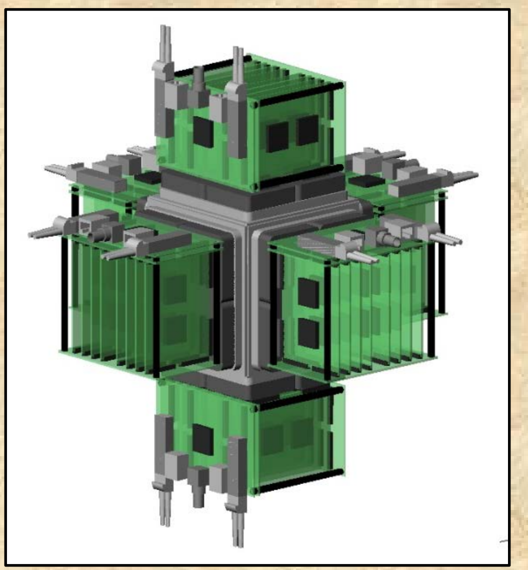
The mini-Time-Cube
A Portable Directional Anti-Neutrino Detector
Introduction

Review of mTC at LLNL 12/11/2012



John Learned

Univ. of Hawaii:

Agenda as Presented at NGA Review in 10/4/12 at UH

Material available upon request to JGL

0830 *Gather at EWC, coffee and pastries, meet and greet*
0900 **Introduction to mTC project at UH**, *John* THIS TALK
0930 Go to **laboratory in Watanabe Hall** for show and tell

1030 *back at EWC for coffee break*

1100 **Mechanical overview**, *Marc*
1120 **Electronics overview**, *Luca*

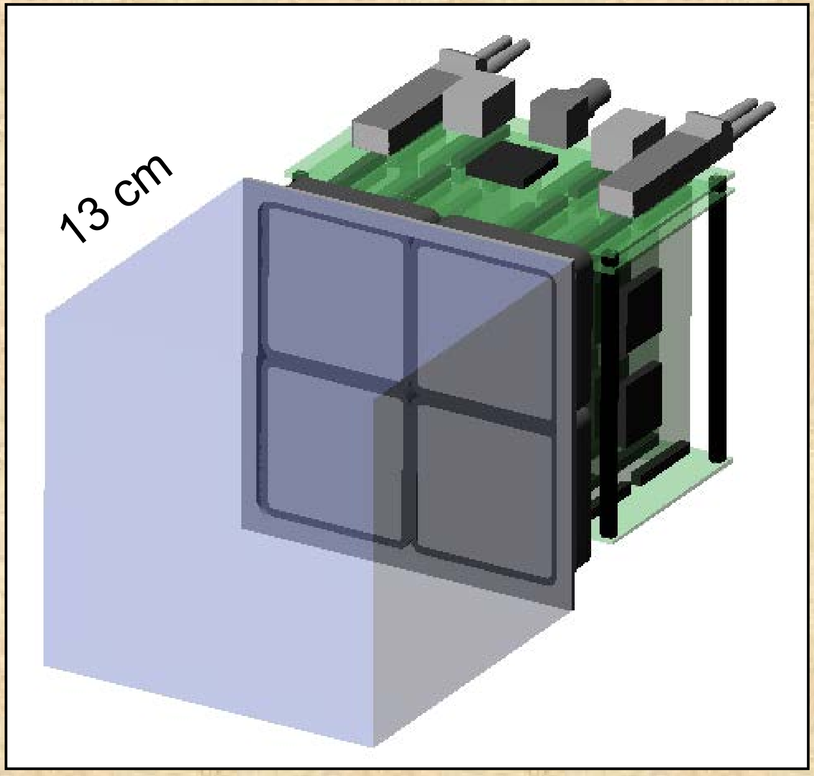
Noon *Lunch on campus*

1300 **HV system**, *Joshua*
~1315 (Adm) Michael Vitale, Director of ARL Hawaii, will come by to meet NGA folks.
1320 **Calibration laser and sources**, *Shige*
1340 **Data Harvesting and database software**, *Serge*
1400 **Event simulations**, *Stefanie and Mich*
1430 **Event display and reconstruction**, *Glenn*

1500 *Break*

1530 **New physics Prospects (double beta decay? Sterile neutrinos?)**, *Steve*
1600 **Schedule for finishing mTC**, *John and Chris*
1630 **Future directions discussion**, *All*
1730 *Finish*

mTC Idea



2.2 liter

Imaging via fast (<100 ps) timing, not optics (time reversal imaging).

