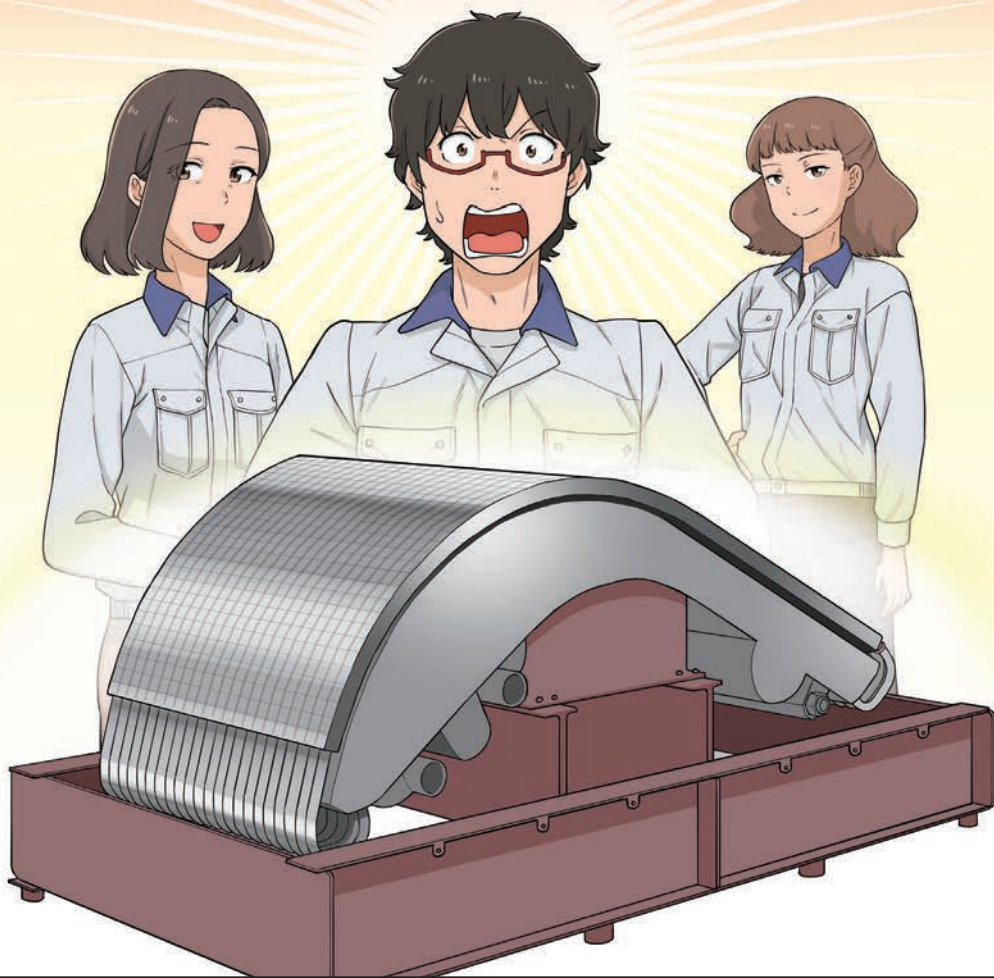


# A small Sun on Earth

# ITER

イーター

Vol.6 ~ The Spirit of Monozukuri: Divertor ~



# CHARACTERS



## TAIYO TENNO

New recruit at QST (National Institutes for Quantum Science and Technology), the Japanese Domestic Agency of the ITER project. He is on a whirlwind tour of the ITER-related facilities at QST's Naka Fusion Institute.



## MIRAI MITSUHASHI

Veteran QST staff member. She is in charge of leading the tour of QST facilities for new hires.



## MAKO KAWAI

Researcher at QST, responsible for the development of the components for ITER's divertor.



## Group leader ŌHATA

Researcher at QST and a kind-hearted boss.



## Company M

In charge of manufacturing the divertor.



## Company Y

Specializing in metal alloys and tasked with manufacturing the copper piping.



## Company A

Tasked with preparing the tungsten materials.



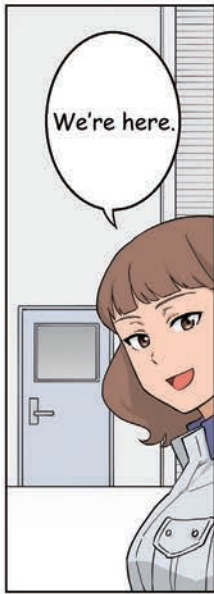
## Company N

Tasked with the tungsten bonding process.

