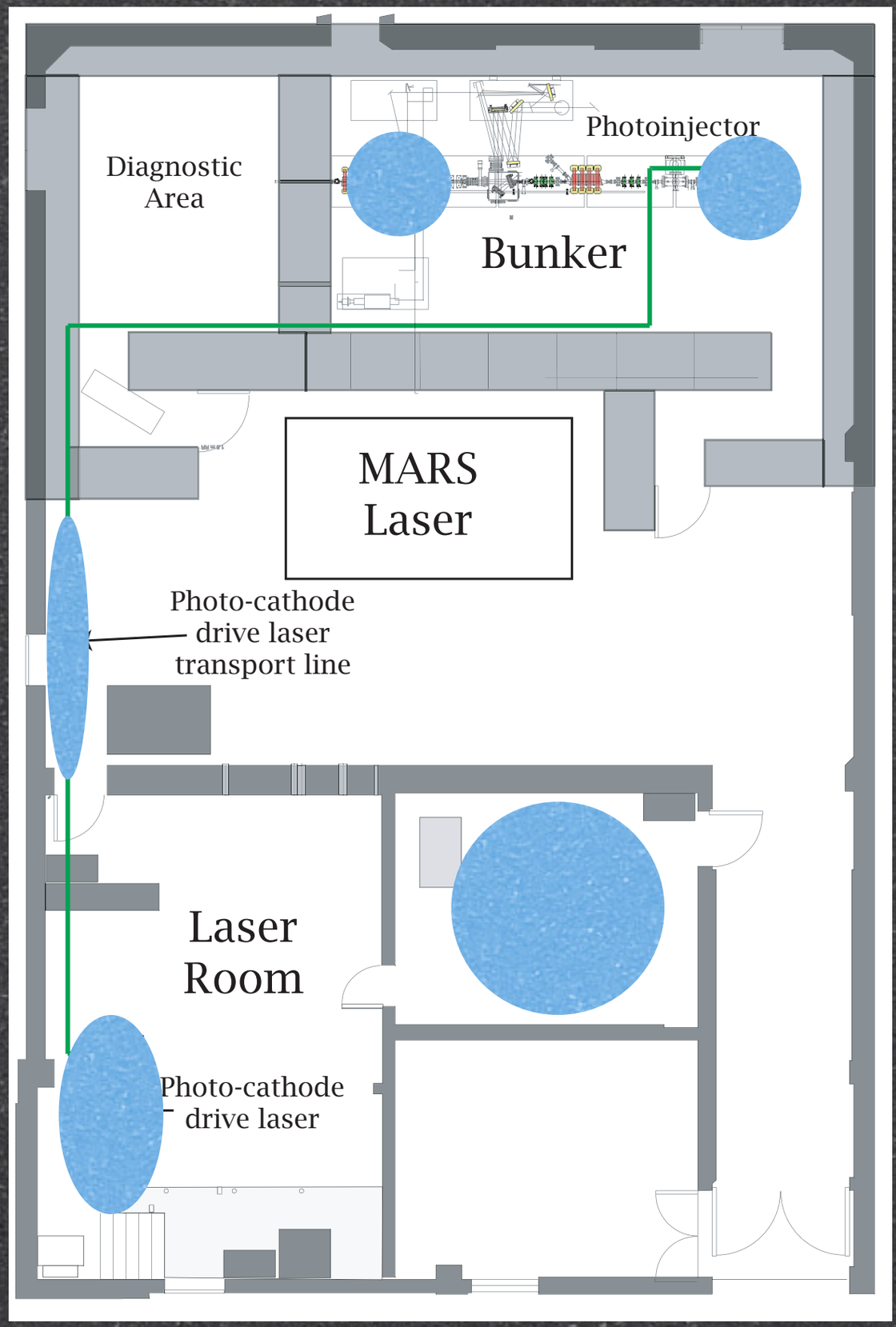
The Neptune Photoinjector

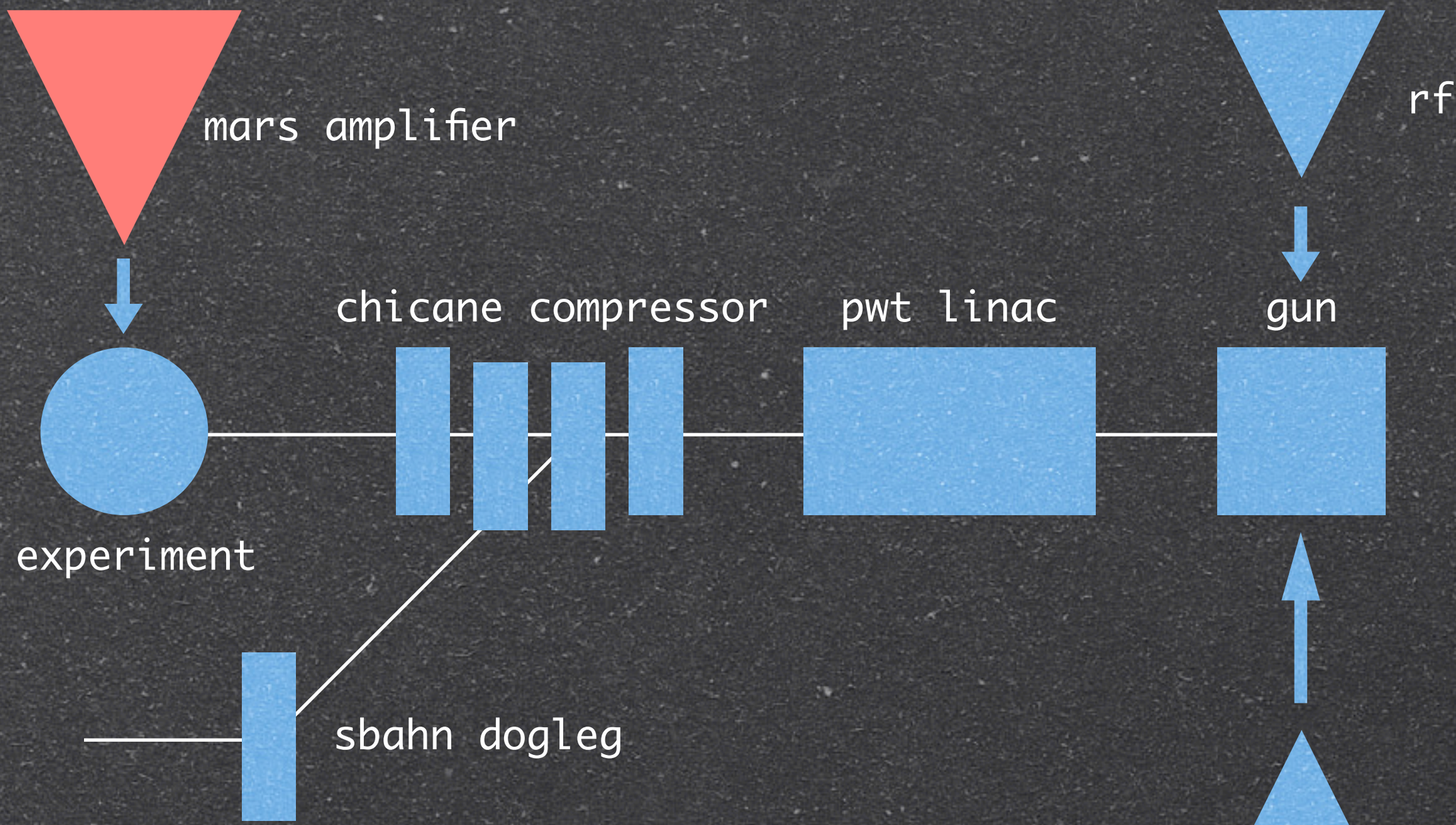
Past Performance | Present Status | Future Plans

Gil Travish

Physical Layout



Block Diagram



Rough Timeline

- Beatwaves
  - Velocity Bunching
    - Big Shutdown
      - SBahn
        - IFEL
          (electrical incident)
          (heroic efforts)
          More IFEL

Status During Beatwave Runs

- Single Crystal Cu Cathode
- Linac phase & temp drifts
- Constant gun arcing
- Laser power supply shutdowns
- Low charge

Past Performance

Energy (max)	12 MeV
Energy Spread (rms)	0.3 %
Emittance	6 μm (20μm) ← with window
Charge (max)	200-300 pC
Bunch Length	8 - 9 ps green
Compressed	350 fs ← velocity bunched 600 fs ← chicane
Spot Size @ IP (sigma)	100 μm

