

Quantum Hardware Components in Navaho (Diné Bizaad)

Onri Jay Benally, Mohamad Ibrahim, Mural Hashim, Noah Lee

Introduction

Hastiin Biłééhóziní Binalí 'akót'áó shi zhi', kót'éego. 'Ako shik'a'i dii shi zhi' ṭa' sheiní'a'dikwii naahai yęę dák'. T'aadoo shi ei Táchii'nii nishłj, Naakaii Dine'é 'báshíshchíín, Bit'ahnii dashicheii, Kinłichíi'nii dashináli, Ta'neeszahnii dashicheii 'alááhgo, dóó 'Áshíjhí dashinaakidi nácheii. 'Áadóó, Tsé Ch'il Yaa Tó go éí naashá. 'Akót'áó Diné nishłj.

'Axhéhee'.

An Educational Idea



OJB-Quantum/Navaho-Linguistics

A repository for Indigenous American language material for quantum hardware education from the Diné/Navaho/Navajo tribe. Collected & writ...

[native](#) [linguistics](#) [quantum-computing](#) [indigenous-languages](#) [spoken-language](#)

● Jupyter Notebook · ⭐ 8 · Updated 1 hour ago

★ Unstar

Presented at University of Maryland.

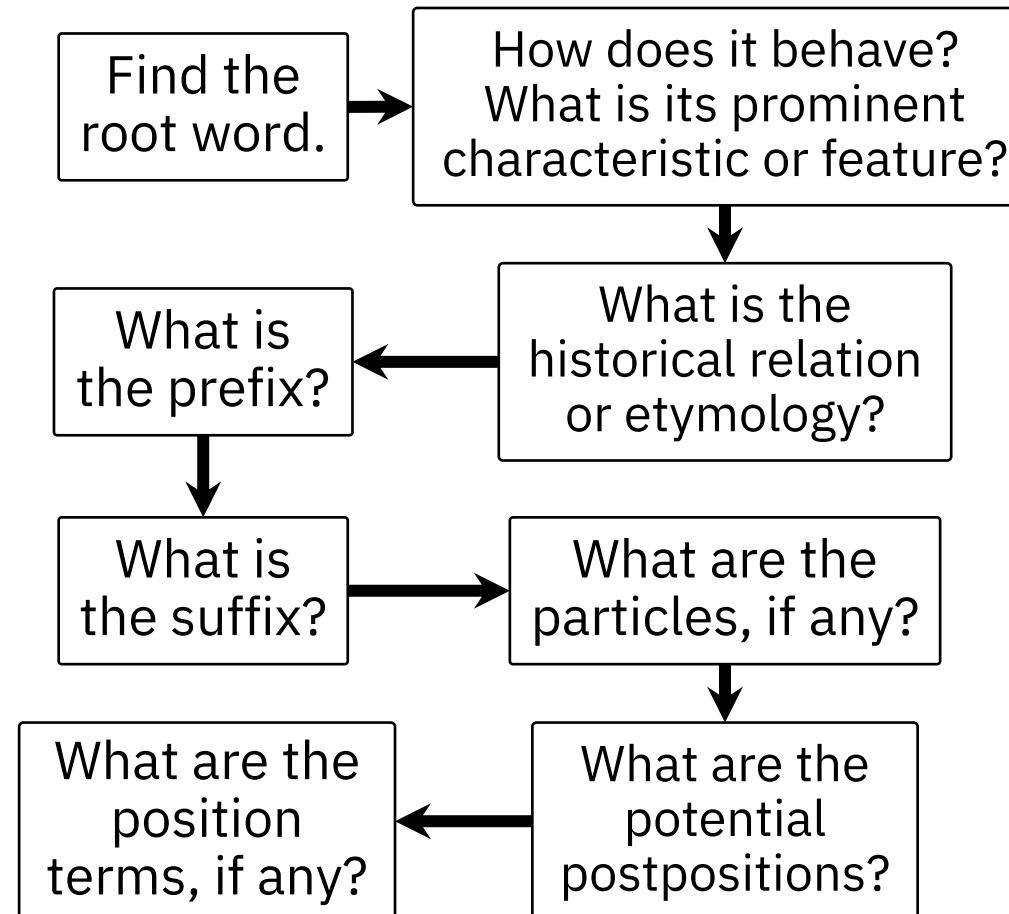


Thinking and Writing in Navaho

- Since Navaho/ Navajo is a **speaking-focused** language, you may notice variations of word spellings in writing, whether in literature or video or other media. It is possible to provide a more correct spelling in writing when converting speech to text to accurately match the phonetics.
- Using the term '**particular**' in English usually means to single out something, and the equivalent of this is used heavily in Navaho to highlight objects.
- When a word starts with an 'a', 'e', 'i', or an 'o' sound (Navaho vowels) and their variations, it is usually preceded by an apostrophe.

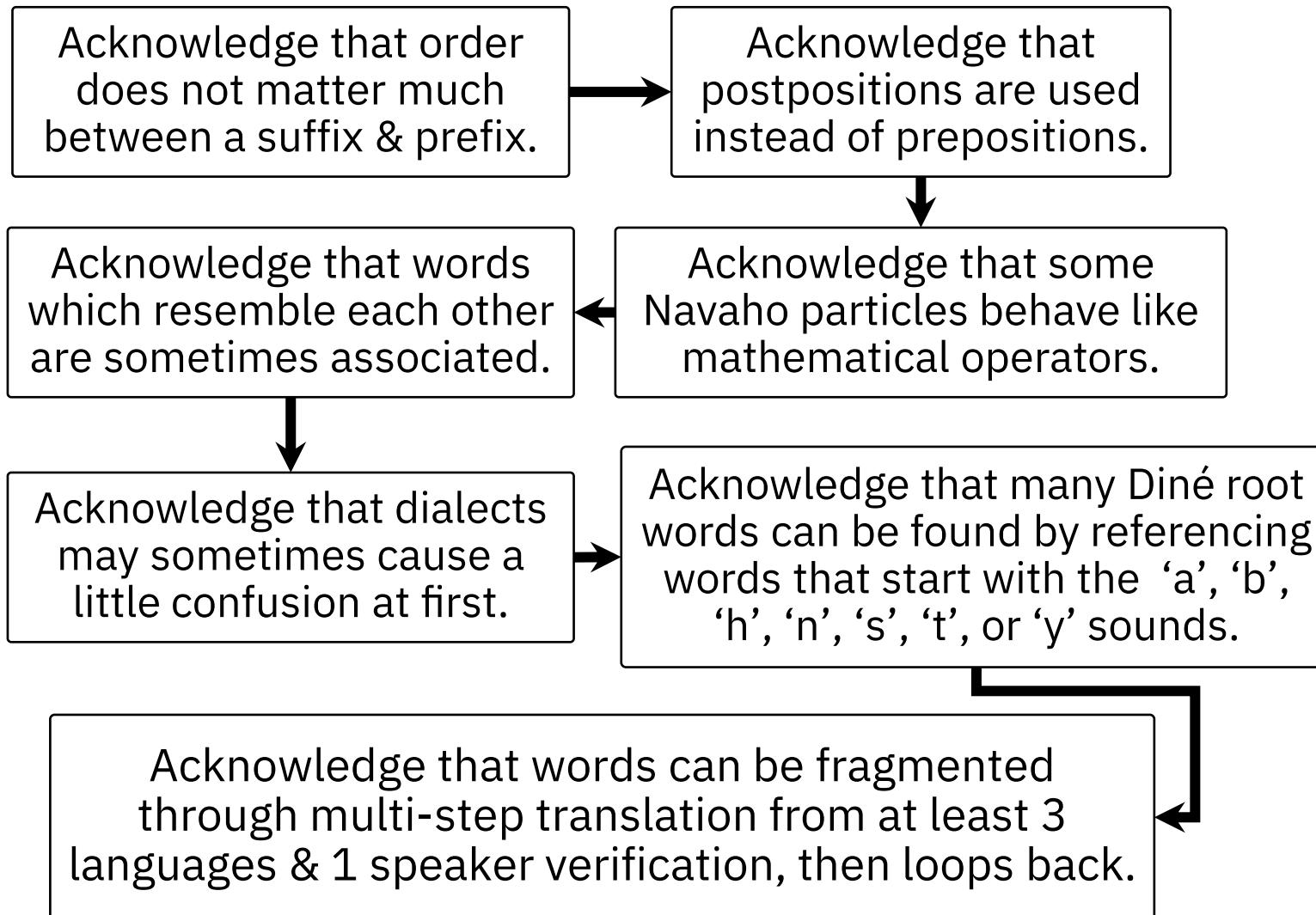
Onri's Two-Part Navaho Translation Model

Part 1

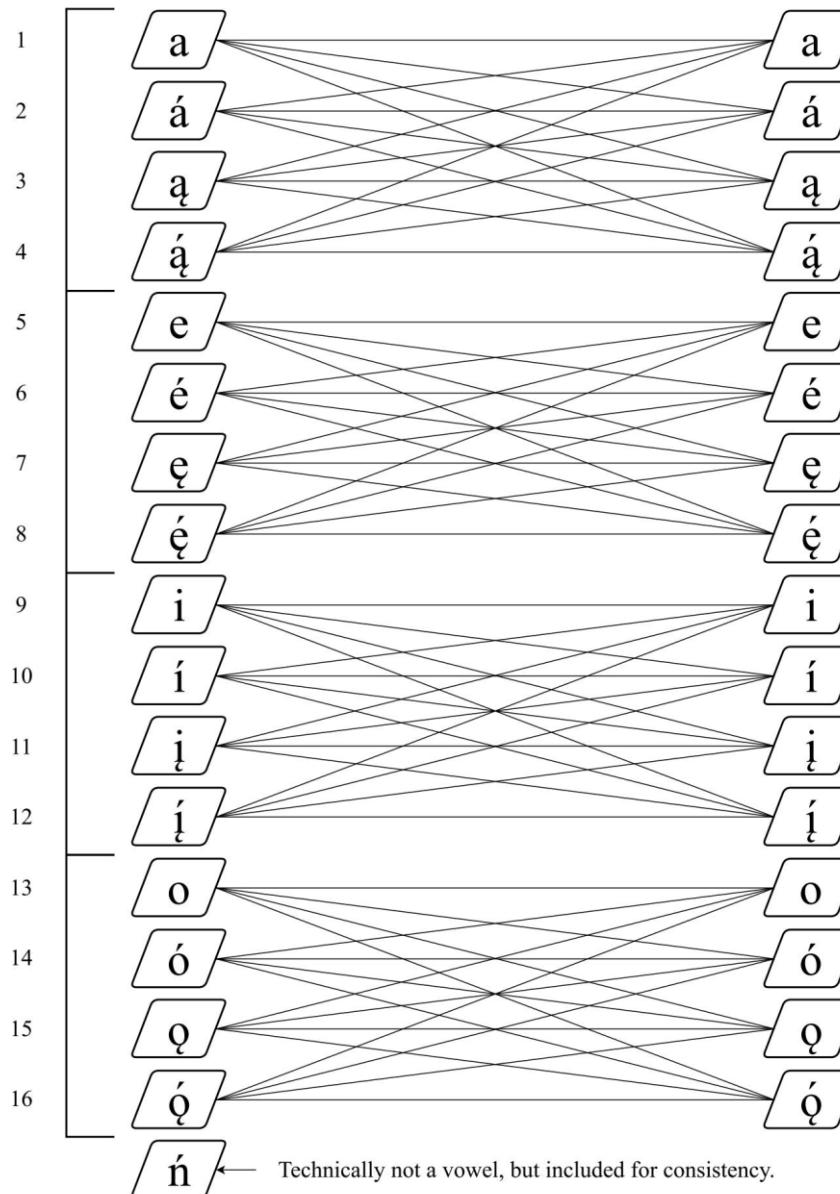


Onri's Two-Part Navaho Translation Model

Part 2



Onri's Navaho Long Vowel Network



Available on GitHub at: [OJB-Quantum/Navaho-Linguistics](https://github.com/OJB-Quantum/Navaho-Linguistics)

The Need for a Navaho Alphabet Unicode Table

- The limitation of Navaho/ Navajo language literature primarily is based on its availability in digitized form.
- Typically, the rendering of symbols that represent characters in virtually any written language is performed using something called a Unicode encoding.
 - This encoding can be interpreted on virtually any modern electronic computing system (to show text on the display).
 - One example is the **UTF-8 encoding**, which uses one to four 8-bit code units (bytes) in binary. The binary code is what a classical computer can understand and is “low-level”.



Character	Binary code point	Binary representation	UTF-8 encoded bytes
W	U+0057	0000 0000 0101 0111	0101 0111 57
B	U+0392	0000 0011 1001 0010	1100 1110 1001 0010 CE 92
위	U+C704	1100 0111 0000 0100	1110 1100 1001 1100 1000 0100 EC 9C 84
Y	U+10345	0 0001 0000 0011 0100 0101	1111 0000 1001 0000 1000 1101 1000 0101 F0 90 8D 85

1. Figure borrowed from: [Wikipedia](#)

The Need for a Navaho Alphabet Unicode Table

- Proper character combination in Navaho can be performed using a Unicode reference.
- The first Navaho font (phonetic Latin-based script) was created in the 1970s. Meanwhile, a digital Navaho/ Navajo keyboard was released in 2012-2013 for smartphones; Unicode was needed to enable this.
- Below is an example of generating Navaho characters and words using strings of UTF-8 encodings in the Python programming language.

```
print("\u0054\u0142\u0027")
Tł'

# Here is a whole Navaho word represented in (UTF-8) Unicode
print("\u004E\u0061\u0062\u00ED\u006B\u0027\u00ED\u0074\u0073\u00ED\u0064\u007A\u00ED\u0142\u006B\u0065\u0065\u0073")
# English meaning: careful thought or consideration

Nabík'ítsídzíłkees
```

Onri's Unicode Table for Navaho Alphabets

Navaho Character	[UTF-8] "U+" Notation	[UTF-8] "\u" Notation			
A	U+0041	\u0041	hw	U+0048 U+0077	\u0048\u0077
a	U+0061	\u0061	hw	U+0068 U+0077	\u0068\u0077
B	U+0042	\u0042	I	U+0049	\u0049
b	U+0062	\u0062	i	U+0069	\u0069
Ch	U+0043 U+0068	\u0043\u0068	J	U+004A	\u004A
ch	U+0063 U+0068	\u0063\u0068	j	U+006A	\u006A
Ch'	U+0043 U+0068 U+0027	\u0043\u0068\u0027	K	U+004B	\u004B
ch'	U+0063 U+0068 U+0027	\u0063\u0068\u0027	k	U+006B	\u006B
D	U+0044	\u0044	K'	U+004B U+0027	\u004B\u0027
d	U+0064	\u0064	k'	U+006B U+0027	\u006B\u0027
Dl	U+0044 U+006C	\u0044\u006C	Kw	U+004B U+0077	\u004B\u0077
dl	U+0064 U+006C	\u0064\u006C	kw	U+006B U+0077	\u006B\u0077
Dz	U+0044 U+007A	\u0044\u007A	L	U+004C	\u004C
dz	U+0064 U+007A	\u0064\u007A	l	U+006C	\u006C
E	U+0045	\u0045	t̥	U+0141	\u0141
e	U+0065	\u0065	t̥	U+0142	\u0142
G	U+0047	\u0047	M	U+004D	\u004D
g	U+0067	\u0067	m	U+006D	\u006D
Gh	U+0047 U+0068	\u0047\u0068	N	U+004E	\u004E
gh	U+0067 U+0068	\u0067\u0068	n	U+006E	\u006E
H	U+0048	\u0048	O	U+004F	\u004F
h	U+0068	\u0068	o	U+006F	\u006F
			S	U+0053	\u0053
			s	U+0073	\u0073
			Sh	U+0053 U+0068	\u0053\u0068
			sh	U+0073 U+0068	\u0073\u0068
			T	U+0054	\u0054
			t	U+0074	\u0074
			T'	U+0054 U+0027	\u0054\u0027
			t'	U+0074 U+0027	\u0074\u0027
			Tt̥	U+0054 U+0142	\u0054\u0142
			tt̥	U+0074 U+0142	\u0074\u0142
			Tt̥'	U+0054 U+0142 U+0027	\u0054\u0142\u0027
			tt̥'	U+0074 U+0142 U+0027	\u0074\u0142\u0027
			Ts	U+0054 U+0073	\u0054\u0073
			ts	U+0074 U+0073	\u0074\u0073
			Ts'	U+0054 U+0073 U+0027	\u0054\u0073\u0027
			ts'	U+0074 U+0073 U+0027	\u0074\u0073\u0027
			W	U+0057	\u0057
			w	U+0077	\u0077
			X	U+0058	\u0058
			x	U+0078	\u0078
			Y	U+0059	\u0059
			y	U+0079	\u0079
			Z	U+005A	\u005A
			z	U+007A	\u007A

Onri's Unicode Table for Navaho Vowels & Their Variations

Á	U+00C1	\u00C1
À	U+0104	\u0104
É	U+00C9	\u00C9
Í	U+00CD	\u00CD
Ó	U+00D3	\u00D3
-----	-----	-----
Ń	U+0143	\u0143

Remaining Navaho vowels and their variations in lowercase are available on the complete table in GitHub.