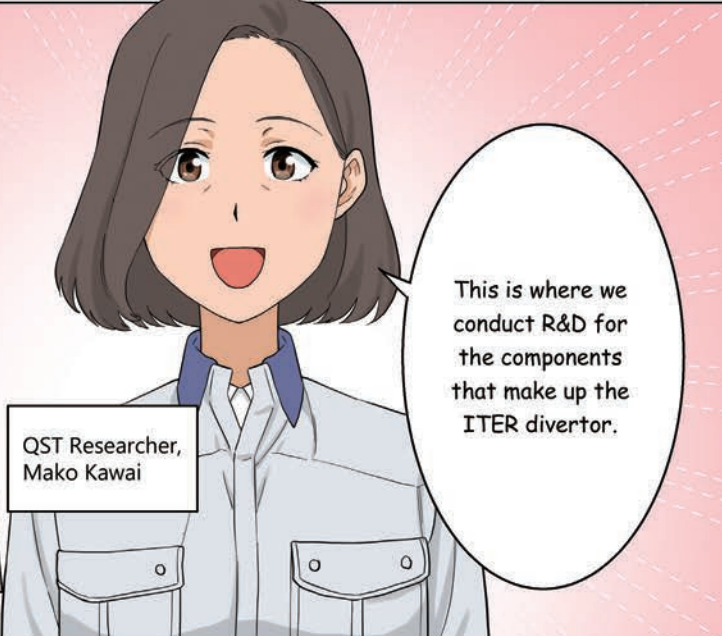
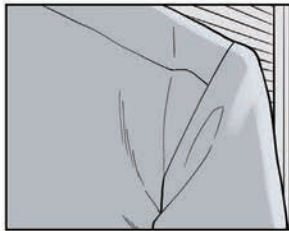
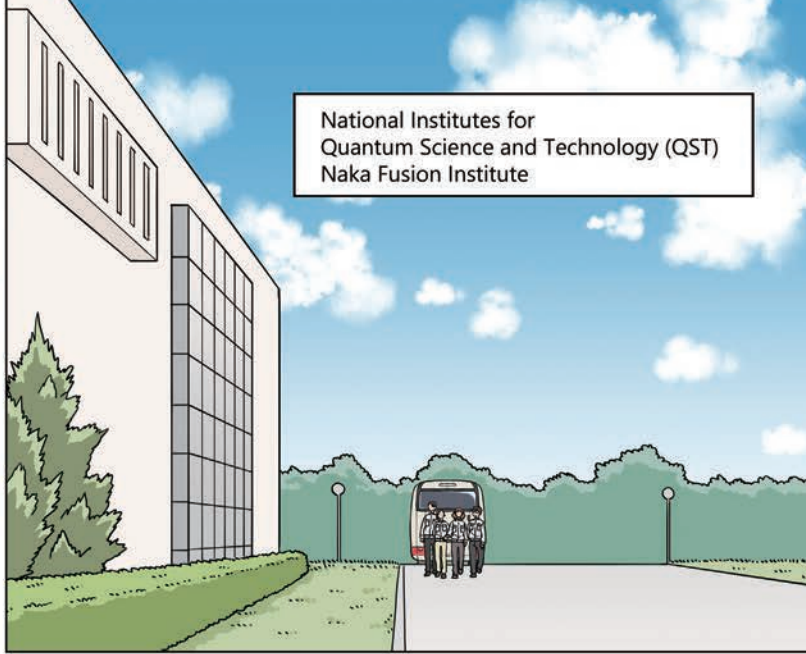
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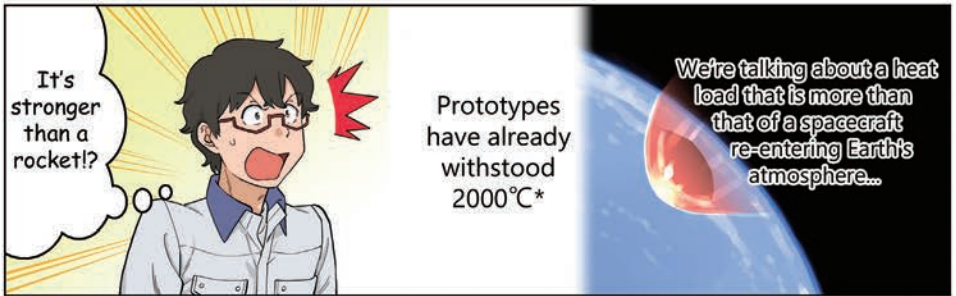
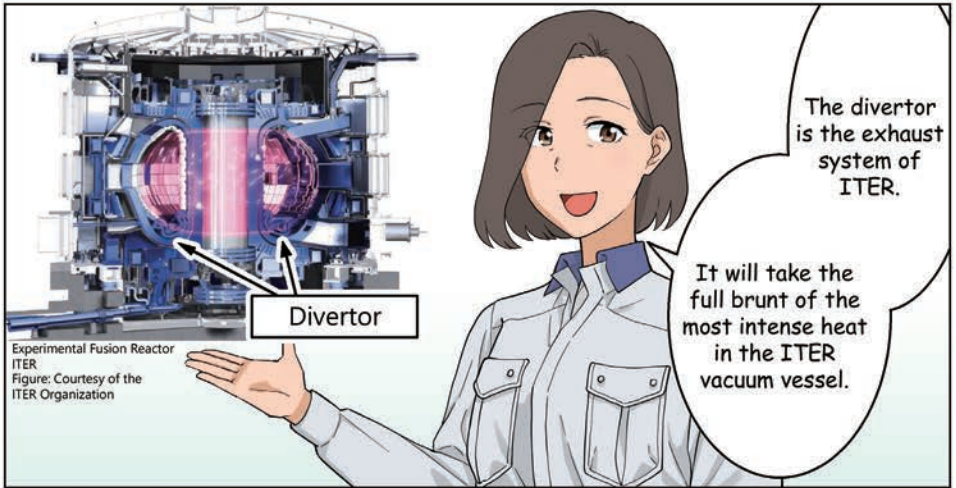
## Our story so far...

Our protagonist, Taiyo, who met Soléane when he was a student and ever since became fascinated with ITER, has graduated from university and is now an administrative staff member at QST. He is taking part in a tour of QST's Naka Fusion Institute as part of his training for new hires, led by QST veteran staff member, Mirai. In the previous issue, we learned about the "gyrotrons," one of the systems used to heat the plasma in ITER. In this issue, we will visit the R&D facility for the "divertor," a system that is essential for maintaining the plasma in ITER.



National Institutes for  
Quantum Science and Technology (QST)  
Naka Fusion Institute





\*In high heat flux tests, an electron beam gun cycled about 1000 times, in a succession of 10-second shots, to create a high heat load of 2000°C

Japan is responsible for manufacturing the divertor's outer vertical targets, a critical plasma-facing component.

- 1 It extracts helium ash and other impurities produced by the fusion reaction.
- 2 It extracts heat from the super-hot plasma.
- 3 And It improves plasma confinement.

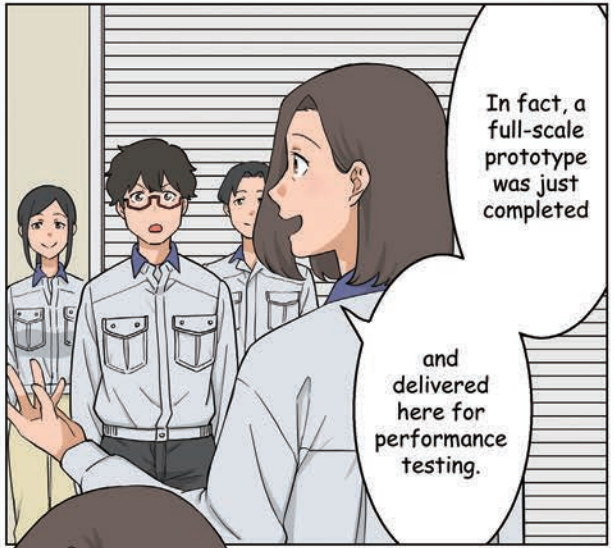
The divertor's role is three-fold.

Outer Vertical Target, OVT

Figure: Courtesy of the ITER Organization



How long did that take to develop?