Small portable 2.2 liter scintillating cube, Boron doped plastic, later 6LI.

1536 pixels cover 75% surrounding faces.

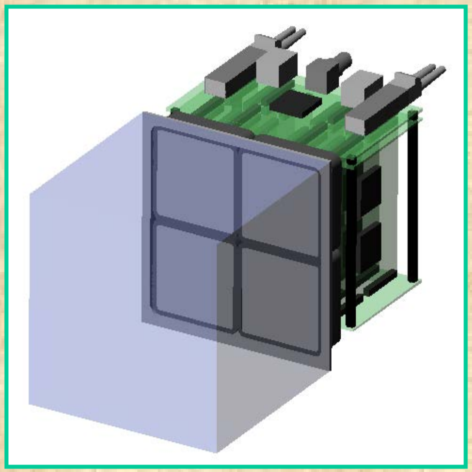
Millimeter event reconstruction.

Reject noise on the fly.

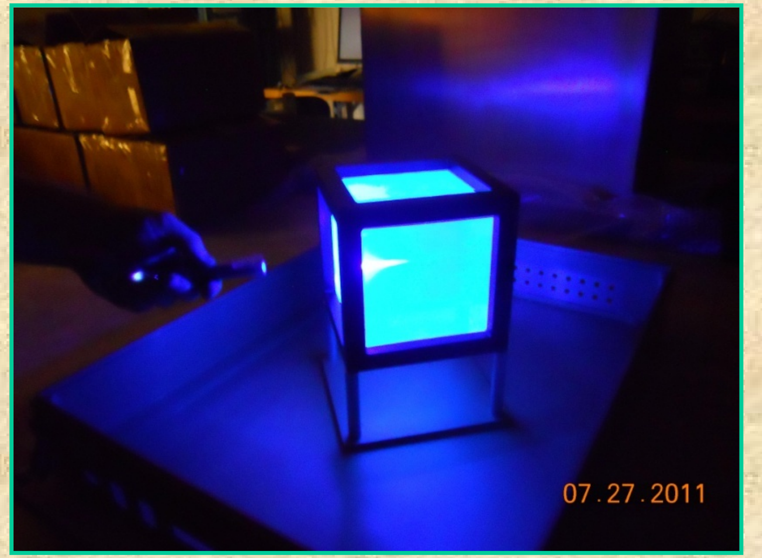
Get some neutrino directionality through precise determination of topology.

~10/day electron anti-neutrino interactions (inverse beta decay signature) from power reactor (San Onofre).