Linguistic Idea Table Aimed Toward Translation Use

Stage	English Term	Navaho Term
Initial Idea	Some Word (Eng)	Nv
	Eng	Nv
	Eng	Nv
Final Version	[Rough Transcription] <> Final Word	Navaho Term Spelled

Generic blueprint for language breakdown from Navaho to English and vice-versa.

(Classical) Computer in Navaho

Stage	English Term	Navaho Term
Initial Ideas	metal	béésh
	red	łichíí '
	think	nitsékees
Final Version	[A piece of] copper that thinks. ([Electronic] Computer).	béésh łichíí ' nitsékeesí

Quantum Computer in Navaho

Stage	English Term	Navaho Term
Initial Ideas	metal	béésh
	truly	t' áá 'aníí
	think	nitsékees
	fundamental or elements	'á'ádaat 'éhígíí
Final Version	Metal or piece of metal that thinks at a truly fundamental level (Quantum Computer).	béésh t' áá 'aníí 'á'ádaat 'éhígíí nitsékeesí

Electrical Charge Current in Navaho

Initial Ideas	English	Navaho
	electricity or electrical	'atsiniltł'ish
	strength or to be strong	dziil
	his strength or he is strong	hadziil
	energy or his strength	bidziil
	it flows. You are	ńl̄j
	a particular one that is	-ígíí
	that which flows	ńlínígíí
Final Outcome	Strength of electrical [charge] flow. (Electrical [charge] current).	'atsiniltł'ish bidziil ńlínígíí

Superconductor in Navaho

	English	Navaho
Initial Ideas	electricity or electrical	'atsinilt'ish
	by means of it, by means of, or with	bee-
	strength or to be strong	dziil
	energy or his strength	bidziil
	it flows. You are	ńl̄j̄
	a particular one that is	-ígií
	that which flows	ńlínígíí
	very, extremely, really	t'áá 'íiyisíí
	'atsinilt'ish bidziil ńlínígíí	[electrical charge] current
Final Outcome	By which the strength of the electrical charge current [can] extremely flow. (Superconductor).	bee 'atsinilt'ish bidziil ńlínígíí t'áá 'íiyisíí dabidziil

Refrigerator in Navaho

	English	Navaho
	By means of it, by means of, or with	bee-
	Cold	sik'az
	Coldness. Chill. Frigidity.	hak 'az
Initial Ideas		
Final Outcome	By which [something] is [made] cold. (Refrigerator).	bee 'azk'azi

Measurement Refrigerator in Navaho

	English	Navaho
Initial Ideas	by means of it, by means of, or with	bee-
	cold	sik'az
	coldness, chill, or frigidity	hak'az
	experiment	t'áádoole'é nabíhonitaah
Final Outcome	By which is made cold for experiment (Measurement refrigerator or cryostat).	t'áádoole'é nabíhonitaah bee 'azk'azi

Quantum Mechanics Intro in Navaho & Transcribed in English

Navaho	English
Díí 'á 'ádaat 'éhígíí náás góne'é t'áá kóníghánígo 'akwe'é 'ahóodziil doo bee 'atsiniltl'ish biyi' 'asdizígíí éidí 'í'neel'qah 'áadóó yidísin. T'áá bééhodoozjł yił 'ałhii'níná'iidzóóh nida'ałkáá'ii' Schrödinger dóó Pauli dóó Dirac bits'áądéké nihináát 'áadóó bee béédahodoozjł.	In fundamental or elemental objects such as an atom, further within it, at short intervals here, is energy that one can observe, and from there, measure it, as well as its electron spin [depending on which measurement tool is used]. It must be explained with [the language of] mathematics that we can watch or observe and of which can be studied to learn more, introduced by Professors Schrodinger, Pauli, and Dirac.

Quantum Mechanics Intro in Navaho Braille

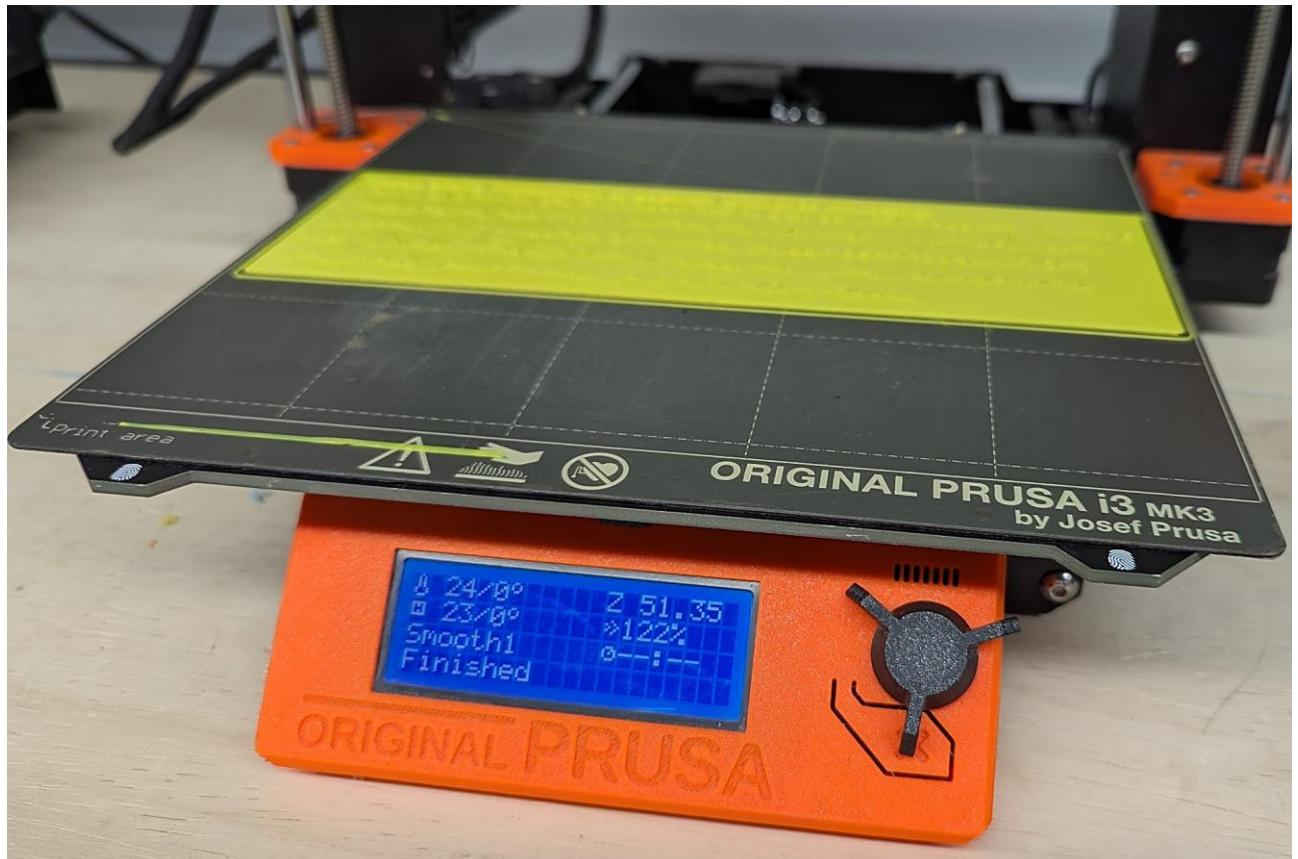
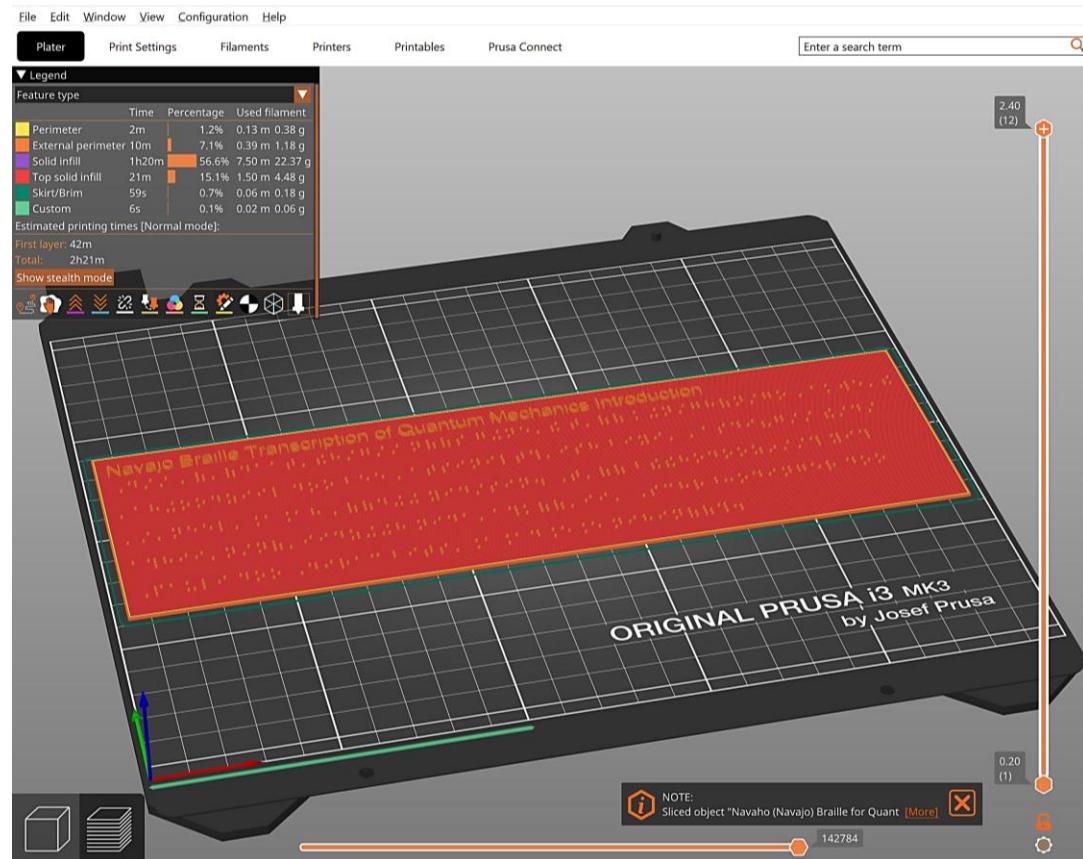
Navaho

Díí 'á 'ádaat 'éhígíí náás góne'é t'áá kóníghánígo 'akwe'é 'ahóodziil doo bee 'atsiniltl'ish biyi' 'asdizígíí éidí 'í'neel'qah 'áadóó yidísin. T'áá bééhodoozjíł yił 'ałhii'níná'iidzóóh nida'ałkáá'ii' Schrödinger dóó Pauli dóó Dirac bits'áądéké nihinááł 'áadóó bee béédahodoozjíł.

Navaho Braille

.•..•..•..•..•..•..•..•..•..•..•..
:..•..•..•..•..•..•..•..•..•..•..•..
:..•..•..•..•..•..•..•..•..•..•..•..
:..•..•..•..•..•..•..•..•..•..•..•..
:..•..•..•..•..•..•..•..•..•..•..•..
:..•..•..•..•..•..•..•..•..•..•..•..
.•..•..•..•..•..•..•..•..•..•..•..
.•..•..•..•..•..•..•..•..•..•..•..
.•..•..•..•..•..•..•..•..•..•..•..
.•..•..•..•..•..•..•..•..•..•..•..
.•..•..•..•..•..•..•..•..•..•..•..
.•..•..•..•..•..•..•..•..•..•..•..
.•..•..•..•..•..•..•..•..•..•..•..
.•..•..•..•..•..•..•..•..•..•..•..
.•..•..•..•..•..•..•..•..•..•..•..

Quantum Mechanics Intro in Navajo Braille



Encoded based on the Navajo Braille code by Carol Begay Green
en.wikipedia.org/wiki/Navajo_Braille

Supplementary Example Equations in Nemeth Braille

	Nemeth Braille	English
J1	INPUT FLOOR & CEILING OPERATOR DEFINITION	FLOOR & CEILING OPERATOR DEFINITION
J2	NUMBER OF A NUMBER IS THE NUMBER ITSELF	NUMBER OF NUMBER IS NUMBER
J3	NUMBER = FACTOR NUMBER = FACTOR	NUMBER = FACTOR
J4	LIMIT OF A FUNCTION IS THE DERIVED FUNCTION = DERIVED	LIMIT OF FUNCTION IS DERIVED FUNCTION
J5	DEFINITION = DEFINITION + DEFINITION	DEFINITION
J6	EXPLANATION = EXPLANATION + EXPLANATION	EXPLANATION & EXPLANATION

Included are:

- Classical comparison to Ehrenfest's Theorem
- Ehrenfest's Theorem
- Time-Independent Schrödinger Equation
- Dirac Equation
- Dirac Equation in covariant form