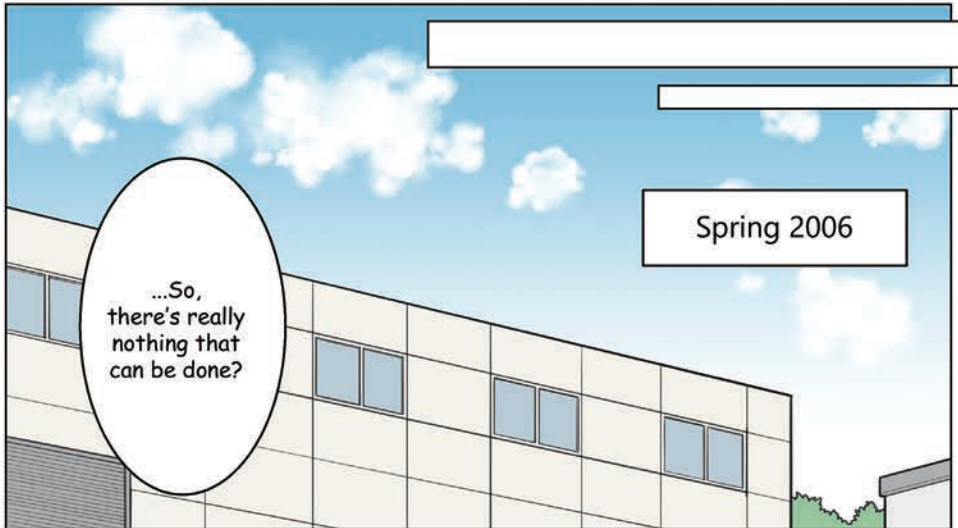
In fact, a full-scale prototype was just completed

and delivered here for performance testing.



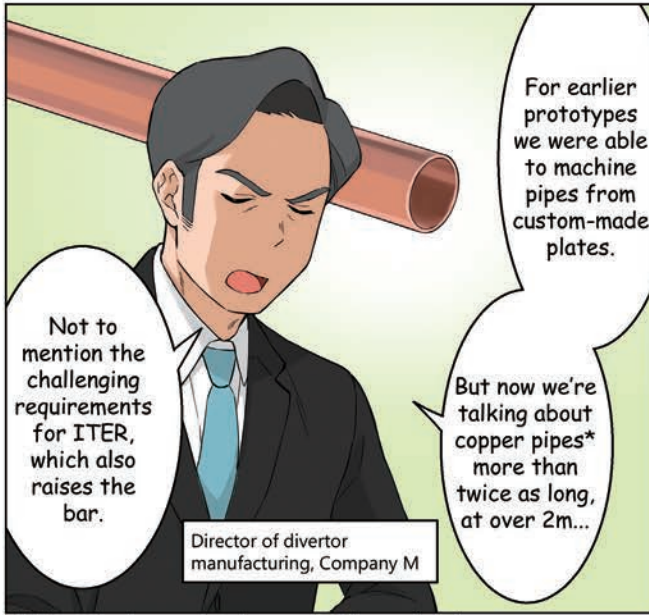
Let's just say it didn't happen overnight.

Well,

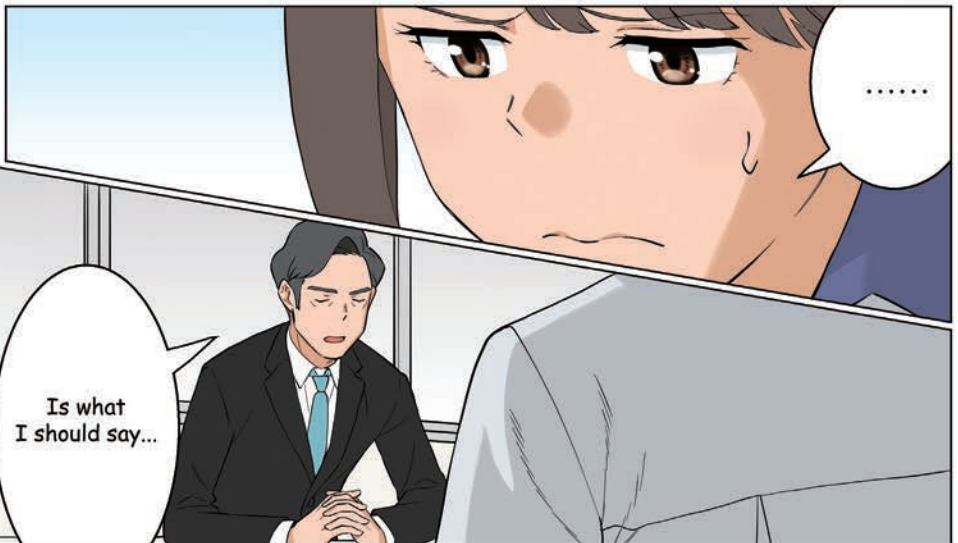


Spring 2006

...So, there's really nothing that can be done?



\*ITER-grade, chrome-zirconium-copper alloy cooling pipes





!!

But there is one other company that comes to mind.



Did you hear that, group leader Ohata!

QST Researcher, group leader Ohata (a kind-hearted boss)

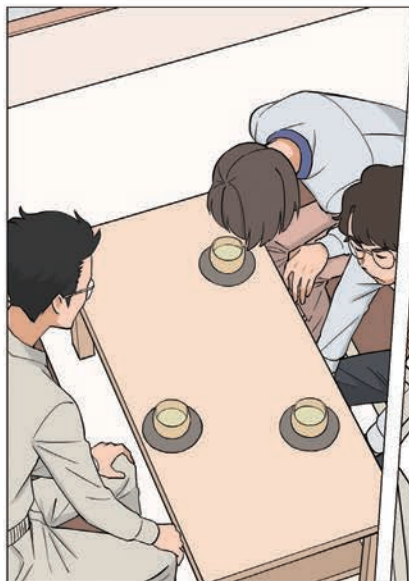


And that's Company Y. Their expertise is second to none.

If they can't do it, no one can.



