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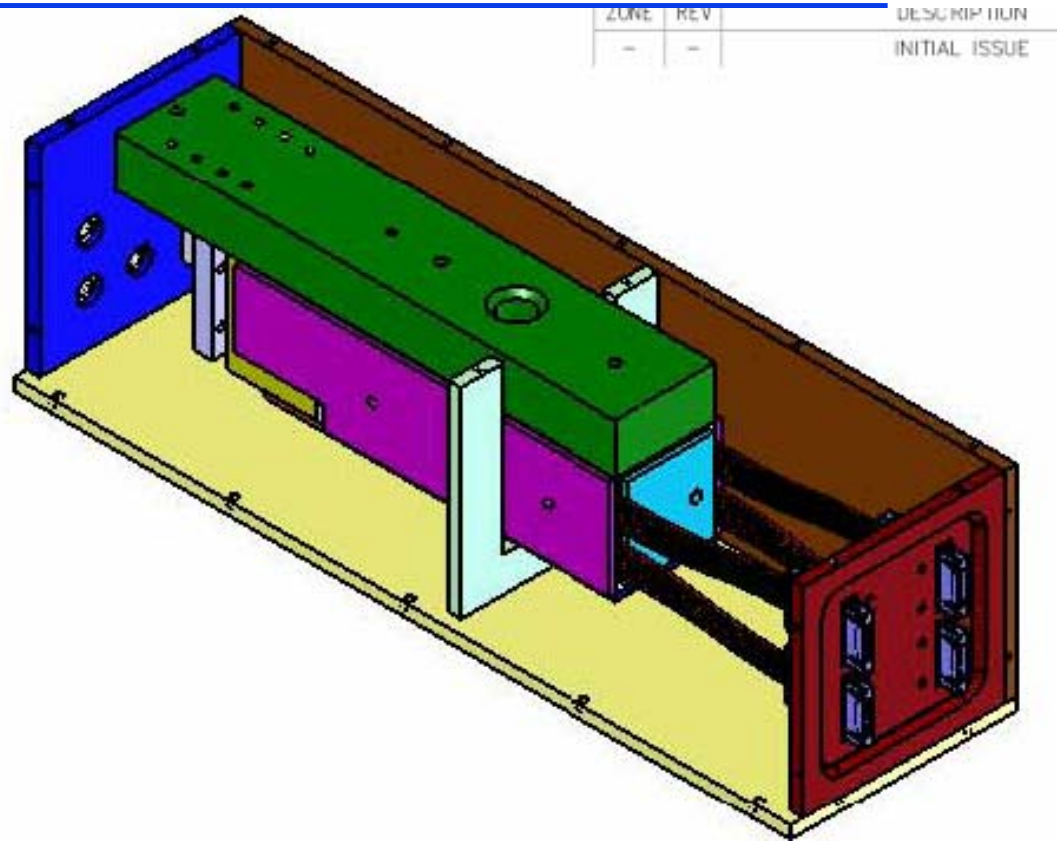
Optical acceptance of the DDK connectors or What exactly do you mean by transmission?

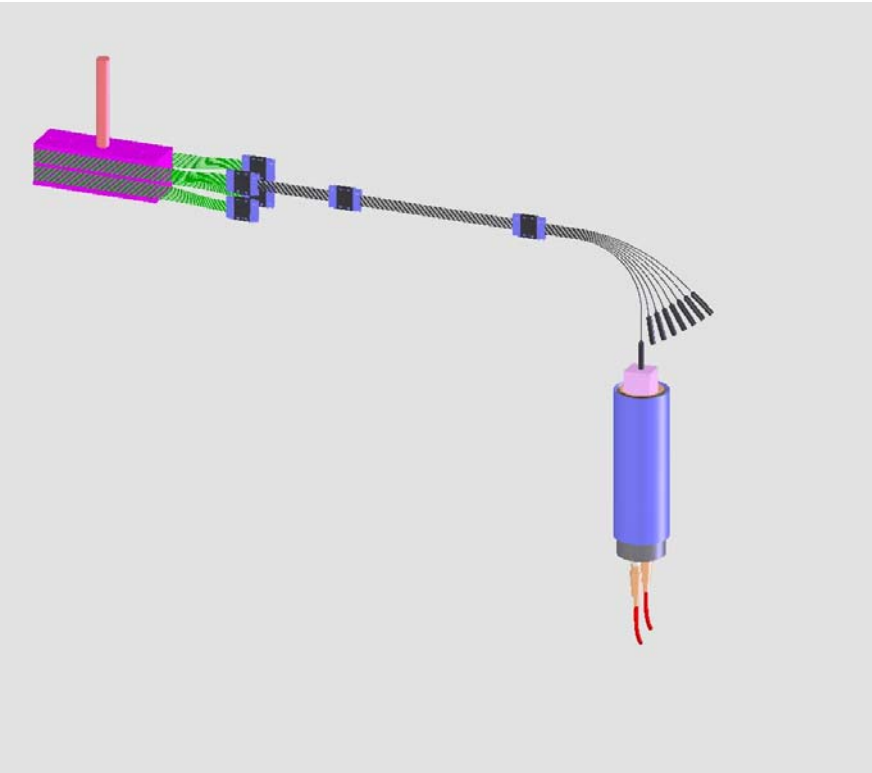
Howard Budd

Light Injector

- Source part of the light injector is contructed
- A wand source is inserted into the hole in the green piece
- The purple and cyan piece is scintillator
- The scintillator excites WLS fiber
- For testing cables LED and pin diodes will be installed