mTC Virtues

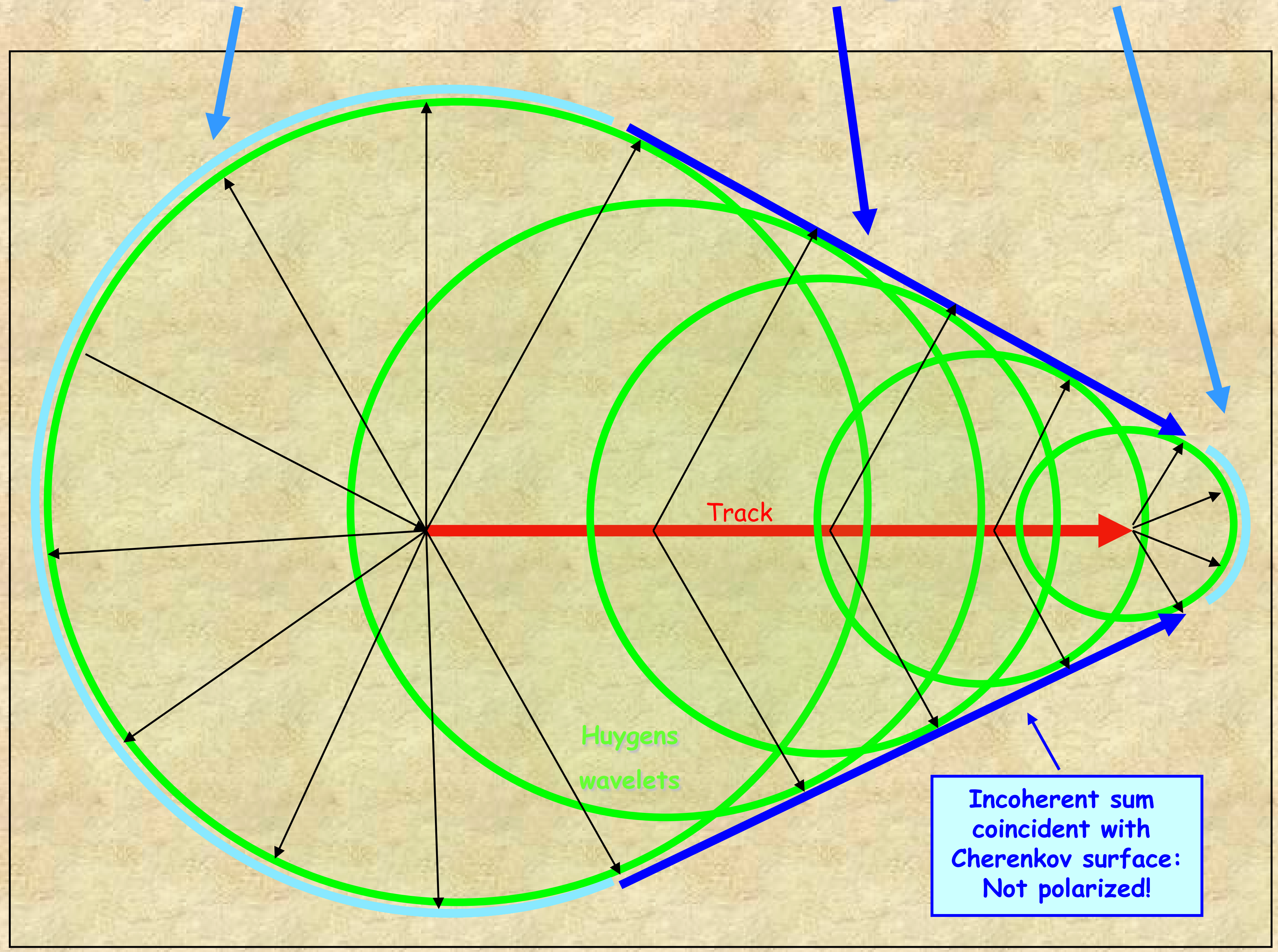


- Small size avoids positron annihilation gammas which smear resolution (X_o ~42 cm).... gammas mostly escape, permitting precise (mm) positron creation-point location.
- Fast pixel timing (<100ps) and fast pipeline processing of waveforms rejects background in real time. UH made state-of-the-art electronics, with huge value added
- Having many pixels plus use of first-in light permits *mm* precision in vertex locations.
- Neutrino directionality via precision positron production and neutron absorption locations.
- No need for shielding (unlike other detectors).
- Whole portable system footprint ~1mx1m, rack size, needs 110AC power and wireless internet.
- Feasible even in high noise environment, near reactor vessel, at surface (eg. in a truck).



Using first light gets topology well below decay time of scintillator.