Company Y

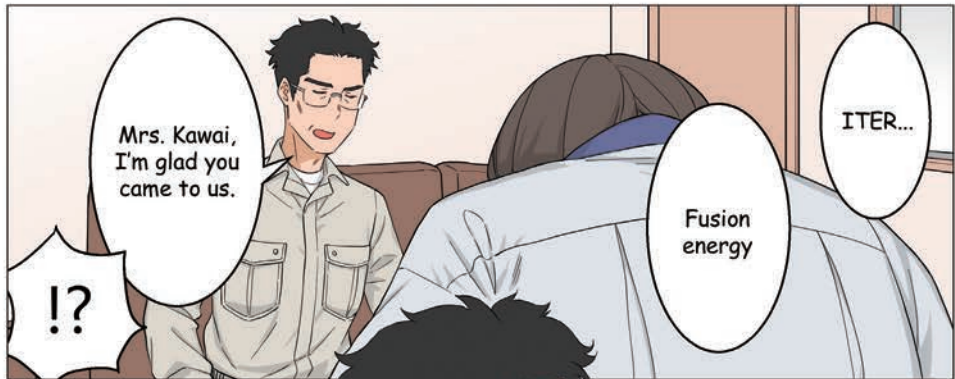




It makes absolutely no sense from a business perspective.

The more I explain, the more absurd it must sound.

They're going to turn us down...



Mrs. Kawai, I'm glad you came to us.

ITER...

Fusion energy

!?



If we can assist you in any way, we'd be more than happy to help.

In fact, it'd be an honor.

Director of Company Y's special copper alloy factory, Shigejiro Hagino

You really mean it!?

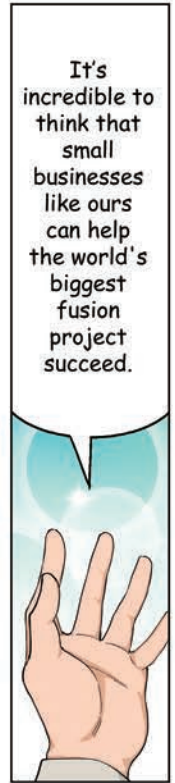
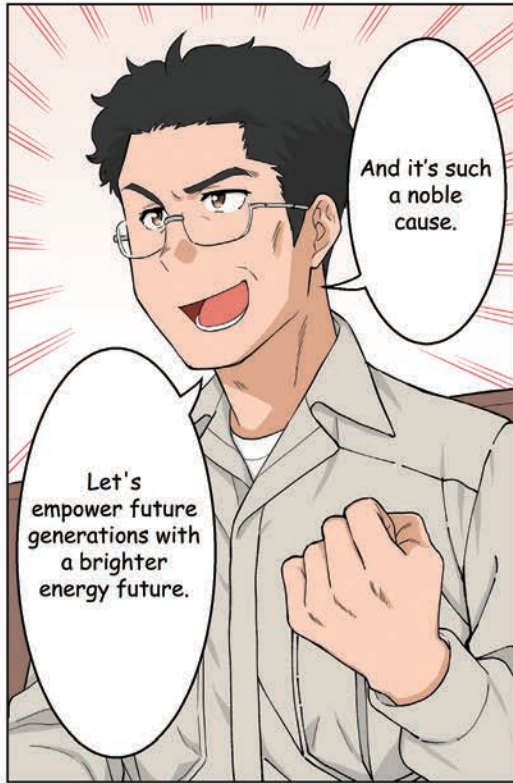
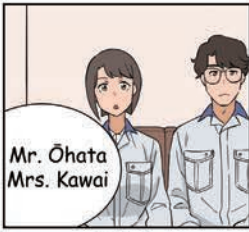


You can count on us!

I'll need all hands on deck...

Boss!

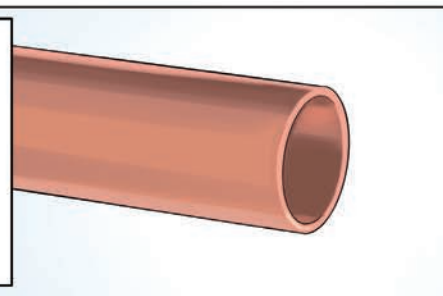




Company Y—  
with their years of  
experience, skill,  
and know-how in  
copper alloys—  
gave it their all to  
develop the  
full-scale copper  
pipes.



To say it was  
an exercise in  
trial and error  
would be an  
understatement.



It took eight years to  
achieve that goal.

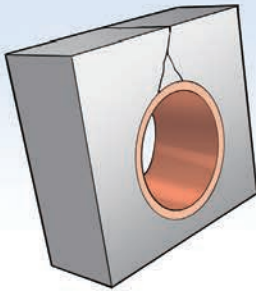
2011

WHAT!?

and if we can't demonstrate that in three years, it'll have broader implications for the ITER project as a whole.

This change also calls for about twice the heat resistance and cooling performance as before,

Redesigning the divertor... at this stage?



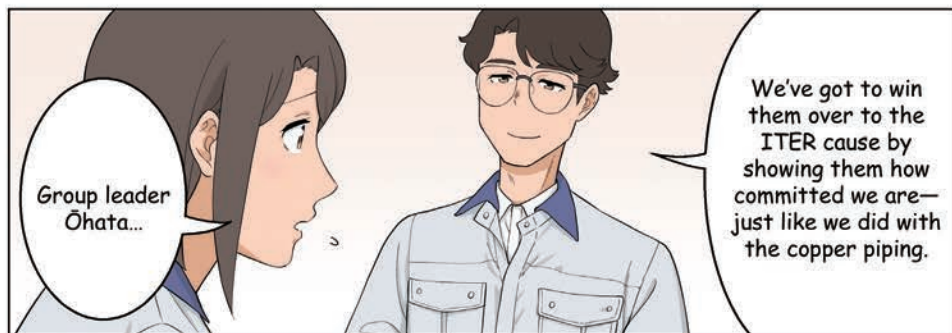
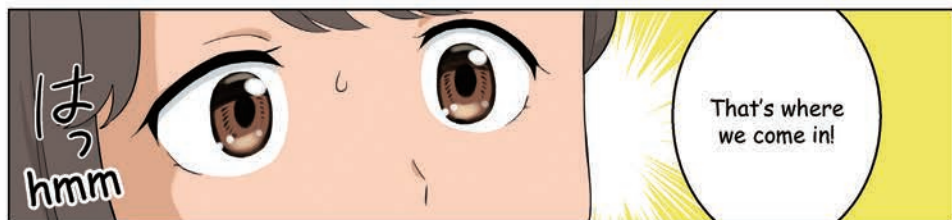
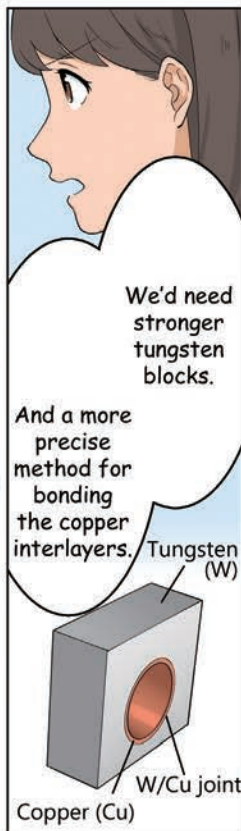
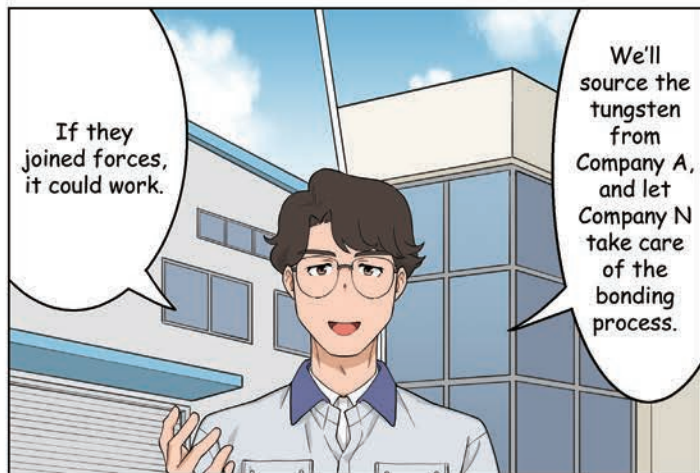
Tungsten test specimens are known to crack...

