**Draft plan for FRS Engineering run 2019**

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## General :

* Several dry runs in period May-November 2019, possibility for extension in November (if necessary)
* Engineering run with beam: 6 weeks (Nov. 11 – Dec. 15, 2019), online (with beam) during Mon-Fri 8-18 o’clock, other times: offline work (documentation & analysis, simulations & preparations)
  + FRS main branch, slow extraction: SIS – TA – S1 – S2 – S3 – S4,   
    3 different energies (1000, 800, 600 MeV/u)
  + SIS –TA – S8 (slow extraction)
  + SIS – TA – S6 (fast extraction), ESR injection/storage
  + Training
  + Optional activities

## 0) Dry Runs to test the latest developments in the FRS control system

Many applications for operation of the FRS have been developed; testing of all routines is needed during next few months, i.e.: before the engineering runs in November.

Among the list of features and programs to test are:

* Target alignment knob
* Machine model operation with and without energy loss calculation
* Magnetic cycling of dipoles
* Read/save/recover of different settings
* Scaling procedure
* Monitoring programs
* Training on new FRS control programs

We suggest to spend ~1 day every two weeks to test the developed applications. The list of days is as follows:

|  |  |  |
| --- | --- | --- |
| Dates | Type | Purpose, comments |
| 20-24.05.19 | General | Java update |
| 04.06.19 | Soft | Test new features updated in Sep 2018 and March 2019 |
| 21.06.19 | Soft | Test debug of the above |
| 02.07.19 | Soft or hard | Pre-cycling (if hardware available) |
| 16.07.19 | Soft or hard | Pre-cycling (if hardware available) |
| 30.07.19 | Soft or hard | Full “fake” operation to see problems |
| 20.08.19 | Hard | (could be skipped if program on track) |
| 27.08.19 | Hard | Test problem resolution (or skipped if everything works) |
| 09.09.19 | General | Test machine model and pattern with ESR? |
| 24.09.19 | Hard | Last debugging/ operator training |
| 08.10.19 | Hard | Operator training (short) |
| 15.10.19 | General | Final repetition before engineering runs |

Table: **soft dry runs** means only software and debugging, closed HFS area (S4), test control system and communication to devices; **hard dry-runs** means possibility to have a pattern with the whole chain being tested; in **general dry runs** some specificities shall be tested (e.g. machine model FRS/ESR)

# **1) Primary beam SIS-TA, TA-S4, new SIS energy, detector signals, ID (including verification via tagging)**

a) Transport beam to TA

* **load and set dataset with Bρ change**
* **SE01 + CG’s: align beam on CG01 and CG02 (MIRKO + “knob”)**
* **SC00 - SC02 for counting**
* **IC for counting and current measurement**
* calibration Sc’s+IC+SE01
* histogram PTD (particle time distribution)
* extraction efficiency measurement

b) Primary beam to S4

* **load and set (parammodi) a dataset TA-S4**, go from focal plane to focal plane with attenuated beam, pre-cycle and center the beam at all focal planes; test whether automatic interlock works properly; check/adjust y-position of beam with steering magnets (“knob”, TRIM, MIRKO)
* **Check positions at S1-S4 with MWPCs (x and y) and TPCs (x; y needs calibration; will be done later if MWPCs work properly), record file at every focal plane**
* **save dataset**
* check position at S1 with – CG11, S1-slit
* **Check function of current grids (CG11, 21, 31)**
* calibrate TPCs S2-S4 (with de-focused beam)

c) Particle ID, DAQ and online analysis:

* **Check raw signals and spectra of detectors for particle ID (SCI41, MUSIC41/42,** travelling MUSICs, Big MUSIC
* **Insert SCI21, check raw signals and spectra**
* **Scale S2-S4 and obtain first TOF/MUSIC calibration point**
* Brho: monitor the u\_hall in DAQ, use ρ\_eff (determined with primary beam + minimum matter)
* **Change SIS energy 2x** (change Bρ), check save and restore and scale of separator), **scale FRS sections accordingly and pre-cycling, record TOF/MUSIC spectra for tof calibration point,** “identify” primary beam at different Ebeam, position, or angle
* **IO tests: dispersion measurements (TA-S1/S2/S3/S4, S2-S4, etc.)**
* Defocus the beam (learn how to do it with LSA!) at S2 and S4, calibrate TPCs
* Calibrate SE01, IC01, SCI01
* Check efficiency of TPCs, plastics, and MUSICs
* Calibrate position by (Sci TL – Sci TR) and dE by Sci
* Check S2 degrader thickness with beam (to verify proper positioning of degraders)
* ID tagging by mass or isomer or alpha (heavy fragments)

## 2) Beam to S8 (slow extraction)

a) Switch branch (SIS-S2 fix, modify settings S2-S8)

b) start detectors, check signals, alignment of primary beam up to S8, using…)

c) …etc. (details to be added)

## 3) Beam to S6, fast extraction

a) …similar procedure as before

b) injection/storage of primary beam via FRS into ESR, in close cooperation with ESR group

## 4) Training of people

* 5…7 days training for NUSTAR Beam Team

## 5) Further options (if time is available):

* **Start/run approved experiments**
  + **S469, Purushothaman: dE/dx measurement S2-S4, solid/gas targets, (Pb/U)**
  + **S479, Kraft-Bermuth, Detector test Calorimeter, (Xe-U)**
  + **S470, Pietri, TEGIC (A>120)**
* **Detector tests for approved experiments:**
  + **Ion Catcher**
  + **AIDA, Despec equipment, finger scintillator**
  + **Active stopper**
  + **…**
* Test FRS optical elements (e.g. polarity of sextupoles and steering magnets)
* Test other optical modes (e.g. achrom. TA-S2 for S459/S443)
* Develop new optical modes (e.g. high-transmission mode for NUSTAR)
* Increased yields: very thick targets (Ag, Xe or similar/lighter)
* Tests of other detectors
  + Tests GEM-TPC
  + Travelling MUSICs
  + Cherenkov
  + …