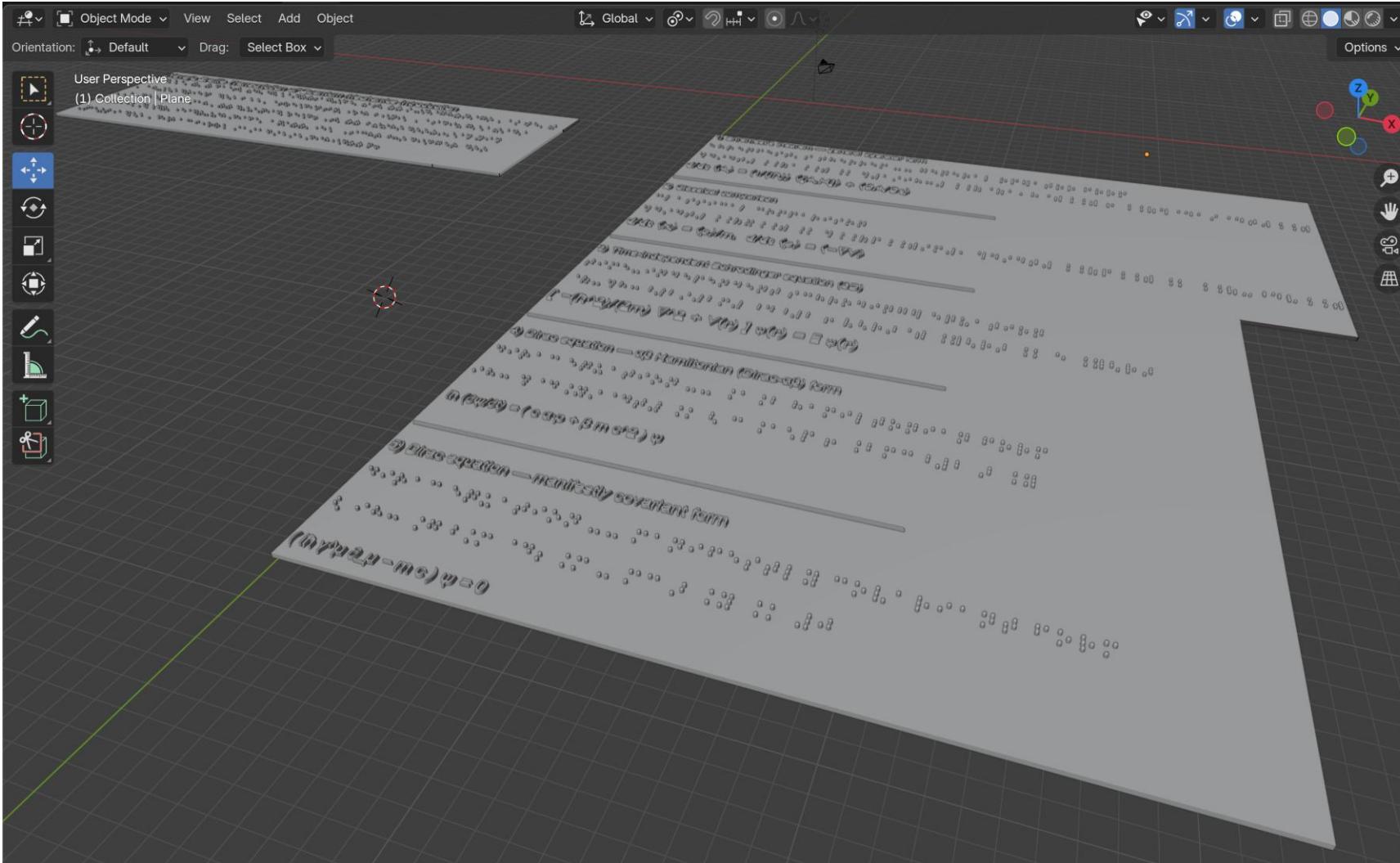
Supplementary Example Equations in Nemeth Braille

#	Equation (LaTeX or MathTex)
1	$\frac{d}{dt} \langle A \rangle = \frac{1}{i\hbar} \langle [A, H] \rangle + \left\langle \frac{\partial A}{\partial t} \right\rangle$
2	$\frac{d}{dt} \langle x \rangle = \frac{\langle p \rangle}{m}, \quad \frac{d}{dt} \langle p \rangle = \langle -\nabla V \rangle$
3	$\left[-\frac{\hbar^2}{2m} \nabla^2 + V(\mathbf{r}) \right] \psi(\mathbf{r}) = E \psi(\mathbf{r})$
4	$i\hbar \frac{\partial \psi}{\partial t} = (c \boldsymbol{\alpha} \cdot \mathbf{p} + \beta mc^2) \psi$
5	$(i\hbar \gamma^\mu \partial_\mu - mc) \psi = 0$

Included are:

- Classical comparison to Ehrenfest's Theorem
- Ehrenfest's Theorem
- Time-Independent Schrödinger Equation
- Dirac Equation
- Dirac Equation in covariant form

Supplementary Example Equations in Nemeth Braille



Medical/ Biological Research vs. Quantum Hardware Terms

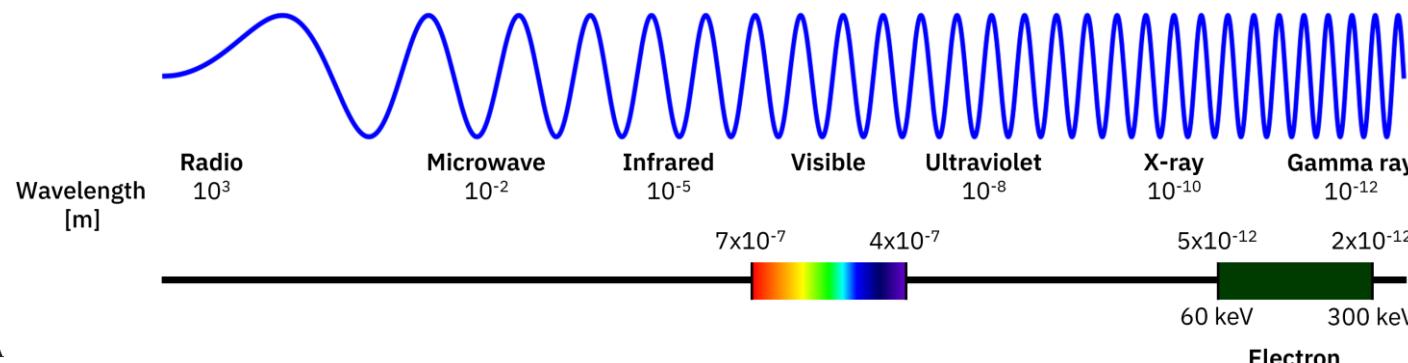
Navaho Term	English Term
Bee níl'iní	By means of the one that is used to see by you. Viewing instrument or tool.
Ch'osh doo yit'iinii bee níl'iní	By means of the one that is used to see by you on insects that cannot be seen. Viewing instrument for invisible bugs. Biological microscope .
'á'adaat 'éhígíí doo yit'iinii bee níl'iní	By means of the one that is used to see by you on fundamental or elemental objects [such as an atom] that cannot be seen. Viewing instrument for atoms, which are invisible to the naked eye. Electron microscope, scanning probe microscope, ion microscope, X-ray microscope, super-resolution microscope , and others with nanoscale, atomic, or near-atomic scale resolution.
Tóshjeehtso biih ho'dilzho' dóó béésh ná'iiláahii bee hats'iís naalkaah dóó yida'ale'	Big barrel, while inside it, [there is a] sliding [mechanism], and magnets with it, by which a study is done and pictures are taken of one's body. [Biological] magnetic resonance imaging (MRI) [technique].
Tóshjeehtso biih ho'dilzho' dóó béésh ná'iiláahii bee hináanii dóó t'áadoole'é ndaaznilí t'áá 'álah naalkaah dóó yida'ale'	Big barrel, while inside it, [there is a] sliding [mechanism], and magnets with it, by which a study is done, and pictures are taken of living things or anything that is an inanimate grouped object. [General] magnetic resonance imaging (MRI) [technique].
Bee na'anishí hináanii dóó t'áadoole'é ndaaznilí yida'ale' kindéé' báah neheeshgizh nahalingo hahinidééh	Apparatus by which pictures are taken of living things or anything that is an inanimate grouped object, similar to sliced bread from the store or shop, that falls out after one another. Computed Tomography (CT) [technique].
'Agháda' dildlaadí	Examine with an X-ray tool.
Na 'alkid	Temperature or time (depending on context)
Djj' bich'j'go na 'alkid Kelvin da'azjah	4 degrees Kelvin
Bee 'azk'azi	Refrigerator. By which [something] is made or kept cold
T'áadoole'é 'ádaal'jígi	A factory [of things]
T'áadoole'é nabíhonitaah bee 'azk'azi	Refrigerator for experiment. Measurement refrigerator or experimental measurement refrigerator
T'áadoole'é nabíhonitaah bee 'azk'azi ni'góó sizínígíí	Refrigerator for experiment, the one standing on the floor. Floor standing experimental measurement fridge
T'áadoole'é nabíhonitaah bee 'azk'azi tsoh	Large refrigerator for experiment. Large experimental measurement refrigerator
T'áadoole'é nabíhonitaah t'óshjeehtso bee 'azk'azi ni'góó sizínígíí or t'áadoole'é nabíhonitaah bee 'azk'azi ni'góó sizínígíí t'áadoo bitoo'	Refrigerator for experiment, the one standing on the floor. Floor standing experimental measurement fridge.
T'áadoole'é nabíhonitaah bee t'óshjeehtso góne' honeezk'az or t'óshjeehtso góne' honeezk'az Dewar bijoosye'	A big barrel where something is kept cold for experiment(s). Experimental measurement cold keeping barrel. Dewar (large Thermos)
T'óshjeeh góne' honeezk'az	Barrel where it [something] is kept cold

Partial Electromagnetic Spectrum in Navaho

English Term	Navaho Term	Literal Meaning
Radiation	Shá or hatsoo'algħa k'aa	Radiation in general, whether ionizing or non-ionizing (depends on context). It uses its tongue to produce extreme arrows
Light	'Adinídíin	Light
Visible rays	Shá dahootl̄íí or shá eii dahootl̄íí	Radiation by which there is visibility. (Could be used to explain visibility techniques beyond the detectability of the human eye)
Wave	Yilk'oołígíí	That particular ripple
X-rays	'Aghá'deeldlaad or shá 'aghá'deeldlaad	An extreme projection
Gamma rays	'Aghá'deeldlaad t'áá 'íiyisíí dabidziil or shá 'aghá'deeldlaad t'áá 'íiyisíí dabidziil	An extreme projection that is truly strong
Extreme ultraviolet [light] rays	'Aghá'deeldlaad t'áá tsídídééh nahalingo or shá 'aghá'deeldlaad t'áá tsídídééh nahalingo	Extreme projection that is barely purple-like

Partial Electromagnetic Spectrum in Navaho

English Term	Navaho Term	Literal Meaning
Radiation	Shá or hatsoo' algha k'aa	Radiation in general, whether ionizing or non-ionizing (depends on context). It uses its tongue to produce extreme arrows
Light	'Adinídíín	Light
Visible rays	Shá dahoot'jíigíí or shá eii dahoot'jíigíí	Radiation by which there is visibility. (Could be used to explain visibility techniques beyond the detectability of the human eye)
Wave	Yilk'oołígíí	That particular ripple
X-rays	'Aghá'deeldlaad or shá 'aghá'deeldlaad	An extreme projection
Gamma rays	'Aghá'deeldlaad t'áá 'iiyisíí dabidziil or shá 'aghá'deeldlaad t'áá 'iiyisíí dabidziil	An extreme projection that is truly strong
Extreme ultraviolet [light] rays	'Aghá'deeldlaad t'áá tsídídééh nahalingo or shá 'aghá'deeldlaad t'áá tsídídééh nahalingo	Extreme projection that is barely purple-like



Common Cryostat/Cryogenic Vessel Formfactors

Item	
Large-frame dilution refrigerator (DR).	DR available (Integrated or insert attachment)
Floor standing cryostat (cryogen-free PPMS-type).	
Floor standing cryogenic vessel (liquid cryogen Dewar type).	No DR available

Common Cryostat/Cryogenic Vessel Formfactors



**Large Frame Dilution
Refrigerator (Cryogen-Free)**



**Floor Standing Cryostat
(Cryogen-Free)**



**Floor Standing
Cryogenic Vessel
(Dewar w/ Liquid Helium)**

Díí bee 'azk'azi dóó bee honeezk'az 'ályaa yígíí 'át'é



T'áadoole'é nabíhonitaah
bee 'azk'azi tsoh



T'áadoole'é nabíhonitaah
bee 'azk'azi ni'góó sizínígíí



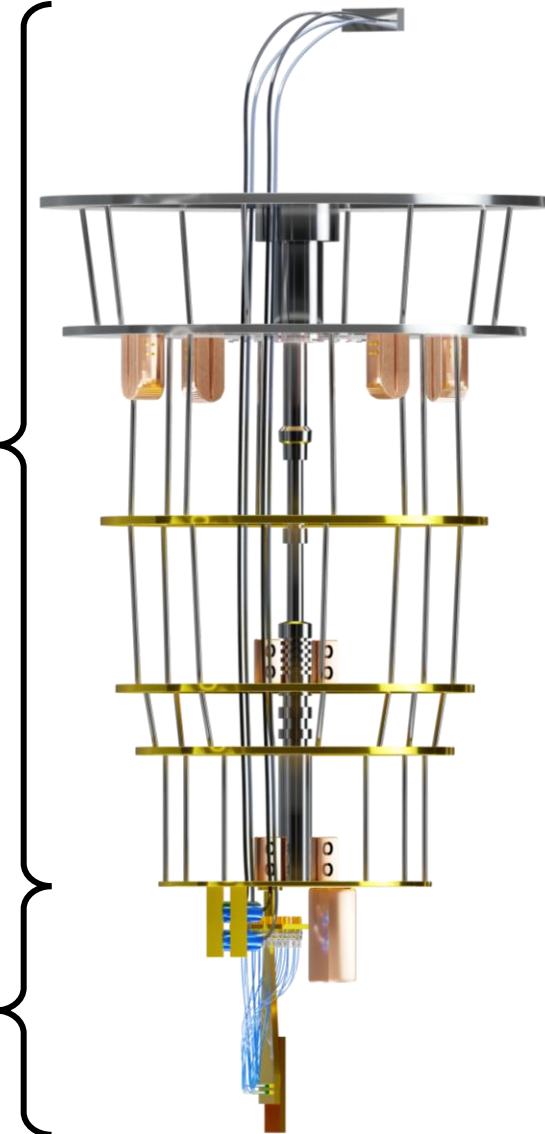
T'áadoole'é nabíhonitaah
bee t'óshjeehtso góne' honeezk'az

Dilution Refrigerator Stages in Navaho



Dilution Refrigerator Stages in Navaho

Bee 'azk'azi
bijéí
T'áádoole'é
T'ááláhádí nabíhonitaah bee 'azk'azi



Táadi neeznádiin bich'j'go na'alkid Kelvin da'azjah (300 K)

Dízdiin bich'j'go na'alkid Kelvin da'azjah (40 K)

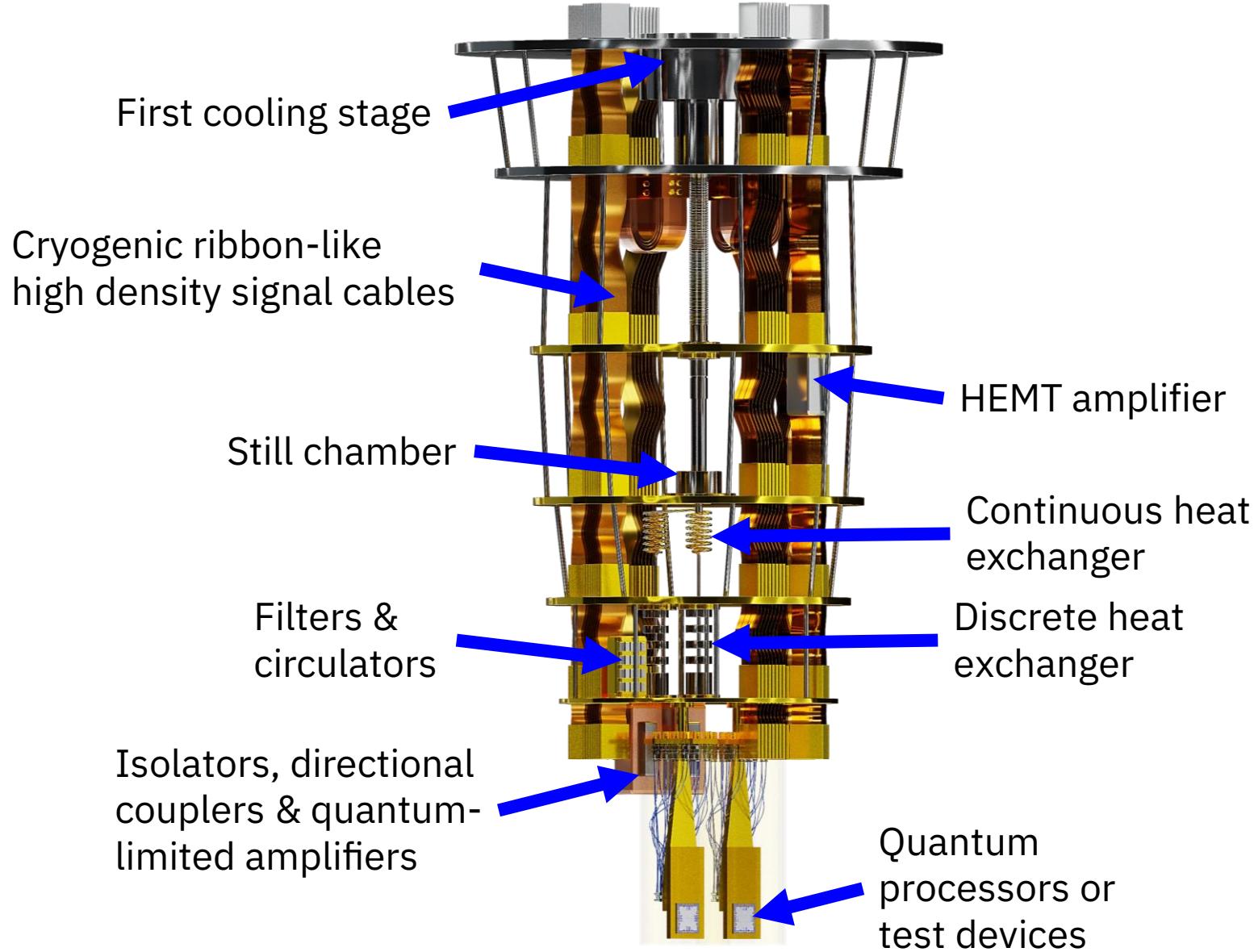
Djj' bich'j'go na'alkid Kelvin da'azjah (4 K)