Transmission using Light Injector



- Insert 40 cm jumper into left bottom connector
- Insert 205 cm cable to be tested onto jumper
- Plug 90cm pigtail with Single Fiber Ferrules into Cable to be tested
- Single Fiber Ferrules go directly on light mixer of R580-17
- Measure all the fibers with the Single Fiber Ferrules
- Cut cable in half and insert connectors on both ends

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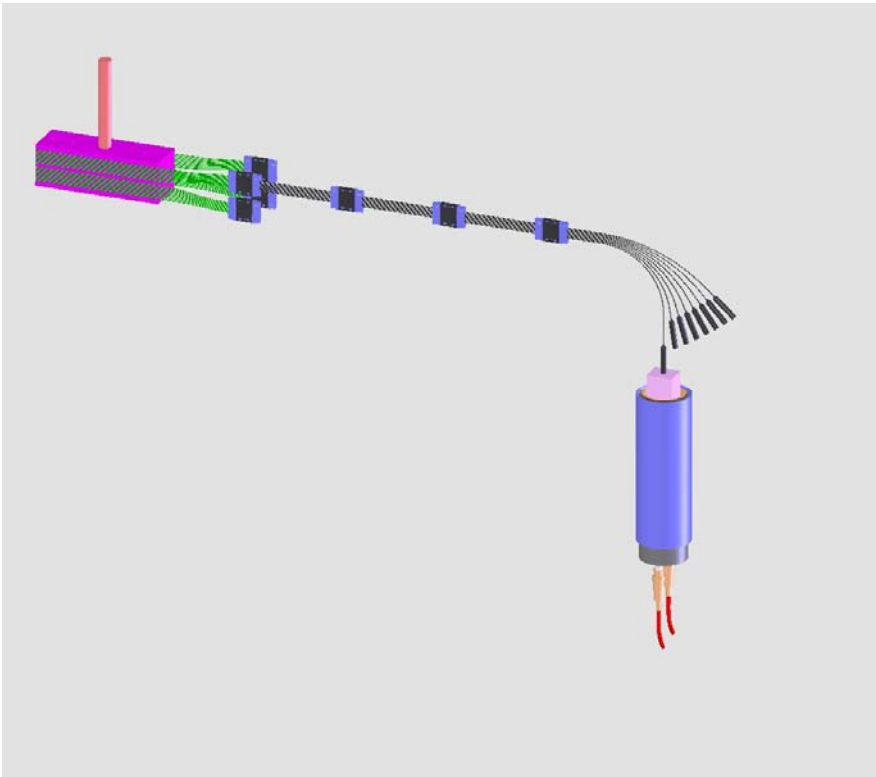
Transmission Using Light Injector



- Eileen in Lab 7 polishes the connectors
- 2 halves connected together in the identical way as before
- transmission (after cut)/(before cut)
- Since it's a ratio the amount of light injected into the light by the light injector should not matter.
- Light Injector Fiber Number 1 is at the top of the connector in the Light Injector Box.
- Transmission is plotted for each Light Injector Fiber Number

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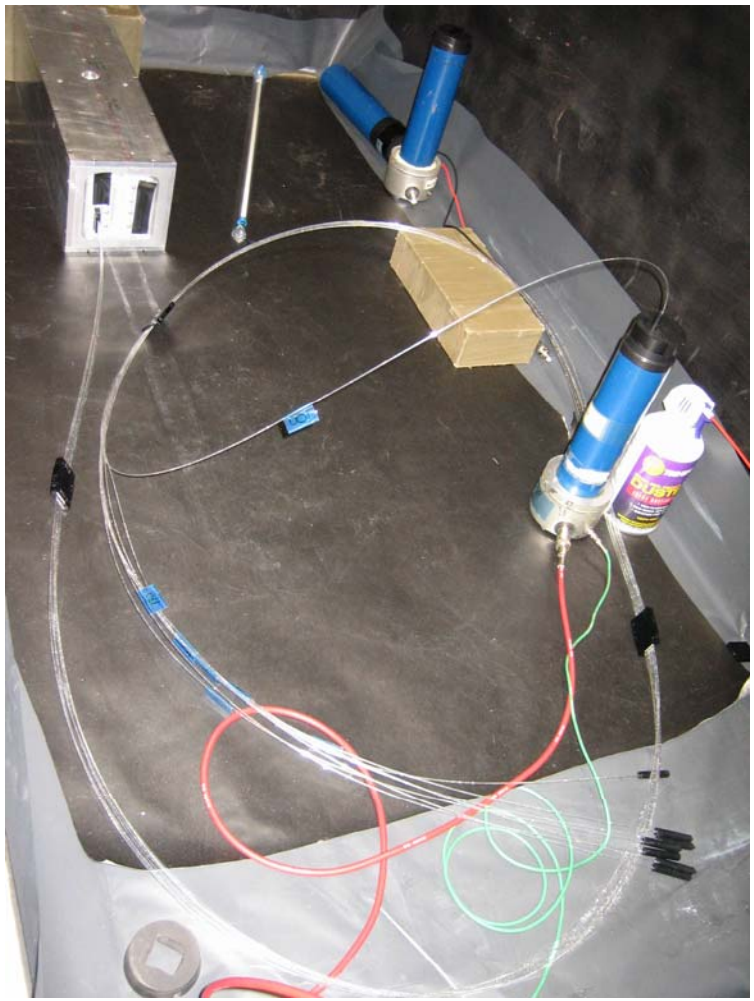
Setup in the Dark Box, with Cut Cable