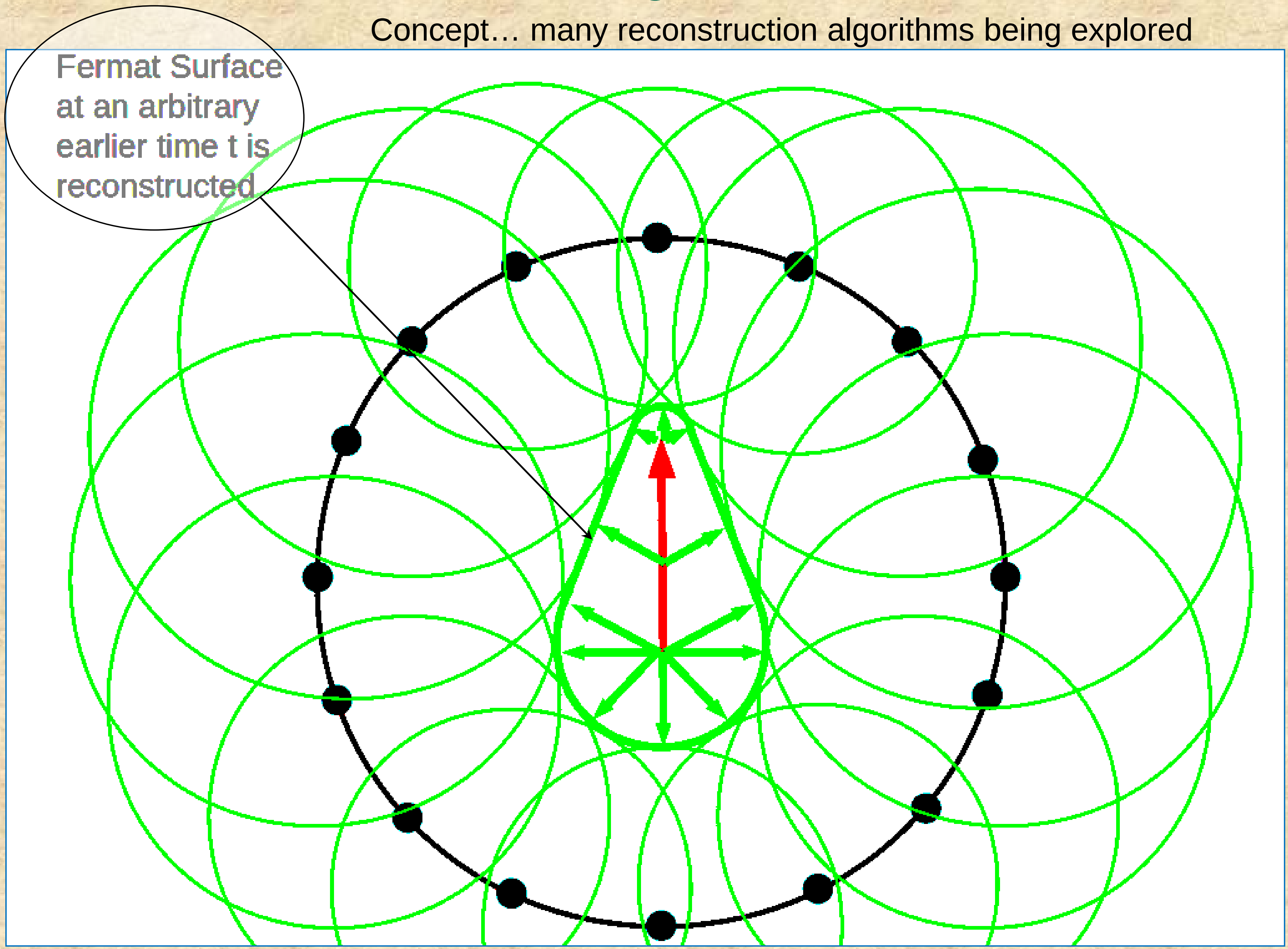
Snapshot of the Fermat Surface for a Single Muon-likeTrack



J. Learned arXiv:0902.4009v1

Time Reversal Image Reconstruction

Concept… many reconstruction algorithms being explored



Goals of mTC Program

As JGL presently sees them

Short term (year scale)

- Build demonstration 2 liter prototype using state of the art technology
- Test in laboratory with sources
- Take to reactor and count neutrinos, demonstrate background rejection.
- Demonstrate reconstruction ability in software
- Explore other than present scintillator (Boron loaded)… ideally 6Li
- Explore utility for immediate physics applications
- Publish results, present to scientific community

Longer Term (several years)

- Design for larger scale Time Cube (m^3 scale), using LAPPDs
- Explore utility for km range monitoring in portable containers.
- Push on prospects for large scale detectors with some angular resolution

Immediate Program

As of Fall 2012

Biggest problem: Electronics are > 1 year behind schedule
Relied on need by BELLE II need for these, but this program has fallen behind schedule

Hence our students with Gary Varner and Luca Macchiarulo have taken over the realization of the electronics for mTC (in parallel with BELLE)

Get mTC up and running with one output per PMT (24 x $(5cm)^2$ pixels)

With this we can do studies of sensitivity, noise rates, neutron tagging etc.

Aim for data during this Fall 2012.

Real electronics coming along in Fall 2012 – Spring 2013.

Take to reactor in mid-2013.

Second biggest problem: Slowness of release of funds… takes more than six months.

UH has given us $50K to boost electronics production.