T'ááláhádí mííl yázhí dóó ba'aan naakidi neeznádiin bich'j'go na'alkid Kelvin milligo da'azjah (1.2 K)

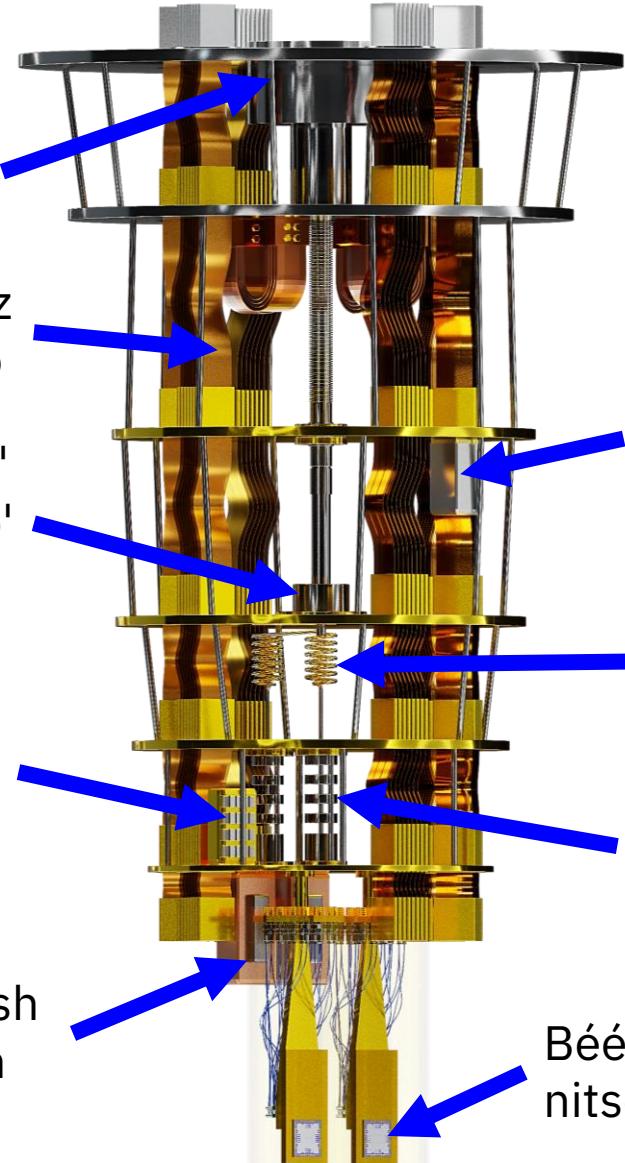
T'ááláhádí neeznádiin bich'j'go na'alkid Kelvin milligo da'azjah (100 mK or 0.1 K)

Neeznáá bich'j'go na'alkid Kelvin milligo da'azjah (10 mK or 0.01 K)

Dilution Refrigerator Parts Labeled



Díí t'áádoole'é nabíhonitaah bee 'azk'azi bi 'éhééstł'inígíí



Béésh 'alájjí' bee naalnishii
t'ah kodáá 'góne' honeezk'az

Béésh 'áltsózí sik'az
lashdóón nahalingo

Niłch'i Łikoní Hiiliyos bijoosye'
éí 'ayoo bił sikaz dóó siil bitoo'
nahalingo díí éí bighan

Béésh bee doo hodiiests'áą' 'ii
nahalingo dóó béésh 'áltsózí
táágóó bee 'ahidinítláago

Béésh bibee 'adiits'a'i t'áá 'aníí
hodéezyéél bee jiłaqhígíí dóó bibéésh
'áltsózí 'ahqah naaznilígíí dóó béésh
'áltsózí bee t'áá 'ádijí'

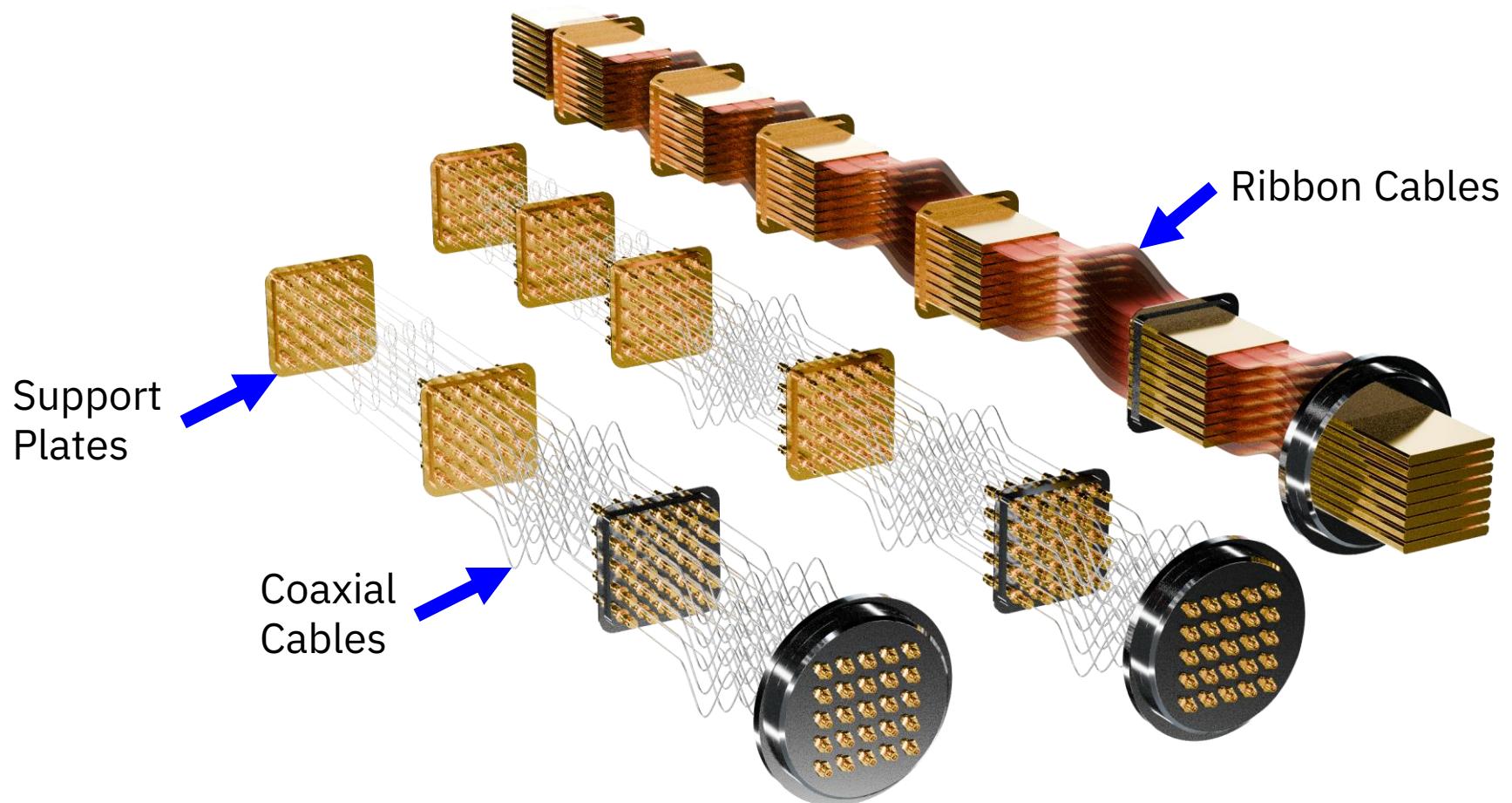
Béésh bibee 'adiits'a'i bee jiłaqhígíí
(Djj' bich'j'go na'alkid Kelvin da'azjah)

Béésh náhineests'ee'
bee bits'áníldoi 'áthaaígíí

Béésh kóníghánígo dóó
béésh ligaii dibahí biyi'di bee
bits'áníldoi 'áthaaígíí

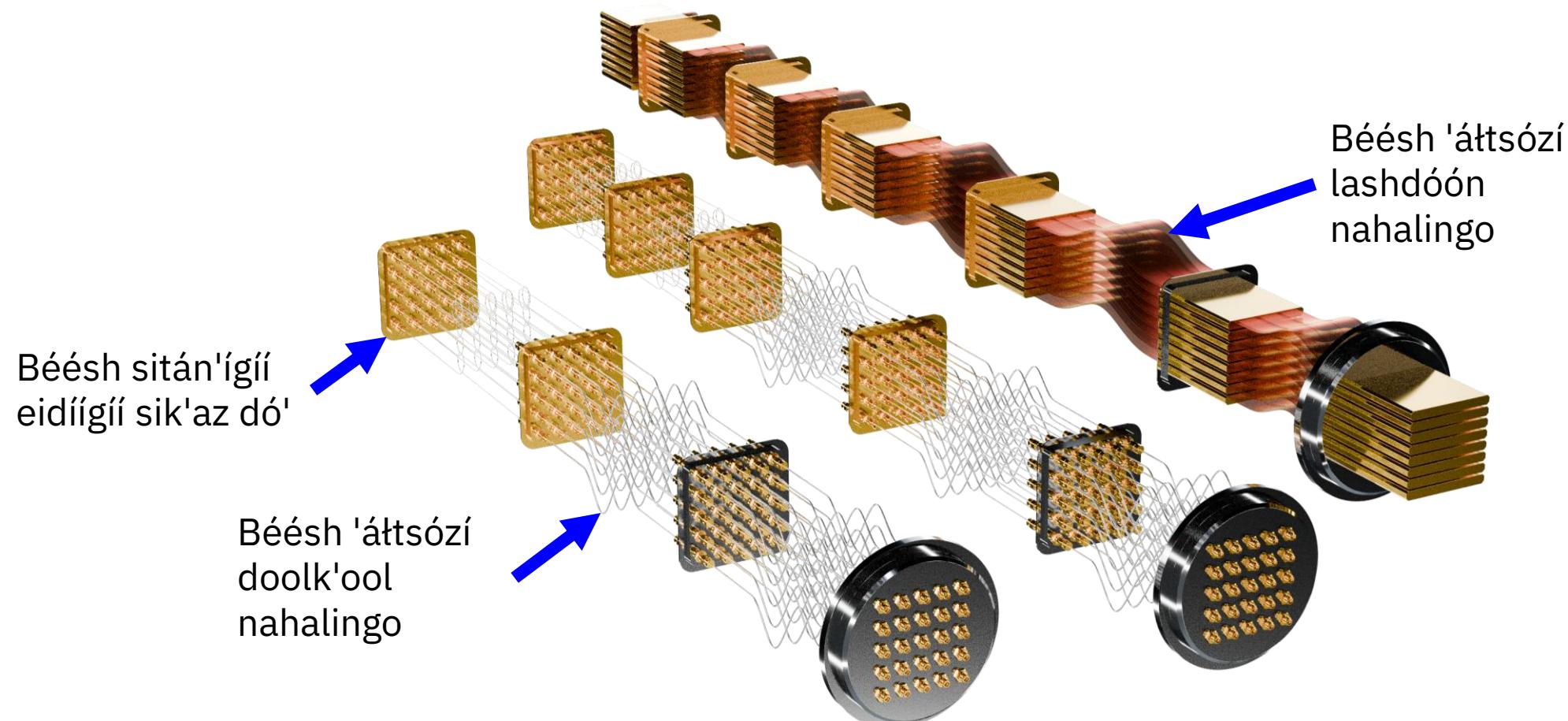
Béésh t'áá 'aníí 'á'ádaat'éhígíí
nitsékeesí bitsiighqa'