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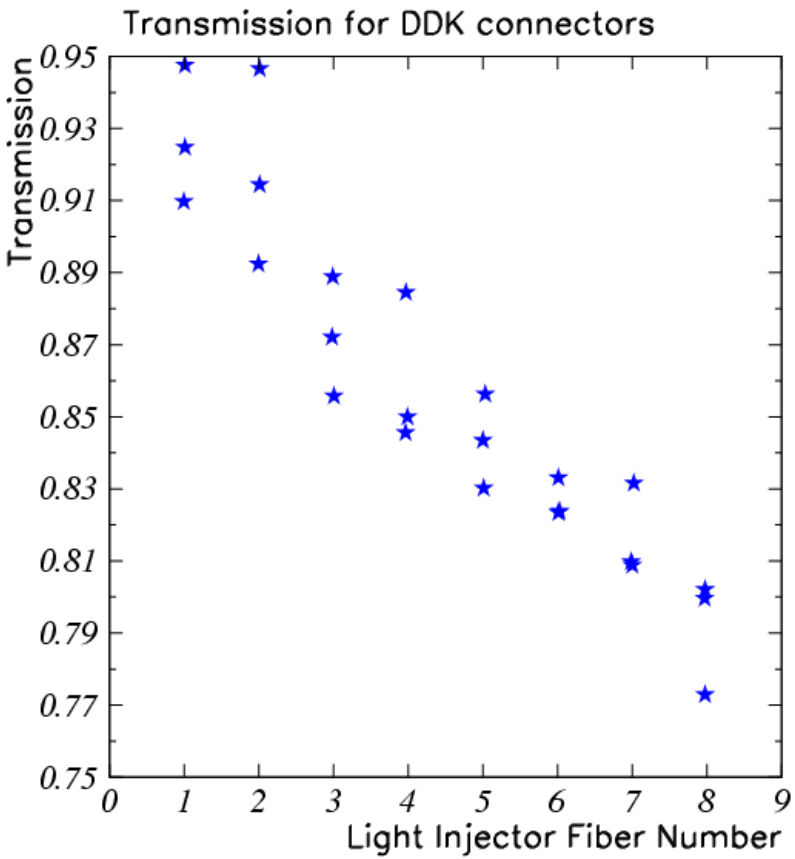
Transmission of DDK connectors



- This has been shown at 2 Friday meetings
  - 14 % difference between fiber 1 & 8
- This pattern doesn't make sense
  - When mated the connectors get mirror imaged
  - All ferrules are made by the same mold
  - DDK Hole 1- DDK Hole 8, 2-7 …
- These connectors are polished by the diamond moving along the long end
  - This effect is not due to the fiber polishing
  - The test is not shown

Injection fiber 1 is the top fiber in the connector in the light injection box

So What is Wrong with the Connector?

- We rotated the box by 180 degrees and got the same answer
- Eva's measurements at Sci Det indicate the connector is fine
- I tried to mechanically demonstrate their failure
  - I plugged 2 ferrules in a DDK box
  - I took 2 of the 48 mil (1.22mm) gauge pins and inserted them in holes 1 and 8, through both connectors
  - They went through fairly easily
  - A 49 mil (1.244mm) mil gauge pin does not go through any hole in any connector
  - This means the holes 1 and hole 8 match to better that 1 mil
  - This agrees with Eva's measurement
  - This test implies that the holes are meeting straight on since the pins are straight
- The DDK connectors and their box are fine

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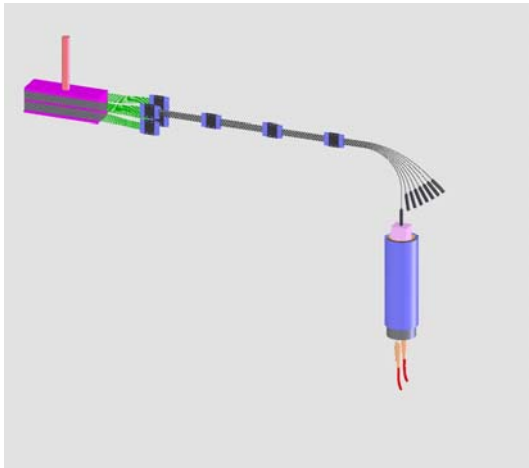
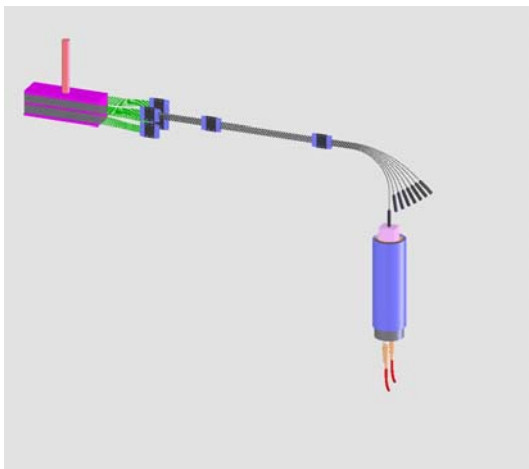
Cut & Uncut Cable Top and Bottom





- Take 2 cables
  - 2 m clear cable (control cable)
  - two 1m clear cables connected together
    - » (used for the previous transmission test)
- Measure both on the bottom left connector on the light injector
- Measure both on the top left on the light injector