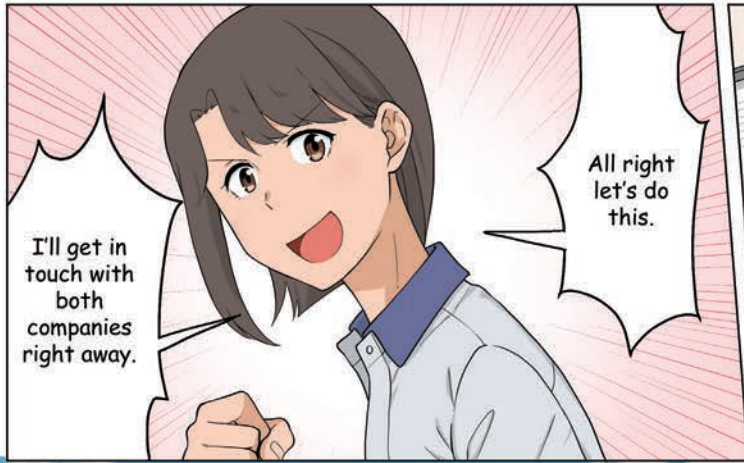
That can't be... Over 40 years of international R&D effort, and what has been shown time and time again.

Yep... Changing the plasma-facing material from carbon fiber composite to full tungsten.

And we only have three years...

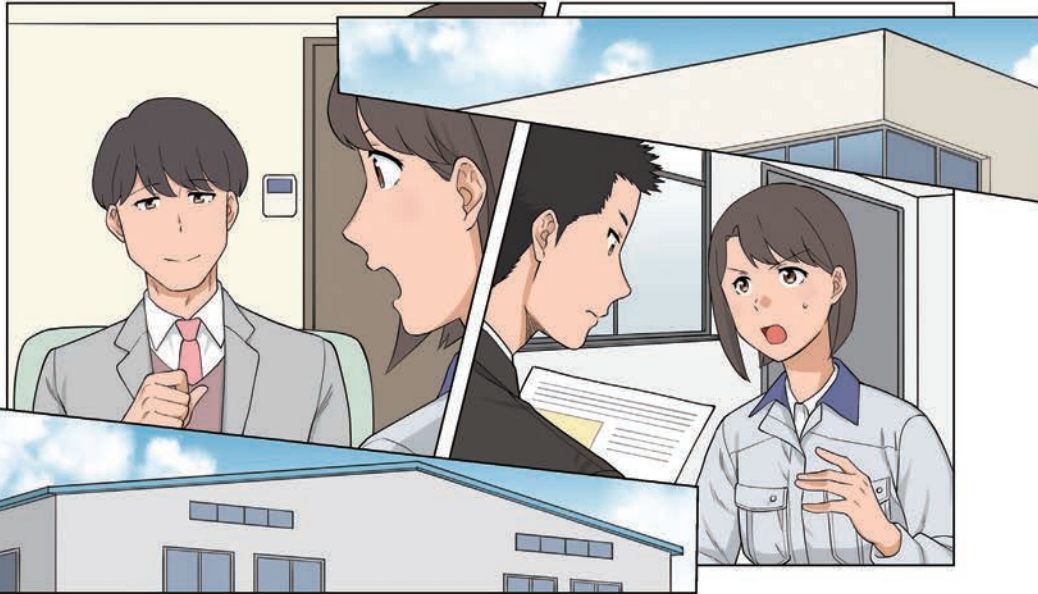
and the interlayer joints separated, making it impossible to conduct heat away.