Cryogenic Cables



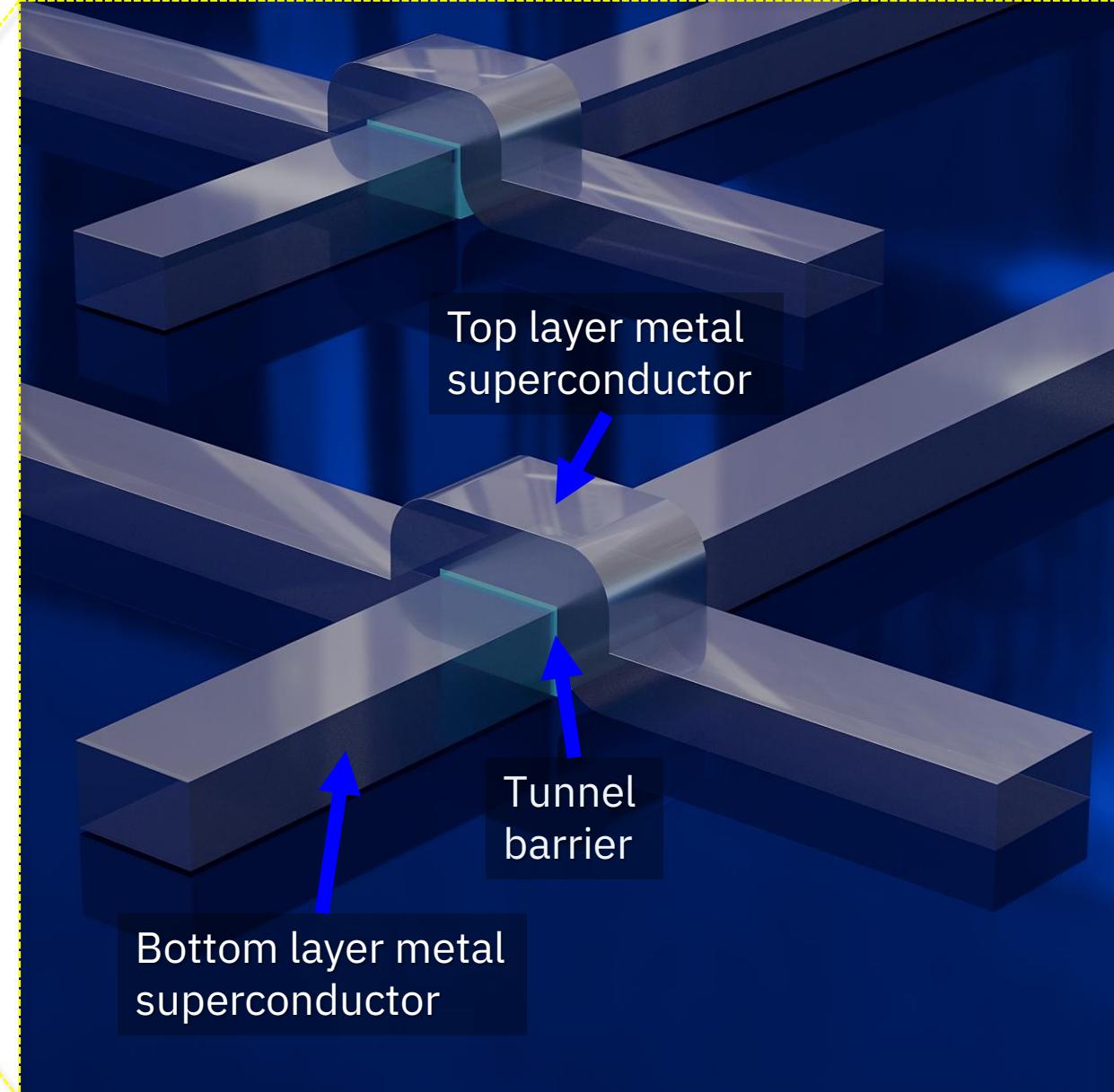
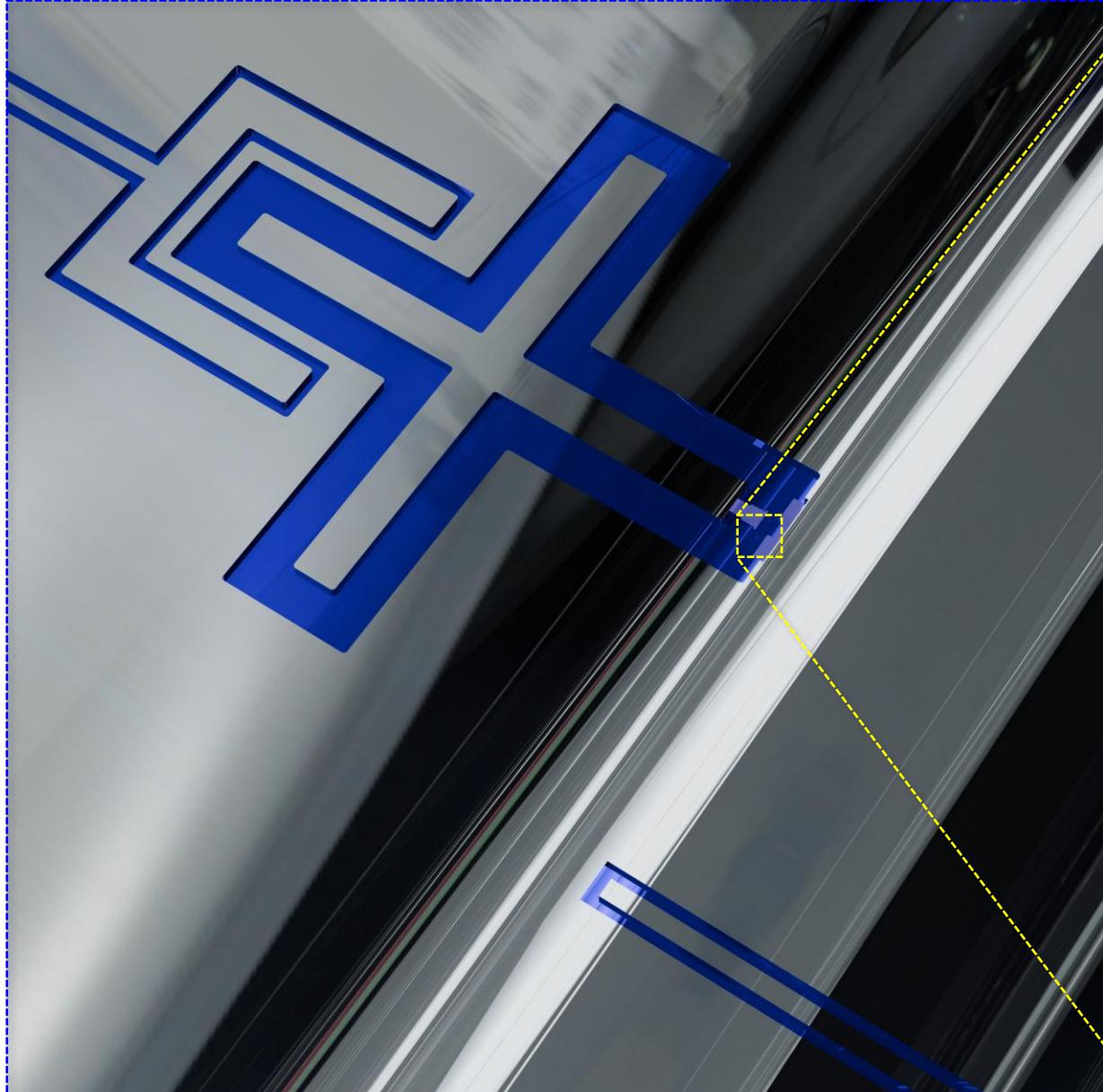
Cryogenic Wiring Examples

Béésh nitsékeesí bibéésh ‘áłtsózí sik’az

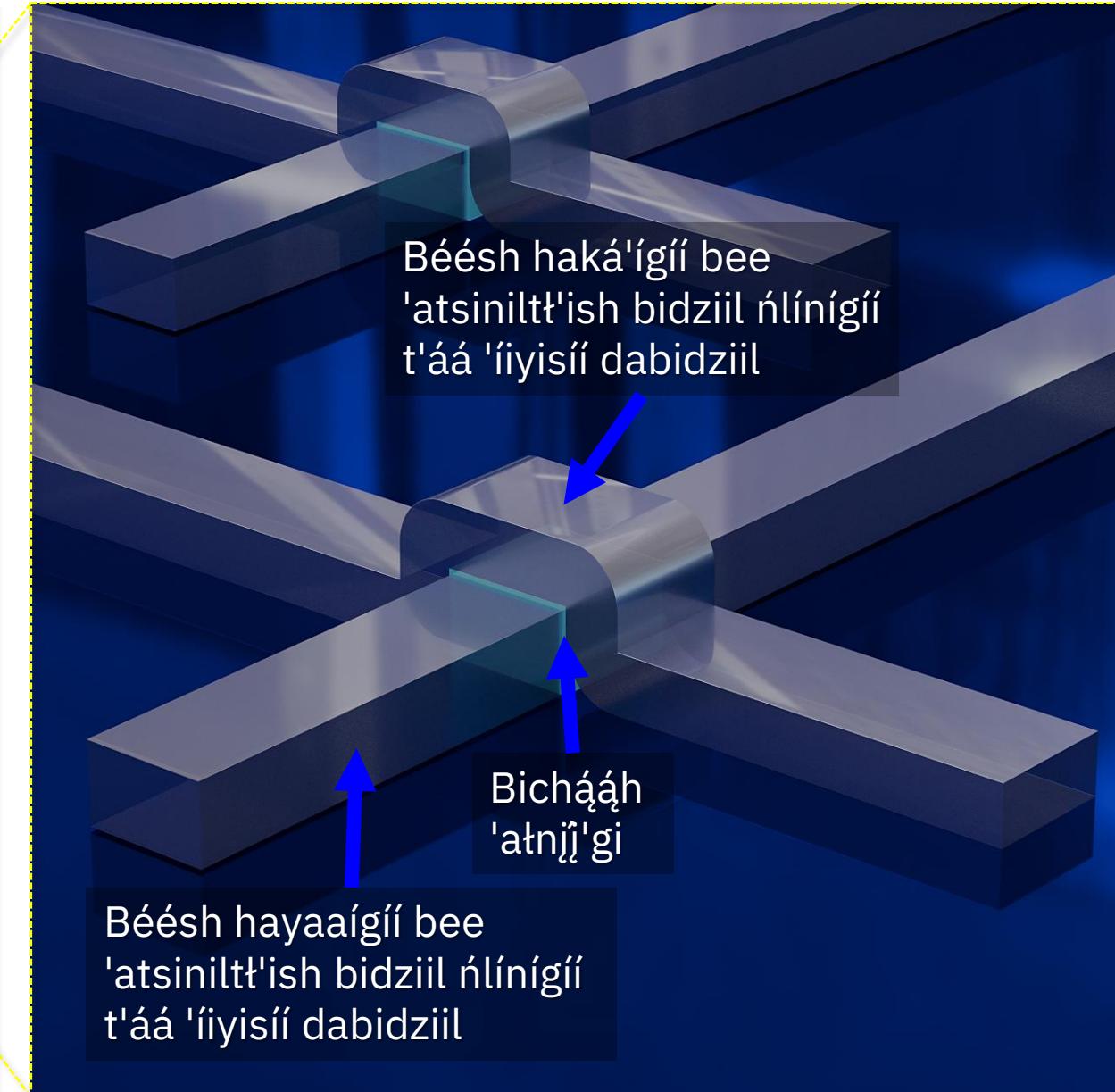
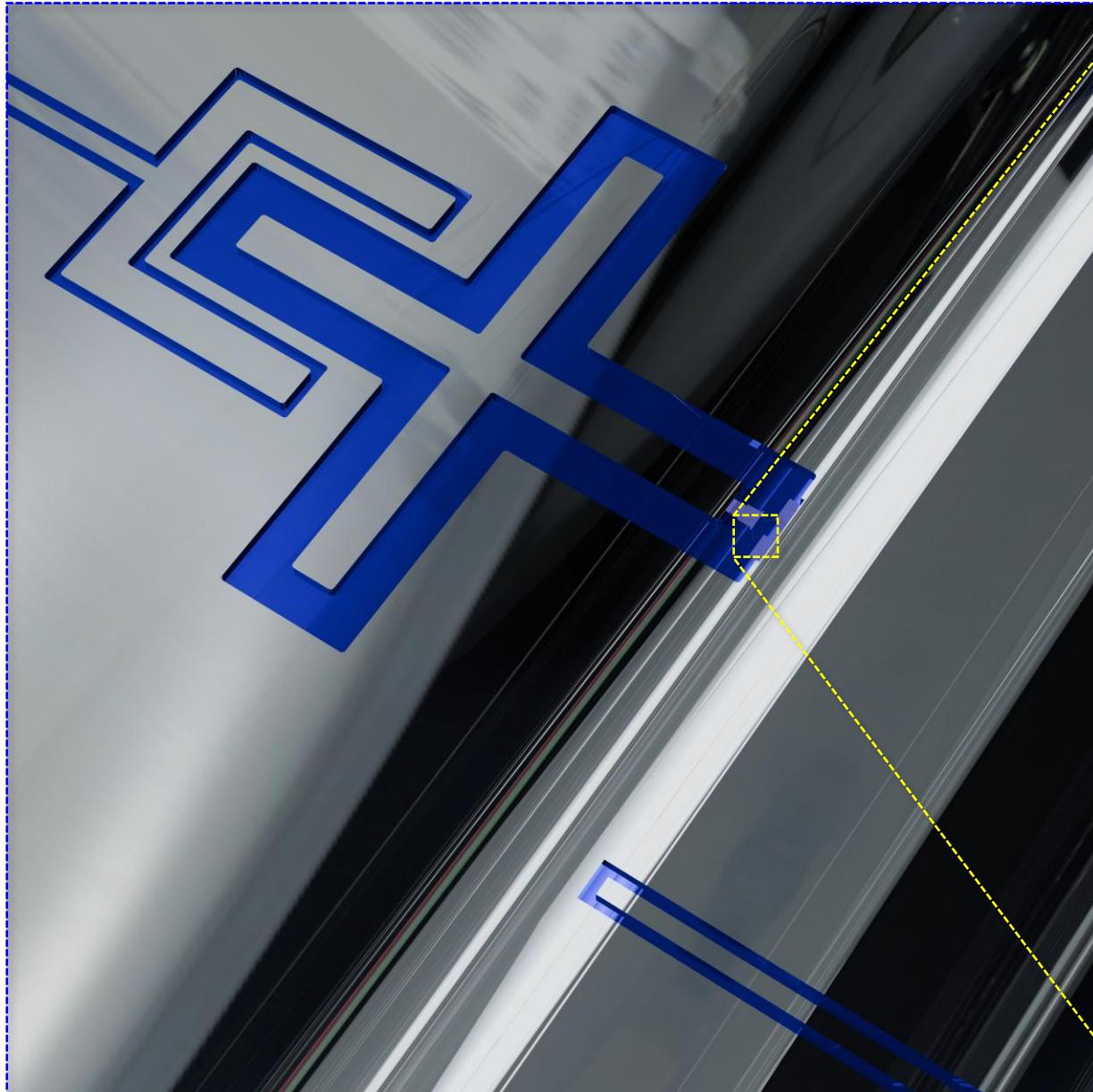


‘Ako díí béésh ‘áłtsózí t’áá ‘álah béésh doo ndiniichxíihii dóó béésh Naiiyob bijoosye’ eíyá bee ‘azk’azi ‘ábidiilyaa.

Some Processor Components (Superconducting Qubits)



