- Includes 21 kg recovered from CH_4 contamination
- Developed O_2 contamination with increased UAr production (@Colorado)
  → Requires installation of an O_2 scrubber
- All UAr still needs final polishing to achieve detector grade UAr
  → Heated getter system installed at PAB
- **Schedule**
  - **2014-10** All UAr purified, followed by UAr detector usability test
  - **2014-11** UAr leaves FNAL to LNGS
  - **2014-12 UAr arrives at LNGS**

Darkside-50 near term plan

- LArTPC (50 kg active, 150kg total) 38 PMTs
- Liquid scintillator veto (30 tons) 110 PMTs
- Water veto (1 ktons) 80 PMTs



Natural argon runs

- ~10Hz for normal runs (20MB/s)
- No practical delay of data transfer (cf. LNGS→Fermilab : ~40MB/s)

Argon spike (^{39}Ar x 10) runs

- Maximum rates (~100MB/s)
- Total data: 250TB/month
- Data transfer lagging expected

Underground argon (^{39}Ar x 10^{-2}) runs

- ~2 Hz for normal runs (4MB/s)
- Total data: 380TB/3-years

Calibration runs

- ~45 Hz for normal runs
- Total data: 400TB/(all calibration runs)

Summary and plan for next 6 months

- DS-50 detector is running with AAr at LNGS since Oct. 2013
- Demonstrated PSD performance background from ^{39}Ar: 2.6 years of DS-50
- DS-50 results extrapolated to DS-G2 for 5 years ^{39}Ar-free

- Cryogenics and gas handling system - excellent stability
- Trigger and data acquisition - functioning well
- Data transfer from LNGS to Fermilab - much improved
- Data storage - more than anticipated for this stage
- Offline system for data processing - ready and functioning well
- UAr purification system - huge progress, some challenges remain

Plan and Schedule

- High ^{14}C rate observed in liquid scintillator veto
  → replace TMB with low ^{14}C contents (ongoing effort)
- ^{39}Ar spike run before the UAr deployment
- UAr run commissioning will begin next year

Special Thanks

- SCD for artDAQ: K.Biery and group
- A lot of help from SCD *art* group
- CCD for data transfer: R.Pasetes, V.Grigaliunas, and A.Bobyshev
- CCD for database mirroring: S.Lebedeva
- PPD EED for PMT bases and continued support of Trigger: B.Baldin
- PPD MD for argon handling system: C.Kendziora
- PPD DDO for construction and support of argon handling and purification:

  PAB technician group under R.Davis