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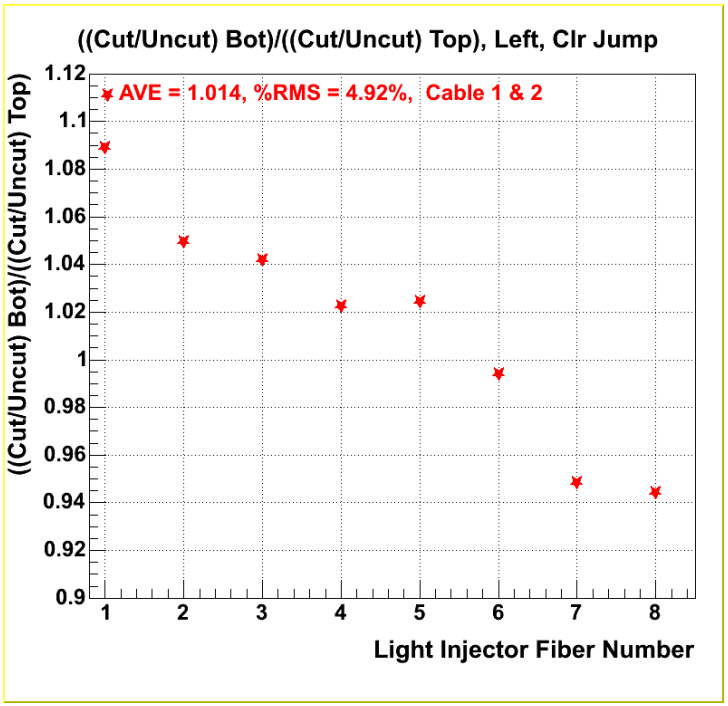
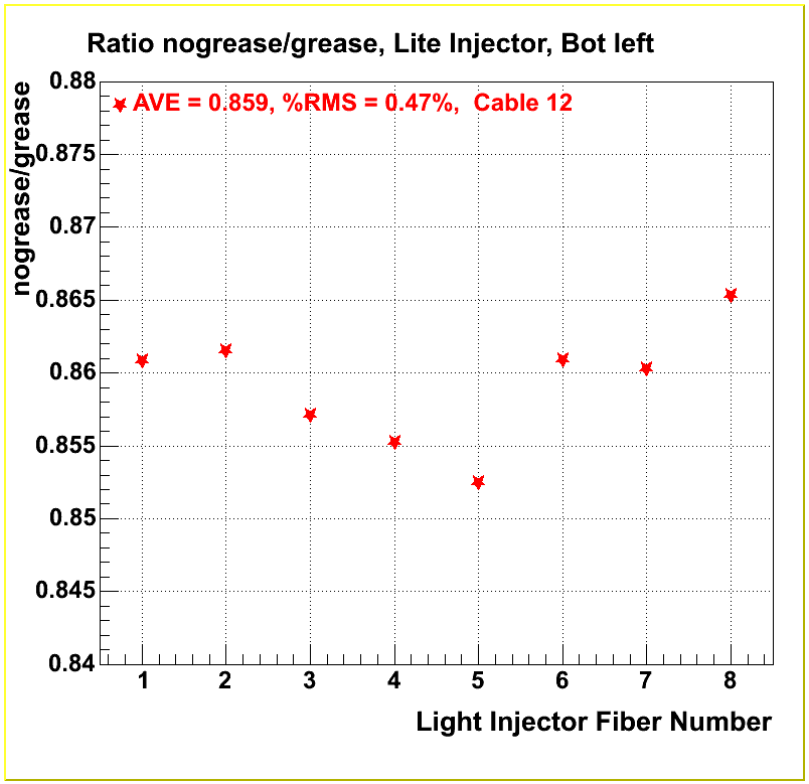
Cut & Uncut Cables Top and Bottom



- ((bottom 2 1m cables)/(Bot 2 m cable))/(top 2 1m cables)/(top 2 m cable)
- (2 1m cable)/(2m cable) is like a transmission = (cut/uncut)
- Transmission measured in the bottom connector is not the same transmission measured in the top connector
- Transmission is a function of the light injector fiber number
- Looks like it's the problem is measurement not the connectors

Can We Explain This Effect?



- If the light angular distributions, the modes, are different then the different reflections at the connector interface may be causing the effect.
- We can test this by putting grease in the connector
- The grease removes the differences in index of refraction across the gap
- The increase in transmission, about 16%, is independent of the fiber number
- Note that the transmission for injector fiber 1 for this cable is 86%, so roughly all the light is being transmitted with grease
  - However, there is some error in this because the clear pigtail had to be replaced between the transmission test and this test