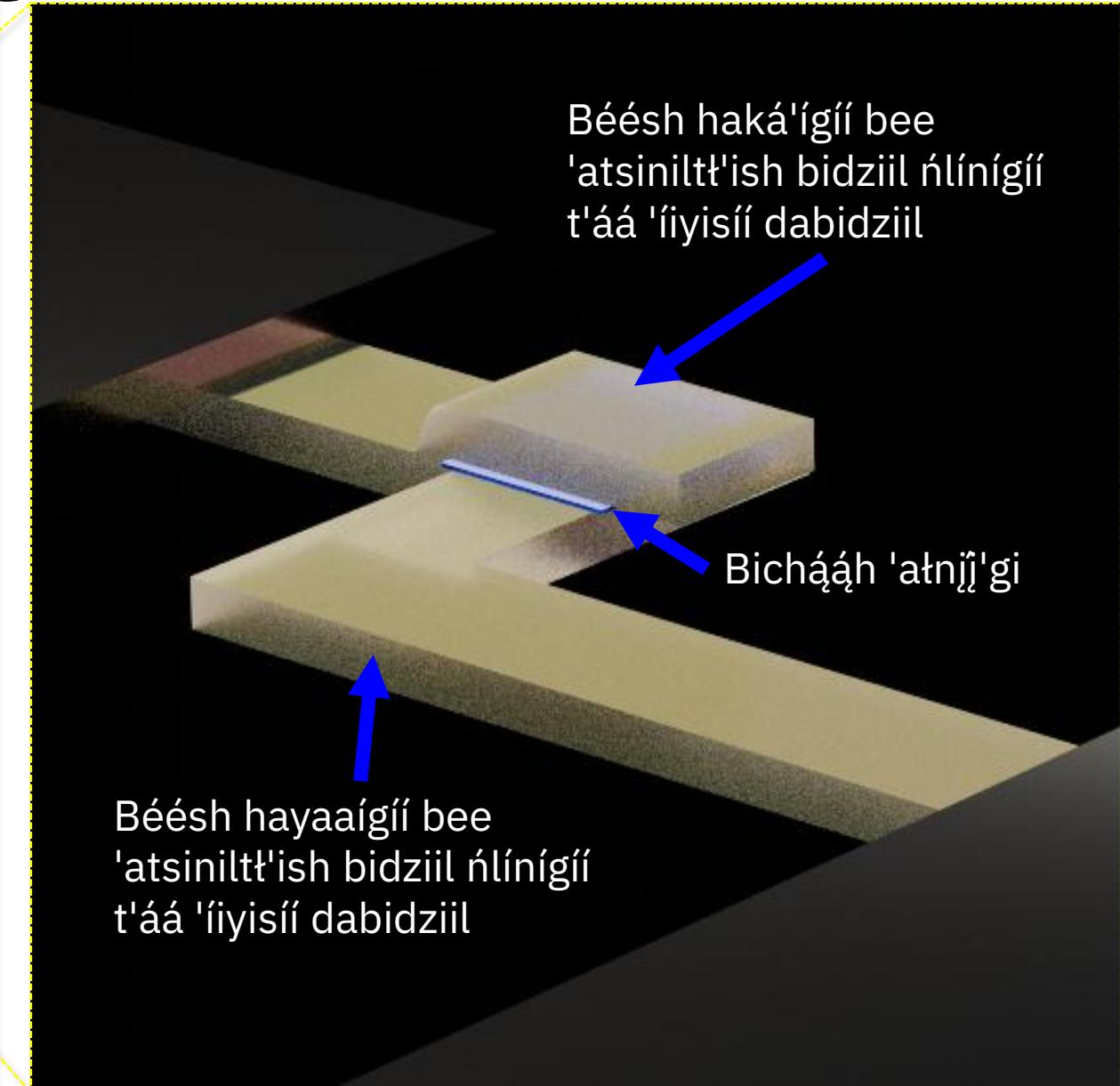
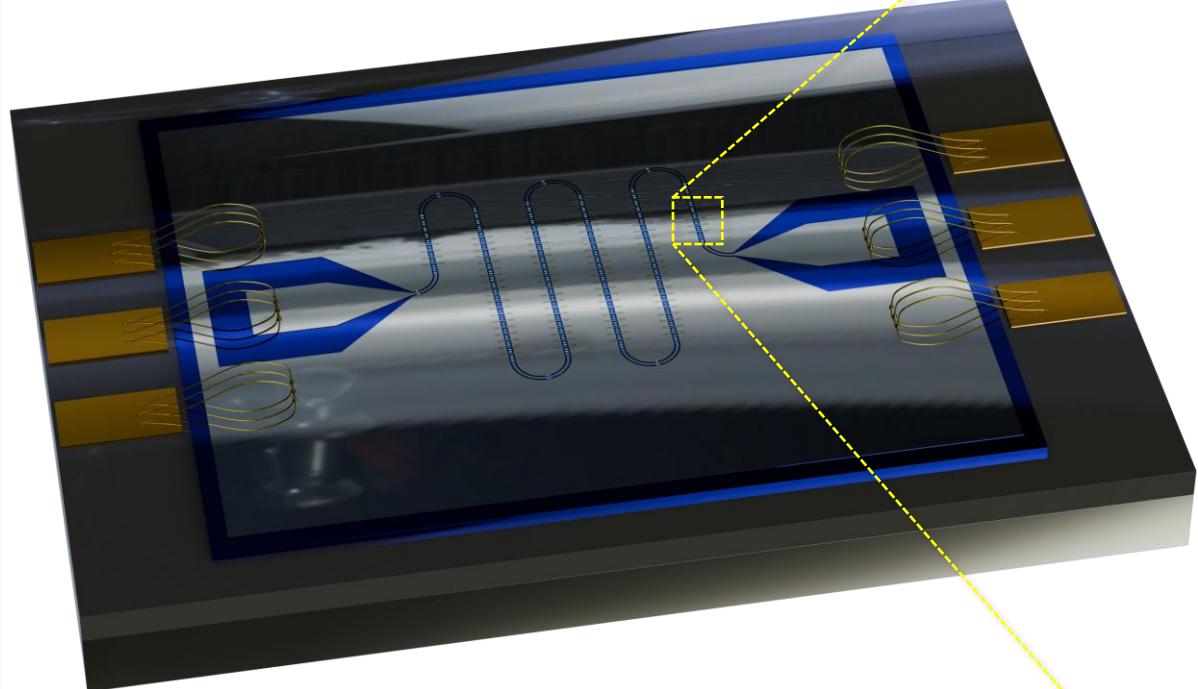
Béésh nitsékeesí bá ‘áłtsózí bee naalnishii



Béésh hayaágíi bee
'atsiniltl'ish bidziil nlinigíí
t'áá 'iiyisíí dabidziil

Béésh haká'ígíi bee
'atsiniltl'ish bidziil nlinigíí
t'áá 'iiyisíí dabidziil

Béésh ‘adiits’á’í bee jiłqahígíí bá ‘áltsózí bee naalnishii

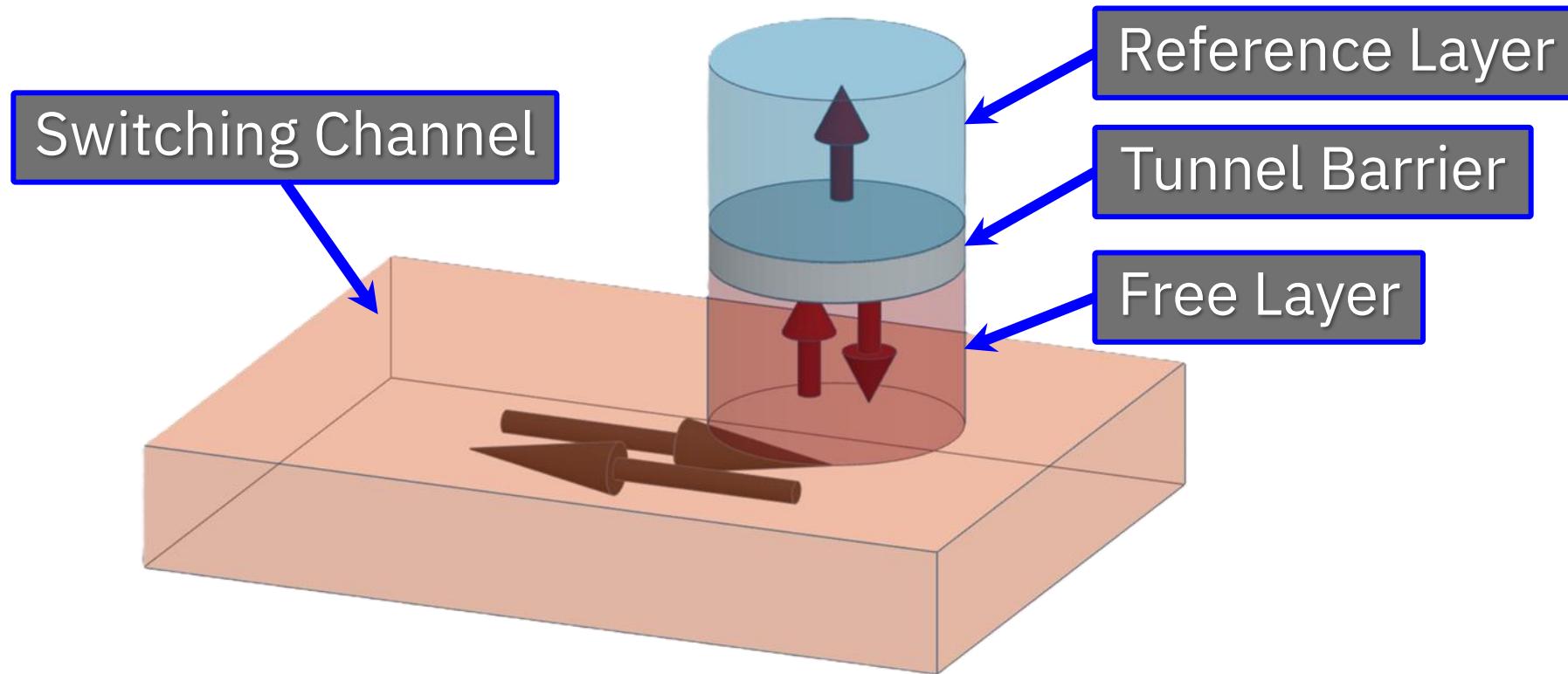


Béésh haká'ígíí bee
'atsiniltl'ish bidziil nłínígíí
t'áá 'íiyisií dabidziil

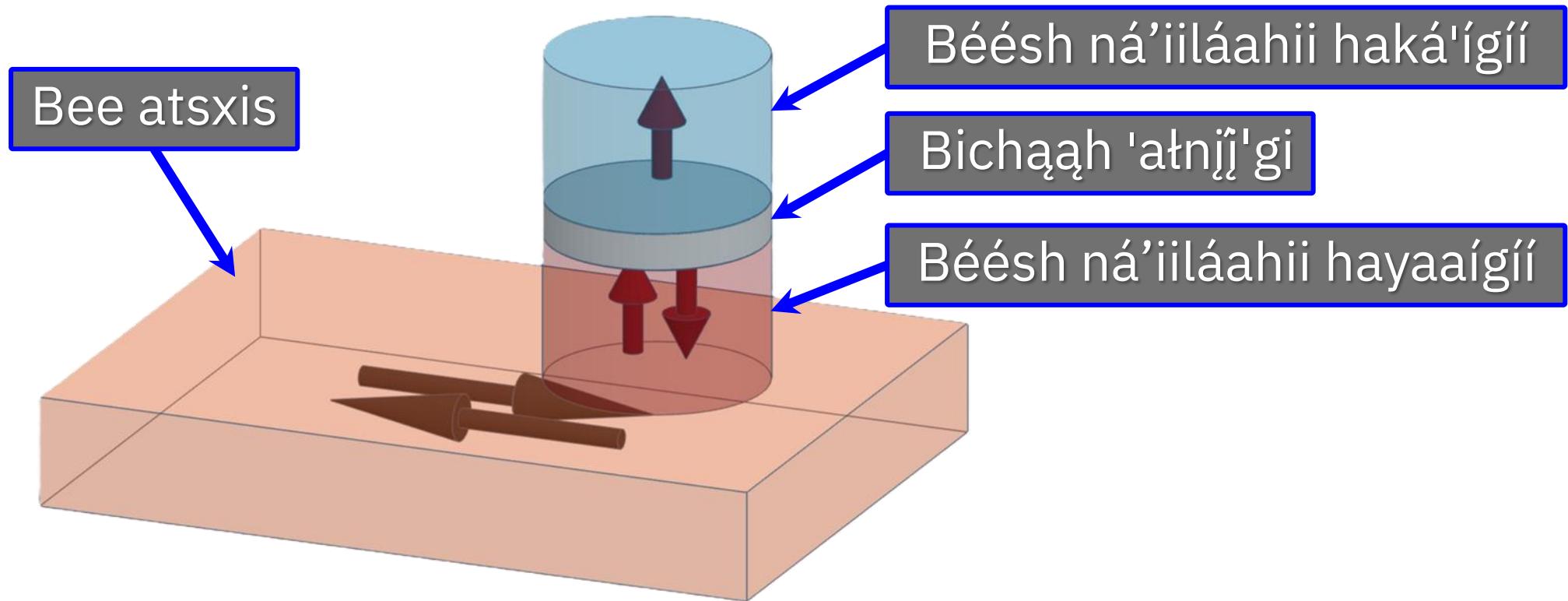
Bicházh 'ałníj'gi

Béésh hayaaígíí bee
'atsiniltl'ish bidziil nłínígíí
t'áá 'íiyisií dabidziil

Spin-Orbit Torque Magnetic Tunnel Junction



Béésh nitsékeesí binoo' 'áadóó bibéésh ná'iiláahii 'asdizígíí bee naalnishii



Known Metal Superconductors Translated in Navaho

English Term	Symbol	Superconductivity	Navaho Term	Literal Meaning
Aluminum	Al	*	Béésh 'ádaaszólígíí	Particular lightweight metal
Mercury	Hg	*	Béésh tózháanii	Metal with mushy or somewhat "watery" characteristics
Lead	Pb	*	Dilyjhlí	Lead
Tin	Sn	*	Béésh kágí	Metal skin or metal hide
Titanium	Ti	*	Béésh doo n̍diniichxíihii	Metal that does not rust
Zinc	Zn	*	Béésh dit'ooí	Hairy metal
Magnesium	Mg	(borderline) ^	Béésh Magniiziya bijoosye' or Magniiziya bibéésh	Metal named after Magnesia (Greece)
Nickel	Ni	^	Béésh Nik sání bijoosye'	Metal named after Old Nick
Tungsten	W	^	Béésh tibáhí 'ádanítláás	Heavy gray metal
Platinum	Pt	(no SC) → stays here if considering alloys	Béésh t̄igaii yázhí	Little silver or little white metal
Cobalt	Co	(no SC) but alloys SC	Béésh kaobel bijoosye'	Metal named after kobald (Germany)
Manganese	Mn	(no SC) but SC compounds exist	Béésh Manganiiziya bijoosye'	Metal named after Manganesia
Molybdenum	Mo	*	Béésh dilyjhlí nahaligo or Béésh maalib'doos bijoosye'	Lead-like metal or metal named after molybdos (Greece)
Tantalum	Ta	*	Béésh Tantalaas bijoosye'	Metal named after Tantalus (Greece)
Niobium	Nb	*	Béésh Naiiyob bijoosye'	Metal named after Niob (Greece)
Palladium	Pd	^	Béésh Balas bijoosye'	Metal named after Pallas (Greece)
Rhodium	Rh	^	Béésh choq bijoosye'	Metal named after a rose (Greece)
Ruthenium	Ru	*	Béésh Wootiinya bijoosye'	Metal named after Ruthenia (Greece)
Iridium	Ir	^	Béésh nááts'iílid	Rainbow metal
Gallium	Ga	*	Béésh Galiya bijoosye'	Metal named after Gallia (France)
Indium	In	*	Béésh taos'nii' nahalingo	Dough-like metal
Cadmium	Cd	*	Béésh Kadmiya bijoosye'	Metal named after Cadmea (Greece)

(legend: * = ambient pressure superconductivity, ^ = superconductivity only under high pressure)

When a metal is named after a noun: Béésh <Navaho transcription of noun> bijoosye' or <Navaho transcription of noun> bibéésh = Metal named after <noun> (additional context)

Supplementary Periodic Table of Superconductors

Periodic Table of Elemental Superconductors (2025)

