BMX demonstrator at BNL

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Anže Slosar, BNL

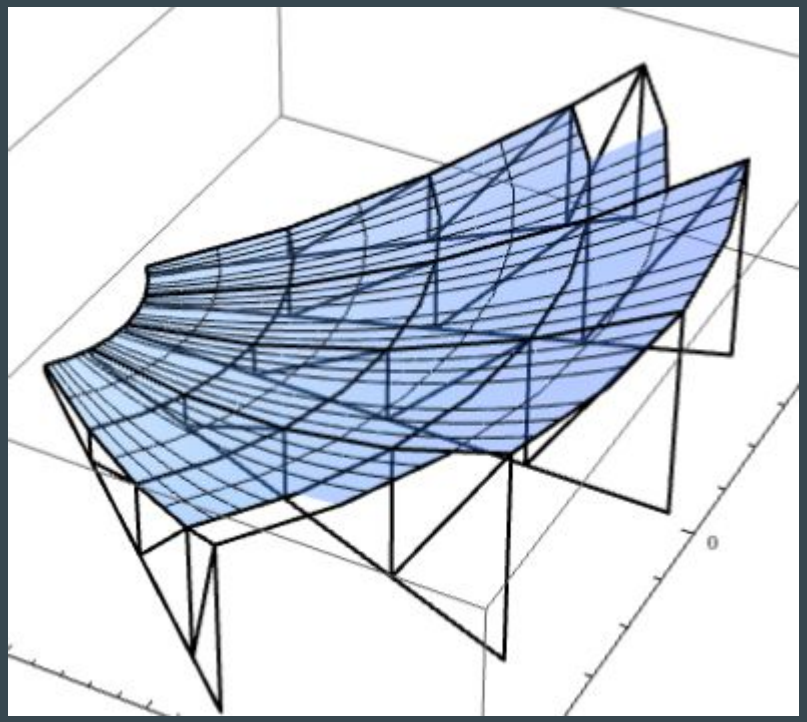
What are we doing

- Received 2 LDRD funding to the level of ~ $1.3 mil to do something future related
- Non-negligible amount of funding, but not enough for a real competitive experiment
- Can build a small test-bed instrument, to learn what we are doing
- Goals:
  - build a 21-cm toy prototype to test various new ideas
  - demonstrate complete understanding of the system to the noise level
  - demonstrate system noise
  - demonstrate amplitude and phase-tracking using tone injection: simultaneous single-dish and interferometric operations
  - Get a detection at low-z in cross-correlation

The team

- At BNL:
  - Chris Sheehy, Goldhaber fellow, full time since 9/2016
  - Anže Slosar
  - Paul Stankus, the dish master
  - Paul O'Connor
  - Students: Evan Arena, TBD
- At Michigan:
  - Jeff McMahon
  - Students: Remington Gerras, Minhyun Kay
- At Arizona:
  - Phil Mauskopf
  - Hamdi Mani
- At Princeton:
  - Daniel Marlow

