From https://github.com/mppmu/MaGe/blob/master/legendgeometry/src/LGND_FiberCladding.cc

```
G4double lengthTotal = 0.5*mm; //total diameter of fiber
G4double innerThickness = 0.04*mm;
G4double outerThickness = 0.02*mm;
//total thickness of cladding (how much it adds to radius of fiber)
//Needed when placing
fRadius = innerThickness+outerThickness; //0.06*mm
```

The diameter of a single fiber is 0.5+2*(0.04+0.02) = 0.62 mm
Note lengthTotal uses diameter, but for some reason innerThickness and outerThickness are radius

---

From https://github.com/mppmu/MaGe/blob/master/legendgeometry/src/LGND_200_14String_FiberArrayAssembly.cc

```
int nFibers = 1620;//972 for inner
```

There are 1620 outer fibers, 972 inner fibers

```
//Placing fibers on a 60 sides polygon
//for Outer array
//Inner array placed below
int nSides = 60;
```

```
//Placing fibers on a 36 sides polygon
//for Inner array
//Inner array placed below
if(fName.contains("Outer")) return;
nSides = 36;
```

Outer fibers placed on a 60-sided polygon, 27 fibers per side
Inner fibers placed on a 36-sided polygon, 27 fibers per side

---

```
LGND_200_14String_FiberArrayAssembly(G4String name, G4String serialNumber, G4double length,G4double placementRadius,G4String shape)
```

From https://github.com/mppmu/MaGe/blob/master/legendgeometry/src/LGND_200_14String.cc

```
LGND_200_14String_FiberArrayAssembly * fiberArrayInner = new LGND_200_14String_FiberArrayAssembly("FiberArrayInner_","000-001",0.650*m, 0.175*m, "sq
fiberArrayInner->Place(fiberPositionInner,rotationFiber,theDetectorLogical);
//outer array should be placed at 0.295*m radius
LGND_200_14String_FiberArrayAssembly * fiberArrayOuter = new LGND_200_14String_FiberArrayAssembly("FiberArrayOuter_","000-002",0.650*m,0.295*m, "squ
```

Both sets of fibers are 65*2 cm length (straight part)
Inner placement radius is 175 mm
Outer placement radius is 295 mm

Outer shroud: 1620 fibers, 0.62 mm diameter each, placement radius 295 mm

For a cylinder of radius 295mm, circumference is $2\pi r$=1853.5 mm

For 1620 fibers placed side-by-side, coverage is 1620*d=1004.4 mm

Laid right next to each other, fibers only cover 1004.4/1853.3 = **54.19%** of the space covered by a cylinder of radius equal to the placement radius

Inner shroud: 972 fibers, 0.62 mm diameter each, placement radius 175 mm

For a cylinder of radius 175mm, circumference is $2\pi r$=1100 mm

For 972 fibers placed side-by-side, coverage is 972*d=602.6 mm

Laid right next to each other, fibers only cover 602.6/1100 = **54.8%** of the space covered by a cylinder of radius equal to the placement radius

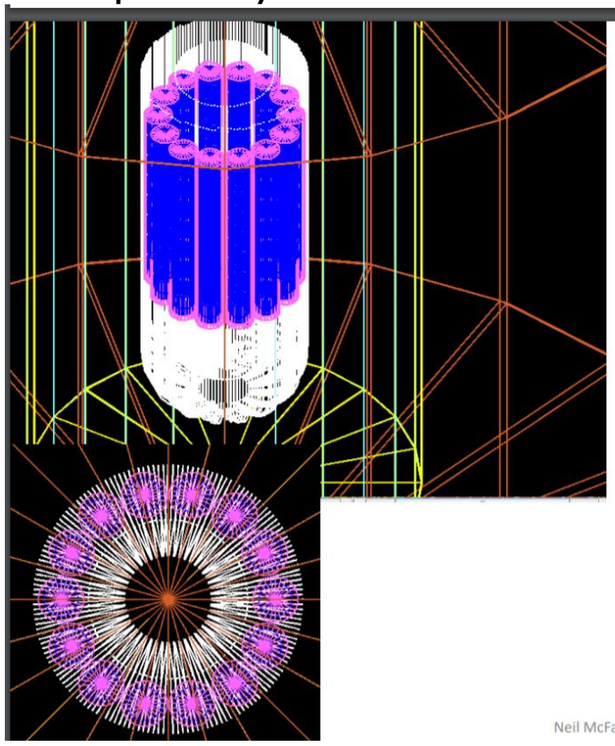
Additional materials and comments

Reference documented in MaGe:
https://indico.legend-exp.org/event/34/contributions/267/attachments/228/358/LAr_inst_low_res.pdf
See especially this slide from that talk:

basic elements:									top readout		top & bottom readout	
1) fiber shroud enclosing full array 590 mm diameter							fibers	SiPMs	SiPM arrays	SiPMs	SiPM arrays	
	requires	18	bundles with	9	SiPMs, connected to	9	fibers each	corresponding to	1458	162	18	324	36
2) fiber interstetious readout (baseline: cylindrical fiber readout around 6 strings of sedonc circle, each with 2 bundles)													
	requires	12	bundles	9		9			972	108	12	216	24
total 1)+2)									2430	270	30	540	864
Alternative baseline: 19 strings, each equipped with individual fiber reaout, as central string in GERDA													
	requires	38	bundles	9		9			3078	342	38	684	76

This has 1458 outer fibers – why is it higher than this in MaGe?

From December 2019 collaboration meeting:
https://indico.legend-exp.org/event/161/contributions/1344/attachments/843/1235/LAr_Veto_Simulations_NeilMcFadden_4.12.2019.pdf
See especially this slide:



- Fiber array is a N-polygons
  - Outer array is a 60 sided polygon
  - Inner array is a 36 sided polygon
- The outer array have a curved portion that wraps under the array
  - Curved portion is a quarter circle with radius 200 mm
  - SiPMs on top and bottom of outer array
- The exterior array is a length of ~1500 mm and has 1620 fibers (27 fibers per side) and is placed at a radius of 295 mm
- The interior array has 936/2 = 468 fibers (26/2 = 13 fibers per side), length of 1300 mm
  - the fibers wrap around at the bottom and connect to nearest neighbor
  - Have SiPMs on the top, previously the interior array had a "reflector" on the bottom to simulate the total length

Neil McFadden, UNM 14

Can do this same calculation for the quarter circle and the curved fibers

Final note: all calculations I've done are for a 14 string array, but I think we're going with a 19 string array, right? The LEGEND-200 geometry I have also has 19 strings. I can re-do these calculations for the 19 string version.