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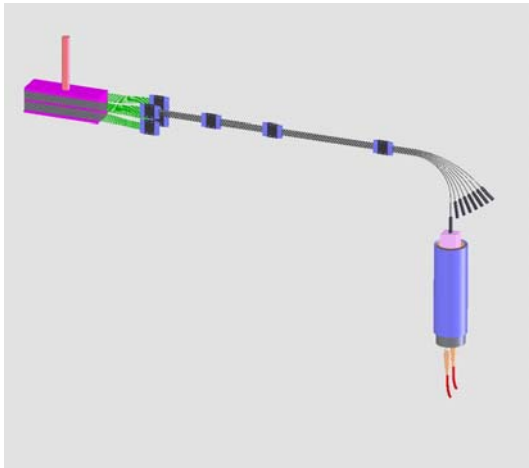
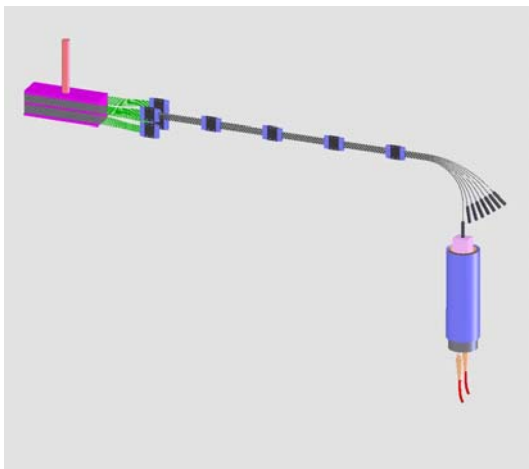
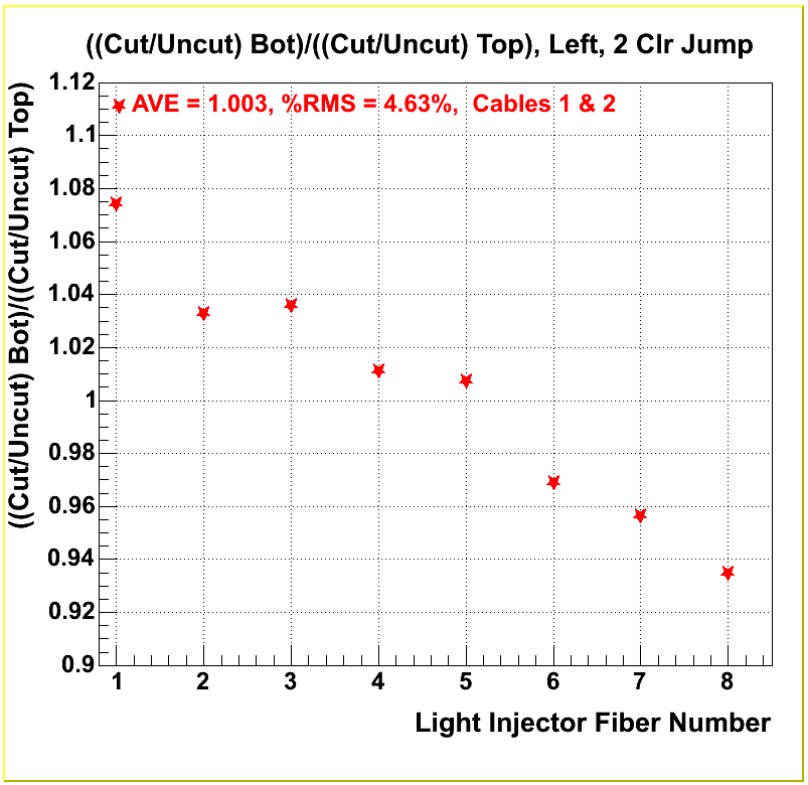
This Light Difference is Hard to Kill





- We would expect that the difference would be removed as the light crosses a connector
- Remember the difference is big 14%
- The previous measurements have 3 DDK connections beside the one being tested
- Lets add another clear jumper
  - Out of light injector there are is a 40 cm jumpers and 37 cm jumper

The additional clear jumper has no effect on removing the difference



- Come hell or high water, once the light is created with this difference it will keep it, or it will be recreated it, knowing which injector fiber it came from
- I call this effect the TMC
  - Transmission Measurement Conundrum
  - Not: Target Mass Correction
- Cladding light differences should have been removed by all these jumpers
  - Cladding light is defined by light that propagates by reflecting in outer cladding air interface
  - 1.8 m of clear before it hits this junction, with 1.9 m of addition fiber to the PMT

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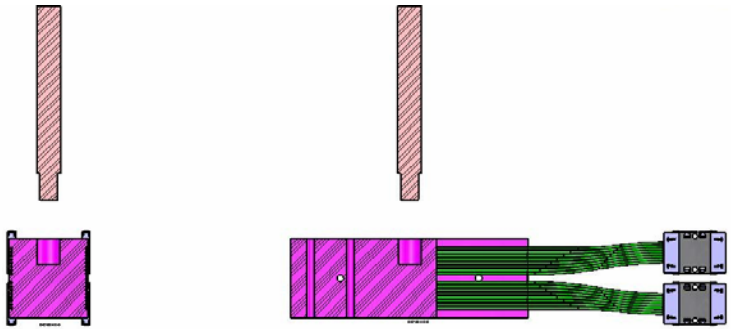
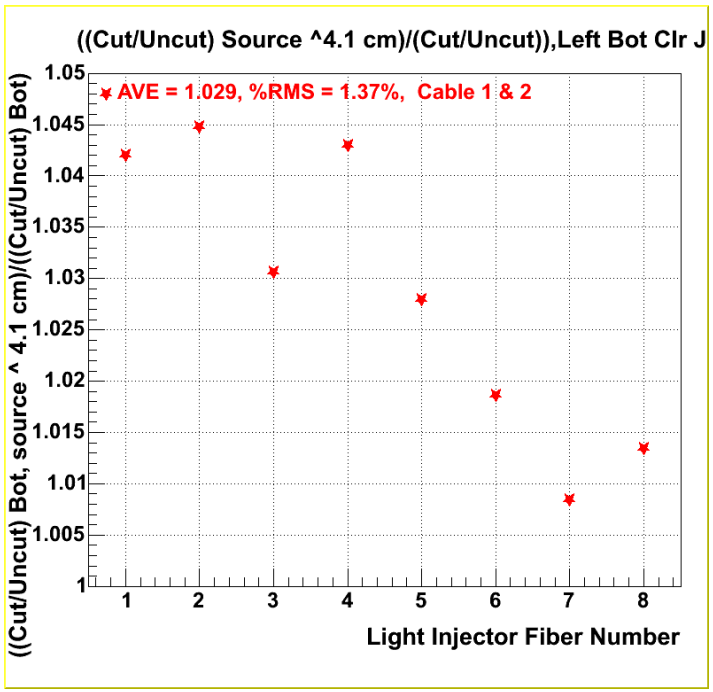
Displacing the source