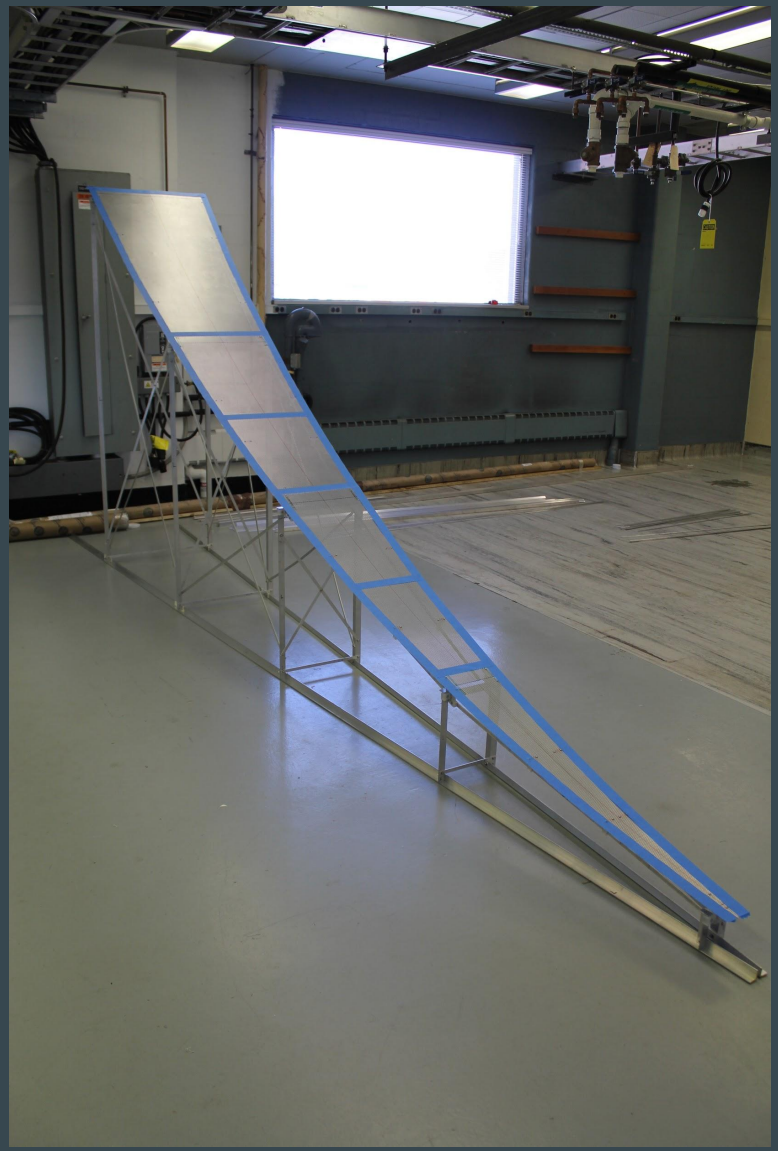
The antenna

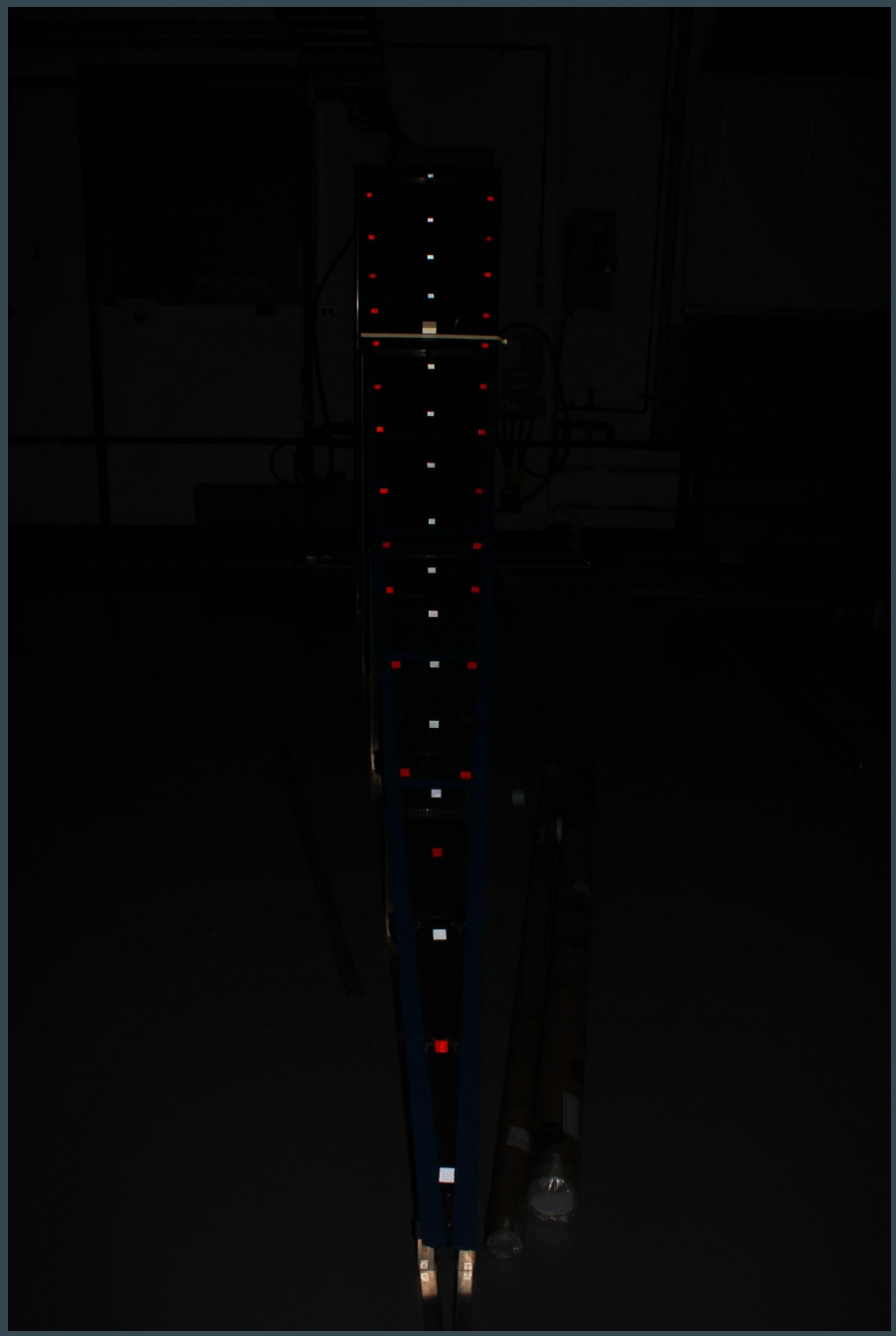


- Home-brew 4m dish
- Start with one, bootstrap to 2x2 compact array: smallest non-trivial FFT.
- Underilluminated, surface control an overkill on purpose

- TIROS 18m dish, currently owned by Princeton