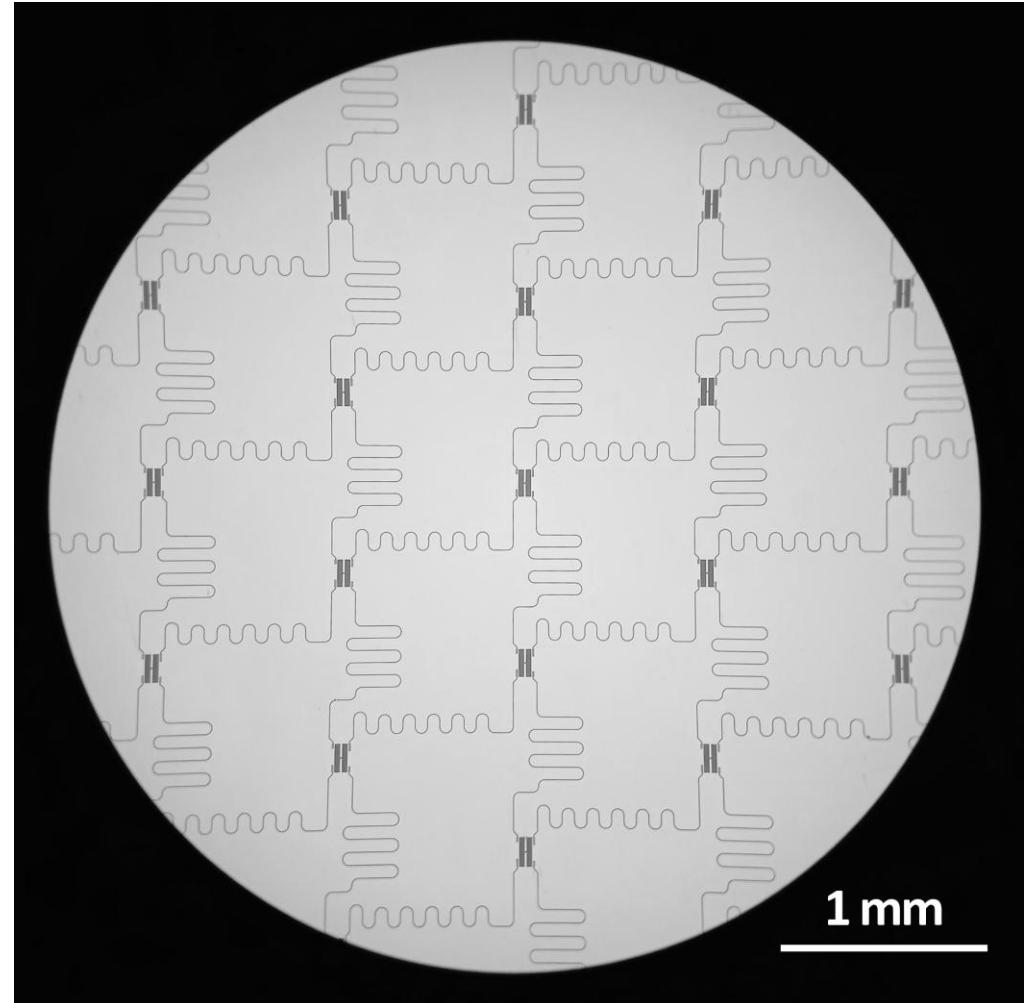
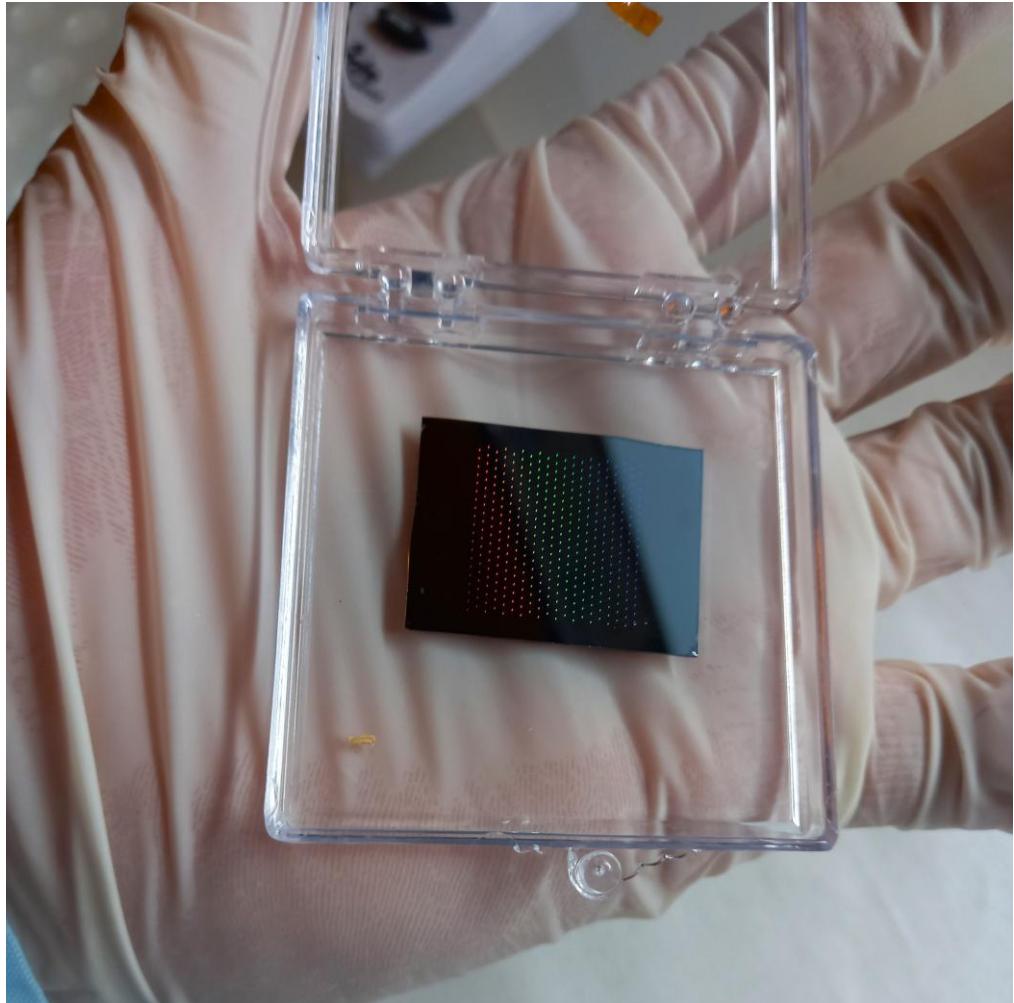
1	H															He				
2	Li*	Be*						B^	C	N	O^	F				Ne				
3	Na	Mg	Al*	Si^	P^	S^	Cl	Ar												
4	K^	Ca^	Sc^	Ti*	V*	Cr	Mn	Fe^	Co	Ni	Cu	Zn*	Ga*	Ge^	As^	Se^	Br^	Kr		
5	Rb^	Sr^	Y^	Zr*	Nb*	Mo*	Tc*	Ru*	Rh*	Pd	Ag	Cd*	In*	Sn*	Sb^	Te^	I^	Xe		
6	Cs^	Ba^	La*	Hf*	Ta*	W*	Re*	Os*	Ir*	Pt	Au	Hg*	Tl*	Pb*	Bi*	Po	At	Rn		
							Lanthanides						Actinides							
							Ce^	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb^	Lu^
							Th*	Pa*	U*	Np	Pu		Am*							

legend: * superconducts at ≈ 0 GPa (ambient) ^ superconducts only under high pressure
 (blank) no superconductivity yet confirmed in the pure element

Other Common Metals in Navaho (Some Translated)

English Term	Navaho Term	Literal Meaning
Metal	Béésh	Metal
Precious Metal(s)	Béésh 'ílíinii	Expensive or valuable metal(s)
Rust	ńdiniichxii'	Became red (generally used to describe rust or oxidation)
Copper (Cu)	Béésh tichíí' or béésh tichíí'ií	Red metal
Iron (Fe)	Béésh dootl'izh	Blue metal
Steel (Fe–C Alloy)	Béésh nitl'izígíí	Particular hard or inflexible metal
Stainless Steel	Béésh nitl'izígíí doo ńdiniichxíihii	Particular hard or inflexible metal that does not rust or oxidize
Gold (Au)	'óola	Gold
Silver (Ag)	Béésh tigaii	White metal
Chromium (Cr)	Béésh tibáhí bitsa'dinidiin	Gray metal that shines
Brass (Cu–Zn Alloy)	Béésh litsoii	Yellow metal
Bronze (Cu–Sn Alloy)	Béésh dinishtsoii or béésh dinitsoii	Dark yellow metal
Solder (Sn–Pb or Pb-free alloy)	Béésh bee 'ahída'diiljehí	Metal glue

Fabricated Quantum Chips Using Electron-Beam Lithography



Design Process Flow to Lithography



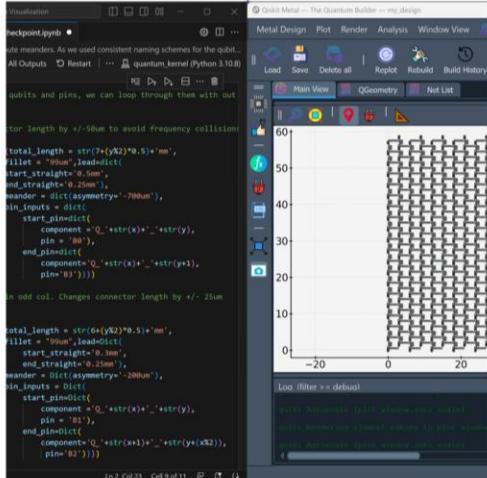
Export GDS file from Qiskit Metal.

For modifiable polygons & layer separation. (Pattern editors allow GDS-to-DXF conversion & some degree of layer separation).

At this point, each layer should be labeled based on their feature sizes, ready for lithography software.

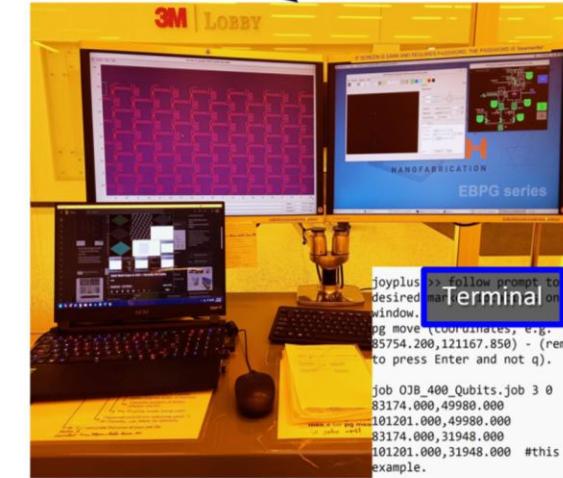
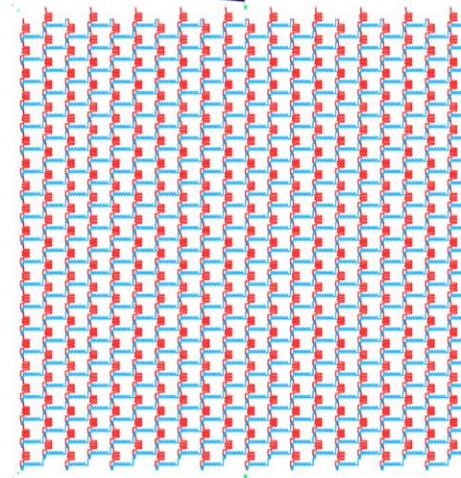
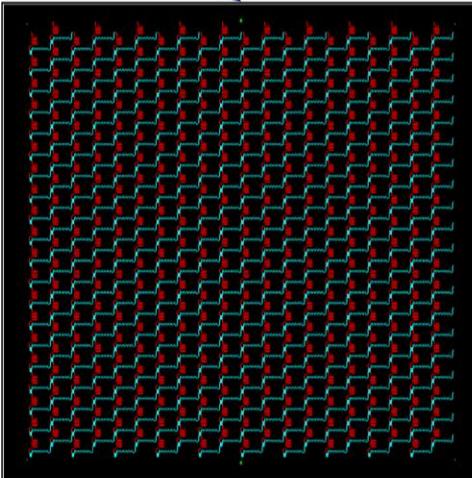
Additional Parameters (dosage, sub. size, etc.)

During final setup, machine actually uses this one.

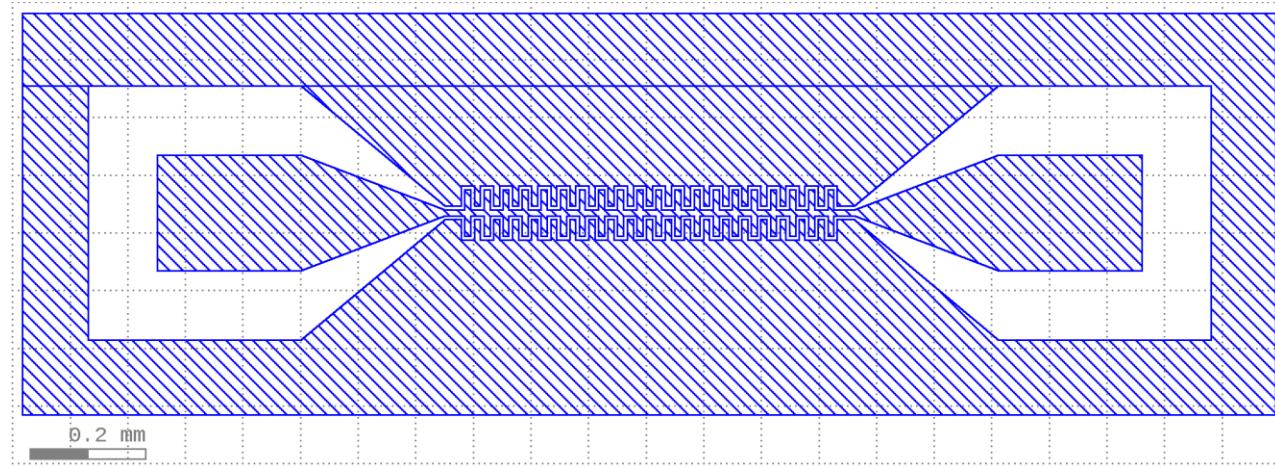
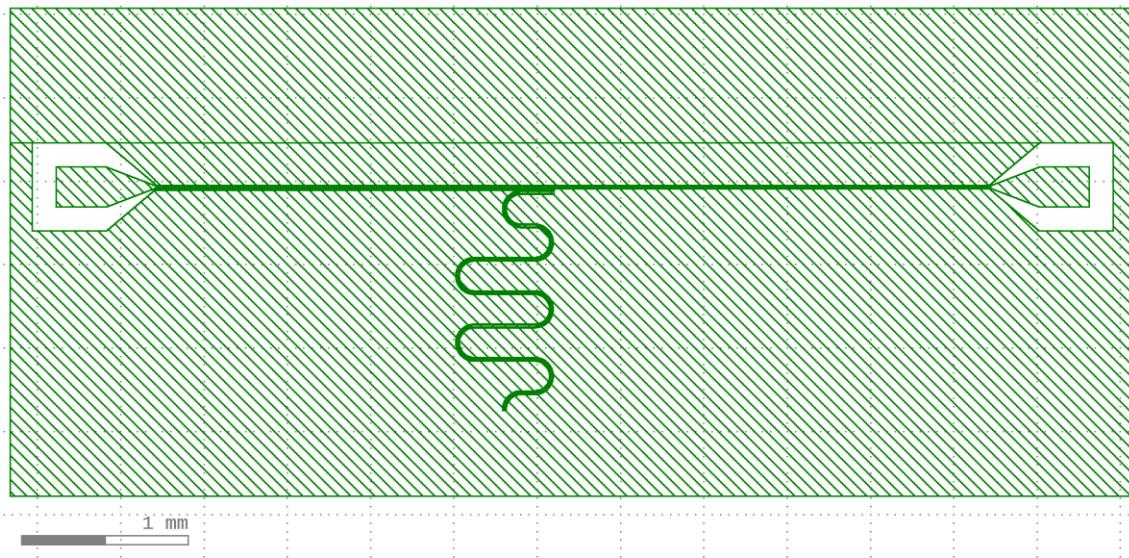


```
checkpoint.ipynb
# ... (code for quantum circuit definition and parameters)

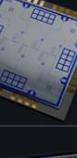
In GDSII ►
Heal ►
PEC ►
Export ►
```