- Bob Flight suggested displacing the source
- Bottom left connector-> 40 cm jumper->1 or 2 cables->90 cm pigtail->PMT
- ((cut/uncut) source up 4.2 cm)/ (cut/uncut) source in normal place)
- Ratio of transmission measured with the bottom connector with source in 2 different positions
- Ave = 1.03, Clearly demonstrates the TMC is not due to difference between pigtails in the light injector

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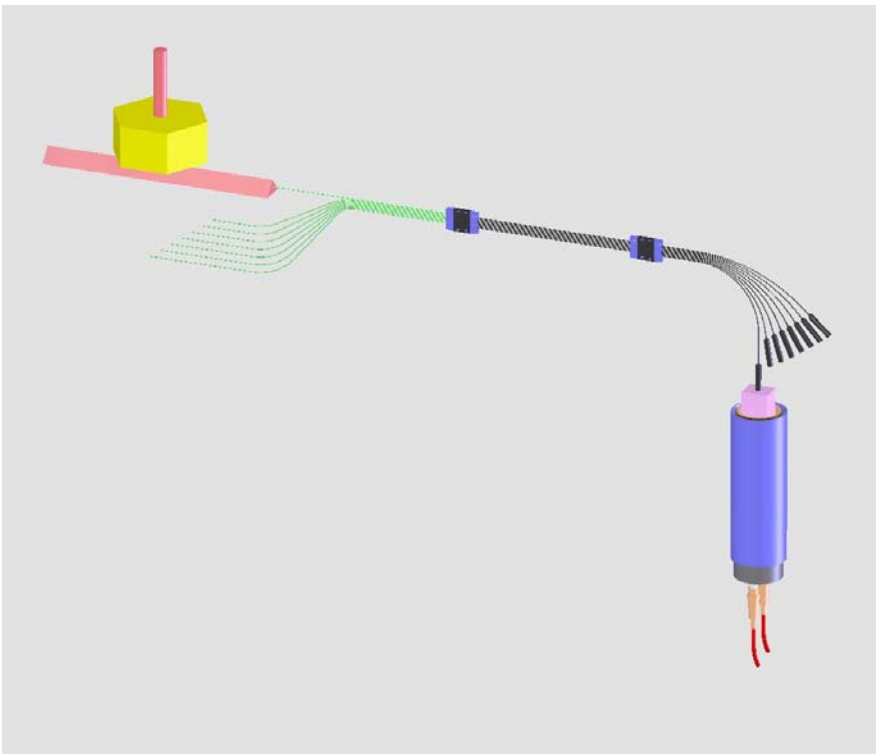
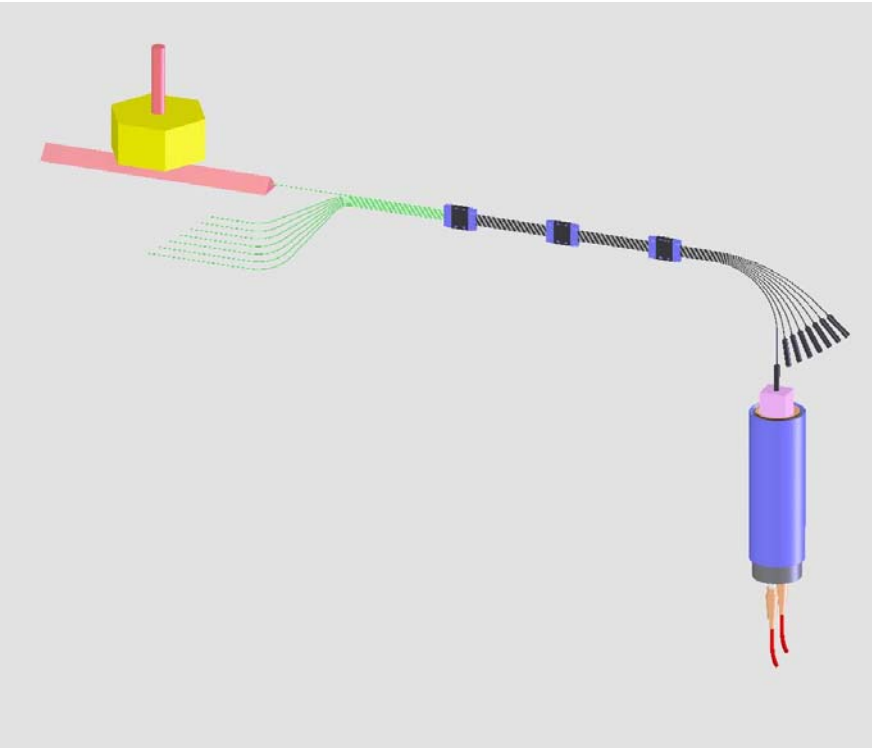
Before Measurement, Coex Scintillator