- Debugged and tracking. Can get lots of time, but non-local

The antenna petal

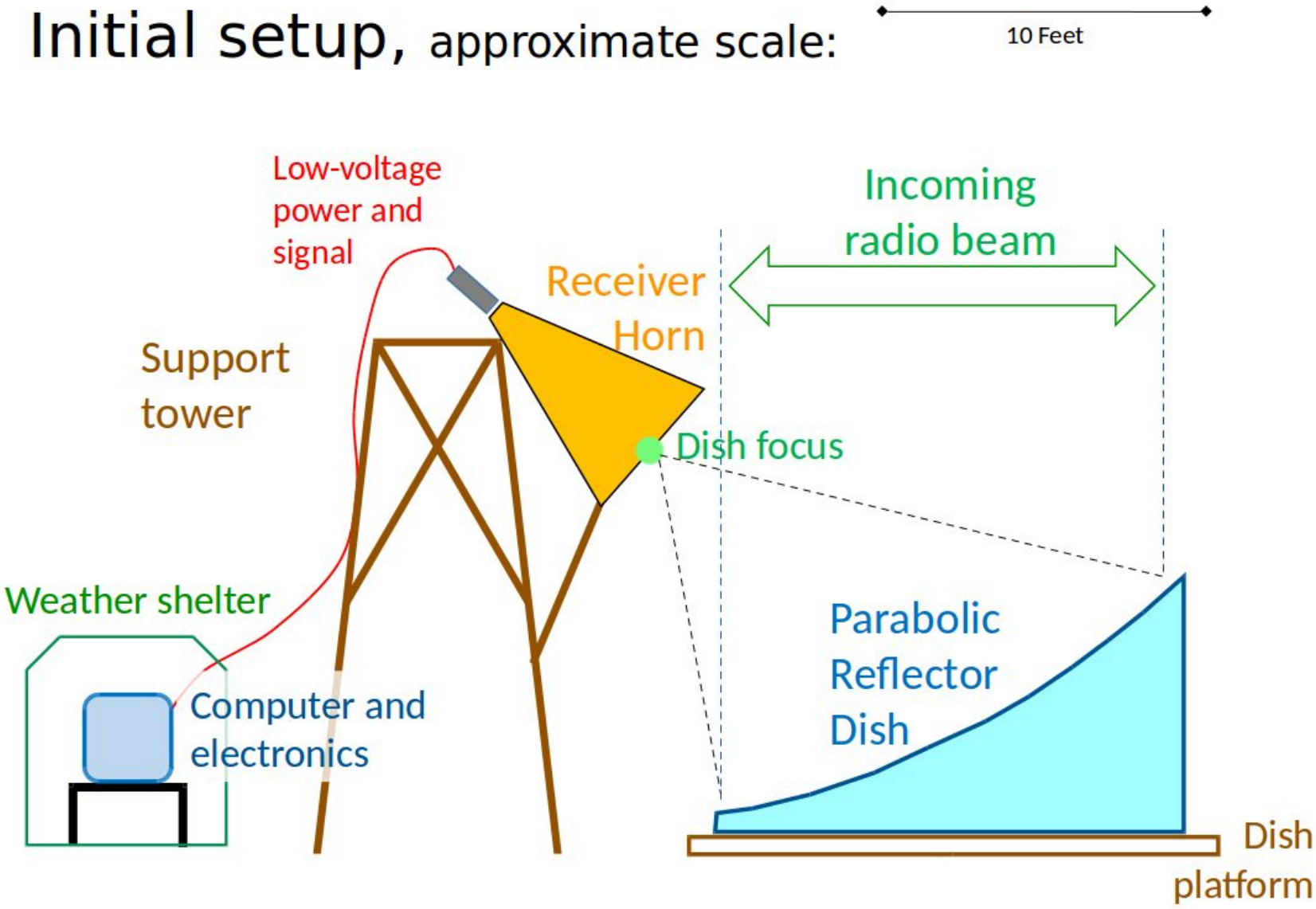




OMT + FEEDHORN

- Horn a scaled-up version of some CMB-inspired magic by Jeff McMahon
- OMT a classical quad-ridge broadband OMT