Upgrades Performed 2002 - 2004

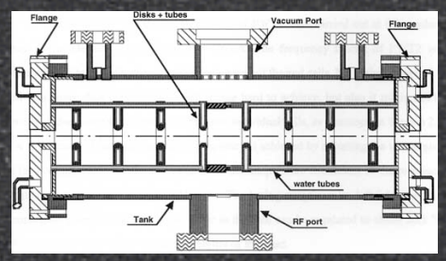
- RF
- Gun
- Laser
- Optics
- Diagnostics
- Controls

Upgrades: RF

- Klystron failure lead to replacement
  - 3rd time was the charm
  - Using PEGASUS klsytron

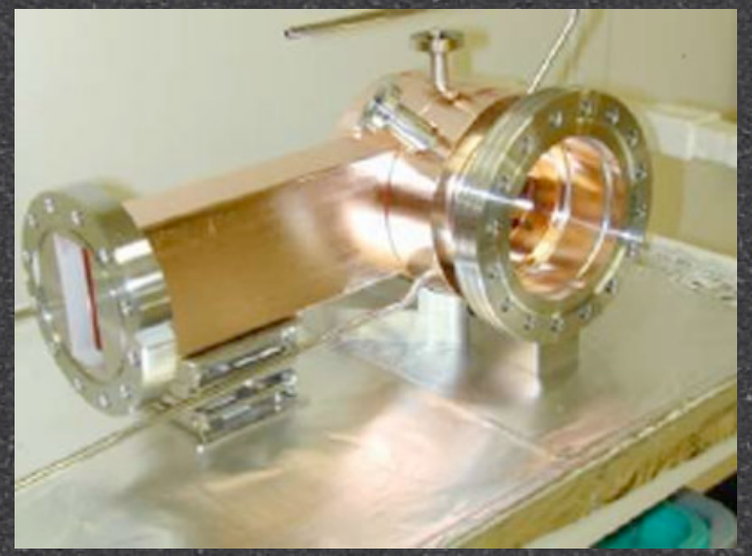
- Waveguide cleaning and RF diagnostic improvements
- Added RF feedback and monitoring

- Improved modulator and HV systems
- Linac temperature control



Upgrades: Gun

- Replaced gun
- Replaced cathode
  - Mg
  - Later, after damage, back to Cu
- Ti:Sub pumping added

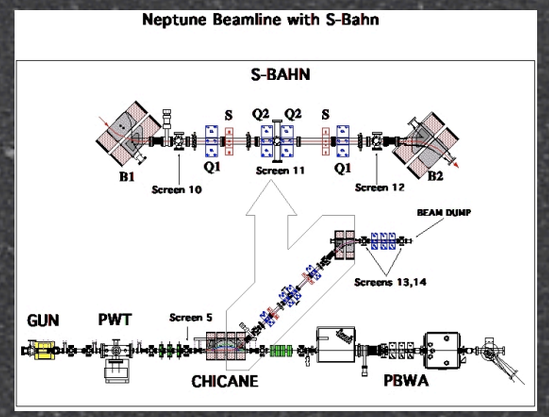


Upgrades: Laser

- Added HV power supply to seperate regen + multipass
- Tested new nonlinear crystals
- Built fiber temperature control
- Numerous other less fruitful studies

Upgrades: Optics

- Installed S-Bahn beamline
- Calibrated Compressor Spectrometer
- Installed large quads for improved transport



- Expanded power supply and degaussing controls channel count
- Improved alignment

Upgrades: Diagnostics | Controls...

- Improved camera intensity controls
- More optical diagnostics
- New control computers
- New video system
- ...