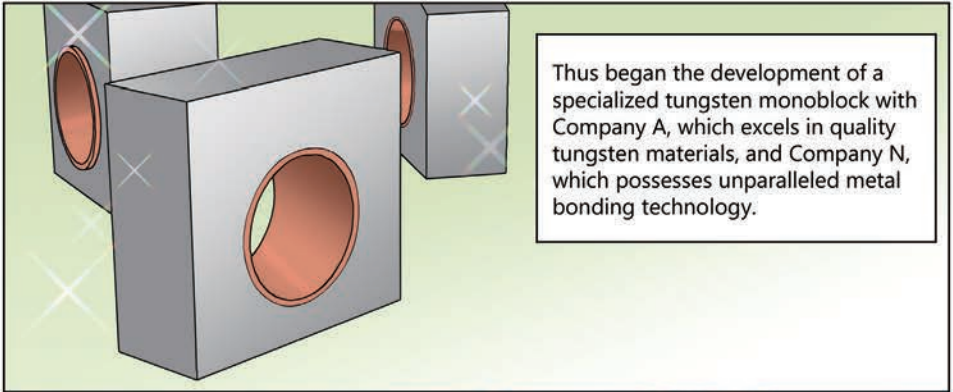
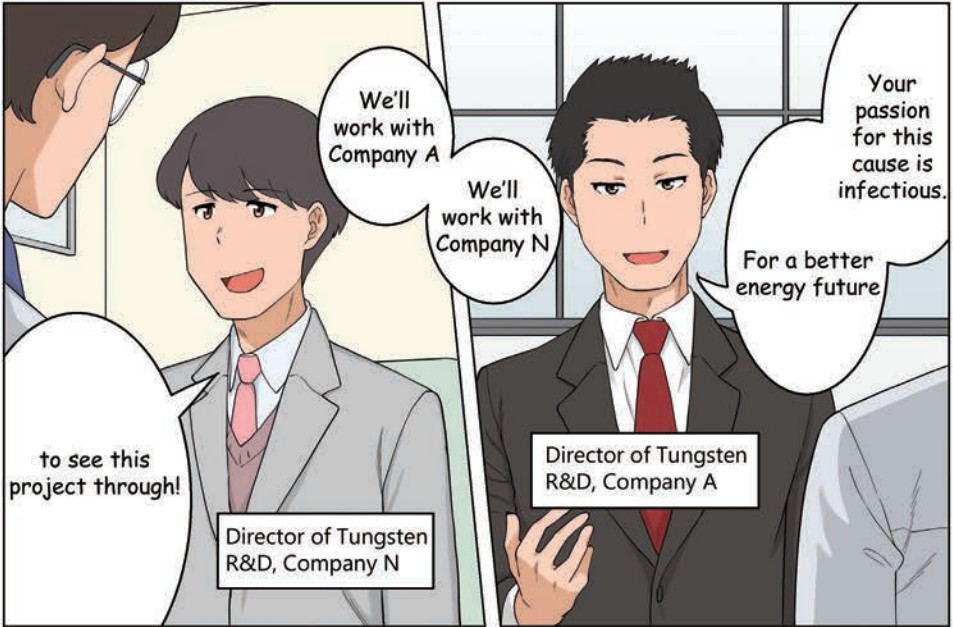




I'll get in touch with both companies right away.

All right let's do this.

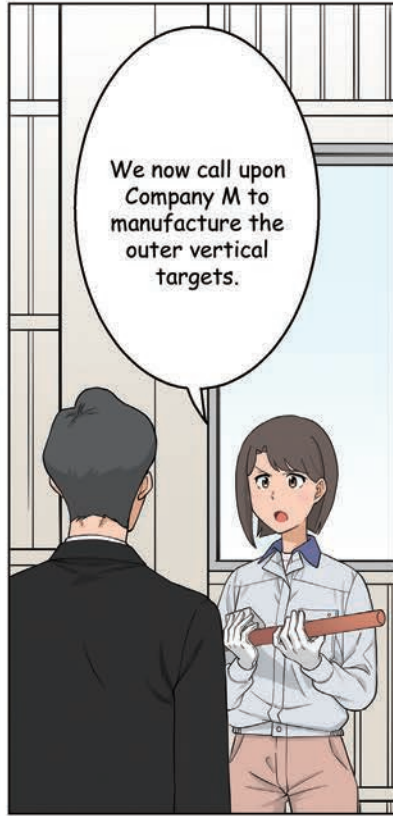




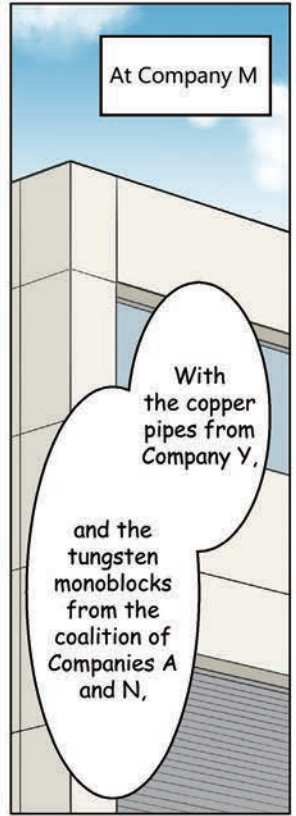


We've got this.

As part of Team Japan, let's make something great together.



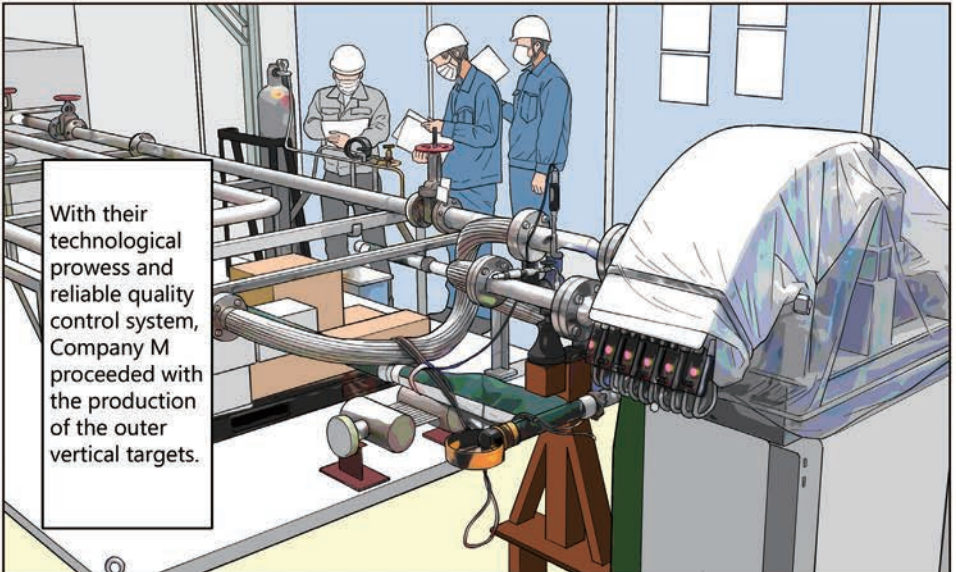
We now call upon Company M to manufacture the outer vertical targets.