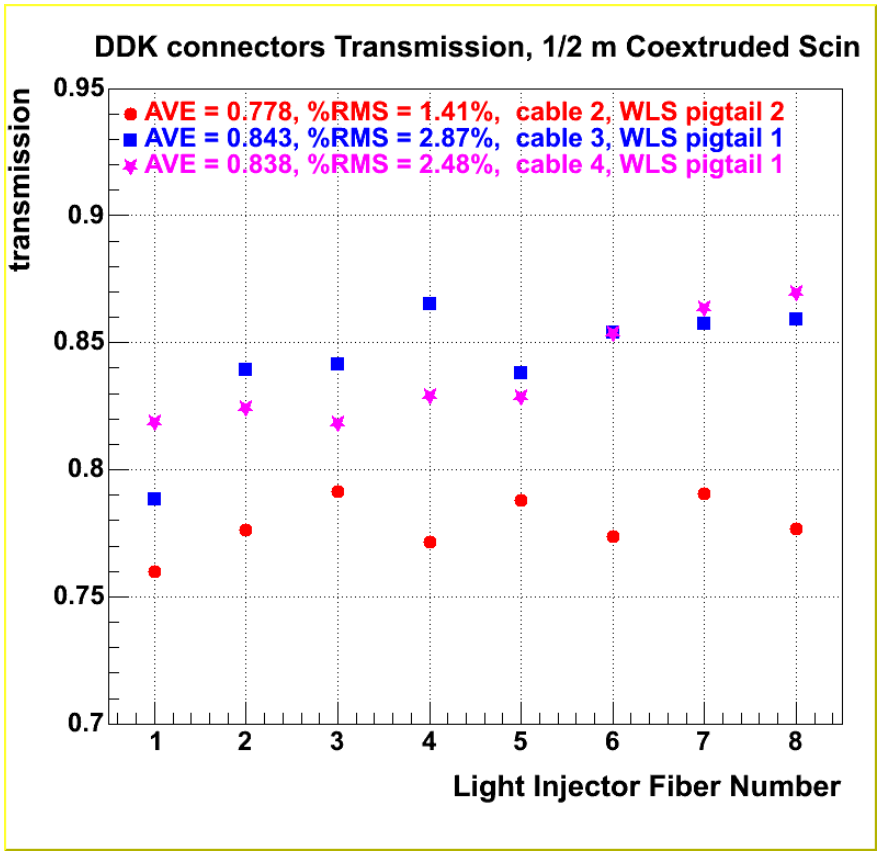
- The TMC tells us a transmission measurement should simulate the real apparatus
- ½ m coextruded scintillator illuminated by source
- 1m WLS pigtail
  - Made 2 pigtails
- 205 cm clear cable
- 90 cm clear pigtail with single fiber ferrule
- R580-17 Green Extended Tube
- Measure all fiber with Single Fiber Ferrules

Cut Measurement



- Insert connector in 205 m cable
- Eileen polishes the connectors
- Measured the same way as before

Transmission Using Coextruded Scin



- Ave = 82% and fairly independent of hole number.
- The result for the 2 pigtails seem to be different
  - Not sure why they should be different but maybe not enough measurements to tell

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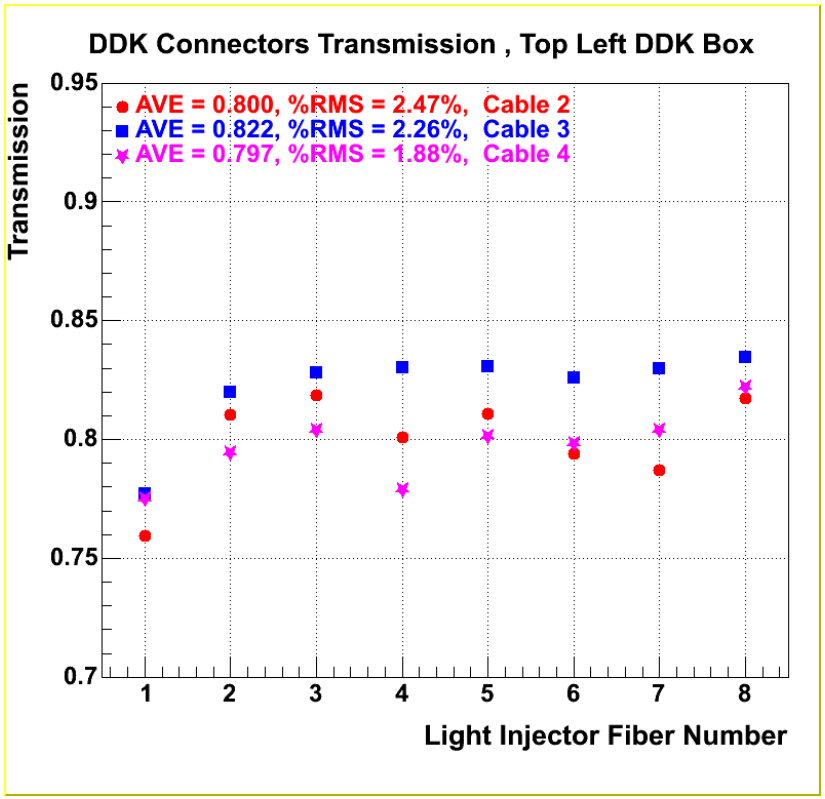
Transmission, Light Injector Top Connector



- Reasonable flat
  - Fiber 1 low is probably from the TMC
  - Remember this is the top connector on the injector box
- Transmission is 80.5%
- Note from the TMC its not clear what this transmission means
  - If we had made the initial measurement using the top connector we would not have seen the light depend on fiber number
  - We would have ignored fiber 1 being low
  - We would be ignorant to the TMC and thought this transmission was a defined number
  - “And there are things we don’t know that we don’t know”

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Conclusion

- Optically the connectors pass – ferrule is fine
  - The hole position and diameter look very good
  - The holes in the ferrule align to better than a mil, better than we had hoped
- We were confused by the TMC, but now “there are thing that we know that we don’t know.”