2 Example Layouts That Can Be Fabricated w/ Raith Picomaster Near-UV LASER Lithography



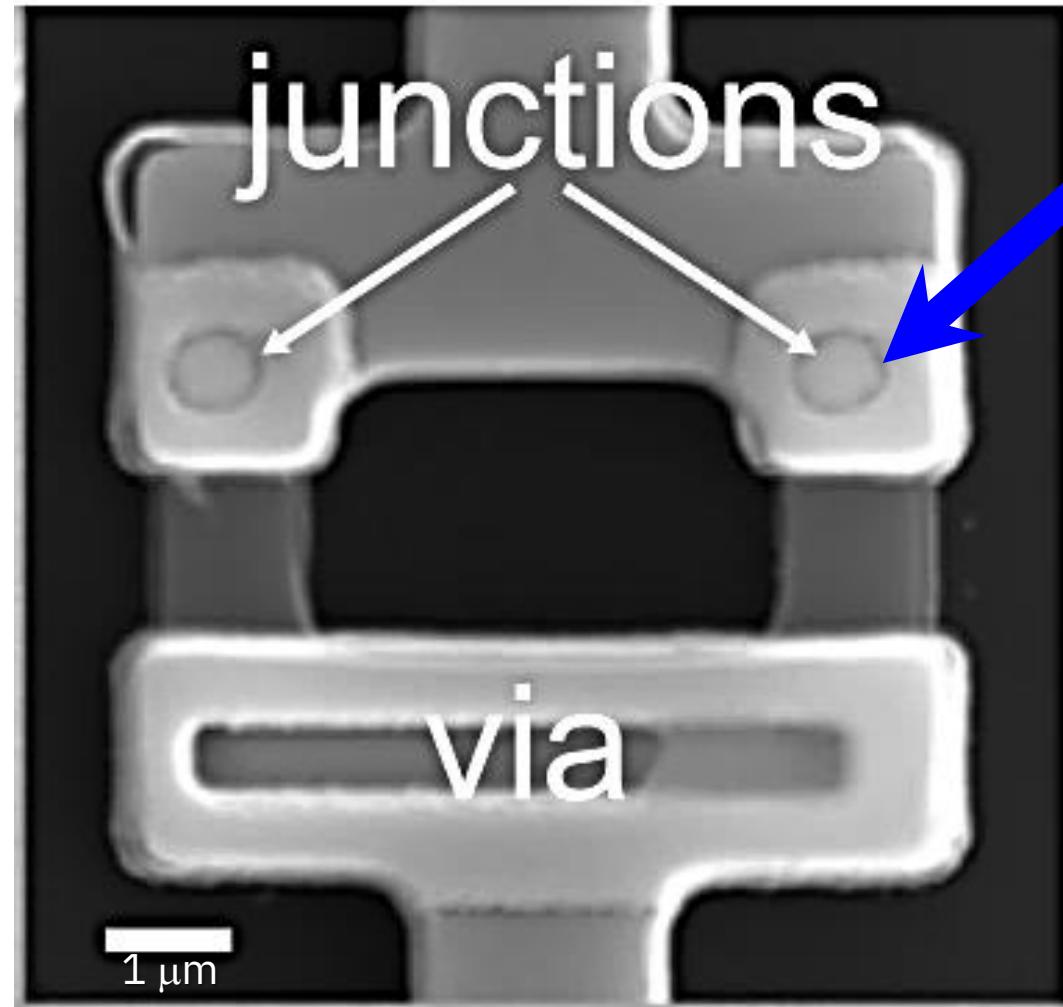
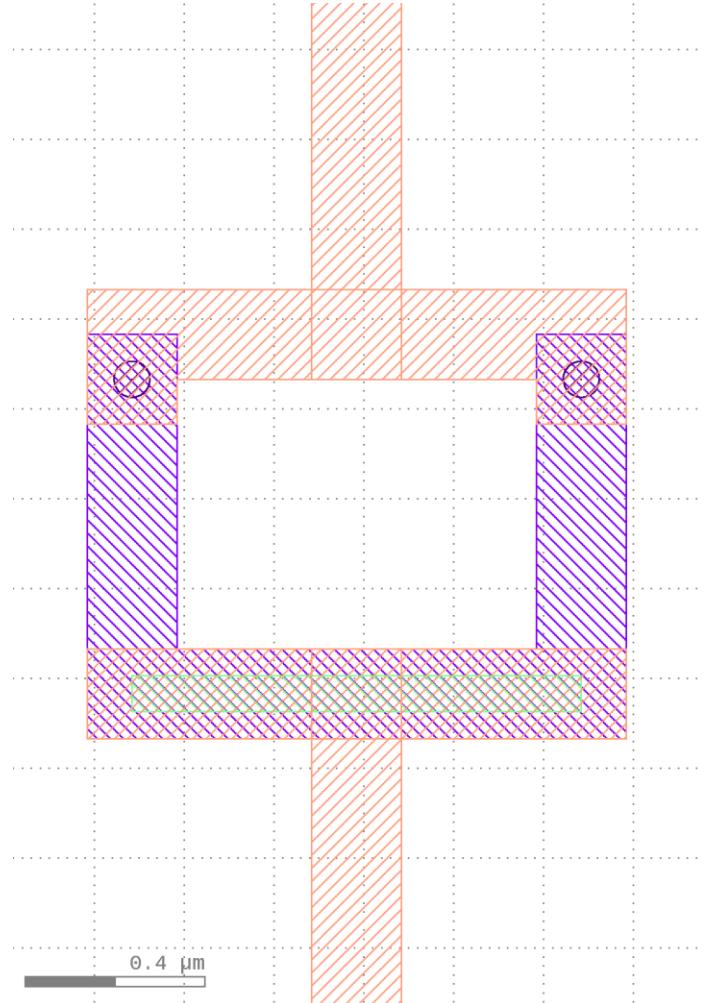
Renderings of the Quantum Hardware Are Now Available on Wikimedia Commons

Name	Thumbnail	Size	Description	Current version
Dilution Fridge with Quantum Processors Enclosed 008 8K.png (file)		236.05 MB	Uploaded own work with UploadWizard	Yes
Dilution Fridge 009 8K.png (file)		112.69 MB	Uploaded own work with UploadWizard	Yes
Dilution Fridge with Quantum Processors Enclosed 16K Resolution.png (file)		901.43 MB	Uploaded own work with UploadWizard	Yes
6 Transmon Superconducting Quantum Processor without Cheesing 012.png (file)		538.9 MB	Uploaded own work with UploadWizard	Yes
6 Transmon Superconducting Quantum Processor without Cheesing 013.png (file)		37.8 MB	Uploaded own work with UploadWizard	Yes
Superconducting Metamaterial Waveguide Chip.png (file)		281.02 MB	Uploaded own work with UploadWizard	Yes



Available at: w.wiki/FHwj or search for “OJB-Quantum Wikimedia”

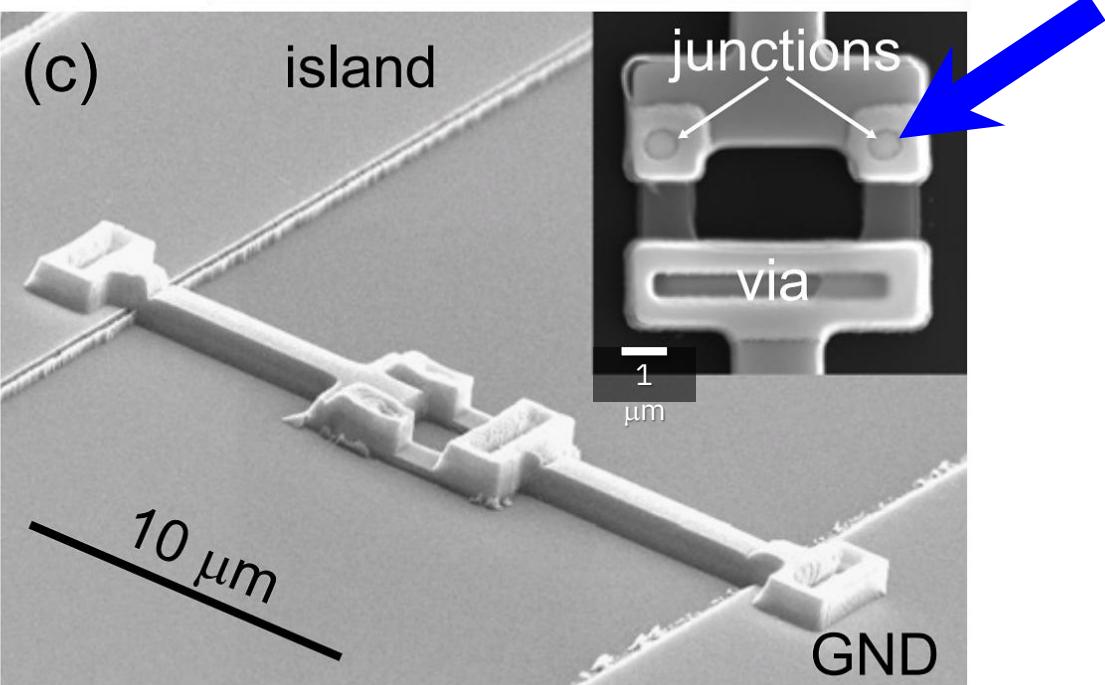
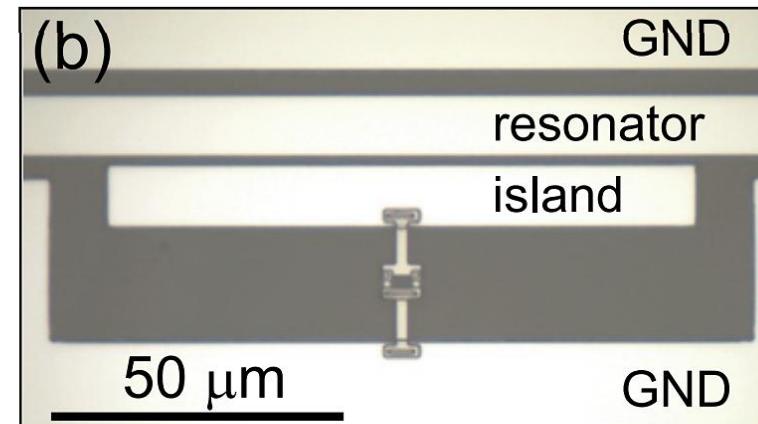
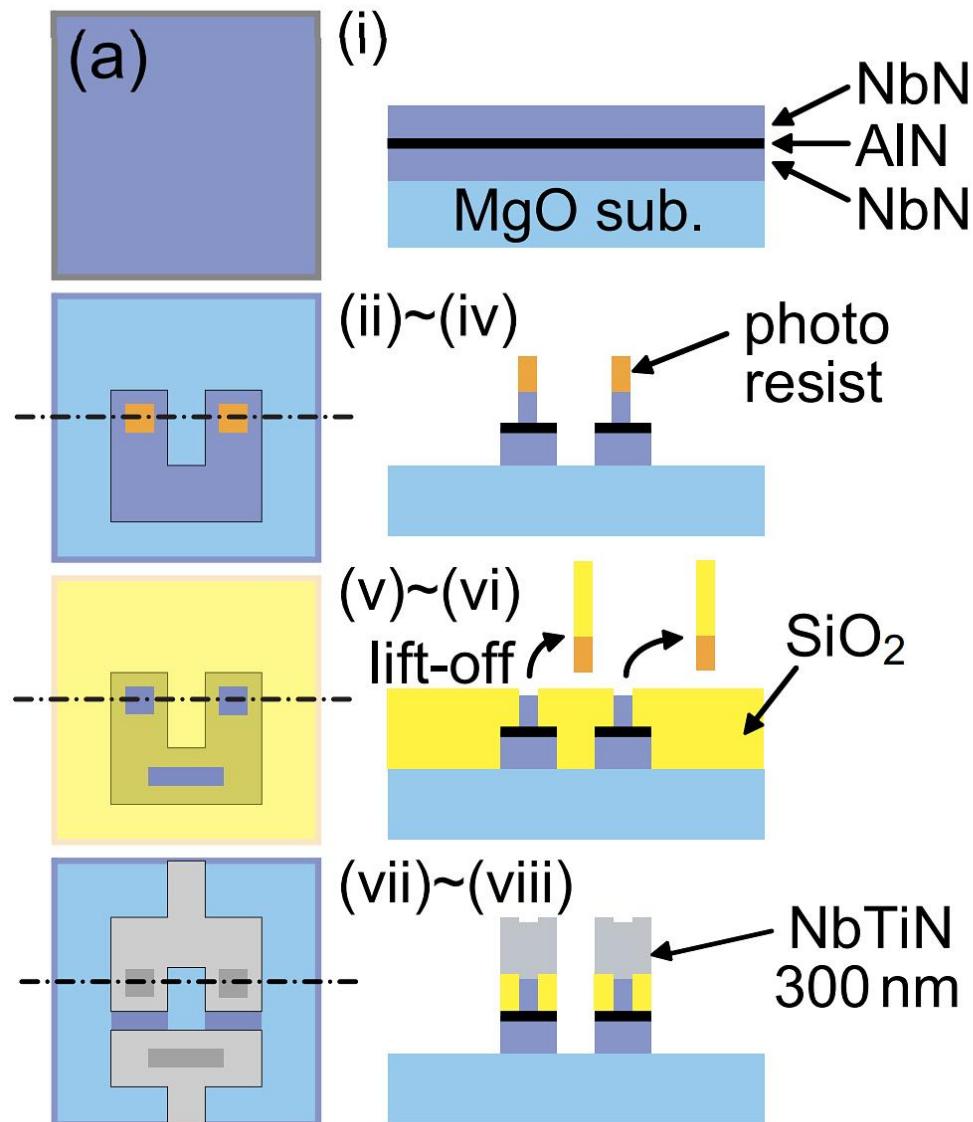
Josephson Junction Patterning Example To Be Finished Imaging (Layout Produced)



1. [Based on: Nakamura et al., *Appl. Phys. Lett.*, 99, 212502 \(2011\)](#)

The remaining examples in the following slides are to be translated beyond the project for future public outreach

Josephson Junction Patterning Example

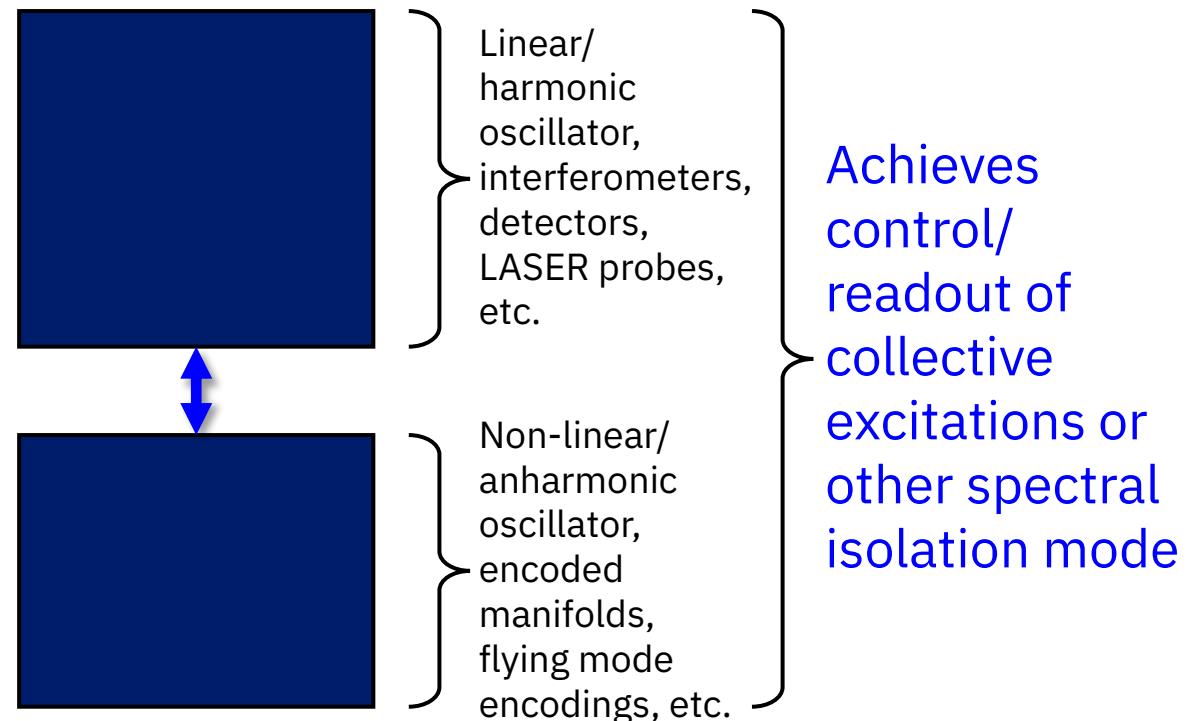


1. [Nakamura et al., Appl. Phys. Lett., 99, 212502 \(2011\)](#)

Mechanism-Agnostic Elements of a Qubit For the Long Term

You will notice that **practical** selection and usage of a physical qubit requires for it to:

- Achieve spectral isolation so that T_1 , T_2 comfortably exceed gate and measurement times
 - Examples under isolation: anharmonicity, selection rules, encoded manifolds, mode orthogonality, etc.
- Allow coherence engineering
- Allow scaling up
 - Often enabled through buses, memory, & transducers
- Be controllable of its quantum states using tailored electromagnetic (EM) fields (DC, RF, microwave, or optical) or magnetization fields/ textures with the carrier being of appropriate wavelength & noise levels



These are various ways to physically simulate nature manipulating and using natural or synthesized quantum objects.