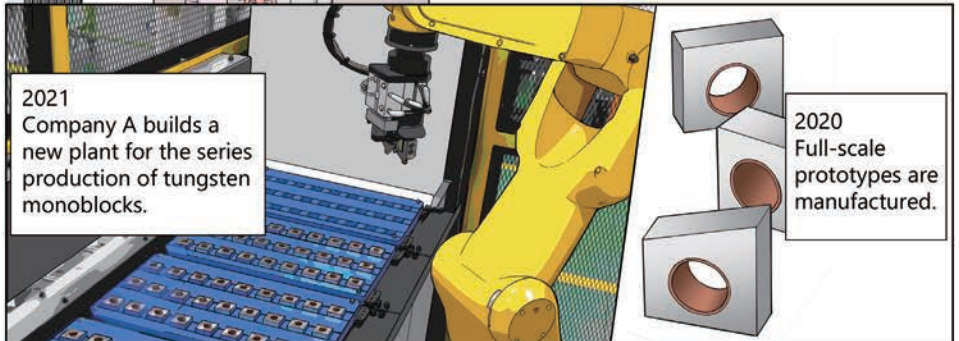
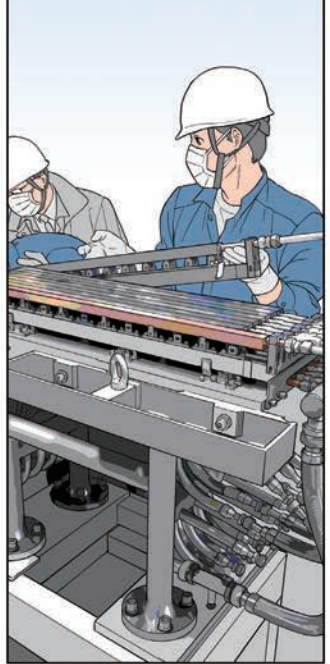
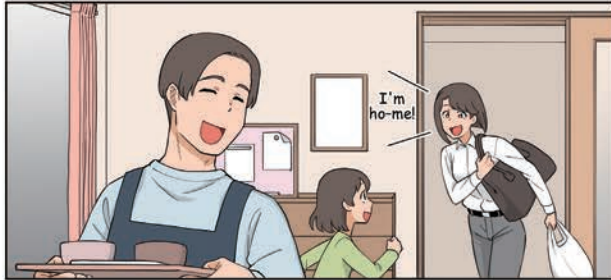
At Company M

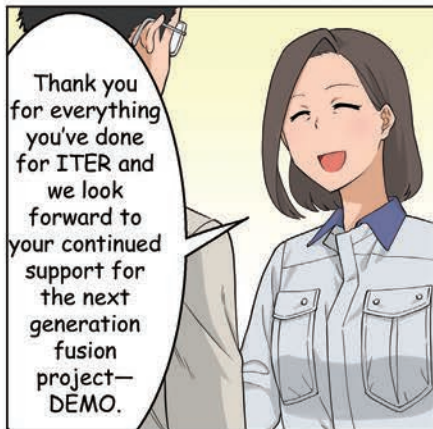
With the copper pipes from Company Y,

and the tungsten monoblocks from the coalition of Companies A and N,

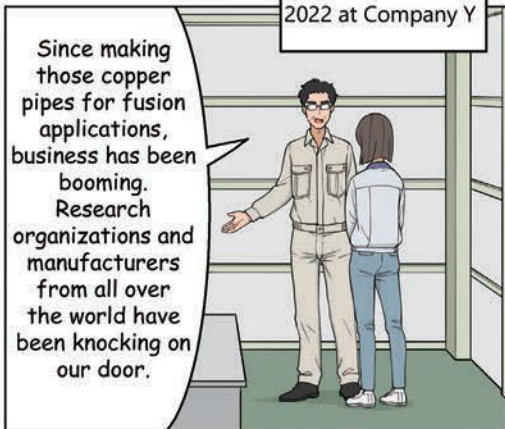


With their technological prowess and reliable quality control system, Company M proceeded with the production of the outer vertical targets.



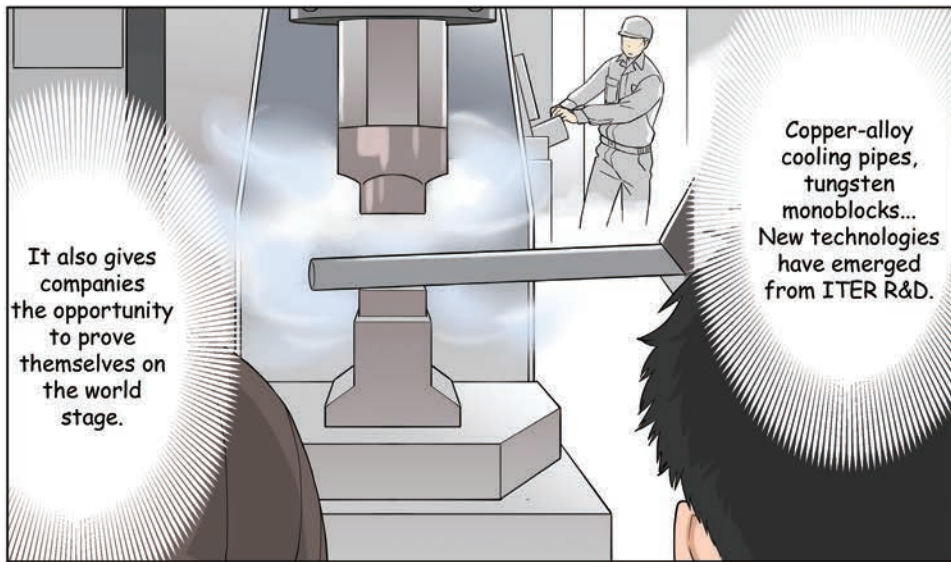


Thank you for everything you've done for ITER and we look forward to your continued support for the next generation fusion project—DEMO.



2022 at Company Y

Since making those copper pipes for fusion applications, business has been booming. Research organizations and manufacturers from all over the world have been knocking on our door.



It also gives companies the opportunity to prove themselves on the world stage.