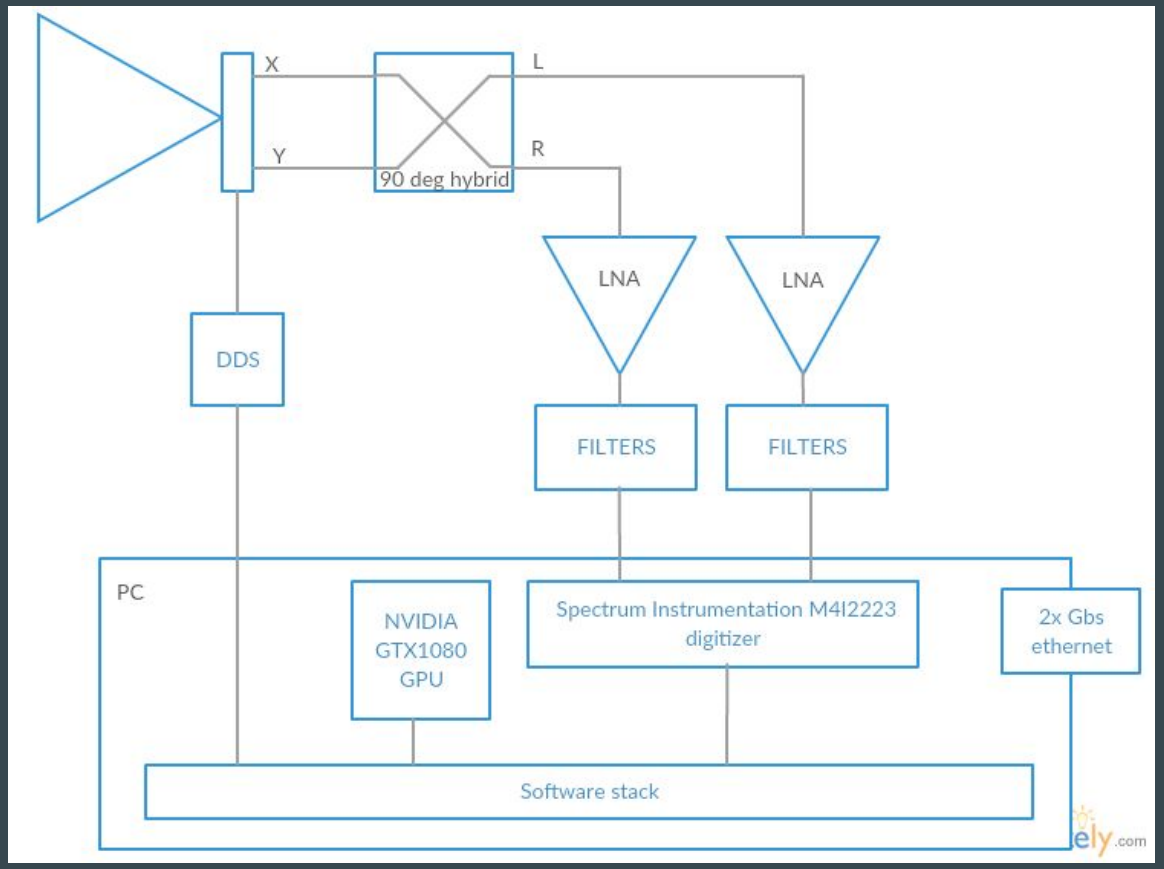
Initial setup, approximate scale:

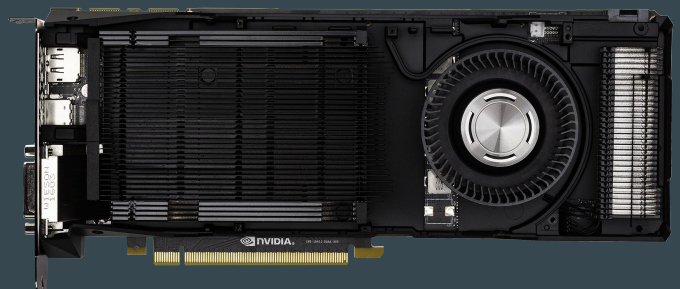


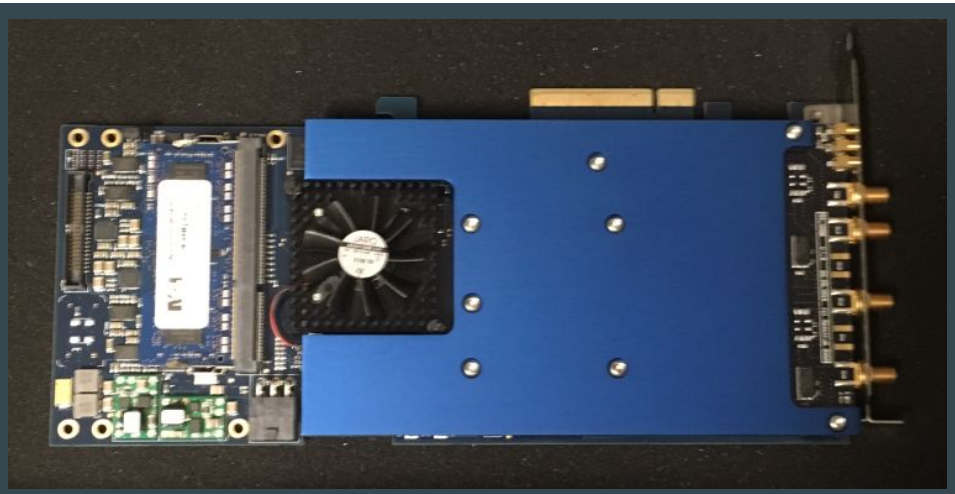
Slide from Paul Stankus

Readout system

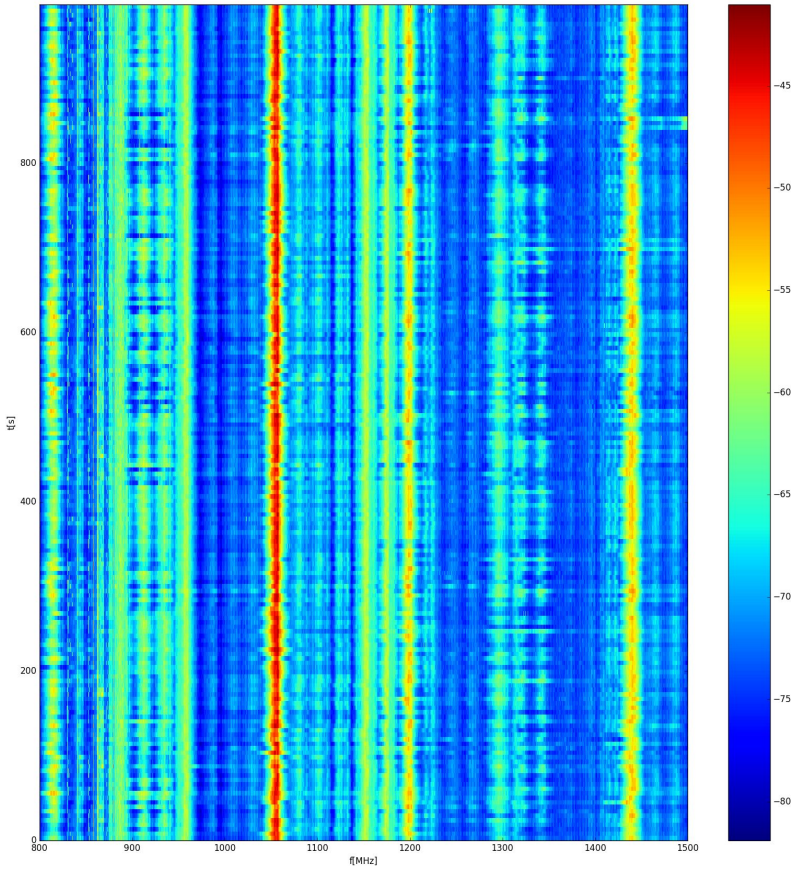
- A system allowing very fast prototyping
- No FPGA bullshit
- 90 deg hybrid to convert X,Y into L,R - borrowed from C-BASS
- Tone injection driven by DDS
- Digitizer can do 2x1.25GS/s with 1.5GHz BW: will rely on undersampling to get 1000-1500MHz in second FT image
- Preliminary test show that we can do very large FFTs (100ms) in real time for a single dish: for correlators we can always rely on Gbs ports to shove data around







The site



- RFI as measured by Signal hound
- Pretty terrible (but note not everything above is real)
- Locally optimal
- Just passed ESH review

Conclusions

- Building a small demonstrator
- We hope to achieve full system understanding to the noise level
- Two sites:
  - BNL site: 4 dishes, pure demonstrator
  - Princeton site: single 18m dish, could do something useful at low-z
- should get on the sky very soon
- Barrier to entry is zilch: **come and help us!**