Present Status

Energy (max)	15 MeV
Energy Spread (rms)	0.3 %
Emittance	5-6 μm
Charge (max)	600 pC (Mg) / 200 pC (Cu)
Bunch Length (FWHM)	15 ps green
Chicane Compressed (rms)	600 fs
Spot Size @ IP (sigma)	<100 μm diagnostic limited

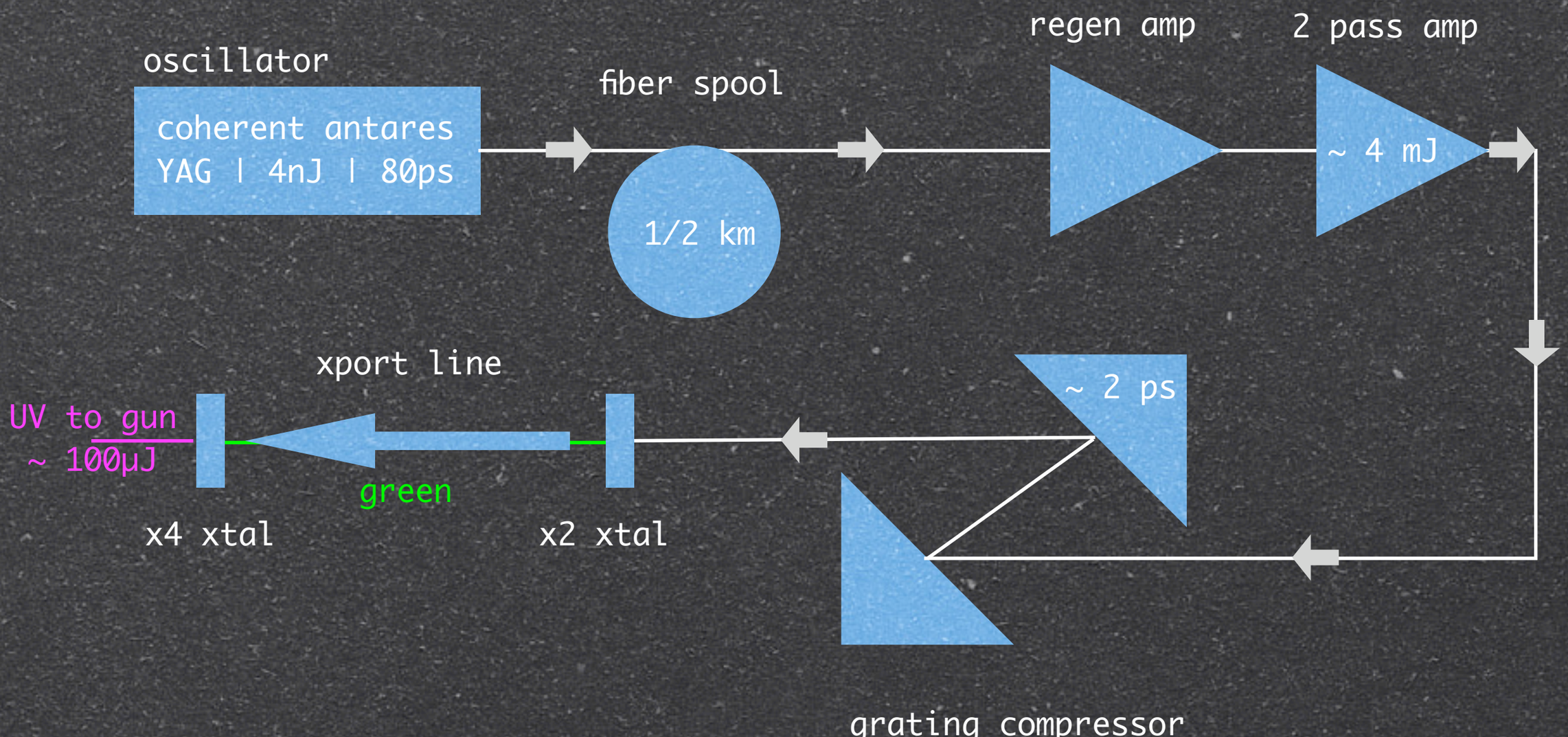
(lack of) Stability

- Linac and laser phase drifts seem dominated by temperature drifts.
- Laser energy fluctuates ~ 20% with 100% pk-pk not uncommon.
- Laser spot changes
- Limited simultaneous acquisition channels make correlations hard to find.