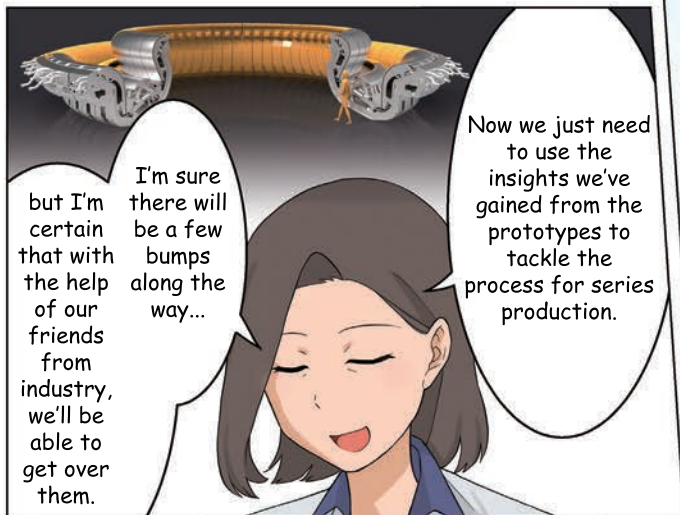
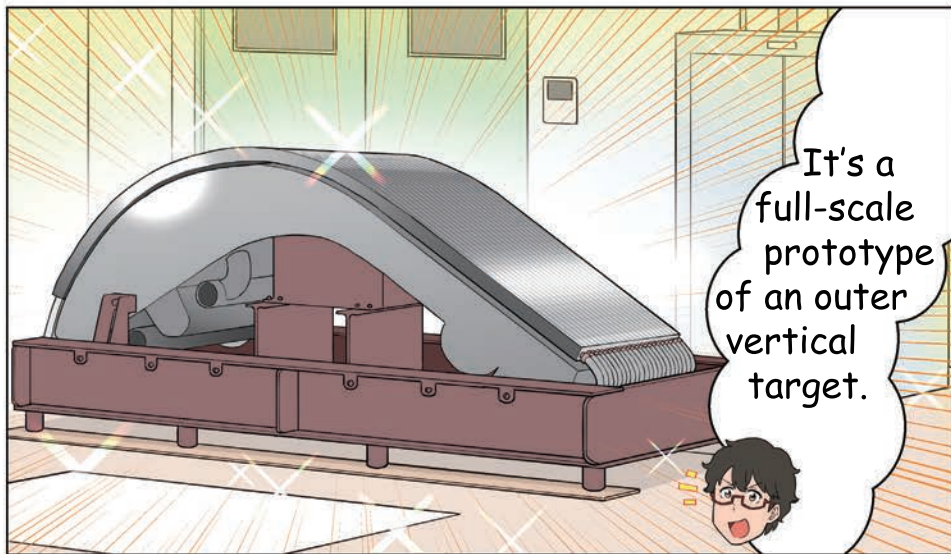
Copper-alloy cooling pipes, tungsten monoblocks... New technologies have emerged from ITER R&D.



Whoa...

And now in 2023 (present time)







ITER is the most complex science project in human history.

Even in the face of adversity, so many companies have stood by our side and risen up to the challenge.

Behind every step of "the way" is the spirit of monozukuri, with people whose dedication is unrivaled and technologies that are truly one of a kind.

何より夢があるじゃないか

未来の子供たちのために新しいエネルギーを実現させるんだ

未来のエネルギー実現のために

A社と

N社と

A社  
タングステン開発部

これで外側垂直タービンの製作をお願いします

まかせてください

To be continued

This story is fiction based on real events.

# ITER component procured from Japan: Divertor (certain parts)



Members of the Plasma Facing Component Technology Group with an outer vertical target prototype

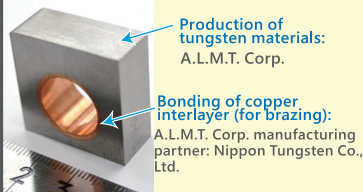
QST has been developing full-scale prototypes and the process for the series production of the outer vertical targets for ITER's divertor. In April 2023, the manufacture of a full-scale prototype, which began in June 2020 with Mitsubishi Heavy Industries, Ltd., was completed and delivered for final acceptance testing at QST's Naka Fusion Institute. (right: high-temperature helium leak tests)



Please visit our ITER Japan News website for more information.  
**"ITER Divertor Outer Vertical Target (OVT) Prototype in Final Acceptance Tests"**



## Tungsten monoblocks

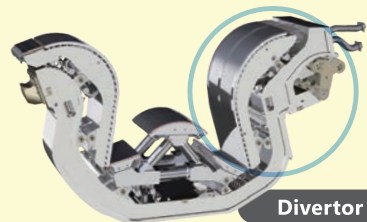


## Copper pipes

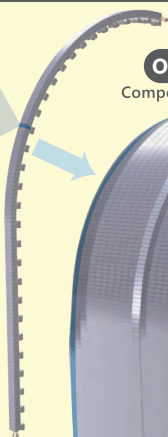
ITER-grade, chrome-zirconium-copper alloy cooling pipes

**Copper pipe manufacturing:**  
Yamato Gokin Co., Ltd./  
Miyoshigokinkogyo Co., Ltd.

**Brazing:**  
Mitsubishi Heavy Industries, Ltd. manufacturing partners:  
Osaka Yakin Kogyo Co., Ltd. & Metal Technology Co., Ltd.  
Hitachi Ltd. manufacturing partner: Metal Technology Co., Ltd.

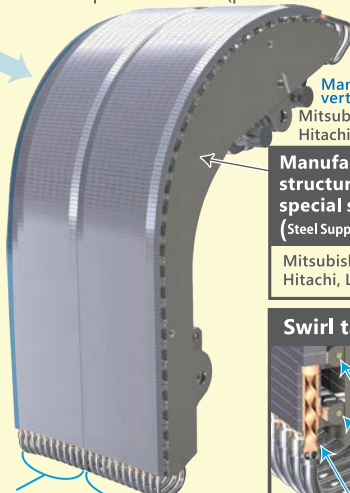


## Plasma-Facing Unit, PFU



## Outer Vertical Target, OVT

Composed of 22 PFUs (per divertor cassette)



Left OVT, 11 PFUs

Right OVT, 11 PFUs

Design and manufacture of ITER components procured from Japan  
**"Introduction of partner companies"**



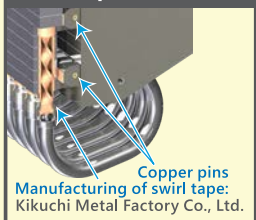
## Manufacturing of outer vertical targets:

Mitsubishi Heavy Industries, Ltd.  
Hitachi, Ltd.

**Manufacture of box-shaped structural supports made of special stainless steel, XM-19 (Steel Support Structure, SSS)**

Mitsubishi Heavy Industries, Ltd.  
Hitachi, Ltd.

## Swirl tape





# A small Sun on Earth

## ITER ~ Vol.6 ~

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Design : **Tarrows**

Translation : Nathaniel Duncan

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ITER Japan Domestic Agency

<https://www.fusion.qst.go.jp/ITER/>

A small Sun on Earth  
ITER Comic  
QR code