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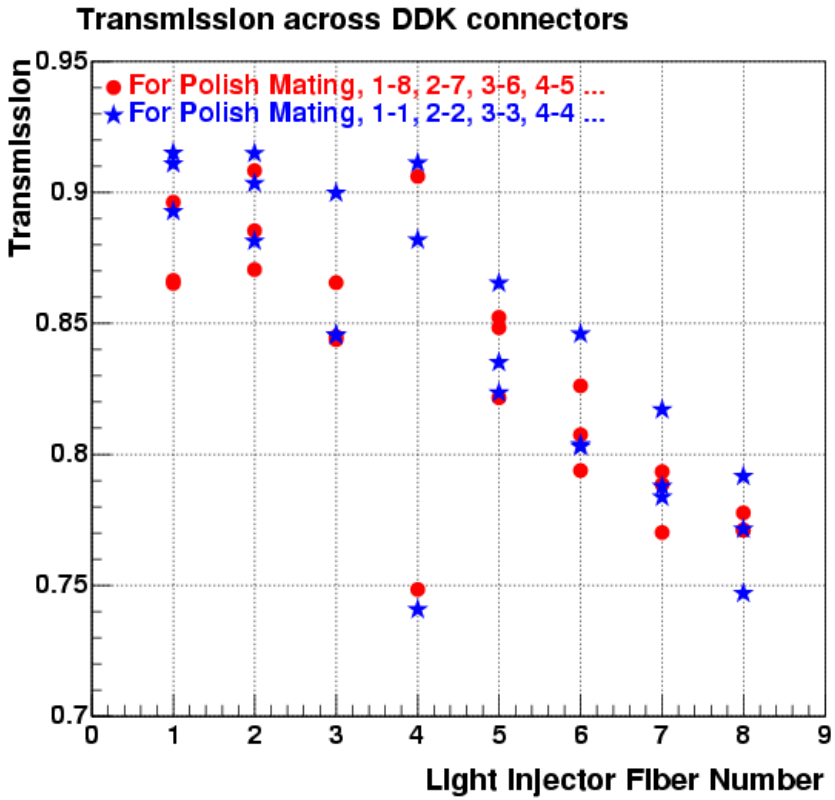
Backup Slides

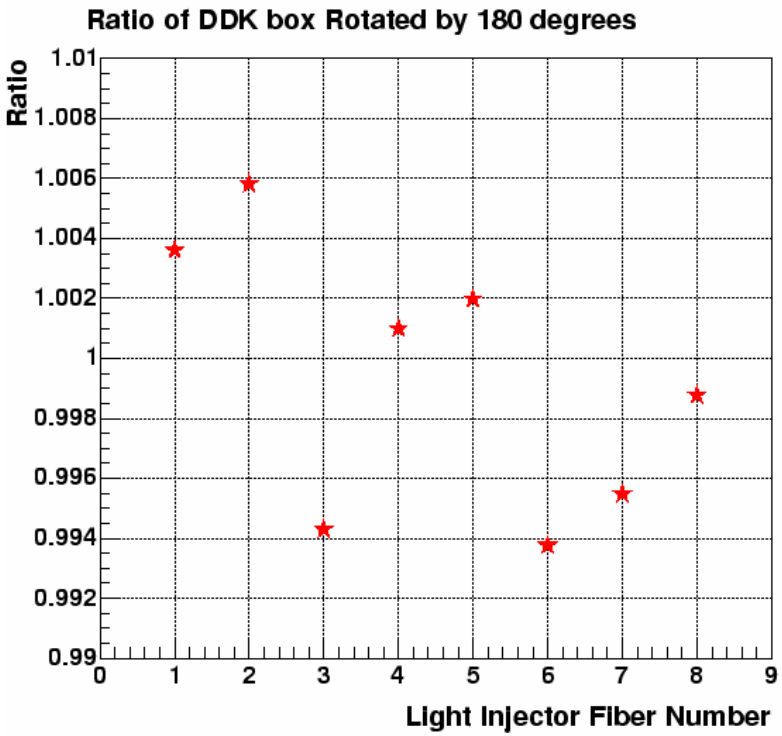
- Measurements not shown

Polishing direction holes 1-8 & 8-1



- The Connectors near the light injector box are polished with the same orientation
- The connectors shown in the red points are polished with the same orientation,
  - This means 1st hole polished matches with the 8 th hole polished…
- The connectors shown in blue points are polished with the opposite orientation to their mate
  - 1st fibers polished mate together …
- Polishing is not the problem
- (Fiber 4 is bad in the clear pigtail)

So What Is Wrong with the Connector?



- For this plot we measure a cut cable
  - One previously used in a transmission test
- The DDK box is rotated by 180 degrees and cable remeasured
  - This is not exactly the rotation one wants to do to test the box, but this is the only one can due because of the key
- The DDK Box appears to be fine
- In addition the RMS of reconnection is 0.6%, it is tight.
- Bob Flight will be machining out a key so we can do exactly the correct test