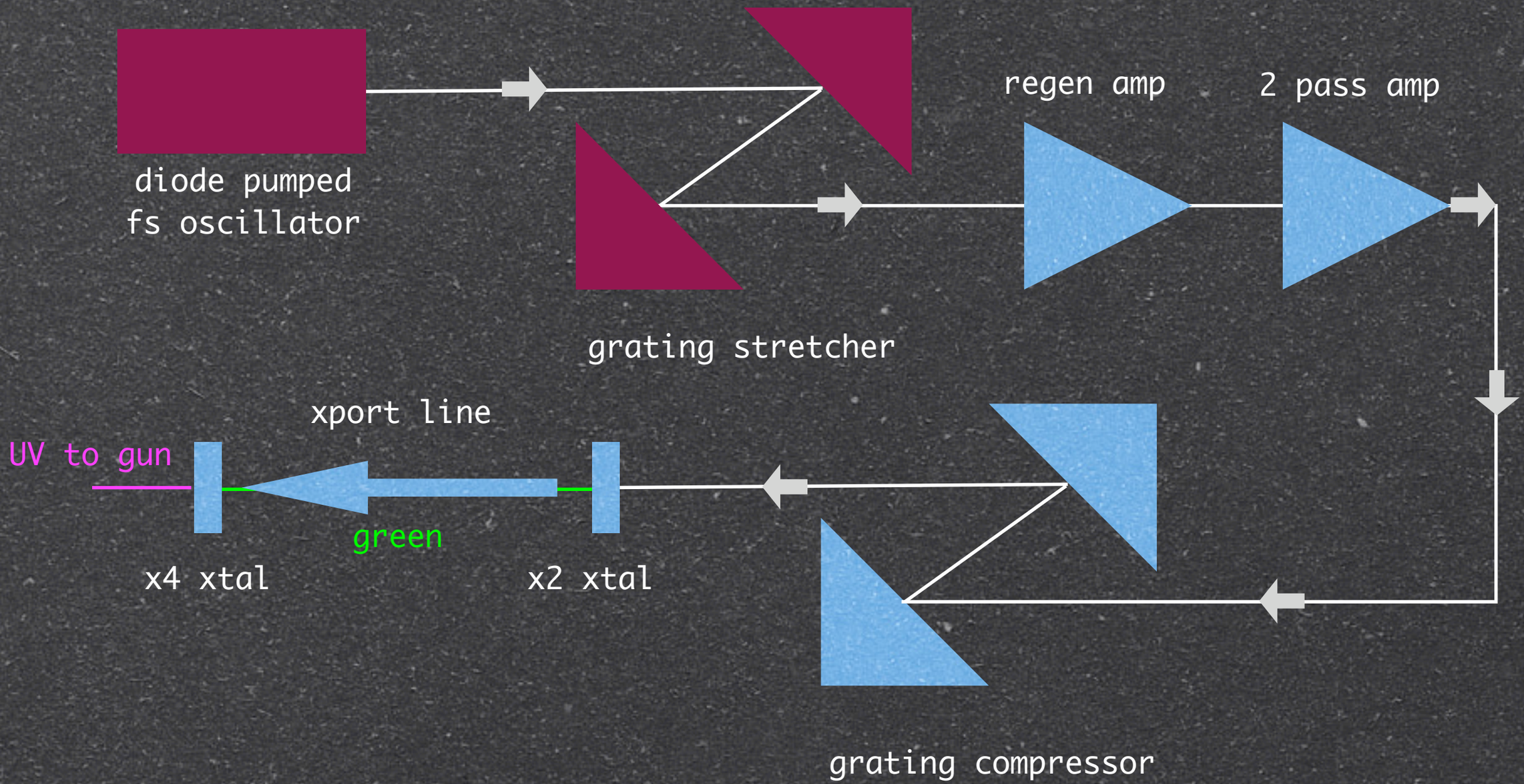
Sources of Pain

- Large time investment in repairing sub systems
- Drive laser older than some of our students
- Low charge; poor charge stability
- Can’t laser clean cathode due to fluctuations
- Aging power supplies - high failure rate
- Lack of spares and old equipment means long down times.

Existing Laser Diagram



Proposed Laser Diagram



+ Diagnostics: Single Shot Autocorrelator | Cameras | Pointing Monitors

Future Soft Goals

- Shorten time to data
  - Increase useable beam time
  - Ease learning curve
  - Reduce experiment interruptions
- Improve diagnostics and controls
  - New types of beam interactions
  - Finding correlations
  - Better statistics

Future Steps

- Reliability
  - Tend to deferred maintenance
  - New power supplies
  - Increase spares inventory
    - Continued reliance on PEGASUS as testbed and spares inventory
- Stability
  - New hardware
  - Improved thermal management
  - Find correlations

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- New oscillator
  - Diode pumped | grating stretched | high stability (< 1%) | high reliability | better lock-to-clock
- RF
  - Spare KW amp
  - Additional couplers & RF detectors
  - Solid state modulator PS & controls | more interlocks
- Controls
  - Multichannel waveform DAQ system
  - New steering magnet supplies
  - New optical diagnostic intensity control

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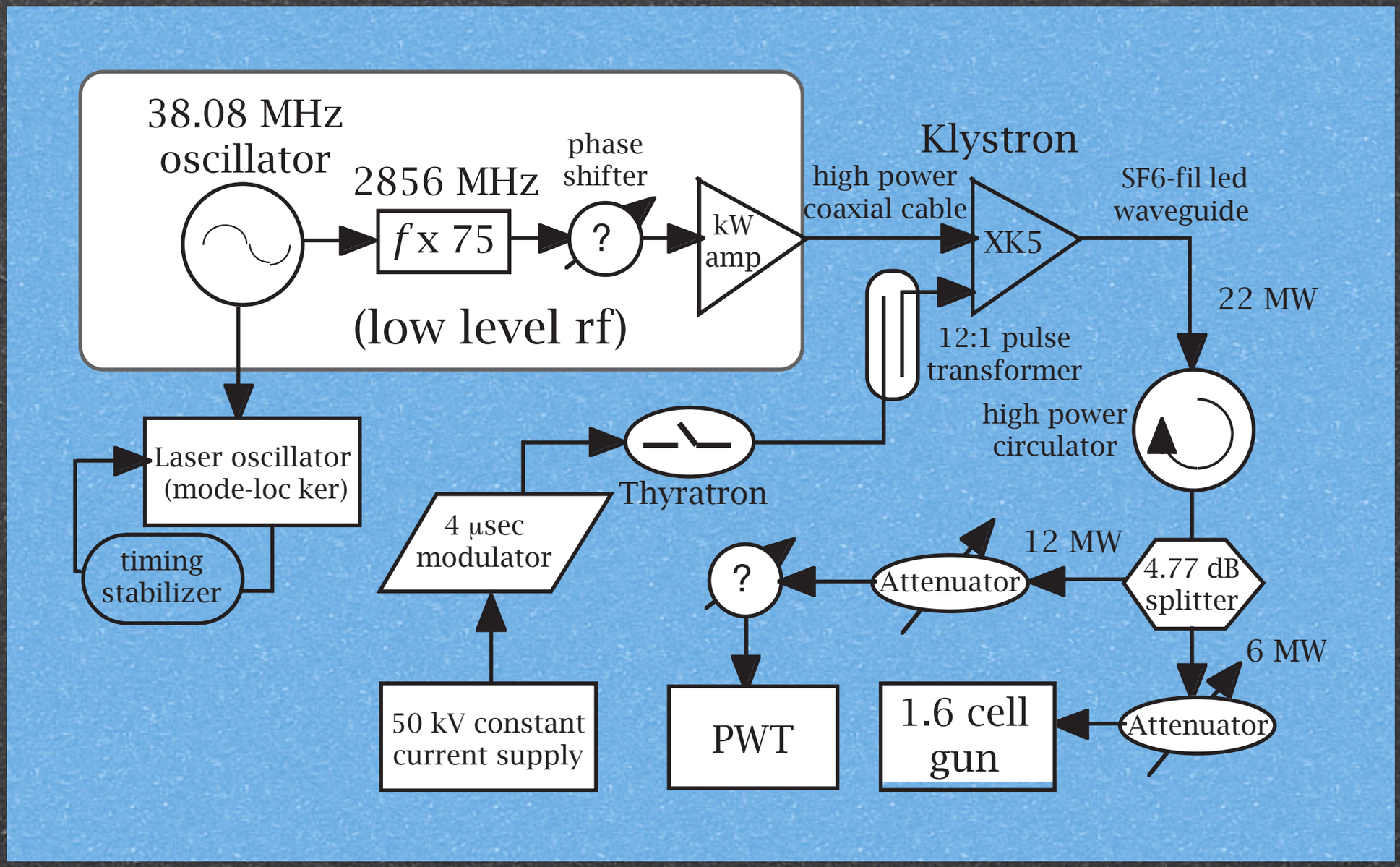
Neptune RF System



Neptune Drive Laser